Texas Water Development Board

FINAL
REGION 4 SABINE
2023 REGIONAL FLOOD PLAN

JANUARY 2023

VOLUME 1

PREPARED FOR THE

REGION 4 SABINE REGIONAL FLOOD PLANNING GROUP

2023 FINAL PREPARED REGIONAL FLOOD PLAN

VOLUME 1 OF 2

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EXECUTIVE SUMMARY

In 2019, the 86th Texas Legislature passed Senate Bill 8 that authorized and established the regional and state flood planning processes. The legislature assigned the responsibility of the regional and state flood planning process to the Texas Water Development Board (TWDB). This report presents the Draft Region 4 Sabine Regional Flood Plan (RFP), which represents the first-ever regionwide floodplain for the Sabine Region. Region 4 is one (1) of 15 Regional Flood Planning Groups across the State of Texas tasked with developing a regional flood plan. The plan consists of ten tasks which are summarized below.

Given the diverse drainage basins of the state, the planning effort is being carried out at a regional level in each of the State's fifteen (15) major river basins. The Sabine Regional Flood Planning Area (Region 4), located in east Texas, is one of these regions for which a plan was developed. A summary of major project deliverable milestone dates is presented in **Table ES-1**.

The Texas Water Development Board (TWDB) will compile these regional plans into a single statewide flood plan and will present it to the State Legislature in 2024. A new or updated version of the RFP is expected to occur every five years thereafter similar to the TWDB's State Water Plan. In this first planning cycle, the TWDB allocated additional funding to each of the 15 regions to perform additional tasks related to additional data collection, public outreach, and performing studies to generate more projects. These tasks were outside of the original scope of the draft and final Flood Plans due in August 2022 and January 2023, respectively; thus, they will be part of the Amended Regional Flood Plans which are due in July 2023.

TABLE ES-1: REGIONAL FLOOD PLAN DEADLINES

Plan Deliverable	Deadline
Draft Regional Flood Plan	August 1, 2022
Final Regional Flood Plan	January 10, 2023
Amended Regional Flood Plan	July 14, 2023
State Flood Plan	September 1, 2024

The TWDB has appointed a Regional Flood Planning Group (RFPG) for each region. The Region 4 RFPG was established by the TWDB on October 1, 2020, to manage the flood planning efforts for the Sabine Flood Planning Region. The TWDB administers the regional planning process through a contract with the planning group's sponsor, who is selected by the RFPG. The Region 4 sponsor is the Sabine River Authority of Texas (SRATX). The Legislature also allocated funding to be distributed by the TWDB for the procurement of technical assistance to develop the RFPs. Freese and Nichols (FNI) was selected by the RFPG as the technical consultant in the RFPG's April 2021 meeting to prepare the plan for the Sabine Flood Planning Region.

The RFPG's responsibilities include directing the work of their 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 promote input from diverse perspectives, voting members represent a wide variety of stakeholders potentially impacted by flooding as presented in **Table ES-2**.

TABLE ES-2: SABINE RFPG VOTING MEMBERS

RFPG Voting Members	Interest Group
James (Bill) Bruce	Agriculture Interests
Johnny Trahan	Counties
Francis X. Shannon	Electric Generating Utilities
Clyde V. McKee III	Environmental Interests
Don Carona	Flood Districts
Nikki Davis	Industries
Alton Bradley	Municipalities
Michelle Falgout	Public
Travis Williams	River Authorities
Jeff Rogers	Small Business
Roman D. Griffin	Water Districts
Ross Gordon	Water Utilities
William (Bill) Hughes*	River Authorities

Mr. William (Bill) Hughes, a long-time employee of the Sabine River Authority of Texas (SRATX) was the initial representative for River Authorities interest group and served as the initial chair for the Sabine RFPG until his passing on April 6, 2021 and is recognized for his efforts early in the process for this Regional Flood Plan effort and submittal. Non-voting members serving other interest groups were also included in the planning process and regular RFPG meetings. Those members are shown in **Table ES-3**. Additionally, to satisfy TAC §361.11(f)(9) for a coastal liaison, Orange County Drainage District served as a liaison between the Sabine (Region 4) and the Neches (Region 5) groups. Don Carona (Sabine voting member) or Doug Manning (an employee with the OCDD) provided updates during each meeting.

TABLE ES-3: SABINE RFPG NON-VOTING MEMBERS

Sabine RFPG Non-Voting Members	Interest Group
Colleen Jones	General Land Office
Kathy Sauceda	Texas Commission on Environmental Quality
Manuel Martinez	Texas Department of Agriculture
Andrea Sanders	Texas Division of Emergency Management
Robert (Bob) Baker	Texas Parks and Wildlife
Trey Watson	Texas State Soil and Water Conservation Board
Ryke Moore	Texas Water Development Board

Chapters Included in the Regional Flood Plan

The TWDB created the scope of work for all groups, and their technical consultants to follow for consistency across the entire state in the 15 flood planning regions. These guidelines are noted as Exhibit C, Technical Guidelines for Regional Flood Planning and each task follows an item in the Texas Administrative Code (TAC) for specific tasks or analyses to perform. Within those guidelines, the following chapters were outlined for the group to perform which coincide with the same numbering system to match the TWDB guidance.

- Chapter 1: Planning Area Description (Task 1)
- Chapter 2: Flood Risk Analyses
    - Existing Condition Flood Risk Analyses (Task 2A)
    - Future Condition Flood Risk Analyses (Task 2B)
- Chapter 3: Floodplain Management Practices and Flood Protection Goals
    - Evaluation and Recommendations on Floodplain Management Practices (Task 3A)
    - Flood Mitigation and Floodplain Management Goals (Task 3B)
- Chapter 4: Assessment and Identification of Flood Mitigation Needs
    - Flood Mitigation Needs Analysis (Task 4A)
    - Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects (Task 4B)
    - Prepare and Submit Technical Memorandum (Task 4C)
- Chapter 5: Recommendation of Flood Management Evaluations, Flood Management Strategies and Associated Flood Mitigation Projects (Task 5)
- Chapter 6:
    - Impacts of Regional Flood Plan (Task 6A)
    - Contributions to and Impacts on Water Supply Development and the State Water Plan (Task 6B)
- Chapter 7: Flood Response Information and Activities (Task 7)
- Chapter 8: Legislative, Administrative, and Regulatory Recommendations (Task 8)
- Chapter 9: Flood Infrastructure Financing Analysis (Task 9)
- Chapter 10: Public Participation and Plan Adoption (Task 10)

The guiding principles for Regional Flood Planning, as outlined in Exhibit C Technical Guidelines for Regional Flood Planning, Section 3.1 are outlined in Chapter 10 on **Table 10-1** noting where each item can be found within this Regional Flood Plan.

Region Overview

The Sabine Regional Flood Planning Area (Region 4) **(Figure ES-1)** encompasses the Texas portion of the Sabine River watershed as the river demarcates the border between Texas and Louisiana. The Sabine River begins in North Texas and flows southeast through Northeast Texas toward the Gulf of Mexico. The river and its tributaries within Texas make up approximately 6,455 stream miles based on data from the TWDB.

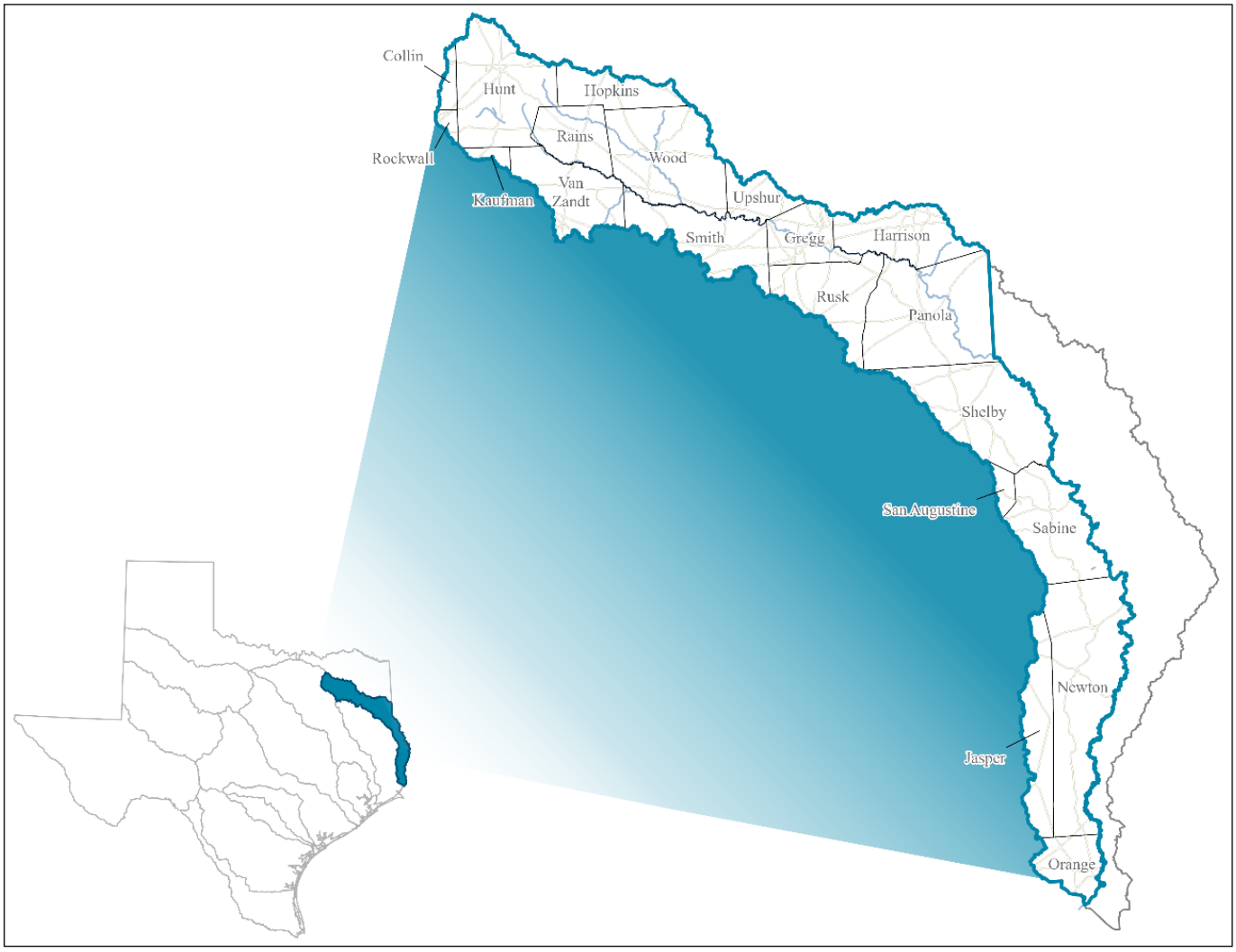

FIGURE ES-1: SABINE (REGION 4) FLOOD PLANNING REGION

Region 4 encompasses over 7,450 square miles within the state of Texas, 2,306 square miles of drainage area in Louisiana for a total of approximately 9,756 square miles. According to the U.S. Census Bureau, data shows it is one of the state's least populated flood planning areas, with an estimated 616,000 people in 2021 which is approximately about 2% of Texas residents living in the area. However, the region is also characterized by very large volume of water. The region is comprised of 21 counties or portions of counties, containing 71 incorporated municipalities. The Sabine Region is a large, geographically diverse region where the needs of rural stakeholders must be balanced with those of the

urban population centers. The flood risks faced by communities and landowners also vary in coastal and non-coastal communities.

The Texas Water Development Board (TWDB) has information posted regarding the total amount of water volume that each stream experiences on an annual basis as presented in **Table ES-4** below. At first glance, it is noticeable that the Sabine River basin, highlighted in blue, experiences a large amount of flow compared to the other basins. Other river basins such as the Brazos River, Trinity River, and Neches River also have a fairly substantial amount of volume. However, when comparing the volume of water to the size of the watershed (volume per area) the Sabine far surpasses other regions highlighting the substantial amount of water volume that passes through it.

TABLE ES-4: WATER VOLUME IN TEXAS' MAJOR RIVER BASINS BY AREA

River Basin	Total Basin Area (square miles)	Average Flow Volume (ac-ft per year)	Volume per Area (ac-ft per yr. per sq. mi)	Volume per Area Rank
Brazos	45,573	6,074,000	133.3	9
Canadian	47,705	196,000	4.1	14
Colorado	42,318	1,904,000	45.0	11
Cypress	3,552	493,700	139.0	7
Guadalupe	5,953	1,422,000	238.9	6
Lavaca	2,309	277,000	120.0	10
Neches	**9,937**	**4,323,000**	**435.0**	**2**
Nueces	16,700	539,700	32.3	13
Red	93,450	3,464,000	37.1	12
Rio Grande	182,215	645,500	3.5	15
Sabine	**9,756**	**5,864,000**	**601.1**	**1**
San Antonio	4,180	562,700	134.6	8
San Jacinto	3,936	1,365,000	346.8	3
Sulphur	3,767	932,700	247.6	5
Trinity	17,913	5,727,000	319.7	4

When plotted graphically (**Figure ES-2**), it is clear to see that the Sabine (highlighted in gold) experiences a lot of water along its stream. A big reason for this is the heavy and intense rainfall the southern end of the watershed experiences on an annual basis. The lower Sabine region has some of the highest average annual rainfall numbers not only in the state of Texas, but in the continental United States. Furthermore, watershed narrows and funnels south towards and adjacent to Orange, TX before it discharges into Sabine Lake and ultimately into the Gulf of Mexico.

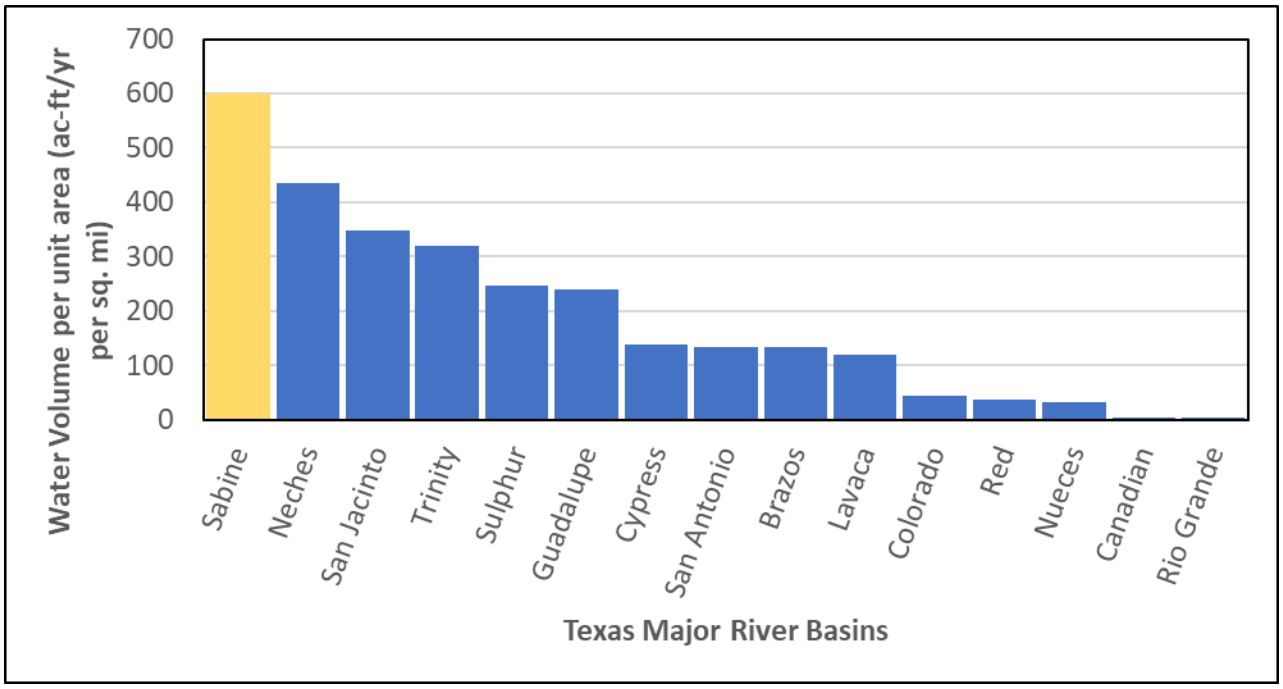

FIGURE ES-2: WATER VOLUME PER UNIT AREA

When comparing the amount of water volume on a per capita basis using the total population in a region, the number is even more staggering as no other region comes close to the amount of water per person the Sabine region experiences.

TABLE ES-5: WATER VOLUME IN TEXAS' MAJOR RIVER BASINS BY POPULATION

Planning Region	Population (from TWDB)	Avg. Flow Volume (ac-ft per yr.)	Vol. per Population (ac-ft per yr. per person)	Volume per Area Rank
1 & 2 – Red, Sulphur, Cypress	1,119,380	4,890,400	4.4	3
3 – Trinity	7,853,969	5,727,000	0.7	7
4 – Sabine	**585,732**	**5,864,000**	**10.0**	**1**
5 – Neches	918,370	4,323,000	4.7	2
6 – San Jacinto	6,297,609	1,365,000	0.2	11
7 & 8 – Brazos	3,371,443	6,074,000	1.8	5
9 & 10 – Colorado	2,507,574	1,904,000	0.8	6
11 – Guadelupe	621,166	1,422,000	2.3	4
12 – San Antonio	2,225,430	562,700	0.3	9
13 – Nueces	782,528	539,700	0.7	8
14 & 15 – Rio Grande	2,713,290	645,500	0.2	10

In addition, this region – as well as other regions along the upper Texas coast – has experienced major floods in the last decade alone. Hurricane Harvey, a tropical cyclone which produced the highest amount of rainfall in US history on multiple levels of analysis, devastated the general area in August 2017. According to the National Oceanic and Atmospheric Administration's (NOAA) Weather Prediction Center (WPC), the area around Beaumont (Neches, Region 5) and Orange (Sabine, Region 4) actually received some of the highest rainfall totals from the entire event and harshly impacted the area. Furthermore, when evaluating the wettest tropical systems in the US, 4 of the top 6 occurred in the upper Texas coast. This highlights the large amount of rainfall the area experiences, especially from tropical systems, and in turn, the large amount of need required for mitigating floods.

In addition, oil and gas production is an integral component of Texas industry, and the Sabine Basin is no exception. The upper portions of the planning area known as the East Texas Oil Field possess the highest percentage of oil production for Region 4, primarily in Gregg, western Rusk, southern Upshur, and southeastern Smith Counties. In the central portion of the basin, gas wells associated with the Texas-Louisiana Salt Basin are more common. In the southern portion of the region, there are concentrations of pipeline networks connecting national trunk systems to refineries on the Gulf Coast, along with associated chemical manufacturing industries. Major rainfall events and tropical systems can greatly impact these industries which have far greater effects than the Sabine region alone. Some of these petrochemical industries have an effect on the national level; therefore, protection of these systems and the necessary funding to do so is vital.

Key Findings

Flood Risk, Exposure, and Vulnerability

Relative to the rest of the nation, the Sabine region is subject to intense rainfall and multiple flooding types. Primary among these is riverine flooding, with storm surge as an additional significant risk. There are dangers of swift-moving flood waters in riverine areas, especially in the upper portion of the basin where there is more terrain relief and slope. The southern portion of the basin can be susceptible to storm surge and coastal flooding in addition to potential flooding from very heavy rainfall as outlined in the above section. Urban flooding is likely also a source of significant flooding exposure, particularly in larger cities. An analysis was performed to determine three components: risk, exposure, and vulnerability.

An evaluation of flood risk in the region was performed for the 1% annual chance and 0.2% annual chance events, per TWDB requirements. This included evaluating currently mapped FEMA floodplains as well as other sources of flood information. The analysis was performed for existing conditions of the basin, as well as a future condition scenario that considers changes in flood hazards over the 30-year planning horizon considering current floodplain management criteria. It is noted that the analysis primarily evaluated riverine flooding; thus, there is still residual risk which has not yet been identified as part of this plan.

The analysis concluded that the majority of the currently identified flood risk in Region 4 is either based on out-of-date studies and/or low-detail floodplain maps that are not based on a technical or

engineering study. As a result, most of the flood risk across the region is not well quantified, meaning that people, property, and infrastructure items in the region may be unknowingly in harm's way.

The many infrastructure items identified in Task 1 (Chapter 1) were evaluated against the existing flood risk to determine the number of items deemed to be exposed to flood risk. The analysis determined that of the 375,000 structures which were identified by TWDB to be within the Sabine basin, 9% of them are within the existing 1% annual chance floodplain with 23,000 residential structures at risk. In addition to the number of structures, a total of 470 critical facilities were identified in areas of flood risk.

An additional analysis was also performed to quantify the potential risk that may happen in the future. This included evaluating current drainage and floodplain management criteria to assess what flooding conditions might be in 30-years as well as evaluating the amount and location for population growth. Factors which were included in the future conditions included: population growth, sea level change, and rainfall increases (Atlas 14). A summary of the results of the analysis are shown below.

TABLE ES-6: FUTURE CONDITIONS EXPOSURE INCREASES

Exposure Feature Type	Existing Conditions 1% ACE	Future Conditions 1% ACE	Increase	Existing Conditions 0.2% ACE	Future Conditions 0.2% ACE	Increase
Structures (#)	34,592	79,674	+45,082 (+130%)	48,703	99,250	+50,547 (+104%)
Residential Structures (#)	24,066	65,689	+41,623 (+173%)	34,839	80,739	+45,900 (+132%)
Population (#)	65,006	159,110	+94,104 (+145%)	90,557	198,225	+107,668 (+119%)
Critical Facilities (#)	401	472	+71 (+18%)	470	526	+56 (+12%)
Roadway Segments (mi.)	1,518	1,897	+379 (+25%)	1,897	2,752	+855 (+45%)
Roadway Stream Crossings (#)	4,983	5,486	+503 (+10%)	5,486	7,863	+2,377 (+43%)
Agricultural Areas (sq. mi.)	325	358	+33 (+10%)	358	430	+72 (+20%)

As can be seen in the above table, there is a significant risk to structures and population that already exists, and the future conditions analysis estimates additional risk could occur. Therefore, it is critical to construct flood mitigation projects, better identify flood risk identification, and improve communication strategies to the public to help avoid these risks and provide a more resilient future against flood losses.

Floodplain Management Practices and Flood Protection Goals

In Texas, enforcement of floodplain management regulations is the responsibility of local governments; thus, the Sabine RFPG does not have the authority to enact or enforce floodplain management, land use, or other infrastructure design standards. However, the Sabine RFPG encourages cities and counties without floodplain regulations to adopt standards that at least meet the NFIP minimum requirements and consider adopting higher standards to provide higher levels of protection against loss of life and

property due to flooding. Floodplain management regulatory practices could be more beneficial by being more clear, easily interpretable, broadly understood, and consistently enforced. Doing so would provide forward guidance on new development expectations.

Entities were grouped into 1 of 4 categories based on their existing floodplain management practices. These category divisions were set by TWDB in the guidelines. Per TWDB, entities which only meet minimum National Flood Insurance Program (NFIP) standards are considered to have "low" floodplain management practices. All of the counties within the Sabine basin were determined to be a part of the NFIP, but not all municipalities participate. From the review, 12 communities (14%) do not participate in the NFIP and all 12 of those entities are generally smaller communities with lower population and are located in the northern part of the Sabine basin.

Entities which meet NFIP standards and have additional higher or more restrictive floodplain management standards are considered "moderate" in their enforcement. Entities considered to have "strong" standards are those which meet and exceed NFIP standards and are also active in the Community Rating System (CRS) which is a system through the NFIP giving additional credits and reduced insurance premiums in areas for additional floodplain management practices.

Since there are no communities in the Sabine River basin that participate in the CRS program, none were identified as having strong floodplain management practices. A key takeaway from this is the need to move more communities to moderate or strong categories. In order to do this, many of these communities need additional support and/or funding from a federal or state level to help them achieve a better level of floodplain management. This could be in the form of assistance and support to participate in the CRS system and implement new programs in areas to improve their CRS rating over time. An additional item would be the funding necessary to update building codes or local criteria manuals to require freeboard above BFEs. Increasing the level of floodplain management will help to create a more resilient Sabine basin in the future.

TABLE ES-7: FLOODPLAIN MANAGEMENT REGULATIONS SUMMARY

Category	Number of entities
Unknown	22
Low	23
Moderate	45
Strong	0

The Sabine RFPG also discussed goals as part of the Regional Flood Plan. Additional goals the group considered important for a more resilient watershed are outlined in **Table ES-8**.

TABLE ES-8: FLOODPLAIN MANAGEMENT RECOMMENDED STANDARDS

Recommended Standards	Category
RFPG recommends all roadways be designed such that the 5-year HGL is below the top of curb and the 100-year HGL is no more than 1 foot above the top of curb and the 100YR inundation extent is contained within the right-of-way.	**Roadways**
RFPG recommends all roadways designed without curb and gutter be designed such that the 100YR inundation extent is contained within the right-of-way and at least one navigable lane is maintained.	
RFPG recommends all roadways designated as evacuation routes are designed such that the 100YR inundation extent is contained within the right-of-way and at least one navigable lane is maintained in each direction.	
RFPG recommends all communities have Culvert and Bridge Hydrologic & Hydraulic Analysis Requirements	**Culvert and Bridge Crossings**
RFPG recommends all culverts demonstrate no adverse impact for 100YR storm event.	
RFPG recommends all communities adopt the TxDOT Hydraulic Design Manual most current version; EXCEPT where stricter local standards apply.	
RFPG recommends that all communities require compensatory storage for all fill in the regulatory 100-year floodplain.	**Detention**
RFPG recommends all communities detain proposed condition peak discharge for the 25-year and 100-year event below or equal to the existing condition peak discharge	
RFPG recommends that communities require all new development in Zone A or unmapped areas to provide a hydrologic and hydraulic study and demonstrate no adverse impacts downstream.	
RFPG recommends all habitable structures in coastal communities are designed such that finished floor elevations are 2 feet, or more, above the BFE including the combined riverine and coastal effects, EXCEPT where stricter local standards apply.	**Habitable Structure**
RFPG recommends all habitable structures in non-coastal communities are designed such that finished floor elevations are 2 feet above the riverine 100-year WSE, EXCEPT where stricter local standards apply.	
RFPG recommends all critical facilities in coastal communities are designed such that finished floor elevations are 2 foot above the highest elevation of either the riverine 500-year or coastal 100-year WSE including the combined riverine and coastal effects	**Critical Facilities**

Recommended Standards	Category
RFPG recommends all critical facilities in non-coastal communities are designed such that finished floor elevations are 2 foot above the riverine 100-year WSE.	
RFPG recommends that communities require all dams be designed to TCEQ standards.	**Dams**
RFPG recommends that communities require all earthen embankments and floodwalls compliant with FEMA 44 CFR 65.10	**Levees**
RFPG recommends that all new construction consider nature-based and sustainable solutions.	**Nature Based Solutions**

One of the key recommendations is freeboard, which is an additional vertical distance from the 100-year (1% annual chance) base flood elevation (BFE) to a structure or facility's finished flood elevation (FFE). NFIP requires structures to be at or above the BFE; however, additional freeboard above that elevation is an additional measure which can lessen the risk to properties. Hence, it was included as a recommended standard under the habitable structures and "critical facilities categories. It was found that 45 of the 93 entities in the basin have additional freeboard requirements in place ranging from 1 foot to 2 feet above the BFE. Another important item in floodplain management is "no adverse impact" which requires proposed construction to prove that it does not negatively affect areas upstream and downstream of the project to not create or add to existing flood risk that an area currently experiences. This item is located in both the culvert/bridge crossing and detention categories.

The Sabine RFPG discussed potential goals for the regional flood plan over a series of monthly meetings from October to December 2021. Some goals have both a short- (within the next 10 years) and long-term (within the next 30 years) goal while others only have a short-term goal. The approved goals are listed in **Table ES-9**.

TABLE ES-9: FLOODPLAIN MANAGEMENT RECOMMENDED STANDARDS

Short Term Goals (10 year)	Long Term Goals (30 year)
Improve 20% of Low Water Crossings to no longer be classified as Low Water Crossing.	Improve 40% of Low Water Crossings to no longer be classified as Low Water Crossing.
Improve flood protection for 15% of critical facilities in flood prone areas.	Improve flood protection for 25% of critical facilities in flood prone areas.
Reduce exposure of existing structures in flood prone areas by elevating, acquiring, relocating, or otherwise providing flood protection to 10% of structures.	Reduce exposure of existing structures flood prone areas by elevating, acquiring, relocating, or otherwise providing flood protection to 20% of structures.
Advance multiple regional flood infrastructure projects designed for larger storm events.	Promote, facilitate, and construct regional infrastructure projects designed for the 100-year and larger storm events.
100% of counties to perform public education and awareness campaigns to	Maintain 100% participation of counties that perform public education and awareness

Short Term Goals (10 year)	Long Term Goals (30 year)
better inform the public of flood-related risks on an annual basis.	campaigns to better inform the public of flood-related risks on an annual basis.
Increase number of monitoring gages and associated real time reporting technology installed and maintained in the region to 1 in 50% of HUC-10s.	Increase number of monitoring gages and associated real time reporting technology installed and maintained in the region to 1 in 50% of HUC-12s.
Increase number of communities with documented, operational, and funded stormwater asset management plan and maintenance operations to 50%.	Increase the coverage of regulatory flood hazard mapping to at least 50% of the region.
Increase regulatory flood hazard mapping in at least 50% of the areas identified as having out of date flood mapping.	
Advance multiple flood protection planning studies and preliminary engineering efforts in flood prone areas including the Sabine Pass to Galveston CSRM.	
Install warning signage at 100% of identified low water crossings in the floodplain and coordinate with TxDOT where applicable.	
Increase number of communities with a comprehensive drainage policy and criteria manuals to reduce flood hazard and increase education to include 75% of the region's population.	
Increase the number of communities that utilize the latest and most most current precipitation data as a basis for design criteria to cover at least 75% of the region's population.	

Assessment and Identification of Flood Mitigation Needs

The RFPG conducted a flood mitigation needs analysis based on information generated in the first 3 chapters of this plan. The goal of the analysis is to guide the effort in determining the flood mitigation needs across the Sabine River basin and identify specific locations where there is a large need for flood mitigation to reduce the overall risk and be in line with the RFP's overarching goal of reducing the loss of life and property. The factors in this analysis (listed below) were items noted in Chapter 1 which identified different elements within the basin, Chapter 2 which identified existing and future flood risk, and Chapter 3 which outlined the goals the Sabine RFPG wanted to use in accomplishing reduced flood risk.

- Flood risk exposure to buildings
- Critical Infrastructure
- National Flood Insurance Program Participation
- Lack of Hydrologic and Hydraulic Models
- Existing Flood Risk Mitigation Plans
- Historic Flooding Reports
- Low Water Crossings
- Agricultural Areas
- Gaps in Flood Hazard Mapping
- Emergency Need
- Ongoing or Proposed Flood Mitigation Projects
- Social Vulnerability Index (SVI)

This was a geospatial analysis performed across all 196 of the HUC-12 watersheds in the Sabine basin as shown in **Figure ES-3** below. HUC-12s shown in red and orange indicate a large need for flood mitigation. Areas in blue represent a lower need. Areas identified as “low” does not mean that an area has a low risk of flooding, it simply means that area has a lower or less urgent flood mitigation need than an area which has “high need”.

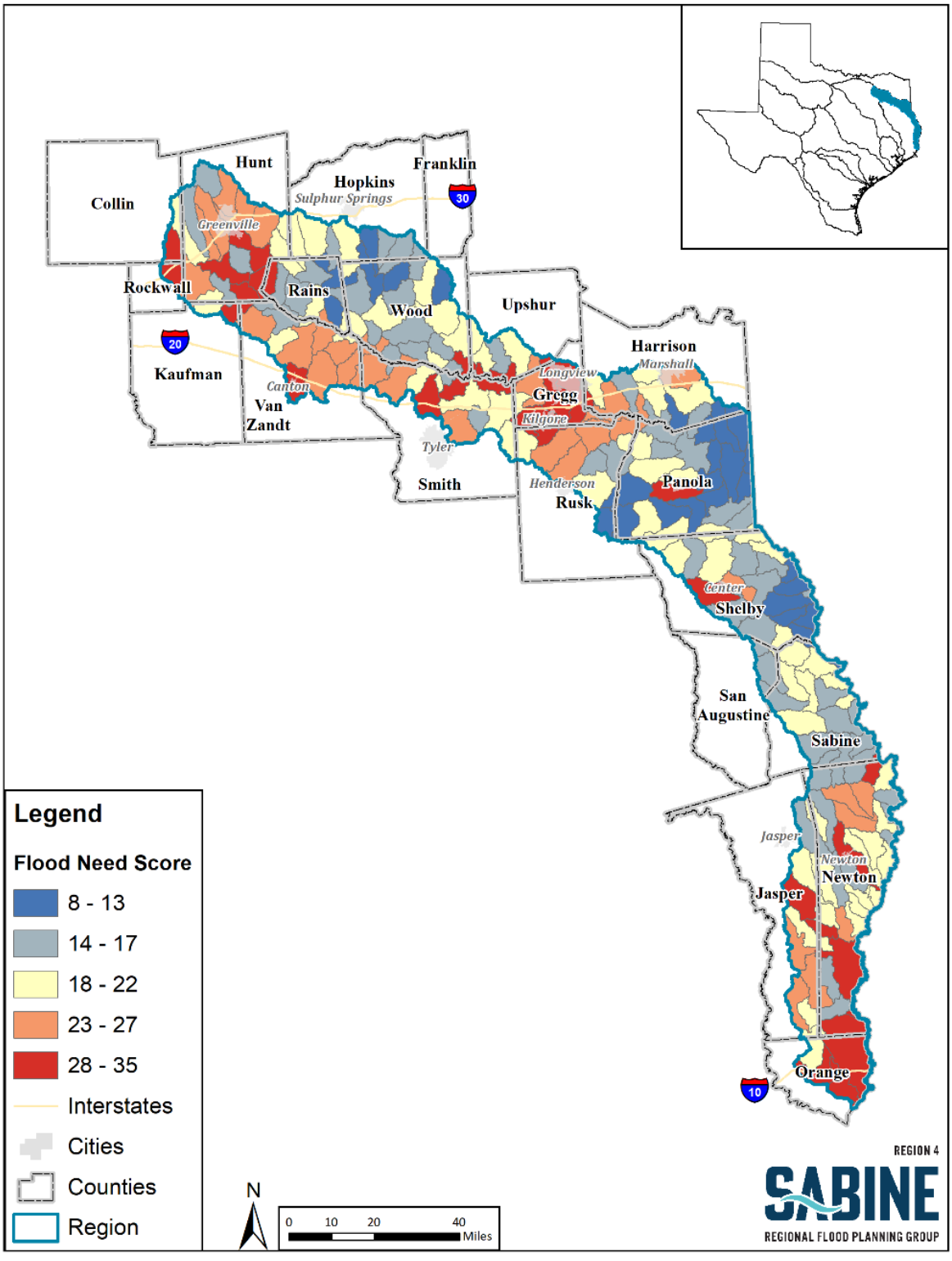

FIGURE ES-3: FLOOD MITIGATION NEED BY WATERSHED

The different factors were discussed with the RFPG over the course of several RFPG meetings and the analysis resulted in a wide array of mitigation needs across the basin. Areas in the lower portion (Orange

and Newton Counties) showed a large need for flood mitigation while scattered areas in the upper basin also showed a large need for mitigation.

Based on the results of the flood mitigation needs analysis, several sources of data were used to develop a list of potential flood risk reduction actions that may address the basin's needs. These actions are called Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs), colloquially known as FMXs. Potential actions included the identification of detention basins, flood protection studies, drainage master plans, floodplain mapping, flood risk communication, and others.

Evaluation and Recommendation of Flood Management Evaluations, Flood Management Strategies, and Associated Flood Mitigation Projects

As part of Task 5, Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) were further evaluated in order to compile the necessary technical data for the RFPG to decide whether or not to recommend these actions or a subset of these actions.

FMEs were recommended to clearly identify what additional studies, and funds to support them, are needed to adequately evaluate all flood prone areas within a region. FMEs are studies that are required to identify and determine what FMPs can be recommended. FMSs and FMPs were recommended be based upon the identification, analysis, and comparison of alternatives that the RFPG determined to provide measurable reductions in flood impacts in support of the RFPG's specific flood mitigation and floodplain management goals. In total, 63 FMEs were recommended in the Sabine basin.

TABLE ES-10: RECOMMENDED FME BY EVALUATION TYPE

FME Type	Description	Count	Estimated Cost
Watershed Planning	Floodplain mapping update includes hydrologic and hydraulic modeling to determine flood hazard areas.	15	$30,870,500
	Drainage master plan includes hydrologic and hydraulic modeling to determine potential flood mitigation alternatives for a county or city.	16	$9,760,000
Project Planning	Feasibility assessments and impact analyses of potential future flood mitigation projects.	31	$19,094,500
Other	Floodplain mapping for dam failure hydrologic and hydraulic modeling to determine flood hazard areas in the event of a dam breach.	1	$500,000
	Total	**63**	**$60,225,000**

FMSs and FMPs were recommended be based upon the identification, analysis, and comparison of alternatives that the RFPG determined to provide measurable reductions in flood impacts in support of the RFPG's specific flood mitigation and floodplain management goals as presented above in

Table ES-8 and **Table ES-9** and detailed more in Chapter 3. The RFPG used criteria (listed below) to determine which identified potential items would be recommended in regional plan in order to ensure that the recommended FMSs and FMPs are sensible so that resources can be directed efficiently and accordingly for implementation.

- No Adverse Impact
- High Existing Flood Need
- Quantifiable Flood Risk Reduction Benefits
- Regional Benefit (1.0 square mile)
- Existing Flood Risk to Critical Facilities

TABLE ES-11: RECOMMENDED FMSS BY STRATEGY TYPE

FMS Type	Description	Count	Cost
Education and Outreach	Implementation of program to educate the public on the hazards and risks of flooding.	14	$204,475
Flood Measurement and Warning	Installation and operation of stream gauges, monitoring stations, alert systems to provide flood hazard information.	5	$380,200
Infrastructure Projects	Improvements to or construction of channels, ditches, stormwater pipes, or any other hydraulic structures to mitigate flooding.	1	$44,000,000
Property Acquisition and Structural Elevation	Administration of program to acquisition and demolition structures and conversion of the land to open space to mitigate flooding.	4	$300,000
Regulatory and Guidance	Development of ordinances, development criteria, building codes, design standard to prevent new flood risk.	15	$552,000
Other	Maintenance and inspection of constructed flood infrastructure to maintain design level of service.	10	$541,000
	Total	**49**	**$45,977,675**

TABLE ES-12: RECOMMENDED FLOOD MITIGATION PROJECTS

FMP Name	Description	Sponsor	Cost
Sabine Pass to Galveston Bay Coastal Storm Risk Management Program – Orange County Project	Program comprised of improvements and construction of new infrastructure to reduce the risk of storm surge impacts in Orange County and provide internal pump stations for internal drainage	USACE, GCPD, Orange County, OCDD	$2,270,099,968

Kilgore Downtown Storm Sewer Master Plan Improvements	Implementation of Downtown Storm Sewer Improvements	City of Kilgore	$2,242,305

As can be seen by the estimated costs, there is a large amount of funding needed for the Sabine basin to implement these FMEs, FMPs, and FMSs in the future.

Impacts of the Regional Flood Plan

The step is summarizing the overall impacts of the Regional Flood Plan. This includes potential impacts to areas at risk of flooding, structures and populations in the floodplain, number of low water crossings impacted, impacts to future flood risk, impact to water supply and overall impact on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation.

The impacts from FMSs are more qualitative in nature and are summarized in Chapter 6. Based on the future flood hazard analysis, over 135,000 new residential structures are projected to be constructed across the region to accommodate population growth over the next 30 years. The potential flood risk of new structures can be reduced, and resiliency could be increased for many of these structures by communities adopting more stringent floodplain management criteria and standards than the minimum ones set by the National Flood Insurance Program (NFIP) with FEMA. Regulation of development, implementation of higher standards, and use of best available data are all interdependent strategies for avoiding potential increases in flood risk and exposure over time. Through these development regulations, the Regulatory and Guidance FMSs have the potential to reduce flood risk for newly constructed buildings in the Sabine River Basin.

In Chapter 2, 100% of HUC-12 watersheds and 99% of the region area by area were identified as being in need of better identifying the flood risk or updates to existing flood risk information. After the completion of recommended FMEs, 1 precent of the region area will be in need of flood risk identification, a reduction of 7,351 square miles (99%). The 1% of the region represents presents small portions of counties which intersect the Sabine basin but are not significantly within the basin. However, there is the possibility that flood studies in those counties and flood planning regions may bring the total closer to 100%.

TABLE ES-13: REDUCTION IN FLOOD RISK EXPOSURE DUE TO RECOMMENDED FMPS

Flood Exposure Region-wide	Existing Conditions		After Implementation		Reduction in Exposure	
	1% ACE	0.2% ACE	1% ACE	0.2% ACE	1% ACE	0.2% ACE
Total Structures	34,592	48,703	32,974	46,539	1,618 (-4.7%)	2,164 (-4.4%)
Residential Structures	24,066	34,839	23,283	33,011	783 (-3.3%)	1,828 (-5.2%)
Critical Facilities	401	470	392	461	9 (-2.2%)	9 (-1.9%)
Population	65,006	90,557	62,631	86,801	2,375 (-3.7%)	3,756 (-4.1%)
Low Water Crossings	107	132	106	131	1 (-0.9%)	1 (-0.8%)
Road Length (Miles)	1,518	1,897	1,489	1,840	29 (-1.9%)	57 (-3.0%)

Impacts to water supply were also evaluated as part of Task 6B. The TWDB established 16 regional water planning areas (RWPA) and appointed members who represent key public interests to the regional water planning groups (RWPG). This grassroots approach allows planning groups to evaluate region-specific risks, uncertainties, and potential water management strategies. Region 4 primarily covers the North East Texas (Region D) and East Texas (Region I) RWPA regions it partially covers Region C, Region G. Of the actions analyzed, none of the recommended flood management actions were deemed to have an impact on water supply.

Administrative, Regulatory, and Legislative Recommendations

The Sabine RFPG is provided an opportunity to make recommendations to improve floodplain management and mitigation within the region. It can be viewed as the beginning of a multi-year statewide initiative that identifies and ultimately constructs water management networks and policies that reduce flooding impacts while also supporting water supply needs across Texas. The Sabine RFPG discussed draft recommendations during the April, May, and June 2022 meetings. A total of 17 recommendations were developed and are summarized below.

Legislative Recommendations

- Continue biennial appropriations to the Flood Infrastructure Fund (FIF).
- Increase state funding for technical assistance to develop accurate watershed models and floodplain maps.
- Allow counties the opportunity to establish drainage utilities and to collect drainage utility fees in unincorporated areas.
- Incentivize jurisdictions to work together to provide regional flood mitigation.
- Incentivize buy-out programs to convert frequently flooded properties/neighborhoods into natural beneficial use areas.

Regulatory and Administrative Recommendations

- Develop model floodplain management standards and ordinances.
- Provide support for ongoing education/training for floodplain management.
- Provide technical assistance to smaller jurisdictions.
- Establish a process to take BLE data to regulatory information .
- Review and Update TxDOT design criteria.

Flood Planning Recommendations

- Develop guidance and a process for emergency needs
- Utilize alternative statewide Social Vulnerability Index (SVI) than the one developed by the U.S. Center for Disease Control (CDC).
- Reassess requirements for potentially feasible Flood Mitigation Projects (FMP).
- Consider prioritizing FMEs which establish FEMA effective floodplains for a community.
- Develop publicly available, statewide database of all the GIS deliverables associated with the development of the State Flood Plan.
- Incorporate State and Federal Agencies in the Regional Flood Planning process as a non-voting RFPG member.
- Update Future Population Projections.

Upon implementation of the legislative recommendations, there will be a continued stream of funding for studies and flood mitigation projects under TWDB's FIF program as well as opportunities to generate local funding for capital improvement projects. Administrative recommendations include providing support to the smaller communities who may not have the resources or capabilities as larger regions to pursue different funding avenues. Another important recommendation is the inclusion of state and federal agencies into the planning process as it would be beneficial to both the agencies as well as the flood planning process.

Flood Infrastructure Financing Analysis

The Sabine RFPG recommended a total of 110 flood mitigation actions to address flood risk across the planning region. Combined, these flood mitigation actions are anticipated to cost approximately $2.4 billion to implement. Much of the total cost is associated with the Sabine Pass to Galveston Bay Coastal Storm Risk Management Project in Orange County. The complete cost of this project is split between the Sabine and Neches RFP as the project will benefit communities in both regions. The breakdown of costs for recommended flood mitigation actions are shown in **Table ES-14** and is further detailed in Chapter 9.

TABLE ES-14: TOTAL COST OF RECOMMENDED FLOOD MITIGATION ACTIONS

Flood Mitigation Action Type	Number of Recommended Actions	Anticipated Total Cost of Implementation
FME	63	$60,225,000
FMS	49	$45,977,675
FMP	2	$2,272,342,305
Total	**110**	**$2,378,544,980**

The costs presented in the above table represent the estimated cost of the Regional Flood Plan and includes and both the local and federal/state share of the project.

Stormwater infrastructure and floodplain management activities are historically underfunded programs compared to other infrastructure types, and this is a continued challenge that local entities documented through their initial survey responses. Furthermore, in nearly all of the responses from the survey conducted in 2021 it was noted that the lack of funding was a major hindrance and a primary cause of inadequate or deficient drainage infrastructure. The Sabine RFPG surveyed sponsors to determine how much local funding is available to contribute to these actions. Overall, there is an estimated $1.295 billion of funding needed to implement the recommended FMEs, FMSs, and FMPs in this RFP beyond what is anticipated to be funded by local sponsors. This figure represents 40% of the total cost of the flood mitigation actions identified in this plan. This number does not represent the amount of funding needed to mitigate all risks in the region nor to solve flooding problems in their totality. This number simply represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. Future cycles of regional flood planning, as well as other avenues and studies like TWDB's Flood Infrastructure Fund program, will continue to identify more projects and studies needed to further flood mitigation efforts in the Sabine Region to reduce the overall risk to life and property in the planning area.

CHAPTER 1
PLANNING AREA DESCRIPTION

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CHAPTER 1. PLANNING AREA DESCRIPTION

The Sabine River begins in North Texas in Collin, Hunt, and Rockwall Counties and flows southeast through Northeast Texas towards Shelby County, where it becomes the border between Texas and Louisiana. The Sabine River and neighboring Neches River outfall into Sabine Lake, which drains to the Gulf of Mexico. Although a quarter of the drainage area of the Sabine River is located in the state of Louisiana, the Sabine Regional Flood Planning Area (Region 4) (**Figure 1-1)** encompasses only the portion of the Sabine River Basin which is located within the state of Texas. The drainage area includes a wide variety of landscapes and communities. The region is served by a vast network of natural and constructed flood infrastructure, such as an expansive system of creeks, bayous, ponds, wetlands, reservoirs, and urban drainage systems. The portion of these components within Texas make up approximately 6,455 stream miles of conveyance as determined by the TWDB.

The Sabine Flood Planning Region encompasses three major land resource areas: the Blackland Prairie, East Texas Timberlands, and Coastal Prairie. Developed land area is comprised of predominantly rural and small urban communities. The name Sabine comes from the Spanish word for cypress, in reference to the extensive growth of Bald Cypress trees along the lower portion of the flood planning region.

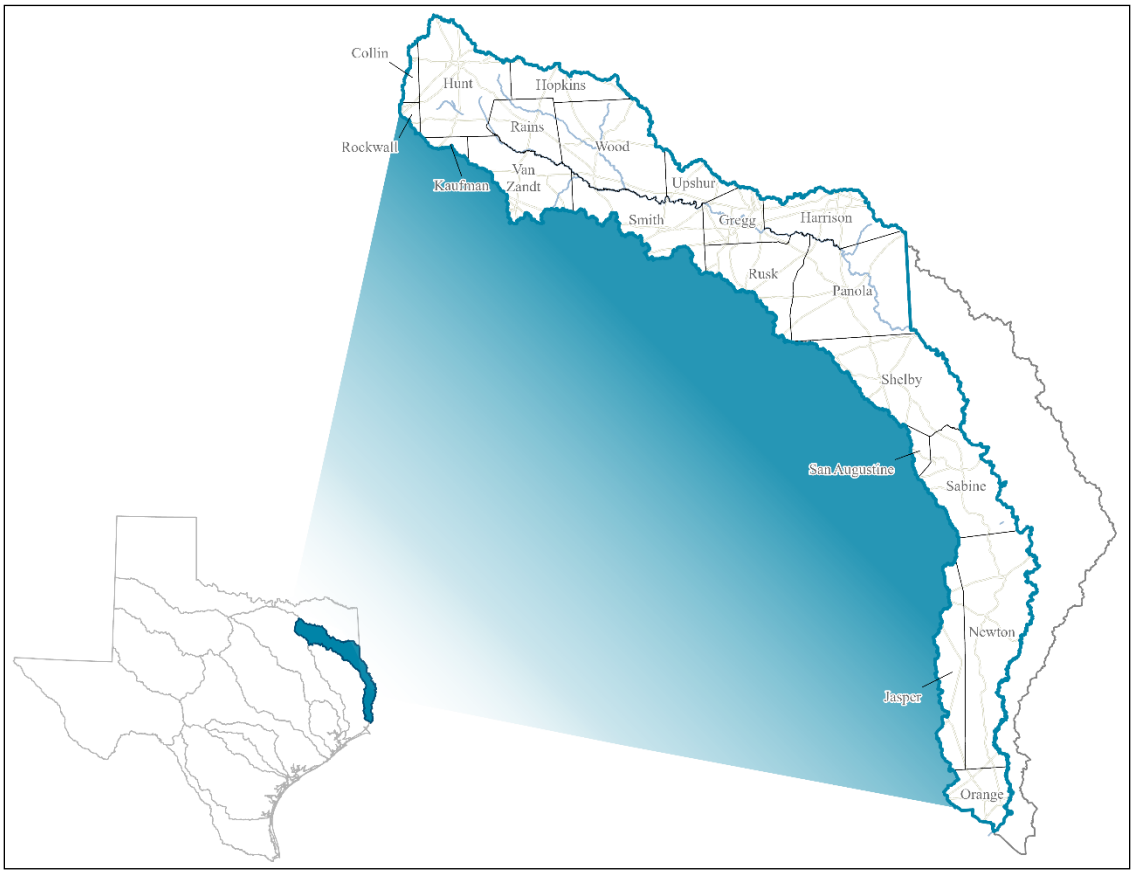

FIGURE 1-1: SABINE (REGION 4) FLOOD PLANNING REGION

Land surface elevations across the planning area range from a few feet above sea level in the tidal region, to approximately 700 feet above sea level at the headwaters. The Sabine River Basin

encompasses 9,756 square miles, 7,550 square miles of which are in Texas. Climate characteristics for the planning area are typified by relatively high rainfall and low evaporation rates. Average annual precipitation ranges from 44 inches near the Sabine River headwaters near the Dallas-Fort Worth Metroplex area to 56 inches at the mouth of the Sabine River near Orange, TX. Comparing flow volume per basin area for the major river basins of Texas, Region 4 has the highest ratio of average annual flow volume to basin area in the state. A complete list of comparative statistics for major river basins in Texas can be found in **Table 1C-1** in **Appendix 1-C**.

Chapter 1.A. Social and Economic Character of the Region

1.A.1. Population and Future Growth

Region 4 is less densely populated than many of the other regional flood planning areas in the state, with an estimated 2020 population of 616,155 people, or approximately 2% of Texas residents according to the 2022 State Water Plan (SWP) (TWDB, 2021). It is a geographically diverse region, requiring consideration of the needs of rural stakeholders along with those of the urban population centers. Flood risks faced by communities and landowners varies significantly across this region. To better understand the nature of that flood risk, this section discusses the people, types and locations of development, and the economic activities and sectors at greatest risk of flood impacts.

1.A.1.a. Current Conditions

Patterns of land use in the region include oil and gas production, forestry, agriculture, manufacturing, shipping, recreation, and tourism. Most of the population is concentrated in the upper basin along the U.S. 80 and IH-30 transportation corridors east of Dallas, as well as in the southern portion of the basin near the coast. The remaining population is distributed in predominantly smaller communities and rural areas across the central portion. Cities larger than 5,000 population are listed in **Table 1-1.**

TABLE 1-1: PRINCIPAL CITIES IN THE REGION

City	Population	City	Population
Tyler*	105,995	Kilgore	14,827
Longview	81,638	Bridge City	7,961
Greenville	28,164	Carthage	6,535
Marshall	23,080	Center	5,115
Orange	19,324	Gladewater	6,397

Source: 2020 Census Redistricting (census.gov)

**A portion of Tyler is within Region 4 boundary.*

1.A.1.b. Economic Activity

In order to illustrate the economic risk that the region faces from flood events, this section summarizes the major industries within the region utilizing data from the United States Census Bureau's Economic Census. Industries were divided by the North American Industry Classification System (NAICS), which classifies all business establishments. The combined total Gross Domestic Product (GDP), annual payroll,

and number of industrial establishments per county for the region is included in **Table 1C-2** in **Appendix 1-C**. Regarding industry types, 9 of the 21 counties cite manufacturing as the leading industry in terms of ratio of total county payroll, and 4 counties cite construction as the leading industry. Leading industries by county are shown in **Figure 1-2.**

Agricultural and Ranching

East Texas and the Sabine River Basin generate nearly $1.7 billion in agricultural revenue each year. Although fewer individuals are exposed to flood hazards in rural areas, flooding impacts agriculture and ranching. Floods can kill crops or livestock and damage barns or other structures, causing significant economic hardship to the farmers and ranchers. Additionally, prolonged inundation or flooding of farmland can also damage and kill crops.

A large portion of the agricultural revenue in Region 4 is generated by livestock operations, primarily poultry production in Shelby County and cattle in various northern basin counties including Hopkins, Franklin, and Wood counties. Crops generate roughly 12% of the basin total agriculture revenue. **Table 1C-4** in **Appendix 1-C** shows agriculture revenue according to most recent available data from United States Department of Agriculture (USDA) 2017 Census of Agriculture.

Energy

Oil and gas production is an integral component of Texas industry, and the Sabine Basin is no exception. The upper portions of the planning area known as the East Texas Oil Field possess the highest percentage of oil production for Region 4, primarily in Gregg, western Rusk, southern Upshur, and southeastern Smith Counties. In the central portion of the basin, gas wells associated with the Texas-Louisiana Salt Basin are more common. These gas wells are primarily located in Harrison, Panola, Rusk, Shelby and San Augustine Counties. In the southern portion of the region, there are concentrations of pipeline networks connecting national trunk systems to refineries on the Gulf Coast, along with associated chemical manufacturing industries.

Table 1C-5 in **Appendix 1-C** shows Region 4's gas and oil production in millions of cubic feet (MCF) relative to the state overall, using production data provided by the Texas Railroad Commission for December 2021. The most prominent producer of renewable energy in Region 4 is the hydro-electric generating system at Toledo Bend which produced approximately 200,000 megawatt hours per year.

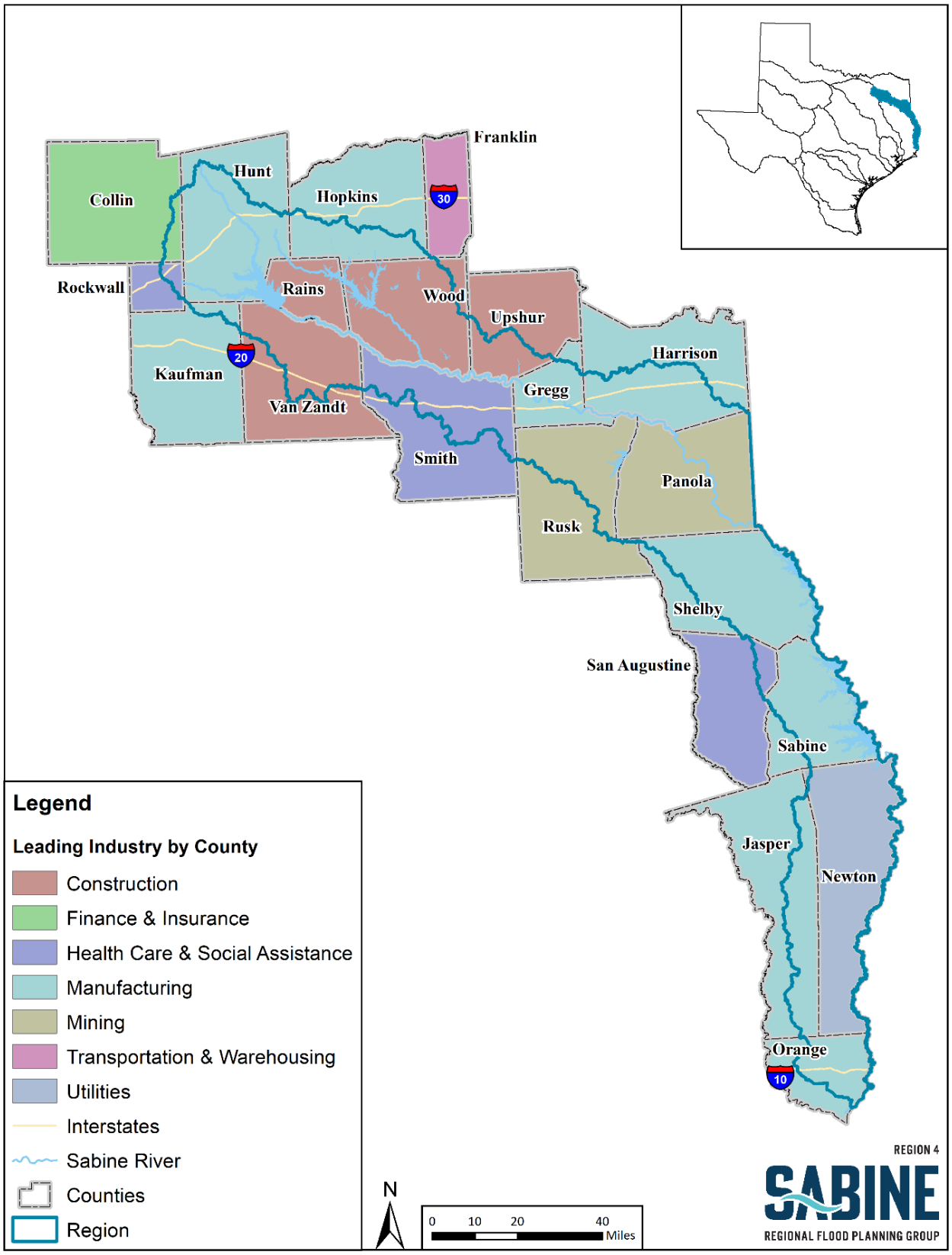

FIGURE 1-2: LEADING INDUSTRY BY COUNTY

Timber

There are over 2,666,000 acres of forestland within the planning region. According to a joint inventory by the Texas A&M Forest Service and USDA National Forest Southern Research Station, the State's principal forest region is located in eastern Texas, based on its abundance of pine and hardwood tracts which produce nearly all the State's commercial timber. While the majority is privately owned, notable tracts of forest land are federally managed by the Sabine National Forest. Pine species are the predominant forest type in drier upland areas, while lower wetland and riparian zones are comprised largely of hardwood species. As of 2017, annual delivered value of timber harvested was estimated at $200 million, with pine timber making up 82% of this total.

In addition to resource extraction and manufacturing, forested land in the Sabine region also generates measurable economic ecosystem services. Estimates developed by the Texas Forest Service measure value for a range of ecosystem services including air quality, biodiversity, carbon sequestration, cultural value, and watershed benefits. Estimates for the combined total annual value of ecosystem services is over $5.7 billion per year, as shown in **Table 1-2**. The distribution of total annualized ecosystem services value is most concentrated in the southern portion of the basin, as shown in **Figure 1-3**.

TABLE 1-2: ANNUAL ECONOMIC VALUE OF SABINE FLOOD PLANNING REGION FOREST ECOSYSTEM

Ecosystem Service	Rural Value ($)	Urban Value ($)	Total Value ($)
Air Quality	$72,000	$9,980,900	$10,052,900
Biodiversity	$629,849,800	$7,186,900	$637,036,700
Carbon	$239,939,300	$1,670,800	$241,610,100
Cultural	$2,934,859,900	$47,905,000	$2,982,764,900
Waters	$1,798,182,600	$36,549,200	$1,834,731,800
TOTALS	$5,602,903,600	$103,292,800	$5,706,196,400

Source: Texas A&M Forest Service, Forest Ecosystem Values

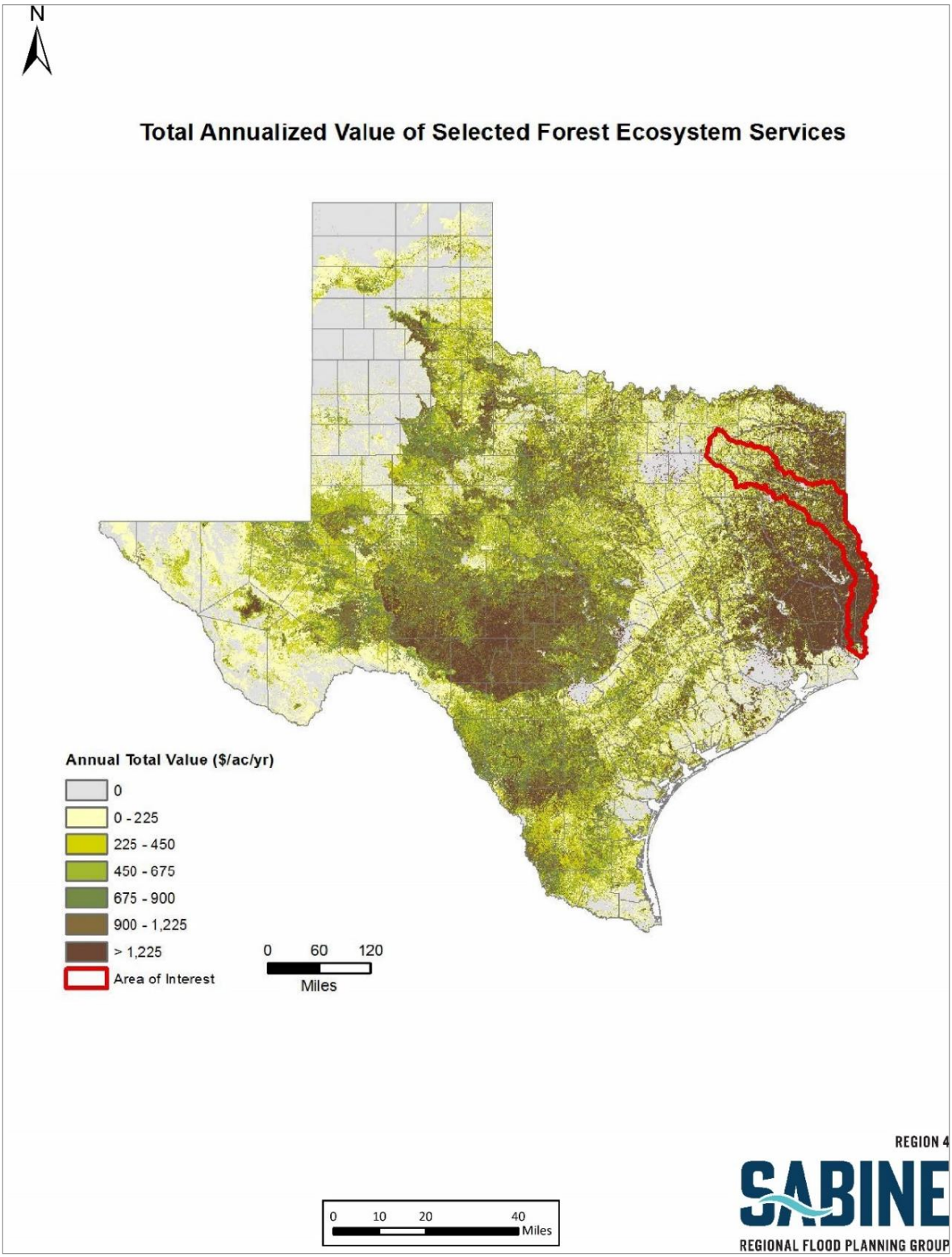

FIGURE 1-3: FOREST ECOSYSTEM VALUES

Source: Texas Forest Service; Forest Ecosystem Values for Sabine Basin

Socioeconomic Status of Population

Examination of median household income provides a useful comparison for gauging income levels across the basin. Median household incomes can be impacted by many factors, including education levels, opportunity of employment, and location. Within the region, the median annual income per capita is $44,038, and median household income is $56,954. This is less than the Texas median ($63,524) and less than the U.S. median ($67,521). 2020 Census data income measures is shown by county in **Figure 1-4**.

1.A.1.c. Projected Growth Within the Region

The population projections completed in the 2022 State Water Plan, shows the highest anticipated population growth concentrated in areas adjacent to the Dallas/Fort Worth Metroplex, such as Collin, Rockwall and Hunt Counties. Significant population growth is expected in existing urbanized areas of Greenville, Farmersville, and Royse City. General trends also indicate that higher projected percent growth is expected in the upper portion of the region compared to the lower portion between years 2020 and 2050. **Figure 1-5** illustrates these trends. **Table 1C-7** in **Appendix 1-C** shows a projected population by Water User Group from 2020 to 2050.

The majority of the population in the region is rural, either located in small rural towns or more remote country settings. National trends in recent decades have shown larger percentages of population growth in urban centers, and relatively slow or negative growth in rural areas. These national trends are also represented in Sabine Basin population projections, with the majority of growth occurring in a few urbanized cities, and population losses or low levels of growth in rural counties.

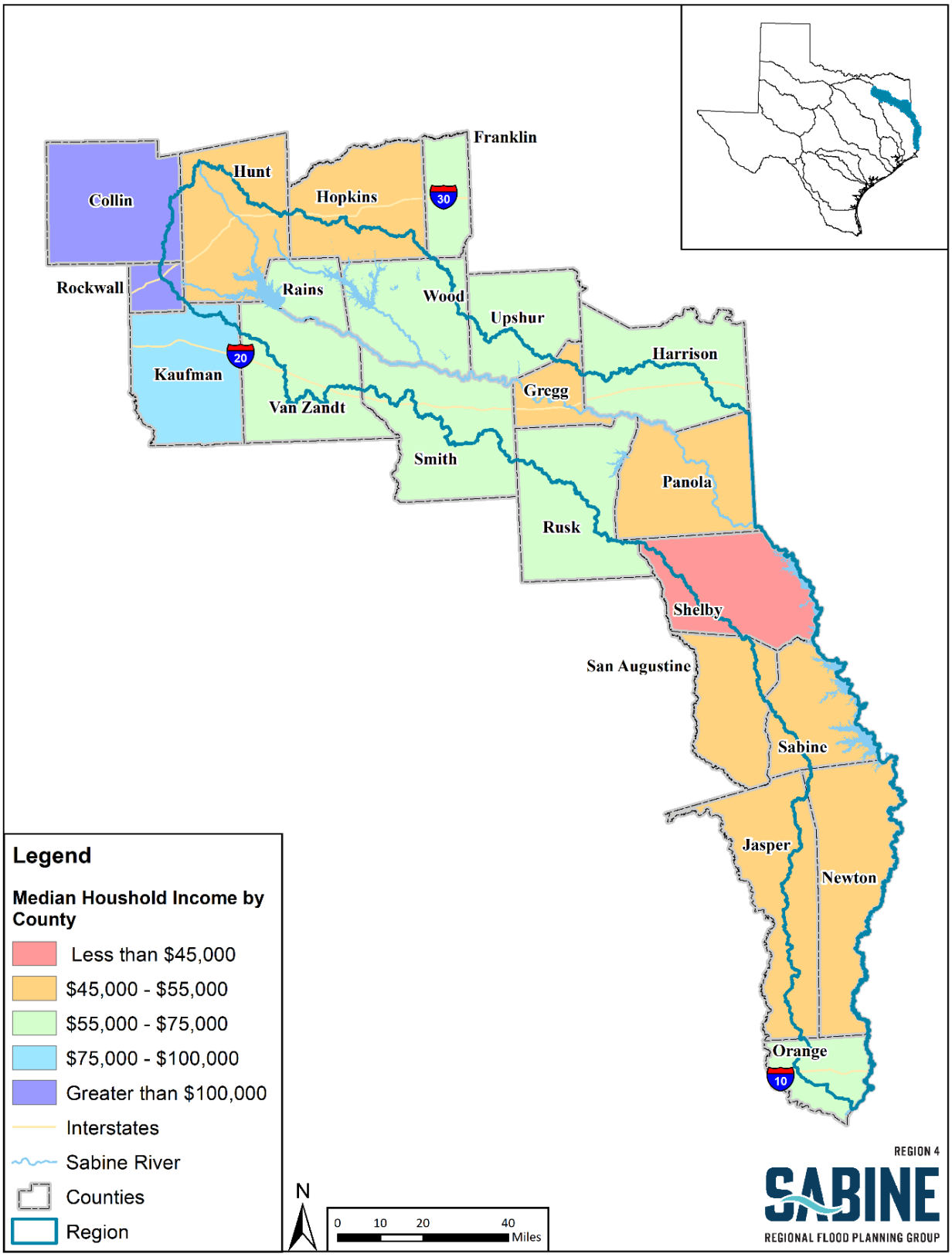

FIGURE 1-4: MEDIAN HOUSEHOLD INCOME BY COUNTY

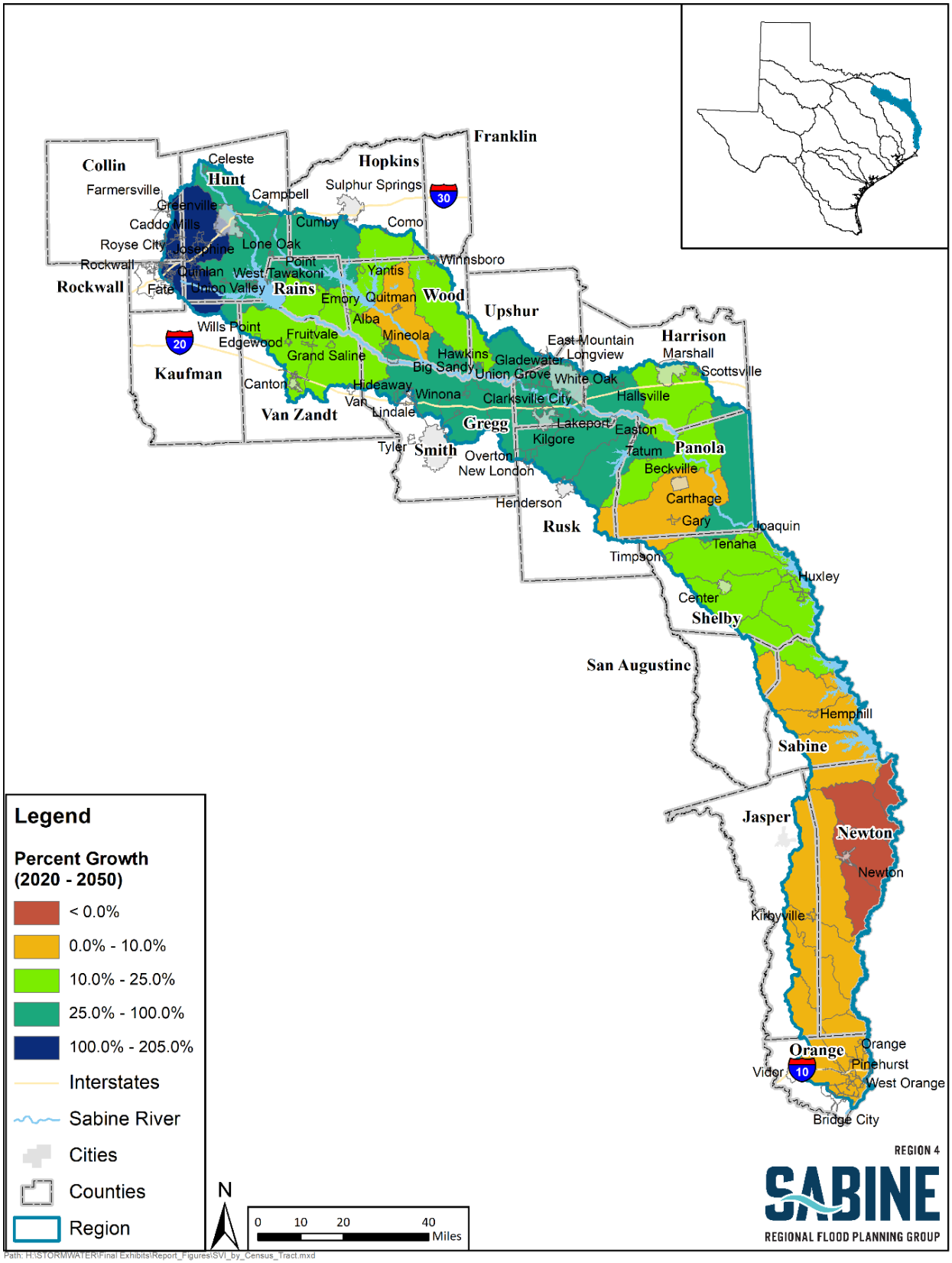

FIGURE 1-5: POPULATION GROWTH BY HUC10 WATERSHED

1.A.1.d. Social Vulnerability Analysis

When anticipating the likely extent of damages to a community from catastrophic floods, it is important to consider both exposures based on geographic location of people and property and vulnerability to floods when they do occur.

Disasters affect different people or groups in different ways, which range from the ability to evacuate an area in harm's way, to the likelihood of damage to homes and properties, to capacity to marshal the financial resources needed to recover and rebuild after a storm. These factors are evaluated by the U.S. Centers for Disease Control and Prevention (CDC) to determine an area's Social Vulnerability, which measures a person's or group's "capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard," based on their relative vulnerability.

The Social Vulnerability Index (SVI) is a standard system for assigning a Social Vulnerability score at a census-tract basis. A score of 0.75 or greater indicates that a community is highly vulnerable to impacts from a natural disaster. Shelby has the highest average SVI among all counties in the planning region. Census tracts identified as highly vulnerable are listed in **Table 1C-8** in **Appendix 1-C**. SVI can be seen by census tract in **Figure 1-6** and by county in **Figure 1C-1** in **Appendix 1-C**.

Baseline of Where Growth Intersects with Vulnerability

Population growth within the Sabine River Basin was analyzed for high social vulnerability areas. For this analysis, the population growth compared to existing population (2020 – 2050) was determined for census tracts with an SVI of at least 0.50. Greenville, TX has an existing vulnerability index of 0.69 and one of the highest population growths (114%) in the planning region. Southern Hunt County near Lake Tawakoni has a similar vulnerability and is expected to grow by 82% by 2050. Newton County is a high vulnerability area, SVI of 0.55, and is projected to experience negative population growth by 2050. Population growth for areas of high vulnerability can be seen in **Figure 1-7.**

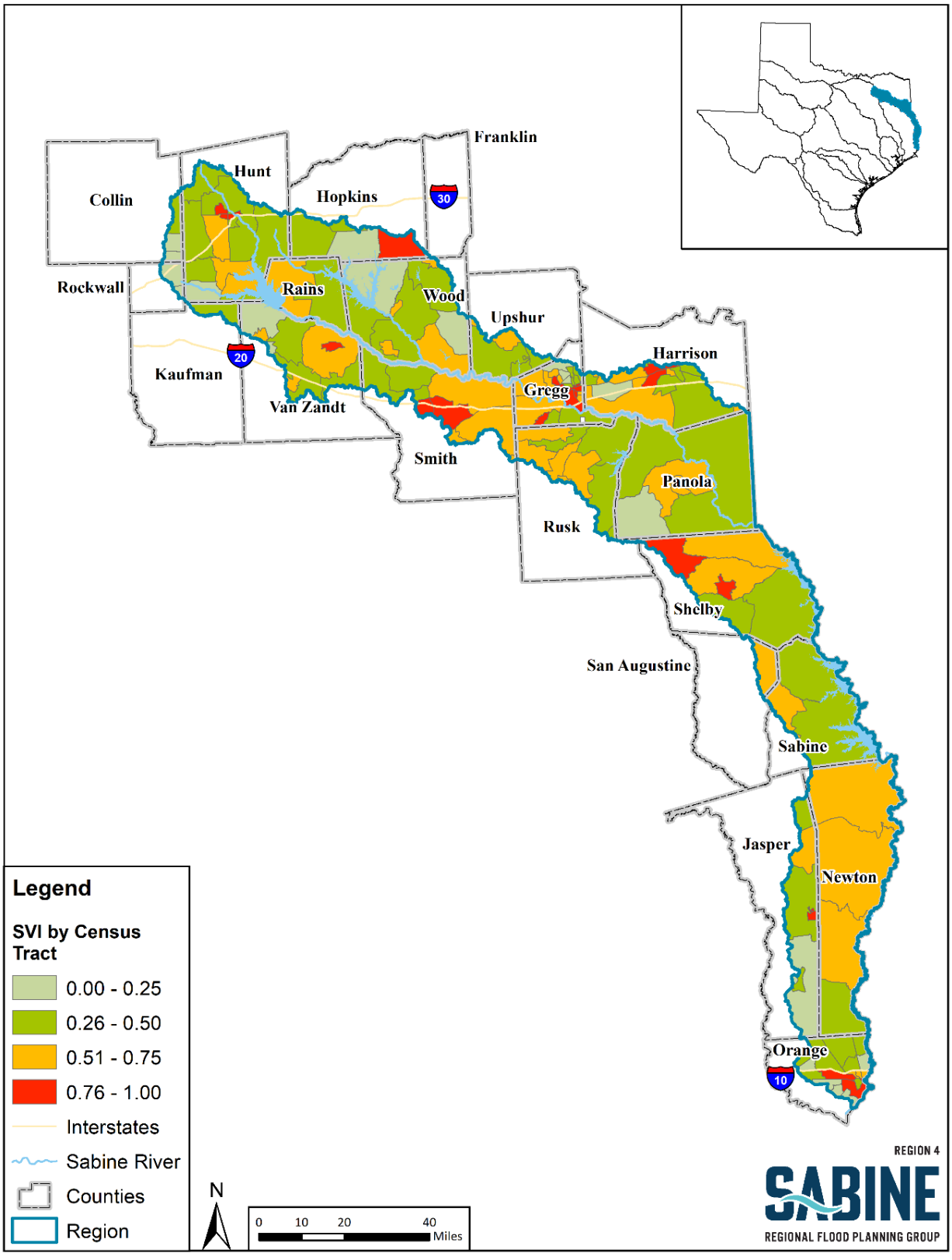

FIGURE 1-6: SVI BY CENSUS TRACT

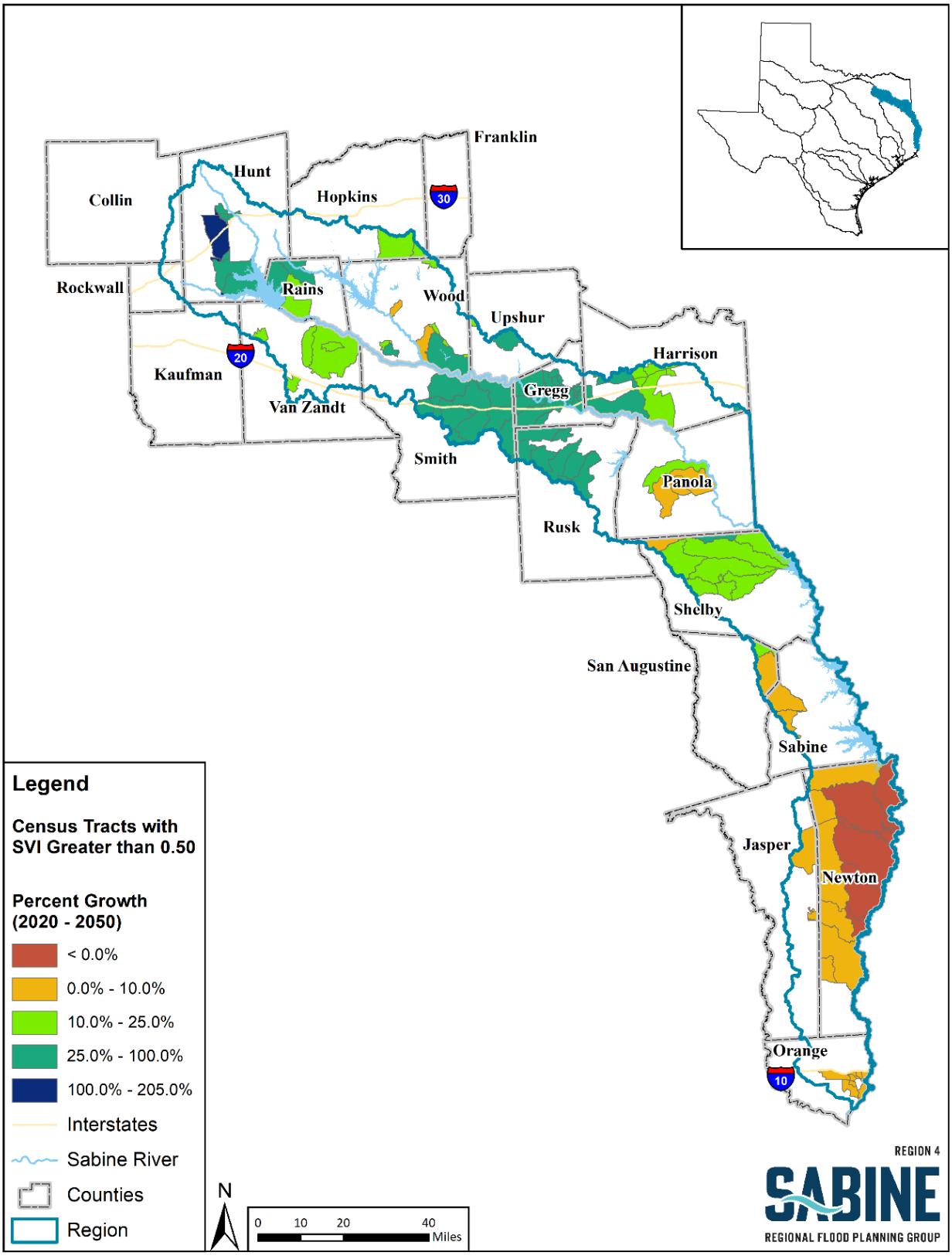

FIGURE 1-7: POPULATION GROWTH IN AREAS OF HIGH VULNERABILITY

1.A.2. Flood Prone Areas & Flood Risks to Life and Property

Currently, a collection of plans, regulations and infrastructure are in place to try to address flood hazards in Texas. This planning largely takes place at a local level, with an inconsistent set of standards from community to community and lack of available floodplain mapping that makes it difficult to quantify regional risk. This section provides a baseline summary of what is known with respect to the area's exposure to flood hazards, as well as the vulnerability of the communities within the region. Flood risks and exposure of life and property to those risks are analyzed and documented in greater detail in **Chapter 2**, Flood Risk Analysis.

1.A.2.a. Types of Major Flood Risks

The primary flood risk types in Region 4 are riverine, local, and coastal storm surge flooding, with coastal storm surge flooding historically impacting Orange County in the southern portion of the region. Most of the riverine flooding risk is centered in the southern portion of Region 4, including Newton and Orange Counties. Additional drainage areas in Louisiana funnel through the lower Sabine Region and Orange County before discharging into Sabine Lake. A secondary flood risk type is tributary flash flooding. This flooding type can occur at various locations across the planning area. Flood risk information considered in **Chapter 2** includes pluvial or rainfall, riverine, and coastal flood types.

1.A.2.b. Identification of Flood Prone Areas

Identification of flood prone areas is complicated by the lack of comprehensive floodplain mapping data for the region. No single county or HUC-12 (a boundary cataloged using a 12-digit hydrologic unit code, or HUC) in the region has complete coverage of detailed and updated floodplain mapping. Notably, Panola County completely lacks regulatory floodplain mapping. Many of the studies and mapping practices that were used to develop floodplain maps and corresponding flood information in the other mapped areas are often decades old. These maps likely do not reflect changing patterns of development and often fail to identify flood risks associated with changes in the environment, updates to better quality topography, and newer hydrology and hydraulics (H&H) modeling technology.

In the absence of a comprehensive flood map that applies across the region, the TWDB has provided a "flood quilt", which is a flood dataset compiling various sources of existing statewide flood hazard information. The flood quilt contains flood data from Federal Emergency Management Agency (FEMA) flood maps, Base Level Engineering (BLE), First American Flood Data Services (FAFDS), Cursory Floodplain Data, and the U.S Army Corps of Engineers (USACE). In a related effort, the TWDB is undertaking efforts to expand the availability of floodplain mapping information in Texas through the development of FEMA BLE data. The Toledo Bend Reservoir Watershed has already benefited by the availability of BLE data, which can be incorporated into the 2023 RFPs. However, the remaining BLE studies in the region are not expected to receive BLE data until 2023, meaning this data will not be incorporated into the flood risk analyses for this first round of RFP development. BLE study availability in the planning region, as of September 2021, is shown in **Figure 1-8.**

It is noted that BLE data for the entire Sabine basin became available in the spring of 2022. However, this was after the existing conditions flood hazard analysis (outlined in Section 2.A.1.a). Thus, to be consistent with the BLE data that was used as part of this 2023 Regional Flood Planning effort for the

Sabine Region, **Figure 1-8** shows the BLE data that was available at the time the analysis was performed. Future cycles of regional flood planning will be able to utilize the newly released data.

Furthermore, after investigation into the available Flood Insurance Studies (FIS) where FEMA mapping was available, a significant portion were found to be outdated or showed approximate floodplain (Zone A) mapping only. Since Zone A mapping is not backed by a detailed study and outdated mapping is not expected to closely reflect the flood risks which may currently exist, they were excluded from the mapping. As a result, identification of flood prone areas for this initial plan relies heavily on the Cursory Floodplain dataset furnished by the TWDB.

Using these various data sources, 2,310 square miles, or 31% of the watershed, is subject to flooding due to the 1% annual chance event (ACE) as shown in **Map 4** in **Appendix 2-A.**

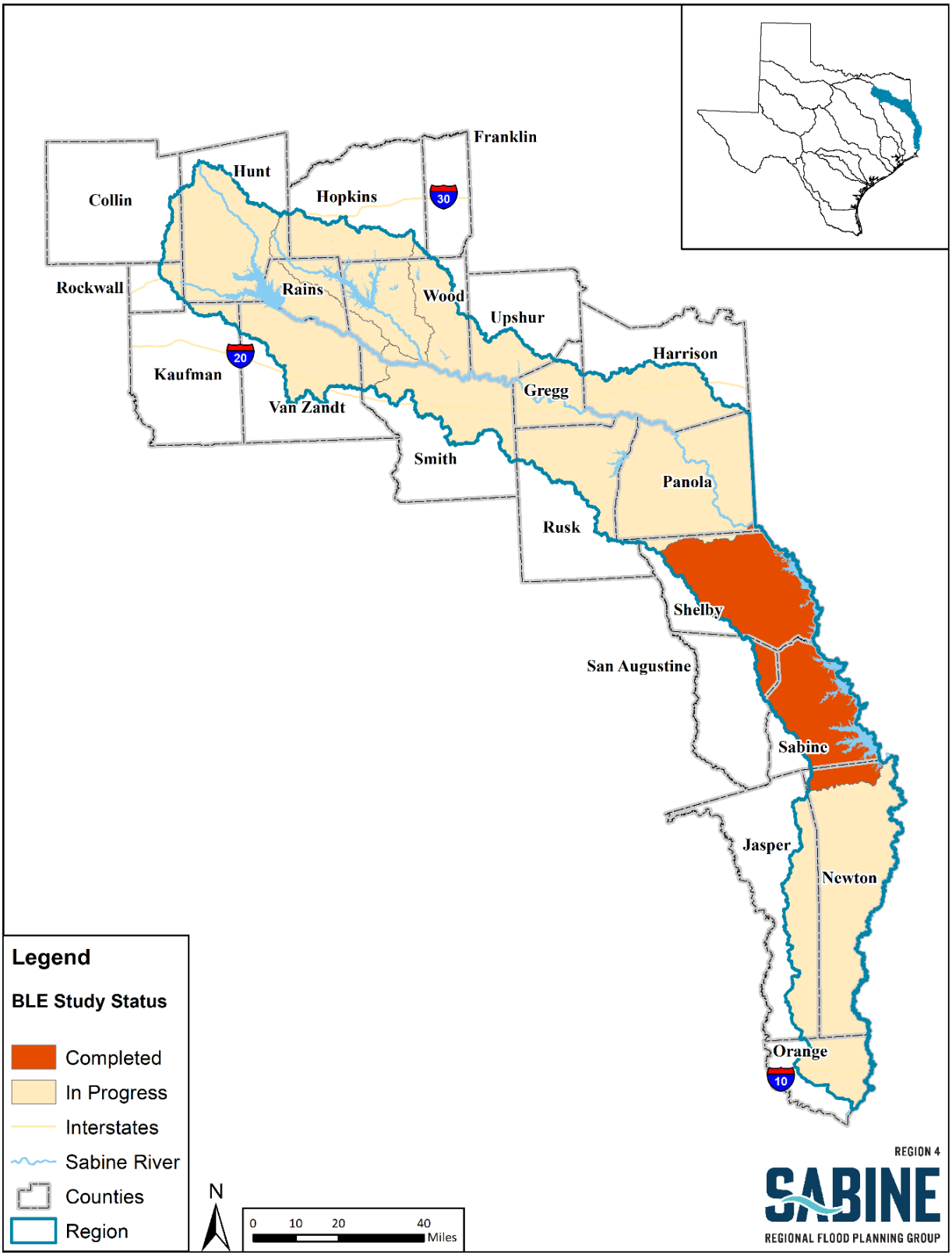

FIGURE 1-8: BLE DATA AVAILABILITY (AS OF FEBRUARY 2022)

1.A.2.c. Rates of NFIP Participation & Flood Related Planning Activities

Approximately 87% of eligible communities in Region 4 participate in the National Flood Insurance Program (NFIP). Participation in the NFIP improves a community's prospects for economic recovery in the event of a major flood. However, many communities are using maps that are decades old and may only tell part of the story. More details regarding NFIP participation and flood related activities are included in Chapter 3**.**

1.A.2.d. Critical Assets in Flood Prone Areas

Critical assets are assets that include schools, hospitals, fire stations, shelters, nursing homes and assisted care facilities, water and wastewater treatment plants, and energy generation facilities. It is recommended that these assets or facilities be given careful consideration when preparing regulatory alternatives and floodplain management plans. **Table 1-3** shows the number of critical facilities by type identified within the region and those within in the 1% annual chance and 0.2% annual chance flood hazard areas.

TABLE 1-3: CRITICAL FACILITIES BY TYPE

Critical Facility	1% ACE	0.2% ACE
Schools	68	89
Medical	3	3
Emergency	1	2
Infrastructure	329	376
Total	692	797

1.A.3. Key Historical Flood Events

The Sabine Flood Planning Region has experienced several devastating floods, however little information is available on the specific impacts of these storms. The following sections outline the flood-related impacts the communities within the region have experienced. The complete lists of federal disaster declarations and emergency declarations within the region are provided in **Table 1C-9** and **Table 1C-10** in **Appendix 1-C.**

1.A.3.a. Historic Events Prior to Current Level of Regulation

May 1884 brought heavy rainfall to the central United States, during which the USGS gage at Sabine River near Ruliff, TX reached a record stage of 32.2 feet. The Great Flood of 1913 impacted much of the central and eastern United States between March 23-26. Heavy rainfall contributed to flooding in nearly every community in the central United States. While damages specific to the Sabine River Basin are unclear, the Sabine River reached a stage of 43.5 feet near Bon Weir, TX. These historical floods set stage height records that would not be surpassed until March 2016.

Sustained heavy rainfall during the Spring of 1953 led to flooding conditions across Louisiana and East Texas. Officials constructed an emergency flood-protection levee in Orange, TX which USACE estimates indicate prevented $5.5 million in damages and saved nearly 3,000 homes and 3 large industrial areas. Surrounding communities and agricultural areas were not as extensively protected and experienced

significant losses. Total flood damages within the Sabine River Basin exceeded $4.3 million as estimated by National Weather Service. Flow at the USGS gage along the Sabine River at gages near Ruliff, TX and Bon Wier, TX set stream flow records that would not be broken until 2016.

1.A.3.b. Historic Tropical Events

Hurricane Rita made landfall near Sabine Pass, TX as a category 3 hurricane on September 26, 2005, severely impacting the Sabine River Basin. Less than one month before Hurricane Rita's landfall in Texas and southwest Louisiana, Hurricane Katrina devastated Louisiana and Mississippi. The peak wind speed brought by Hurricane Rita reached 180 miles per hour (mph) and a minimum pressure of 895 millibars (mbar), making it the strongest storm of record in the Gulf of Mexico according to the National Weather Service (NWS). Orange, TX received wind gusts up to 98 mph along with storm surge of 8 to 10 feet. In response to Hurricanes Rita and Katrina, federal emergency declarations were issued statewide for Texas and Louisiana.

Hurricane Ike made landfall on September 13, 2008, near Galveston, TX as a category 2 hurricane, bringing strong wind and rain to Texas and Louisiana. While Hurricane Ike did not bring record-setting rainfall to the basin, the storm's 400-mile-wide tropical storm force wind field produced severe storm surge, which ranged from 9.3 to 12.5 feet along the coast of Orange County according to NWS. Maximum wind gusts in Orange County reached 96 mph, and many communities experienced sustained wind speeds over 70 mph.

Hurricane Harvey made landfall near Rockport, Texas on August 25, 2017, as a category 4 hurricane impacting the entire Texas Gulf Coast. Orange County received an average of 30-50 inches of rainfall between August 25 and September 1, 2017, flooding over 27,000 homes. Newton County received an average 20-40 inches of rainfall in the same period flooding 2,000 homes. The USGS gage at Big Cow Creek near Newton, TX recorded a stage of 21.08 feet. Based on information from the United States Geological Survey (USGS), the Sabine River reached a stage of 31.60 feet near Ruliff, TX the third highest stage of record surpassed only by March 2016 and May 1884. This extreme rainfall resulted in Hurricane Harvey being the most damaging storm in the basin since NFIP launched in 1968. Floods in Orange County resulted in at least 10 direct fatalities. Two additional fatalities occurred in Newton County.

Tropical Storm Imelda made landfall near Freeport, TX on September 17, 2019. The National Oceanic and Atmospheric Administration (NOAA) National Ocean Service recorded a sustained wind speed of 40 mph with gusts up to 48 mph near Sabine Pass, TX. As the storm stalled over southeast Texas, Orange County received 25-30 inches of accumulated rainfall in 48 hours according to the NWS, which also estimated that 2,600 homes were flooded during Tropical Storm Imelda. The Sabine River near Bon Weir, TX reach a stage of 36.20 feet, the tenth highest stage on record.

1.A.3.c. Historic Riverine Flooding

Severe thunderstorms in East Texas created flooding conditions in the Sabine River Basin during October and November 2002. The peak average rainfall in the region was 4-10 inches in three days. The third highest gage measurement of record was reached for the Sabine River near Beckville, TX at 32.03 feet. Orange, TX received 10.19 inches of rainfall between October 25-29, 2002. Federal disaster declarations were issued for Jasper and Orange Counties (DR-1439-TX).

A series of heavy rainfall events between October 15-22, 2006, ended an approximately year-long period of abnormally dry conditions in southeast Texas. Continuous heavy rain impacted Tyler, Jasper, and Newton Counties. Lower portions of the Sabine River Basin averaged 8-10 inches of rainfall, while Newton, TX received 12.7 inches between October 15-22. The Sabine River near Bon Weir, TX reached a stage of 27.93 feet, the eighth highest stage level of record. Strong costal winds brought by the storms caused the tides to rise 3-5 feet above normal levels. Tides during this period were comparable to levels seen during Hurricane Rita.

A slow-moving storm system brought heavy rainfall to East Texas in March of 2012. (NWS) The Sabine River near Bon Wier, TX reached 34.82 feet, the seventh highest stage at that time. A tornado of EF2 magnitude in Panola County resulted in one fatality.

Significant rainfall in the Sabine River basin led to devastating floods in southeast Texas in March 2016. The basin received an average of 6 inches of rainfall between March 7-12, 2016. Hemphill, TX received 18.60 inches of rainfall and Longview, TX received 12.03 inches of rainfall (NWS). Toledo Bend Reservoir reached a record stage of 174.36 feet on March 10, 2016. Full pool for the reservoir is 172 feet above mean sea level (feet msl). The Sabine River near Ruliff, TX reached a stage of 33.28 feet on March 15, 2016, exceeding the record stage established in 1884.

1.A.3.d. Damages and Flood Claims

Flooding has occurred throughout history across the basin. However, communities in the lower portion of the region are the most impacted by major flood events. This area of the watershed is regularly impacted by tropical storms and hurricanes and is also subject to tidal influence. Recent major storm events and associated NFIP flood claims and damages are reported in **Table 1-4**. The damages and flood claims in **Table 1-4** are limited to the Sabine Regional Flood Planning Area, additional damages were incurred outside the region.

TABLE 1-4: REPORTED FLOOD DAMAGES AND CLAIMS FOR MAJOR HISTORICAL FLOOD EVENTS

Name	Year	Number of Flood Claims	Total Flood Damages	Total Flood Damages in 2020 Dollars
Hurricane Harvey	2017	2854	$349,487,175	$374,304,762
Tropical Storm Imelda	2019	1621	$164,231,312	$167,400,108
Hurricane Ike	2008	1498	$139,486,696	$193,017,281
March 16	2016	151	$11,887,622	$13,346,589
Oct/Nov 2002	2002	142	$2,646,072	$4,624,895
Oct 2006	2006	70	$2,051,917	$2,993,149
Hurricane Rita	2005	76	$1,489,080	$2,299,589

Source: FEMA, NFIP

Hurricane Harvey was the most destructive historic storm event in the basin, as reported by both the number of flood damage claims and total claimed value. It should be noted that for all of these flood events, the true magnitude of damage and property losses is higher than reported values, as flooded properties without flood insurance at the time of the event are not accounted for in the number of flood claims or total damage value.

1.A.3.e. Past Flood-Related Casualties

Fatalities, personal injuries, emotional trauma, and loss of wages and revenue also contribute to the total damages experienced by a community during a flood event. The NOAA National Center for Environmental Information maintains the Storm Events Database which documents weather events that result in loss of life, injuries, or significant property damage. In the Sabine River Basin, there have been a total of 19 losses of life and 6 injuries reported as being direct results of a flood event. **Table 1-5** provides a summary of events, deaths, and injuries documented by NOAA from 1999-2020.

TABLE 1-5: FLOOD-RELATED FATALITIES AND INJURIES

Event	Location	Event Type	No. Fatalities	No. Injuries
Hurricane Laura (2020)	Sabine County	Hurricane	1	0
Hurricane Harvey (2017)	Bridge City, TX	Flash Flood	10	0
	Burkeville, TX	Flash Flood	2	0
March 2012	Bridge City, TX*	Flood	1	0
June 2010	Smith County	Flash Flood	0	1
May 2009	Sulphur Springs	Heavy Rain	0	2
Hurricane Ike (2008)	Orange County	Storm Surge/Tide	1	0
	Winnsboro, TX	Flash Flood	1	0
	Smith County*	Tropical Storm	0	2
Hurricane Humberto (2007)	Orange County	Hurricane	1	0
March 2007	Wills Point, TX	Flash Flood	1	0
January 1999	Timpson, TX	Flash Flood	1	0
September 1996	Orange County	Flood	0	1

**Partially located outside of Sabine Flood Planning Region*
Source: NOAA NCEI Storm Events Database

1.A.3.f. Past Losses for Farming & Ranching

While timber is the primary agricultural activity in the region, communities in the headwaters of the Sabine River produce wheat, oats, and other crops. The cumulative reported financial losses due flood impacts on crops in the region since 1990 amounted to over $400,000 as reported by the USDA Risk Management Agency. Estimates from the USDA *Cause of Loss* dataset are summarized in **Table 1-6**, which shows the crop damages by county within the region since 1990.

TABLE 1-6: TOTAL FLOOD-RELATED CROP DAMAGE VALUE BY COUNTY

County	Years of Loss	Indemnity Amount
Collin	1990, 2015	$52, 989
Hopkins	2009	$189,561
Hunt	1990, 1991	$3,642

County	Years of Loss	Indemnity Amount
Kaufman	1998, 2016	$85,734
Newton	1991	$46,625
Orange	1995	$400
Wood	1991,1992,1993,1994	$24,999
	Total	**$403,950**

Source: USDA Risk Management Agency

1.A.4. Political Subdivisions with Flood Related Authority

A range of political subdivisions hold flood related authority in the Sabine Basin, with various and sometimes overlapping jurisdictions or joint responsibilities. State guidelines for "Flood Protection Planning for Watersheds" define political subdivisions with flood related authority as cities, counties, districts or authorities created under Article III, Section 52, or Article XVI, Section 59, of the Texas Constitution, any other political subdivision of the state, any interstate compact commission to which the state is a party, and any nonprofit water supply corporation created and operating under Chapter 67. State law also provides for limited purpose Water Supply & Utility Districts, known variously as Municipal Utility Districts (MUDs), Municipal Water Districts (MWDs), Fresh Water Supply Districts (FWSDs), and Special Utility Districts (SUDs). These districts may be located in or adjacent to cities or in more rural areas and may be involved in the reclamation and drainage of its overflowed land and other land needing drainage.

The majority of political subdivisions within Region 4 are municipal or county governments, both of which enjoy broad authority to set policy to mitigate flood risk. The data collection effort for this plan identified 90 municipalities, inclusive of cities and counties. The political subdivisions with flood-related authority within the region are summarized in **Table 1-7**. Sabine River Authority (SRATX) and Orange County Drainage District (OCDD) have varying degrees of potential flood-related authority.

TABLE 1-7: POLITICAL SUBDIVISIONS WITH FLOOD-RELATED AUTHORITY

Type of Political Subdivision	Number of Jurisdictions	NFIP Participants
Municipality	71	59
Counties	21	21
Drainage District	1	N/A
River Authority	1	N/A
Other Entities	40	N/A

In the Sabine Flood Planning Region, 87% of eligible entities (municipalities and counties) participate in the NFIP. For political entities that participate in the NFIP program, TWC § 16.315 requires them to adopt a floodplain management ordinance and to designate a floodplain administrator who will be

responsible for understanding and interpreting local floodplain management regulations and reviewing them for compliance with NFIP standards.

1.A.5. Extent of Local Regulations & Development Codes

Non-structural flood management includes the use of policies and regulations to reduce the exposure of people and properties to flood risk. By encouraging or requiring communities to avoid developing in flood-prone areas altogether, communities can reduce the likelihood and extent of damages to new development. Benefits can also be gained through precautions such as increasing building elevation, preserving overflow areas through buffering, and avoiding sensitive natural areas such as wetlands. Local regulations and development codes pertaining to flooding include:

Floodplain Ordinances – Floodplain ordinances regulate development, and the impact new development has on a community's floodplain. Community regulations are typically based on FEMA provided flood hazard information but can be based on other local sources of data as well. Participation in the National Flood Insurance Program (NFIP) requires a community to have adopted a floodplain ordinance with minimum requirements established by FEMA.

Building Standards – Building standards may include special considerations for structures located within a floodplain, including minimum finished floor elevations and flood proofing requirements. NFIP requirements also set standards for property owners seeking to renovate structures in a floodplain including those that experience repetitive or severe flood losses.

Drainage Design Standards – Adopted drainage design standards set the minimum standards for stormwater management that must be met prior to the approval of new construction plans. Drainage criteria in the region are typically adopted by municipalities but are also used by counties and levee improvement districts.

Zoning and Land Use Policies – Planning and zoning ordinances regulate acceptable types of land uses within a community to promote appropriate development, safety, and general welfare. Some communities use zoning and land use ordinances to establish open space requirements, conservation easements, and minimum setbacks from creeks and wetlands to preserve floodplain function and promote sustainable and resilient development.

Local and Regional Flood Plans – Local and regional flood plans analyze a community's flood risk and present how that entity will improve its resiliency. Drainage master plans describe a community's physical and institutional planning environment and establish interjurisdictional roles and responsibilities when many drainage entities are present. Capital improvement plans (CIP) identify capital project alternatives for an entity, provide economic analyses for alternatives, and often rank alternatives based on feasibility.

The extent of existing floodplain regulations adopted by entities in the region are shown in **Figure 1-9**. For many entities in the region, regulations or ordinances could not be identified, however the RFPG could not confirm the lack of regulations. Unconfirmed entities were listed as having "Unknown" regulations and were not assumed to have no regulations in place. Local regulations and development codes, as well as their prevalence in planning region, are discussed in greater detail in Chapter 3.

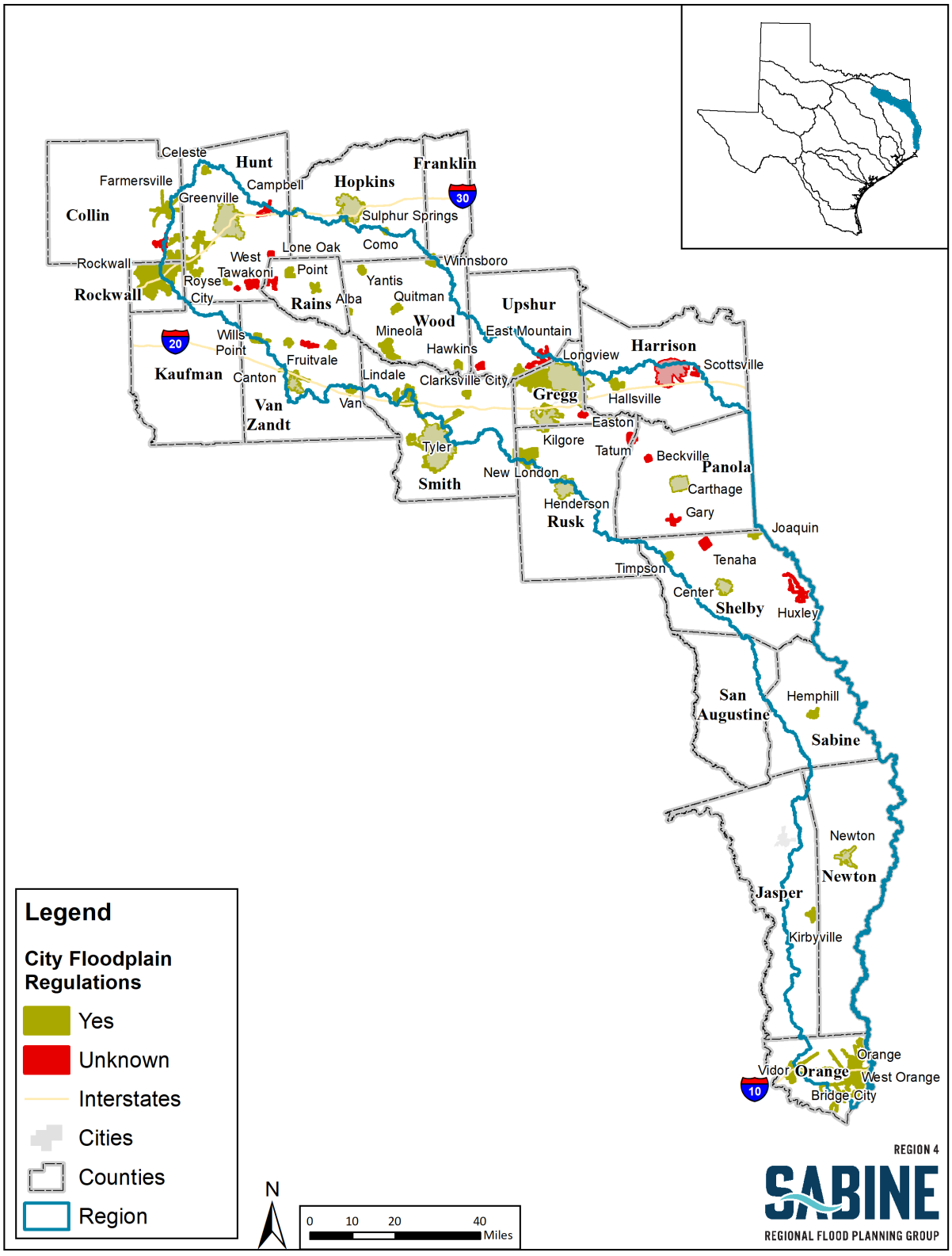

FIGURE 1-9: EXTENT OF FLOODPLAIN REGULATIONS FOR CITIES

1.A.6. Agricultural and Natural Resources Most Impacted by Flooding

Flood events can have a detrimental impact on the agricultural and natural resources of the Sabine Flood Planning Region. Economic factors most at risk include timber (timber, pulpwood, and forest fiber), ecosystem health, petroleum resources (oil and gas production, petroleum refining, and chemical and allied products), farming (hay, rice, soybeans, and vegetables), and livestock production (poultry, cattle, etc.).

1.A.6.a. Farming

Flooding or excess precipitation can wash soil and nutrients downstream or result in complete or partially loss of crops. The severity with which flooding impacts farming depends on many factors, including crop type, what time of year the flood event occurs, and the wind speed of the storm. Additionally, the stage of growth of a crop influences its susceptibility to damage or loss due to excess water. Different crops have different levels of resiliency 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. Further, heavy rainfall prior to planned planting dates could delay planting or prevent it entirely. Damage can also occur after a crop has been harvested. For example, harvested hay or cotton awaiting bailing or processing can be degraded by heavy rainfall in the region.

1.A.6.b. Forestry

Forestry impacts due to flooding are also multifaceted. Flash flooding can bring swift-moving debris that could physically wound a tree, increasing the potential for contaminated flood water to introduce diseases to the plant or weaken it to other stressors such as insects. Sustained flooded 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 (Source: Texas A&M Forest Service). However, under some circumstances flooding can also positively impact forests by clearing weaker trees, spreading seeds, and stimulating growth of surviving trees (Source: University of Arkansas Agriculture Research & Extension).

1.A.6.c. Ranching

Ranching activities, or the practice of raising herds of animals on farmland, can also be 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 vectors such as mosquitoes during flood events. Flood events may also cause delays in building back livestock herds. Damages to feed crops can also reduce ranching capabilities (Source: Texas A&M AgriLife Extension).

1.A.6.d. Natural Resources

The Sabine Flood Planning Region contains many natural resources that can be negatively impacted by flood events. 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 also displace live and

dead livestock as well as dangerous predators such as alligators and snakes into neighborhoods and other densely populated areas. It is often difficult to remove livestock and wild animals because special equipment is needed to capture and remove the animals and heavy equipment is often needed to remove dead livestock. In the meantime, the existence of such animals in a densely populated area poses a significant risk to the population of injury or disease transmission. Oil and gas extraction can also be interrupted by flood conditions.

Flooding is a natural process that has many benefits to human and natural systems. Some flooding is desirable to the natural resources of the Sabine Region. Natural floodplains promote native species, maintain vital ecosystem services, and reduce the chance of flooding elsewhere. Natural landscapes and watersheds also provide flood mitigation functions that should be promoted, protected, enhances, and restored.

1.A.7. Existing Flood Planning Documents

Flood risk across the region is managed through regulations and ordinances as a form of non-structural flood control. Current regulations and development codes include flood plain ordinances, building & design standards, and zoning & land use policies. The following subsections provide insight into the regulatory and policy environment governing floodplain management in the various jurisdictions of Region 4.

1.A.7.a. Floodplain Ordinances

Floodplain ordinances regulate development, and in conjunction the impact that new development has on a community's floodplain. Community regulations are based on FEMA-provided flood hazard information. Participation in the NFIP requires regulations that properly consider flood hazards. Some entities also consider Base Flood Elevations (BFEs) as a regulation criterion.

The most common regulation format is the Flood Damage Prevention Order (for counties) and Flood Damage Prevention Ordinance (for cities). These documents are based on a standard template provided by the NFIP which includes the following major subject headings:

- Preamble: Introduction, General, Who Is Affected, Why is the Program Necessary, 100-Year Flood
- Article 1: Statutory Authorization, Findings of Fact, Purpose and Methods
- Article 2: Definitions
- Article 3: General Provisions
- Article 4: Administration and Article 5: Provisions for Flood Hazard Reduction

1.A.7.b. Building and Design Standards

Most incorporated cities in Region 4 have adopted some form of building code, with the most common examples being the International Building Code (IBC). County jurisdictions do not have set building codes for residential and commercial structures, but most have adopted subdivision regulations and septic site approval mechanisms. Adopted drainage criteria set the minimum standards developments must follow prior to the approval of new construction plans. Drainage criteria in the region are typically adopted by municipalities but are also used by counties and drainage districts. Requirements that are common in the region include mitigating downstream impacts and requiring elevation certificates. Some entities

require stormwater detention to mitigate development impacts, and others require no rise certification for development within the floodway. Some entities in the region require developers to conduct studies to determine BFE prior to design approval and require structures to be elevated at or above the current BFE.

1.A.7.c. Zoning and Land Use Policies

Planning and zoning ordinances regulate acceptable types of land uses within a community. Zoning policies promote appropriate development, safety, and general welfare. Communities establish conservation easements and minimum setbacks from wetlands within land use codes to promote sustainable and resilient development. At the stage when additional communities adopt zoning as a land use development guide, geographic flood risk analysis could be established as a primary data input for decision-making. Similarly, for communities with zoning measures already in place, geographic flood risk analysis could be used in future cycles of zoning evaluation and reconfiguration. With a few noteworthy exceptions, the region is predominantly rural. Relatively low population bases and slow growth patterns are typical. As a result, the implementation of zoning and land use practices should be customized to suit the needs of specific communities.

1.A.7.d. Local and Regional Flood Plans

Local and regional flood plans analyze a community's flood risk and detail how that entity will improve its resiliency. Drainage master plans are required by Texas state law for establishing criteria and regulating drainage in a community. Capital improvement plans (CIP) identify capital project alternatives for an entity, provide economic analyses for alternatives, and often rank alternatives based on feasibility.

For Flood Planning Region 4, no specifically dedicated flood plans were found to be in place, but a close corollary is the broad use and adoption of hazard mitigation plans which include flooding as a technical topic. Additionally, drainage master plans describe a community's physical and institutional planning environment and establish interjurisdictional roles and responsibilities when many drainage entities are present. Within Region 4, the Orange County Drainage District has developed a drainage master plan and associated technical guidance for future infrastructure and development.

Chapter 1.B. Assessment of Flood Infrastructure

This section provides an overview of natural and constructed flood infrastructure in the Sabine Flood Planning Region that contribute to lowering of flood risk. Flood infrastructure in the region includes both natural areas and built features which are owned and managed by stakeholders ranging from the TPWD to individual farmers and ranchers. This plan considers both the natural and man-made features that contribute to risk reduction, which may include:

- Rivers, tributaries, and functioning floodplains
- alluvial fans
- levees
- vegetated dunes
- dams that provide flood protection
- detention and retention ponds
- stormwater canals
- storm drain system
- weirs

- sinkholes
- wetlands
- stormwater tunnels
- tidal barriers and gate

The TWDB provided several data sources to assist with the identification of flood management infrastructure in the Flood Data Hub. There were also a number of questions posed in the data collection survey that were used to complement the information provided by existing data sources to create a more complete picture of how communities in the region protect themselves from flood risk.
A comprehensive inventory of existing flood infrastructure is provided in **Appendix 1-B**. This inventory serves as the basis for several tables, charts, and summary figures provided in this section. Due to the scale of this assessment, the plan includes only major flood infrastructure. For example, regional detention facilities are included, but not small stock ponds servicing individual properties. **Map 1** in **Appendix 1-A** displays the existing flood infrastructure within Region 4.

1.B.1. Natural Features

1.B.1.a. Rivers, Tributaries and Functioning Floodplains

The Sabine River watershed and associated flood plains are described in the following section. Rivers were compiled using the National Hydrologic Dataset (NHD) layer. Functioning floodplain is a broad term used to describe a natural area susceptible to flooding that provides a broad range of ecological and hydrological functions, including the flood storage, water quality maintenance, and groundwater recharge. Functioning floodplain areas were compiled using the NHD dataset.

The Sabine River headwaters begins with the convergence of three branches that feed Lake Tawakoni. Traversing southeast across East Texas, the Sabine River delineates the Texas-Louisiana border south of Panola County. The Sabine River captures drainage from the south side of the Cypress Watershed to the North side of the Neches Watershed on its course to the Gulf Coast. The Sabine River and its tributaries combine for a total of 6,455 stream miles, 9,756 square miles of contributing drainage area (in both Texas and Louisiana), and 2,509 square miles of functioning floodplain within the planning region. **Map 4** in **Appendix 2-A** shows the extent of the 1% and 0.2% annual chance flood hazard areas throughout the region.

1.B.1.b. Wetlands and Marshes

A wetland is an ecosystem that is flooded by water, either permanently, seasonally, or after discrete rainfall events. Wetlands provide an important ecosystem for aquatic plants and animals, as well as significant flood storage. The planning region contains over 679,000 acres of freshwater wetlands concentrated within its major floodplains. Wetland features were compiled from the US Fish and Wildlife Service's Nation Wetlands Inventory Mapper. **Map 1** in **Appendix 1-A** shows existing flood infrastructure including wetlands throughout the region.

1.B.1.c. Parks, Preserves, and Other Natural Areas

Parks and preserves are included in the flood infrastructure assessment because they include essential components for infiltration and retention of stormwater during and after a rainfall. These types of

natural flood infrastructure are generally located within or adjacent to floodplain areas throughout the basin with higher concentrations of them being located along or close to the major rivers. Parks, national forests. And wildlife management areas in the region account for over 160,00 acres within the Sabine Region. **Table 1-8** lists the natural areas within the Sabine Flood Planning Region.

TABLE 1-8: PARKS, PRESERVES, AND OTHER NATURAL AREAS IN SABINE FLOOD PLANNING REGION

Park Name	Location
Martin Creek Lake State Park	Rusk County
Tyler State Park	Smith County
Lake Tawakoni State Park	Hunt, Rains, Van Zandt Counties
Sabine National Forest	Sabine, San Augustine, Shelby, Jasper, and Newton Counties
Tawakoni WMA	Hunt, Rains, Van Zandt Counties
Old Sabine Bottom WMA	Smith County
Moore Plantation WMA	Jasper and Sabine Counties
North Toledo Bend WMA	Shelby County

*WMA = Wildlife Management Area

1.B.1.d. Coastal Areas

Estuaries denote places of transition between riverine and coastal environments. The Sabine-Neches Estuary covers approximately 100 square miles and includes the Sabine Lake, the Sabine-Neches and Port Arthur Canals and Sabine Pass. Both the Neches and Sabine Rivers contribute freshwater flow to the estuary, where it meets salt water from the Gulf of Mexico. The Sabine Lake supports extensive coastal wetland ecosystems and is connected to the Gulf of Mexico via Sabine Pass, which acts as a tidal inlet.

1.B.2. Constructed Flood Infrastructure and Structural Protections

A vast number of stormwater features have been constructed across Texas. From major flood control infrastructure such as reservoirs, dams, and levees, to municipal drainage systems made up of constructed channels and ditches, closed storm drain systems, and detention and retention ponds, each piece plays an important role in protecting Texas communities from flooding. **Table 1-9** summarizes the major reservoirs located within the Sabine Region. The TWDB-provided several data sources to assist with the identification of flood management infrastructure in the Flood Data Hub, such as Dams, Levees, Reservoirs, Stream gages, High Water Marks, and Low Water Crossings. Low Water Crossings included in the Sabine RFP were provided by TxDOT.

1.B.2.a. Dams, Reservoirs, Levees, and Weirs

Reservoirs and their associated dams and weirs in Texas serve many purposes including recreation, flood risk mitigation, irrigation, water supply, hydro-electric generation, and fire protection. Twelve major reservoirs are identified in the Sabine Region, summarized in **Table 1-9**.

TABLE 1-9: LIST OF MAJOR RESERVOIRS IN SABINE FLOOD PLANNING REGION

Lake/Reservoir	Location	Surface Acres	Normal Impoundment Capacity (acre-feet)	Specifically Designed Flood Control Purpose (Yes/No)
Toledo Bend Reservoir*	Newton, Shelby & Sabine Counties	181,600	4,447,000	No
Lake Tawakoni	Hunt, Rains & Van Zandt Counties	36,700	927,440	No
Lake Fork Reservoir	Hopkins, Rains & Wood Counties	27,699	675,819	No
Martin Lake	City of Tatum	5,020	77,619	No
Lake Cherokee	Gregg & Rusk Counties	3,987	46,700	No
Lake Murvaul	Gary City	3,820	45,840	No
Brandy Branch Reservoir	Harrison County	1,242	29,513	No
Lake Hawkins	City of Hawkins	1,260	27,079	No
Lake Winnsboro	Wood County	1,650	25,101	No
Lake Quitman	City of Quitman	1,570	24,370	No
Lake Holbrook	City of Mineola	1,070	17,740	No
Lake Gladewater	City of Gladewater	800	6,950	No

**Partially located outside of Sabine Flood Planning Region*
Source: Sabine River Authority, Hazard Mitigation Plan (Version 1)

Toledo Bend Reservoir

Toledo Bend forms a portion of the boundary between Texas and Louisiana. From the dam site the reservoir extends up the river for about 65 miles to Logansport, Louisiana, and inundates land in Sabine, Shelby, Panola, and Newton Counties, Texas, and the Sabine and DeSoto Parishes, Louisiana. Toledo Bend Reservoir is one of the largest man-made bodies of water in the southern United States and sixth largest in surface acres in the United States, with water conservation pool covering an area of 181,600 acres and a controlled storage capacity of 4,477,000 acre-feet. The Toledo Bend Project was constructed by the Sabine River Authority of Texas (SRATX) and the Sabine River Authority of the State of Louisiana (SRALA) and managed as a joint project. The reservoir was constructed for the purposes of water supply, hydroelectric power generation, and recreation. Similar to the other dams in the Sabine Region, flood control is not a specifically designed purpose for Toledo Bend Reservoir.

Operation of the project for hydroelectric power generation and water supply yields 1.8 billion gallons per day, shared equally by Texas and Louisiana. Most of this water is passed through turbines for electric power generation and is available downstream for municipal, industrial, and agricultural purposes.

Lake Tawakoni

This water supply project of SRATX is located in line with the Sabine River immediately above the old Iron Bridge Crossing on FM 47, about 10 miles northeast of Wills Point, Texas. Surface area of the reservoir at spillway crest is 36,700 acres with approximately 23,400 acres located in Hunt County, 10,600 acres located in Rains County, and 2,700 acres located in Van Zandt County. The permit for project construction was issued by the State Board of Water Engineers on December 20, 1955. The land acquisition for the impoundment area was initiated in 1956 and completed by October 1960 and the subsequent construction on the dam began in January 1958 and was completed in October 1960.

Construction of the Iron Bridge Dam and Reservoir Project was funded through a water supply agreement with the City of Dallas to provide water for municipal and industrial purposes. The reservoir storage capacity at conservation pool level is 926,000 acre-feet. The typical annual yield of the reservoir is approximately 238,100 acre-feet per year. The Sabine River drains an area of about 9,756 square miles, of which 752 square miles, or approximately 8% of the total Sabine River basin, are above the Iron Bridge Dam. Principle tributaries above the dam are South Fork, Caddo Creek, and Cowleech Fork. These tributary watersheds come together to form the oak-leaf shaped basin in which Lake Tawakoni is formed. Annual rainfall over the Lake Tawakoni basin averages 39.5 inches, although it has varied from a recorded maximum of 63.7 inches in 1946 to a recorded minimum of 17.6 inches in 1910.

Lake Fork Reservoir

This reservoir is located on Lake Fork Creek, a major tributary of the Sabine River, about 5 miles west of Quitman, Texas in the northeast portion of the state. The reservoir, which is owned and operated by the SRATX, is located in Wood, Rains, and Hopkins Counties. Preliminary engineering studies for the Lake Fork Reservoir Project were initiated in November 1972. Construction work on the project began in the fall of 1975. Final closure of the dam was made in February 1980, and conservation pool level was reached in December 1985. A total of 41,100 acres of land were acquired for the project. Lake Fork Reservoir has a surface area of 27,690 acres at conservation pool elevation 403.0 feet msl and extends up Lake Fork Creek about 15 miles.

The funding for the construction dam to impound the Lake Fork Reservoir was through a water supply agreement with Texas Utilities Generating Company, Inc. (TUGCO) to provide water for municipal and industrial uses. TUGCO and the Cities of Dallas and Longview have previously contracted for purchase of water from the reservoir. The reservoir's storage capacity at the 403-foot msl conservation pool level is 675,819 acre-feet.

Lake Fork Creek originates in the southeastern corner of Hunt County and flows in an easterly direction for 78 miles to its confluence with the Sabine River eight miles southeast of Mineola. The stream drains an area of approximately 685 square miles, or approximately 7% of the total Sabine River basin, in Wood, Rains, and Hopkins Counties in the uppermost northeast portion of the planning region. Approximately 493 square miles of the Lake Fork Creek drainage area lies above the reservoir dam site. Typical rainfall exceeds 40 inches per year. The remaining identified dams in Region 4 each have

impoundment capacities less than 80,000 acre-feet. The origin and purpose of each of these dams are not well documented. As a result, all identified dams have been included as part of this inventory since they potentially serve a flood protection function.

Levees

Levees are man-made embankments that artificially contain flood flows to a restricted floodplain. More than one million Texans and $127 billion dollars' worth of property are protected by levees. The Texas 2018 Levee Inventory Report lists 51 USACE levee systems, notably the Dallas Levee System along the Trinity River and several levee systems protecting the low-lying areas of coastal Texas. Eight levee systems were identified in the Sabine Region, four in Orange County and four in Hunt County, as listed in **Table 1-10**.

TABLE 1-10: IDENTIFIED LEVEES IN SABINE FLOOD PLANNING REGION

System ID	Levee Name	Location
1605885411	Orange County Lake Levee System	Orange County
1605995054	Orange County Sub Levee Left 2	Orange County
1605995055	Orange County Sub Levee Right 5	Orange County
1605885415	DuPont Plant Reservoir System	Orange County
1605617003	Lower Caddo Creek System 2	Hunt County
1605617004	Lower Caddo Creek System 1	Hunt County
1605617002	Cowleech Fork System	Hunt County
1605617001	Upper Caddo Creek System	Hunt County

1.B.2.b. Stormwater Management Systems

Stormwater management systems serve to manage both the quantity and quality of the water that drains into natural waterways. The TCEQ regulates the discharge of municipal separate storm sewer systems (MS4s) through the two sets of permits administered under the Texas Pollutant Discharge Elimination System (TPDES), known as Phase I (large) or Phase II (small) MS4 permits. To be subject to MS4 permit requirements, a community must own and operate storm drainage infrastructure.

Phase I MS4s are cities that had populations exceeding 100,000 as of the 1990 census. There are no Phase I MS4s in the Sabine Flood Planning Region. A handful of cities in the region are subject to the Phase II MS4 permit, which applies to communities of any size located at least partially within a census-designated urbanized area. The cities of Canton, Carthage, Center, Grand Saline, Greenville, Hallsville, Kilgore, Lindale- Longview, Marshall, Mineola, Quitman, Van, West Tawakoni, Wills Point, and Winnsboro are all subject to Phase II MS4 requirements, and thus own and operate storm drainage infrastructure. The cities of Henderson, Lindale-Hideaway, Sulphur Springs, and Tyler are also classified Phase II MS4 though are only partially in the planning region.

While it is likely that most communities maintain at least a limited amount of storm drainage infrastructure, there is no publicly available dataset of municipal storm drain systems. As a result, collection of spatial data for this plan relied on survey responses. Survey respondents provided information showing they maintain public drainage systems; the Cities of Longview and Kilgore have provided spatial data to include in the GIS inventory at time of writing.

1.B.2.c. Storm Drain Systems and Stormwater Canals

Few publicly digital datasets of municipal storm drain systems are available within the planning region. Storm drain infrastructure is available for the cities of Kilgore and Longview. Kilgore maintains approximately 6 miles of storm drains and over 2 miles of open storm channels. Longview's storm drain system stretches a combined 230 miles long throughout the city. It is known that many other cities maintain storm drain systems, but specifications cannot be provided without digital datasets.

Increasing public engagement in the flood planning process can result in finding both the location and extent of tunnels and canals within the region to be reflected in future updates to the Sabine RFP. To counter this, collection of spatial data of storm drain systems for this plan relied on survey responses. While survey respondents provided information indicating that the entities, they represent maintain public drainage systems, most respondents unfortunately did not have spatial data to include in the GIS inventory.

1.B.2.d. Detention and Retention Areas

Several ponds have been identified within city extents and residential areas throughout the planning region. However, further refinement of the available spatial data is needed to ascertain if these ponds identified are intended for retention and/or detention purposes or if they were designed for another function such as recreation. The City of Kilgore maintains a publicly available dataset of detention points which includes over 7 square miles of ponds and 84 square miles of lakes. Identifying detention and retention areas will be an area of focus in later updates to the Sabine RFP.

1.B.2.e. Coastal Areas

Within the Sabine planning region, the counties of Orange, Jasper, and Newton, either border or are within close proximity to the Texas coastline. Sea barriers and revetments have yet to be ascertained to be within the confines of the Sabine basin. No existing floodwall is present within the region, but 26 miles of new earthen levees and concrete floodwalls within Orange County are planned as part of the Orange County Element of the Sabine Pass to Galveston Bay Coastal Storm Risk Management Program which is included in Chapter 4 and Chapter 5 as a recommended flood mitigation project (FMP).

1.B.3. Assessment of Condition and Functionality of Existing Infrastructure

The State Flood Data Hub from TWDB provided little information about the condition of the region's flood mitigation features. Participants in the Sabine planning region data collection effort provided little information that could supplement the information provided by the TWDB. However, throughout Texas, flood infrastructure is rapidly aging and in need of repair.

Of the communities that responded to the survey, over 60% noted that at least 25% of their flood infrastructure was non-functional, and 73% noted that at least 25% was deficient for current flood mitigation needs. The most common reason given for non-functional and deficient constructed infrastructure was inadequate operation and maintenance budgets and lack of adequate standards during original construction. For natural features, impacts for development were cited as causing non-functional or deficient infrastructure. A summary of survey responses on infrastructure is included in **Table 1-11**. **Map 3** in **Appendix 1-A** includes a graphical representation of assessment of flood infrastructure in Region 4. Low Water Crossings (LWCs) were identified using sites identified by TxDOT provided TNRIS.

1.B.3.a. Dam Safety Assessment

The Texas State Soil and Water Conservation Board (TSSWCB) estimates about $2.1 billion is needed to repair or rehabilitate dams included in the Small Watershed Programs. Even though the minority of the dams in the region were built for flood control, the consequences of dam failure can still be severe, with losses of life, agricultural resources, and property. Of the 7,200 non-federal dams in Texas, approximately 25% could result in loss of life should they fail. More than 3,200 Texas dams are exempt from dam safety requirements by State legislation, which represents almost half of these dams. The Region 4 RFP analyses identified 341 dams in the planning region, spanning the area from Greenville to Sabine Pass. Of those 341 dams, 117 are state regulated. Of the state regulated dams, TCEQ identified 15 dams as being in poor condition, and 31 as not being hydraulically adequate.

TABLE 1-11: NON-FUNCTIONAL AND DEFICIENT INFRASTRUCTURE SURVEY SUMMARY

Entity	Infrastructure	Non-Functional	Deficient
Kilgore	Storm Drain System	25%	25%
	Rivers, Creeks, Tributaries, and Functioning Floodplains	25%	25%
Van	Stormwater Canals	50%	50%
	Storm Drain System	50%	75%
Longview	Regional Detention Facility	100%	N/A
	Storm Drain System	100%	25%
Orange County Drainage District	Regional Detention Facility	0%	0%
	Storm Drain System	0%	25%
	Rivers, Creeks, Tributaries, and Functioning Floodplains	0%	25%
	Pump Stations	N/A	0%
	Stormwater Tunnels	0%	N/A
Winona	Storm Drain System	25%	50%
Royse City	Weirs	100%	100%
	Regional Detention Facility	25%	25%
	Storm Drain System	25%	50%

Entity	Infrastructure	Non-Functional	Deficient
	Rivers, Creeks, Tributaries, and Functioning Floodplains	25%	25%

1.B.3.b. Levee Safety Assessment

Condition-related data for the region's levees is largely unknown, due to the fact that most of the levees in the state are built, inspected and/or maintained by local governing agencies who may not have the resources for routine assessment and performance tracking. Recent increases in frequency and intensity of storms continue to test the capacity of the state's levees. More than 75% of Texas levee systems are without screened risk classification. A clearer picture of levee infrastructure in the state is needed as well as coordinated funding efforts to assist private owners. Without this, a significant portion of the levees in the state of Texas will be presumed deficient. The condition of levees across the region is unknown at this time.

1.B.4. Ongoing Flood Infrastructure Improvements

Ongoing flood mitigation projects in the region were documented as a part of the flood planning effort. Regional flood studies in the Upper Sabine and Lower Sabine watersheds are ongoing and the flood mitigation project alternatives development in these studies will be considered for inclusion in future region flood planning cycles.

In Orange County there are multiple ongoing flood mitigation efforts using funding made available by the federal disaster declaration for Hurricane Harvey in 2017. These efforts include property acquisition, property elevation, bank stabilization, and culvert improvements. In particular, the ongoing FMA-PJ-06-TX-2019-008 grant that Orange County received is to mitigate flood prone structures by elevation. A feasibility study of the Sabine River Relief Ditch Extension and Expansion Project is anticipated to be completed in 2023.

The Orange County Costal Storm Risk Management study is an ongoing study analyzing federal flood protection project with the Gulf Coast Protection District (GCPD) serving as the non-federal sponsor, and Orange County and the Orange County Drainage District serving as the liaison representative of the GCPD regarding design of the project. According to the USACE, preconstruction engineering and design will conclude by the end of 2022. Construction is expected to begin in 2023 and be completed by 2028.

Map 2 in **Appendix 1-A** includes the proposed and/or ongoing flood mitigation projects within Region 4. The list of identified ongoing flood mitigation projects in included in **Table 2** in **Appendix 1-C**. **Figure 1-10** below shows all the areas within the planning region with an ongoing project.

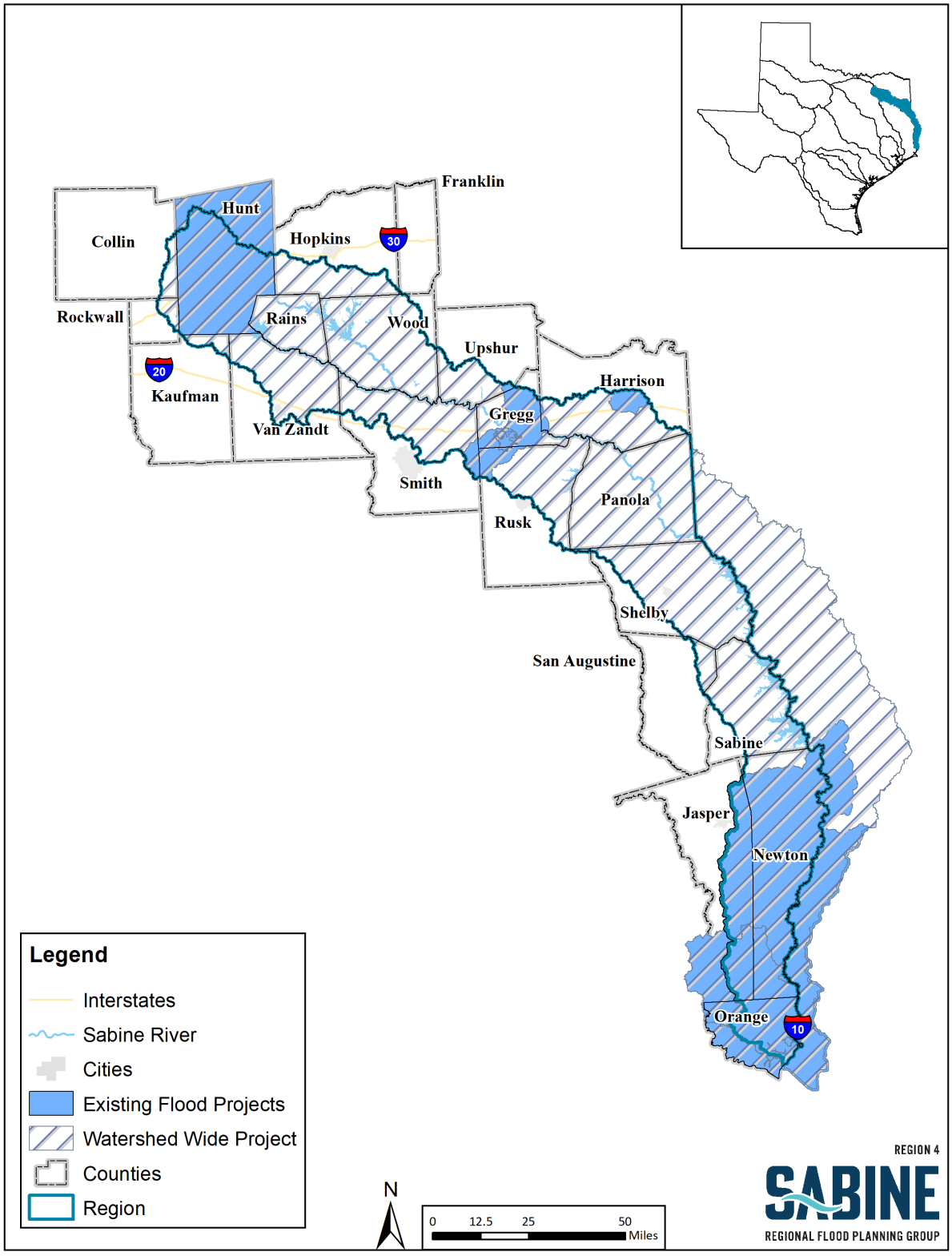

FIGURE 1-10: EXISTING FLOOD PROJECTS

More than half of the ongoing projects are a direct response to disaster declarations issued in response to the recent severe flooding events that have impacted the region. These projects include programs such as voluntary property acquisition that are beneficial as they acquire structures or areas that are flood prone and prevent monetary damage and loss of life due to future flood events. In addition, acquisition projects allow former residents to relocate to areas less susceptible to flood risk. There are also three ongoing watershed level studies, sponsored by the TWDB Flood Infrastructure Fund (FIF) in Hunt County, Upper Sabine (Rusk, Smith and Gregg Counties) and the Lower Sabine (Newton, Sabine and Orange Counties). Recommendations from these ongoing FIF studies are anticipated to be potentially included in the late phases of this planning cycle or in the subsequent one. The categories into which existing projects fall are included in the list below.

- Infrastructure
- Detention Pond
- Property Acquisition
- Property Elevation
- Preparedness
- Watershed Planning
- Project Planning

Most of the funding come from FIF, with a total of seven projects. In addition, six of the projects are funded by the Hazard Mitigation Grant Program (HMGP), four are funded by Community Development Block Grant Disaster Recovery (CDBG-DR), and one of the projects is funded by a utility fund. More information on funding sources for existing projects can be found in **Chapter 9**. The list below shows the list of funding sources for the existing projects.

- HMGP
- CDBG-DR
- FIF
- Utility Fund

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CHAPTER 2
FLOOD RISK ANALYSES

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CHAPTER 2. FLOOD RISK ANALYSIS

The goal of Task 2 was to perform a comprehensive and cohesive flood risk analysis for the planning region. Flood risks for the 1% annual chance (100-yr) and 0.2% annual chance (500-yr) events were assessed. The analysis was performed for existing conditions of the basin, as well as a future condition scenario that considers changes in flood hazards over the 30-year planning horizon. As shown in **Figure 2-1**, the overall flood risk analysis is comprised of three separate but related evaluations, including:

1. Flood Hazard Analyses – characterizes the location, magnitude, and frequency of flooding.
2. Flood Exposure Analyses – identifies who and what might be harmed within the region; and
3. Vulnerability Analyses – identifies vulnerabilities of communities and critical facilities.

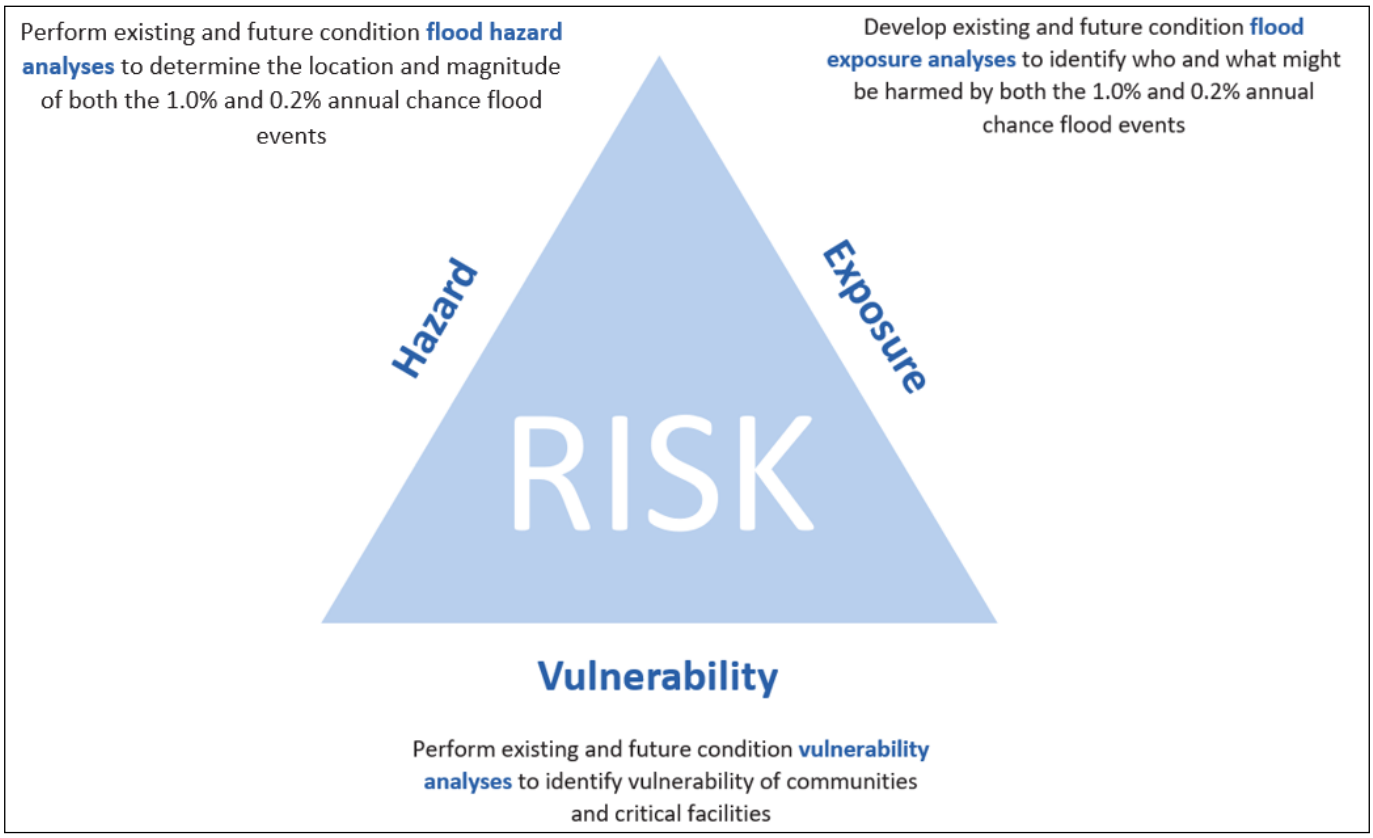

FIGURE 2-1: FLOOD RISK ANALYSIS COMPONENTS

Source: TWDB Exhibit C Technical Guidelines for Regional Flood Planning. April 2021

Chapter 2.A. Existing Condition Flood Risk Analysis

2.A.1. Existing Condition Flood Hazard Analysis

The existing conditions flood hazard analysis was comprised of two major components. First, flood hazard areas were compiled to represent the inundation area anticipated for a 1% and 0.2% annual chance flood events. Later, the people and property exposed to the flood risk were analyzed. The following sections describe the process that was undertaken to determine and quantify flood hazards in the region and present the results of the evaluation, including a summary of the types and magnitude of flooding and the communities most susceptible to its negative effects.

2.A.1.a. Characterization of Existing Condition Floodplains

Initial floodplain information was provided by the TWDB in a multi-source flood dataset compiled to disseminate flood-risk information coverage and availability across the state, referred to as the "floodplain quilt". The floodplain quilt dataset included flood data from FEMA's National Flood Hazard Layer (NFHL), FEMA's Base Level Engineering (BLE), First American Flood Data Service (FAFDS), and Cursory Floodplain dataset. TWDB supplemented this dataset after the second release of statewide Cursory Floodplain Data in late October 2021. A secondary source of commercially available "cursory floodplain data" was utilized to help fill in the remaining gaps. The cursory floodplain data was generated through 2D rain-on-grid hydraulic modeling performed by Fathom. The data was made available by the TWDB through two separate deliverables in July and October of 2021. The primary differences between the deliverables were the data source and resolution for the terrain model, as well as the recurrence intervals evaluated. The Cursory Floodplain Data available are summarized in **Table 2-1**. The October 2021 release of Cursory Floodplain Data was used in the development of this plan.

TABLE 2-1: CURSORY FLOODPLAIN DATA SUMMARY

#	Deliverables	Terrain Source	Modeling Terrain	Mapping Terrain	Recurrence Intervals (Years)	Deployment
1	Draft Cursory Floodplain (raster only)	Digital Elevation Model (DEM)	30 M DEM	30 M DEM	10, 100, 1000	July 2021
2	Cursory Floodplain	Light Detection and Ranging (LiDAR) Data	30M LiDAR	3M LiDAR	5, 10, 100, 500	October 2021

Best Available Data

Per the TWDB guidelines, the initial ranking order of the floodplain quilt data is as follows:

1. NFHL Pending Data
2. Preliminary NFHL Data
3. NFHL Effective Detailed Data
4. Estimated BLE Data

5. NFHL Effective Approximate Data
6. FAFDS Data
7. Cursory Floodplain Data

However, TWDB gave authority to re-prioritize the flood hazard data as the RFPG deemed appropriate. The process to prioritize flood risk data adopted by the Sabine RFPG is outline below.

The adequacy of NFHL data was evaluated for inclusion in the flood hazard datasets. Approximate floodplains, denoted as Zone A in FEMA mapping, were deemed to not be adequate or reliable mapping compared to other available data sources. Zone A represents an approximate or estimated inundation limits and is not based on a detailed study or detailed floodplain mapping. Furthermore, this mapping – which covered a large portion of the planning region – does not have 0.2% annual chance mapping or data which is required as part of this Regional Flood Plan. Thus, all Zone A mapping was removed from the compiled mapping.

Additionally, all NFHL mapping which was backed by a detailed study was also evaluated by reviewing the Flood Insurance Study (FIS) reports for each county. Most of the associated modeling which was used to produce the detailed mapping was performed with outdated HEC-1 and HEC-2 modeling. The year 2007 was used as a cutoff for modeling, data, and associated floodplain mapping. Data produced before 2007 is no longer sufficient compared to current modeling practices. Studies predating 2007 were excluded from the flood hazard layer. Studies completed with current modeling software, and more recent than 2007 were kept in the flood hazard layer. In all areas where FEMA mapping was present but considered to be inadequate, flood hazard data was replaced with Cursory Floodplain Data from October 2021 as this study considers for recent rainfall and land use information. **Table 2-2** below lists all effective NFHL flood insurance studies available in the region, noting which were included in the existing condition flood risk analysis.

TABLE 2-2: NFHL DATA FOR SABINE FLOOD PLANNING REGION

County/Entity	NFHL Effective Date	Hydraulic Analyses Date	Hydraulic Model for Zone AE Analyses	Accept Zone AE/X for Existing Flood Hazard
Orange	2021	1984	HEC-2	No
Newton	2018	2015	HEC-RAS 4.1	Yes
Collin	2017	2006	HEC-RAS 3.1.2	Yes
Gregg	2014	1999	HEC-2	No
Harrison	2014	1997	Revised 1997 model with regression equations and HEC-2	No
Smith	2014	2008	HEC-2	No
Kaufman	2012	2012	HEC-RAS 3.1.3	Yes
Rains	2012	2012	No detailed study	No
Hunt	2012	1998, 1991	WSPRO on Sabine River, HEC-2 Countywide	No
Hopkins	2011	2011	No detailed study	No

County/Entity	NFHL Effective Date	Hydraulic Analyses Date	Hydraulic Model for Zone AE Analyses	Accept Zone AE/X for Existing Flood Hazard
Upshur	2010	2010	No detailed study	No
Rusk	2010	2010	HEC-2	No
Wood	2010	2010	No detailed study	No
Jasper	2010	2010	HEC-1	No
Van Zandt	2010	2010	HEC-2	No
Rockwall	2008	2008	HEC-RAS 3.1.3	Yes
City of Kilgore	1996	1996	HEC-2	No
Franklin	--	--	No Effective FIS	--
Panola	--	--	No Effective FIS	--
Sabine	--	--	No Effective FIS	--
San Augustine	--	--	No Effective FIS	--
Shelby	--	--	No Effective FIS	--

Additional flood risk models were identified in addition to NFHL data. Base Level Engineering (BLE) was present in the middle portion of the watershed around the Toledo Bend Reservoir. The BLE study was completed in January 2021 and includes 1% annual chance and 0.2% annual chance events mapping. cursory floodplain data was used outside of the Toledo Bend Reservoir Watershed as BLE was determined by TWDB to be of higher priority than Cursory Floodplain Data. Coastal flood risk was incorporated into the existing condition analysis using the Orange County FIS as this analysis was completed in 2014.

TABLE 2-3: ADDITIONAL EXISTING HYDROLOGIC & HYDRAULIC MODELS

Model	Description	Location	Source of Data	Date Released
Toledo Bend Reservoir Watershed Hydraulic Analysis (BLE)	Steady flow HEC-RAS (v5.0.7) models developed for the 10-year, 25-year, 50-year, 100-year, and 500-year flood events	Newton, Sabine, San Augustine, Shelby, Panola Counties	FEMA	2021
Cursory Floodplain	Developed for 5-year, 10-year, 100-year, and 500-year flood events	Statewide	Cursory Floodplain Data	2021
Kilgore Downtown Storm Sewer	HEC-HMS and EPA-SWMM models create for the Kilgore Downtown Storm Sewer Master Plan	Gregg	City of Kilgore	2014

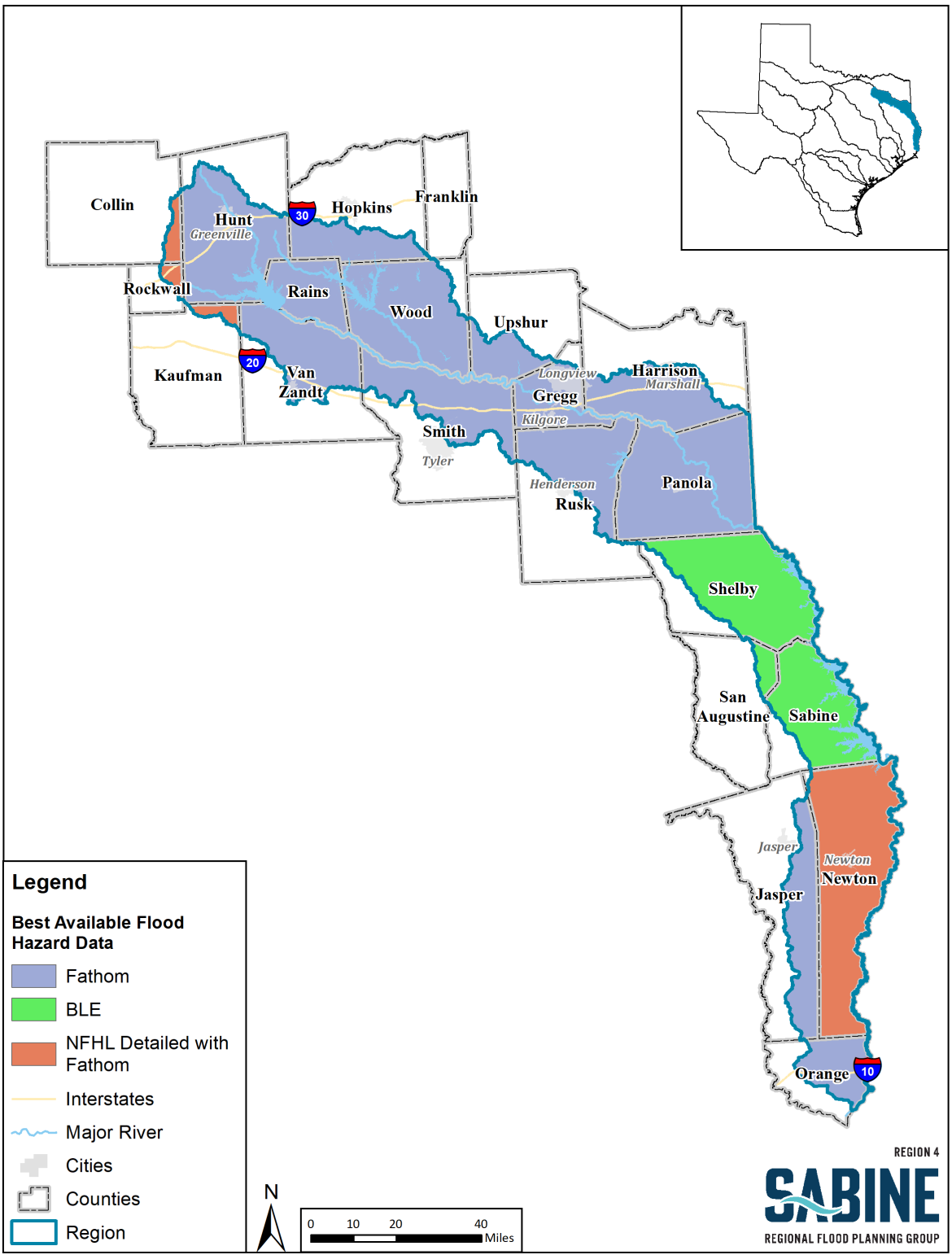

FIGURE 2-2: BEST AVAILABLE FLOOD HAZARD DATA

Data Gaps

Flood data gaps were defined as areas deemed to have inadequate flood risk mapping, map gaps and how the flood plan will address the lack of information are discussed further in Chapter 4. For the gap analysis, the RFPG determined that any HUC12 that is not completely covered in detailed and updated flood risk mapping was considered a data gap. This results in the entire region being listed as a gap, though this was further refined based on the severity of the gap, i.e., an area that has old mapping information versus an area that has had no mapping performed. Additionally, flood hazard data in areas of the region which experienced updated rainfall patterns reflected in NOAA Atlas 14, were required by the Sabine RFPG to incorporate updated rainfall to be considered with adequate flood risk mapping. **Figure 2-3** shows the statewide areas of significant change in rainfall with respect to the Sabine Flood Planning Region boundary. Data gap information is presented visually in **Map 5** (**Appendix 2-A**), which breaks down the data gaps by HUC-12.

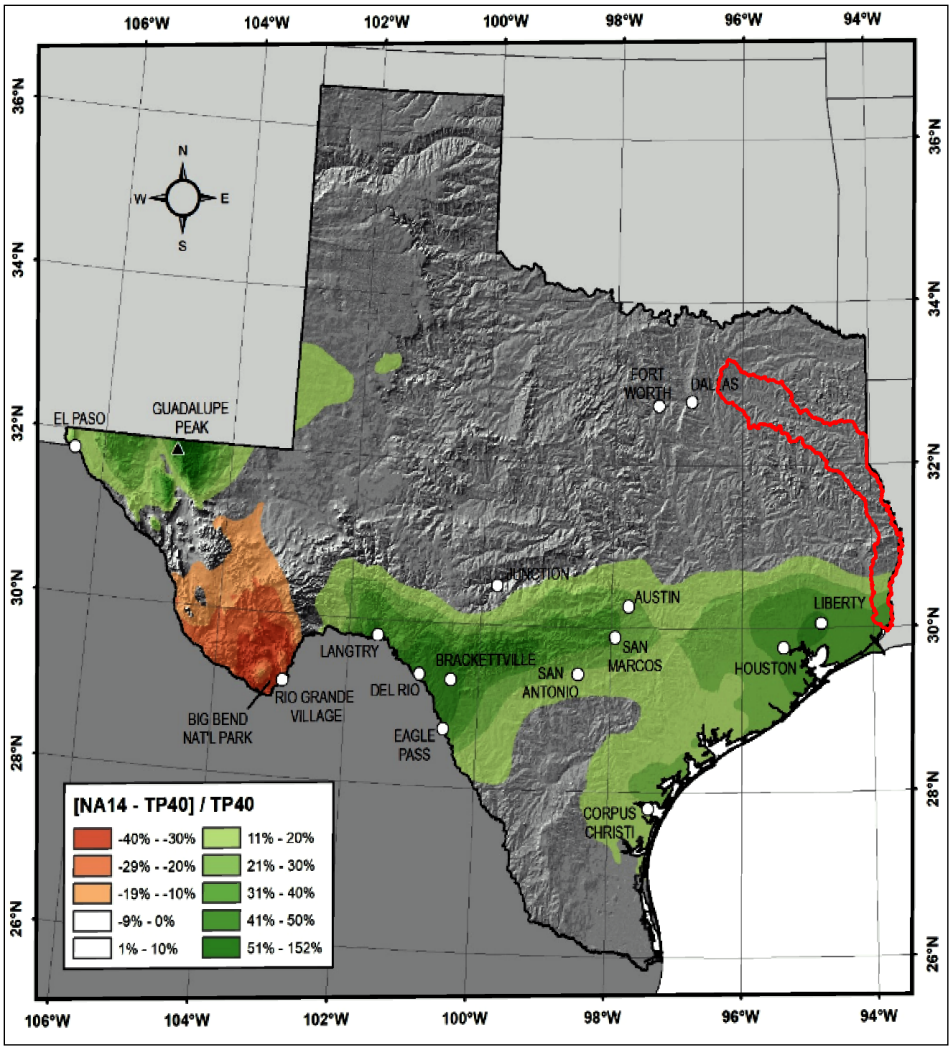

FIGURE 2-3: RAINFALL INCREASE BETWEEN ATLAS 14 AND TP 40

Adapted from NOAA Atlas 14 Precipitation – Frequency Atlas of the United States, Department of Commerce, NOAA

The Lower Sabine River watershed experiences substantial change in rainfall data with the Atlas 14 update. Lower Sabine consists of Orange, Newton, and Jasper Counties. Coastal areas of Orange Counties had up to 50% increase in rainfall from TP40 to Atlas 14. Rainfall values in the planning region for TP40 and Atlas 14 are shown in **Table 2-4.**

TABLE 2-4: RAINFALL INCREASE BETWEEN ATLAS 14 AND TP40

Watershed	TP40 Rainfall (in)	Atlas 14 Rainfall (in)
Upper Sabine	9.8-10.0	9.8-10.0
Lake Fork	9.8-10.0	9.8-10.0
Middle Sabine	10.0-11.0	9.8-10.0
Toledo Bend Reservoir	11.0-12.0	11.0-12.0
Lower Sabine	12.0-13.3	12.0-18.3

Possible Flood Prone Areas

Possible flood prone areas are areas that the RFPG identified as prone to flooding, outside of previously mapped flood hazard areas. They can be identified through the location of hydrologic features, historic flooding, and/or local knowledge. The Sabine RFPG choose to utilize public comments collected through the online survey as flood prone areas. The source of flood prone areas were comments on an ArcGIS Online web map where the public could report areas of flooding. This web map was shared on the RFPG website, as well as emailed to community officials in the region. Points that were outside of the 1% and 0.2% annual chance events flood hazard areas would be delineated as possible flood prone areas based on the description included in the comment. However, all public comments concerning flooding were already located within the 1% existing condition's annual chance events flood hazard area. The comments received are shown on **Map 5**.

2.A.1.b. 1% and 0.2% Annual Chance Exceedance Floodplains

A series of flood hazard area maps displaying existing conditions flood risk is in included in **Appendix 2-A**. Combined, these maps serve as TWDB required **Map 4.** These floodplains cover approximately 2,500 square miles and 34% of the land area in the planning region. Of the mapped flood hazard area, 2,310 square miles are inundated during the 1% annual chance event, an additional 176 square miles are inundated during the 0.2% annual chance floodplain. **Figure 2-4** shows the area in the region by flood frequency and county. **Table 2-5**: Existing Flood Hazard Area by County in shows the total land areas in square miles of each flood risk by flood risk type, county, region, and frequency.

TABLE 2-5: EXISTING FLOOD HAZARD AREA BY COUNTY IN SQUARE MILES

County	1% ACE	0.2% ACE	Coastal Hazard
Collin	8.89	9.73	0
Franklin	0.06	0.07	0
Gregg	72.71	78.69	0
Harrison	109.00	115.32	0
Hopkins	52.49	55.28	0
Hunt	174.69	184.74	0
Jasper	126.52	141.09	0

County	1% ACE	0.2% ACE	Coastal Hazard
Kaufman	8.14	8.53	0
Newton	375.69	418.82	0.17
Orange	148.34	177.75	37.03
Panola	312.73	328.59	0
Rains	84.79	88.00	0
Rockwall	7.62	8.15	0
Rusk	103.43	108.86	0
Sabine	130.71	138.98	0
San Augustine	4.71	5.09	0
Shelby	143.21	150.87	0
Smith	109.27	114.52	0
Upshur	43.79	46.29	0
Van Zandt	101.63	106.87	0
Wood	192.27	200.65	0
Total	**2,310.67**	**2,486.88**	**37.20**

2.A.2. Existing Condition Flood Exposure Analysis

After the existing condition flood hazard areas were defined, the existing condition flood exposure analysis was performed to identify the people and property at risk. The exposure analysis considered several data sets representative of people and property in the region including population, structures, critical facilities, agricultural land, and public infrastructure. This analysis determined the features that spatially intersected with the flood hazard area boundaries. The results of the exposure analysis are summarized in **Table 3 (Appendix 2-B**). Values presented for each county only represent the portion of the county within the Sabine Flood Planning Region, and exclude all features located within other planning regions.

2.A.2.a. Existing Development within Flood Hazard Areas

The following sections describe the results of the existing flood exposure analysis through a series of maps for each type of exposure evaluated. Additionally, **Map 6** shown in **Appendix 2-A** is presented as a density map identifying areas of concentrated exposure features across the region. The coastal communities in Orange County have the highest density of development within the flood hazard area followed by the urban centers of Longview and Marshall for the next highest concentration of flood exposure in the region, due to the density of development and total population in these areas. However, flooded roadways and agricultural areas are found throughout the region, and the impacts due to the loss of function in these areas should not be understated.

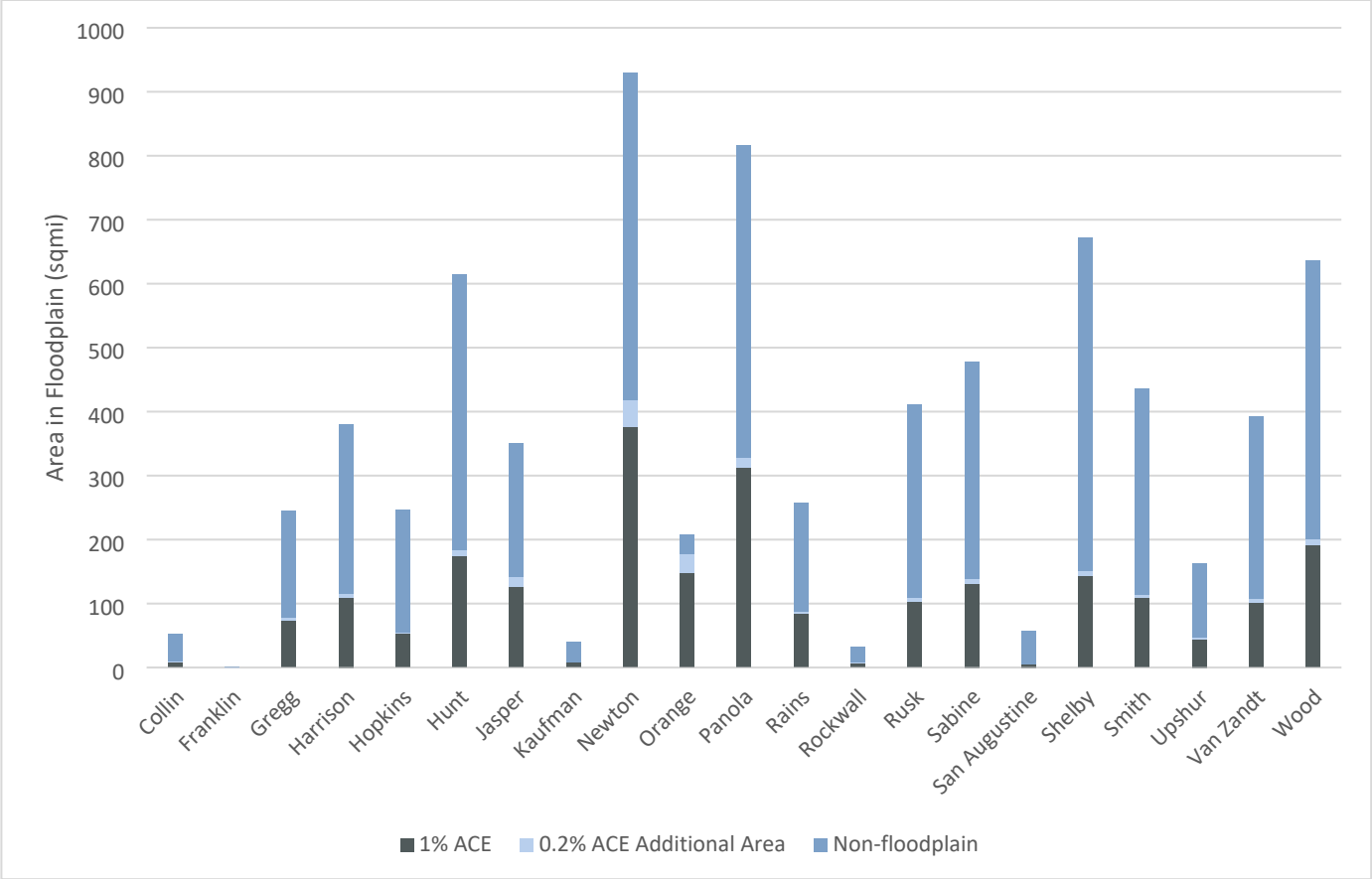

FIGURE 2-4: FLOOD RISK BY COUNTY

Structures within Flood Hazard Area

Building footprints and associated description used in the analysis were produced by TNRIS using Microsoft Buildings and Stratmap LiDAR. TWDB assigned each buildings value on the social vulnerability index as developed by the Center for Disease Control (CDC). Estimated population provided by TWDB was sourced from Land scan Population Estimates (Oak Ridge National Laboratory, 2019). Over 375,000 structures were identified by TWDB within the planning region. About 9% of the total structures within the Region are located within the 1% annual chance flood hazard area and 13% of the total structures within the Region are located within the 0.2% annual chance flood hazard area. The largest exposure to structures in a single county is within Orange County.

Structures found partially within the 1% annual chance and 0.2% annual chance flood hazard areas were included in the count for the 1% annual chance flood risk. **Figure 2C-2** in **Appendix 2-C** shows the number of structures exposed by flood frequency and county.

The user type for each structure was also considered in the exposure analysis. The type categories associated with each structure was assigned by TWDB include agricultural, commercial, industrial, public, residential, and vacant or unknown. Regionwide, 23,000 residential structures are exposed to the 1% annual chance event and around 35,000 structures exposed to the 0.2% annual chance event. Nearly half of the region wide 1% annual chance exposed residential structures are located in Orange County.

Figure 2C-3 in **Appendix 2-C** shows the number of residential structures exposed by flood frequency and county. **Figure 2-5** shows the distribution of building types within the 0.2% flood hazard area.

Population values used in the exposure analysis were included with building footprints used to identify structural exposure. Approximate day and night populations were assigned to each structure. Day and night populations for structures exposed to flood hazard areas were combined for each county. The higher values between day and night population exposed was determined for each county. Orange County has around 26,000 people at risk of the 1% annual chance event with nearly 42,000 people exposed to the 0.2% annual chance event. Gregg and Hunt Counties also have significant population in flood hazard areas. **Figure 2C-1** in **Appendix 2-C** shows the population exposed by county for the 1% and 0.2% annual chance flood hazard areas in the region.

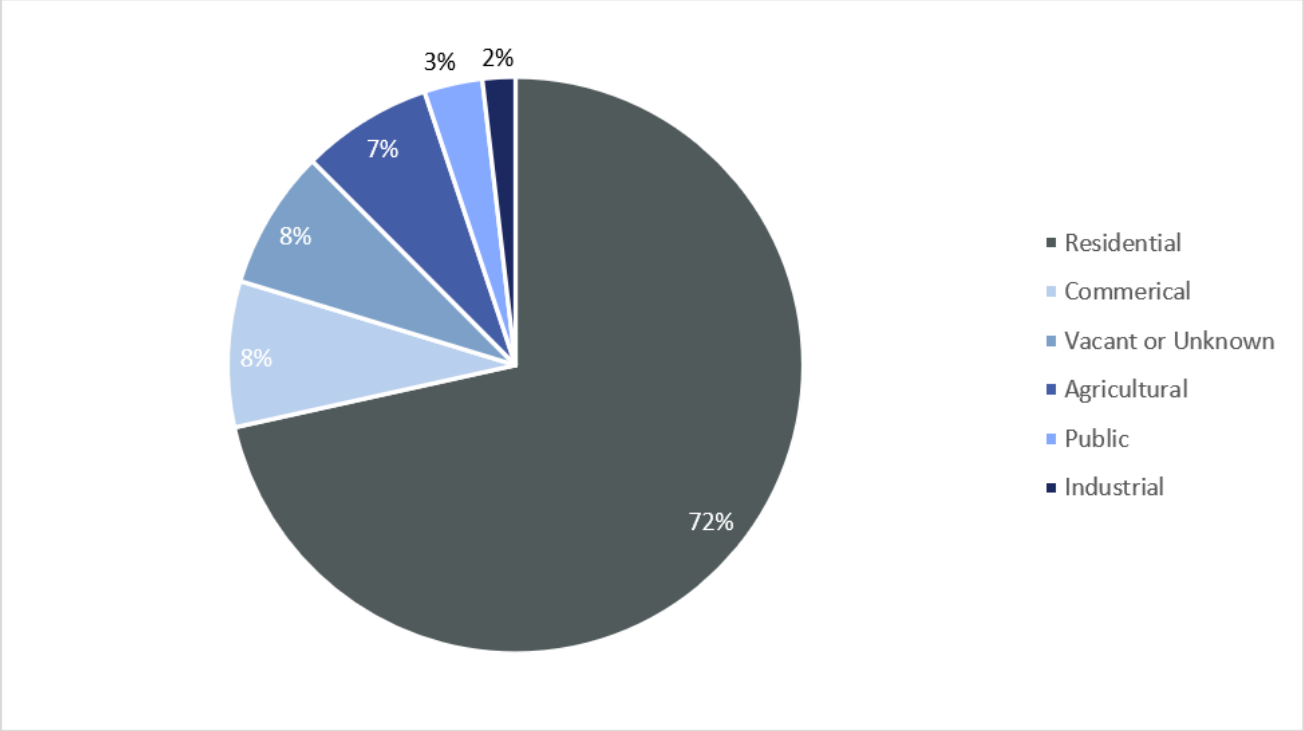

FIGURE 2-5: DISTRIBUTION OF USER TYPES FOR EXISTING STRUCTURES IN THE 0.2% ACE FLOOD HAZARD AREA

Critical Facilities and Public Infrastructure within Flood Hazard Area

Critical facilities and public infrastructure perform essential functions that require enhanced consideration in flood planning. Examples of critical facilities include emergency facilities (fire station, police stations), medical facilities (hospitals, nursing homes), schools, and structures included in the National Shelter System. Public infrastructure considered in the analysis include airports, water treatment plant, wastewater treatment plants, and power generating facilities. For the analysis, each structure associated with the public services described above was considered a critical facility. **Table 2C-1** in **Appendix 2-C** summarizes the critical facilities in flood prone areas identified in the exposure analysis. There are a total of 470 critical facilities or public infrastructure structures in flood prone areas in the planning region, 401 of which are in the 1% flood hazard area. The coastal counties of Newton and

Orange have the highest exposure of critical facilities and public infrastructure which is consistent with the exposure of all structures. **Figure 2C-4** in **Appendix 2-C** shows the critical facilities exposed by county for the 1% and 0.2% annual chance flood hazard areas in the region.

Additional critical infrastructure including pipeline and electric transmission lines were considered but not included in this analysis. These lines were not included in the analysis because the physical location of most are either buried in the ground or elevated reducing the impact cause by flood inundation. The largest risk associated with electric transmission lines during a flood is caused by high winds or debris. Flood water in areas above buried pipelines does not disrupt the service of the pipeline.

Roadway Crossings and Roadway Segments within Flood Hazard Area

Roadways were the next element of existing development considered in the existing condition flood risk exposure analysis. TxDOT roadway data was provided by TWDB and included interstates and highways. Two factors were analyzed for roadways: length inundated in a flood event and number of road stream crossings. Bridge deck elevation data was not included in the analysis, so all points of intersection between streams and roads were considered in the exposure analysis. There are 4,983 roadway and stream crossings in the 1% annual chance flood risk areas with an additional 5,486 crossings exposed to the 0.2% annual chance flood risk for a total of 5,486 crossings in flood prone areas. A subset of the roadway crossings, 113, were identified as low water crossings using a statewide inventory provided by Texas Natural Resources Information System (TNRIS).

The 1% annual chance flood hazard area covers 1,518 miles of roadways with an additional 379 miles inundated in the 0.2% annual chance flood event for a total of 1,897 miles of roadways within flood prone areas. The complete roadway crossing and roadway segment exposure analysis by county can be found in **Table 3** in **Appendix 2-B.**

In addition, major roadways located in the southern portion of the planning region are often vital as they are used hurricane and tropical storm evacuation. Furthermore, major roads which span the Sabine River crossing into Louisiana are also critical for potential evacuation routes for travel in both directions depending on the storm's track. This analysis only accounts for roadway length within Texas with the available data; therefore, the total roadway length presented as part of this plan likely underestimates the total roadway length which may be impacted due to flooding in the region.

Agricultural Area within Flood Hazard Area

Agricultural area in the region was identified using the 2020 CropScape – Cropland Data Layer produced by USDA National Agricultural Statistics Service. Land use categories associated with farming and ranching were included in the exposure analysis as agricultural areas. Fallow or idle cropland and forestry were excluded from the analysis. A total of 324 square miles of agricultural land is exposed to the 1% annual chance flood risk, 34 square miles of which is also exposed to the 0.2% annual chance flood risk. The agricultural exposure analysis by county can be found in **Table 3** in **Appendix 2-B**.

2.A.2.b. Flood Exposure Due to Existing Levees or Dams

The analysis also required the consideration of population and property located in areas where existing levees or dams do not meet FEMA accreditation as inundated by flooding without those structures in place. Spatial data used to evaluate exposure to dams in the region was provided by the US Army Corps of Engineers (USACE) as the National Inventory of Dams Spreadsheet and the Texas Commission on Environmental Quality (TCEQ) for state regulated dams. USACE also provided the National Levee Database. No dams or levees in the region were specifically identified as not meeting FEMA accreditations. Therefore, it was assumed that the current floodplain limits properly reflect the flood protection benefits of these structures. Earthen dams on private property were considered to be too localized for evaluation in the region flood plan.

2.A.2.c. Expected Loss of Function

The impact of flooding on people and property are felt long after high water recedes. To properly assess the damage to a community that experienced flooding, many types of impacts must be considered, including impacts related to disruptions to life, business, and public services. Infrastructure that becomes inundated during flooding events are often non-functional during the event and through the recovery process. A full description of impacts due to historical floods in the planning region is discussed in **Chapter 1**.

Inundated Structures

When flood water inundates a structure, damage is caused to the building and the contents. The severity of damage to the structure increases as the depth of water in the structure increases. Impact also exists in the form of monetary, social, and psychological costs associated with people being displaced from their homes, workplaces, and places of leisure. Businesses are impacted by lost income during the period of time a flood disrupts normal operations and by how the greater community around them suffers its effects.

Loss of function of residential structures can result in content loss and displacement of residents. While loss of function of non-residential structures can result in content and inventory loss, potential relocation, and loss of short-term shelters. These impacts all contribute to operating losses for businesses.

Transportation and Emergency Services

Some of the most immediate and significant impacts of flooding are related to transportation and emergency services. Inundated roadways impede the flow of people seeking to evacuate a flooded area. Impacted roadways can also slow emergency response times or entirely prevent emergency services from reaching people in need of help.

Loss of function of transportation can result in roads becoming impassable due to high water, debris, or damaged structures. Loss of function is dependent on the severity of the storm. During significant storm events, bridges may need repairs and erosion could be exacerbated and force long term road closures.

Health and Human Services

The health-related impacts of flooding can be both direct and indirect. Direct impacts can include drowning, electrocution, heart attacks, and disease caused by rising water and mold spores. A World Health Organization study in 2014 found that two-thirds of flood-related deaths worldwide are due to drowning. Indirect health-related impacts include disruption of food supply, water shortages or contamination and population displacement. Flood preparedness for hospital and other medical facilities is imperative to decreases the health-related impacts of floods.

Water and wastewater treatment plants can be impacted by flood events as these facilities are often located along water courses. If these facilities are not protected from or prepared for flood events, devastating impacts will be felt on the community's water supply and water quality. Floods can damage conveyance infrastructure, including pump stations that are necessary to pump wastewater out of collection systems. Losing function of these facilities can cause wastewater overflows in communities. Floods can also damage treatment equipment, affecting the quality of the effluent that is released into the water courses. Finally, flood events can also affect treatment facilities even if flood waters do not physically damage the treatment plant. Prolonged high flow events through treatment plants can upset the biological treatment processes; thereby, degrading the quality of treatment.

Utilities and Energy Generation

Flood events or associated strong winds can damage power lines and electricity distribution infrastructure with floating debris or downed trees. Roadway inundation often hinders the swift repair of damaged equipment. A prolonged lack of electricity in a community will compound all of the impacts previously discussed.

Energy generation in the region is an important part of both the local, state, and nation economy. Historical flood events in the basin and along the Gulf Coast have had significant impacts to oil and gas production and distribution. Potential failure of power generation plants due to flooding can cause direct losses such as equipment damage as well as indirect impacts to surrounding facilities due to loss of power.

2.A.3. Existing Conditions Vulnerability Analysis

After identifying areas of risk and the people and property exposed to the risk the vulnerability of those affected people was studied. Vulnerability was assessed using the Social Vulnerability Index (SVI) scale which is produced by the Center for Disease Control and Prevention (CDC) an indicator of a community's need for support before, during, or after a disaster. SVI is values range from 0.00 to 1.00 with a higher SVI indicating a higher need for assistance for that community. Vulnerability of the planning region as a whole is discussed in **Chapter 1**.

TWDB provided a building dataset that included SVI values for each building to represent the population associated with each building. Average SVI values were also provided for counties and census tracts to be used in the analysis. Based on the exposure features in the existing condition flood hazard area, an average SVI of the exposed area was computed for each county. Within the region, there are many vulnerable communities exposed to the existing condition flood risk with communities in Gregg, and Shelby Counties showing high vulnerability. Critical facilities in highly vulnerable communities exposed

to flood risk are located in the cities of Greenville, Grand Saline, Swan, Longview, Jasper and Orange. The results of the vulnerability analysis are summarized by county in **Table 3** in **Appendix 2-B**. This information is also shown in **Map 7** in **Appendix 2-A**. **Map 7** also includes the location of critical facilities in the basin identified in the existing conditions flood risk exposure analysis color-coded by their SVI.

Chapter 2.B. Future Condition Flood Risk Analysis

The RFPGs were tasked with considering the change in flood risk over the course of the regional flood plan. Future condition flood risk analyses considered projected increases in flood hazard areas and the additional people and property exposed.

2.B.4. Future Condition Flood Hazard Analysis

The purpose of the future condition flood hazard analysis was to identify the future condition flood hazard area based on:

- Projected increase in impervious cover
- Anticipated change in rainfall patterns
- Anticipated change in relative sea level and/or land subsidence
- Anticipated sedimentation in flood control structures
- Other factors that may result in increased or altered flood hazards in the future.

Flood exposure and vulnerability analyses were performed based on that future condition flood hazard layer. It is noted that the future conditions analysis is a very fluid analysis and will change over the course of flood planning cycles. There are numerous variables which are taken into account based on estimates at the time of the future conditions analysis and these variables will change over time.

2.B.4.a. Future Conditions Based on "No Action" Scenario

The analysis performed as a part of this task is not regulatory in nature, instead intended to gather a single, comprehensive set of best available information on future potential flood risk in the region under a "no action" scenario of 30 years of continued population growth with current regulations and current land use and development trends

Sea Level Change

Relative sea level change (RSLC) refers to the change in sea level compared to land elevation at a particular location. Sea level change is understood to be affected by global and local phenomena including changes in:

- Ocean mass associated with long-term forcing of the ice ages ultimately caused by small variations in the orbit of the earth around the sun
- Density from total salinity
- Heat content of the world's ocean
- Estuarine and shelf hydrodynamics,
- Regional oceanographic circulation patterns (often caused by changes in regional atmospheric patterns),

- Hydrologic cycles (river flow), and
- Local and/or regional vertical land motion (subsidence or uplift)
- Glacial melt

RSLC can increase flood hazards in low lying coastal communities. The Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) developed methodology for tracking RSLC by quantifying the average number of costal flood events per year and estimating anticipated future RSLC. **Figure 2-6** shows the average number of coastal flood event per year for various Gulf Coast communities. EPA found that each station experienced a significant increase in quantity of annual coastal flooding compared to previous decades. From 1960 to present the National Oceanic and Atmospheric Administration (NOAA) tide gauges along the Texas and Louisiana coasts recorded a RSLC increase of 10 to 20 inches, shown in **Figure 2-7**. During this time frame Sabine Pass has experienced 14.55 total inches of SLR.

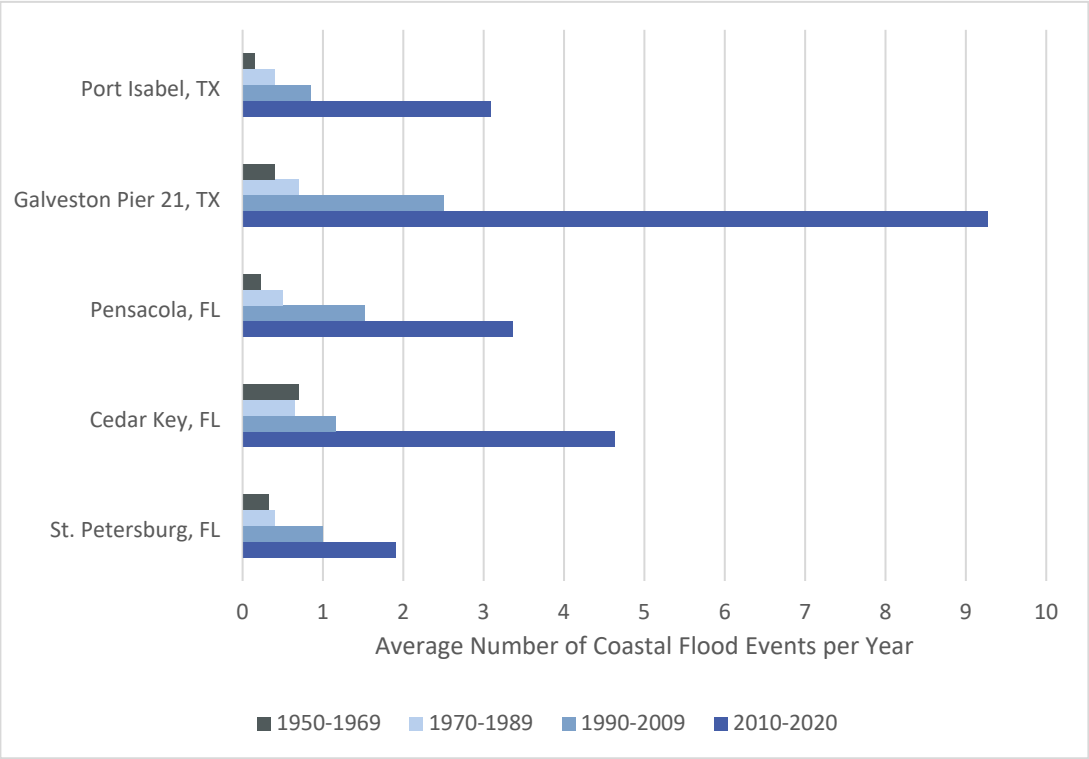

FIGURE 2-6: AVERAGE NUMBER OF RECORDED COASTAL FLOOD EVENTS PER YEAR

(Adapted from EPA's Climate Change Indicators in the United States: www.epa.gov/climate-indicators)

The USACE has developed a methodology to estimate future RSLC by calculating “low”, “intermediate”, and “high” scenarios. The “Low” scenario projects a continuation of the currently observed linear sea level trend. The “Intermediate” scenario uses the National Research Council (NRC) model with low assumed values for global and local phenomena. The “High” scenario uses NRC III model with assumed values for global and local phenomena, as well as low assumptions for glacier melt.

Figure 2-7 shows the relative sea level change (RSLC) along the Gulf Coast from 1960 to 2020. **Figure 2-8** shows the USACE projected RSLC at Sabine Pass. Projected RSLC at Sabine Pass, the approximate "high" RSLC over the next 30 years is 2.30 feet. The "intermediate" SLR projected over the next 30 years at Sabine Pass is 1.36 feet and the "low" scenario is 1.06 feet by 2050.

FIGURE 2-7: RELATIVE SEA LEVEL CHANGE ALONG GULF COAST

(Adapted from: EPA's Climate Change Indicators in the United States: www.epa.gov/climate-indicators)

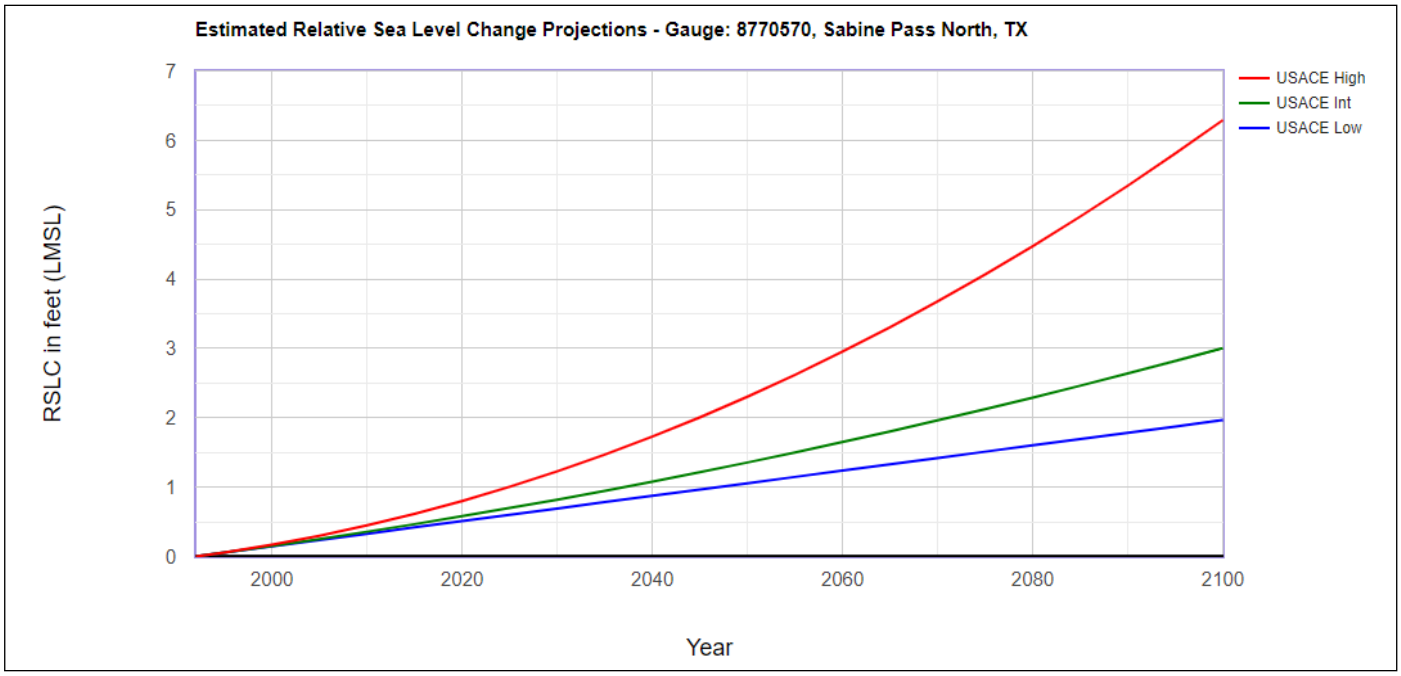

FIGURE 2-8: RELATIVE SEA LEVEL CHANGE PROJECTION FOR SABINE PASS

(Adapted from USACE https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html)

Anticipated Changes in Rainfall Patterns and Floodplains

Changing rainfall patterns in the basin is a significant contributor to increased flood risk. Two major rainfall atlases have been completed in the planning region, which ultimately cover the entire country. Technical Paper Number 40 (TP-40) was released in 1962 and NOAA Atlas 14, an update to TP-40, was released in 2018. In the more than 50 years between both publications, the lower end of the basin experienced increases of 10 – 40% in rainfall associated with a 1% annual chance flood event**. Figure 2-3** shows the statewide historical change in rainfall. Orange County and the southern portions of Jasper and Newton Counties experienced most significant impact in the region. The Texas State Climatologist report, *Climate Change Recommendations for Regional Flood Planning* states that "climate change may lead to substantial increases in flood vulnerability over and above increases due to greater population". Increased rainfall in a community without increased mitigation will result in more expansive flood hazard areas. Anticipated further increases in rainfall throughout the region were reflected in the increase future conditions flood hazard area.

Sedimentation and Major Geomorphic Changes

Sedimentation, erosion, and geomorphic changes, including land subsidence, are significant in the basin. Sedimentation can affect storage capacity of reservoirs, erosion can shift channel flood distribution patterns, and land subsidence can magnify flood potential of affected locations. The Lower Sabine River Basin, downstream of Toledo Bend Reservoir has the most areas of concern for geomorphic changes. Sediment transport on a river system is a complex phenomenon with substantial geographic and temporal variability. The assessment and information provided in this section is based on a series of simplifying assumptions and is only intended to serve as a general indicator of the potential impacts of

sedimentation in future flood risk at a regional scale within a 30-year planning horizon. The following sections speak to these geomorphic changes in the basin and their impact of flood control structures and flood risk.

The Sabine River has many flood control structures including reservoirs, dams, and levees that protect people and property from flood risk. Of these structures, reservoirs are the most susceptible to sedimentation in terms of their effectiveness of flood control. Local sedimentation occurs in storm drain systems that are not properly maintained. Debris or sediment build up in these systems reduce the flow capacity and create unintended blockages. Sedimentation within reservoirs would impact, primarily, the conservation pool which in most cases provides water supply, and in limited cases hydropower generation. The Regional Water Plans evaluate the consequences of sedimentation impacting the ability of reservoirs to maintain a steady supply of water.

Erosion and geomorphic changes are impactful on future flood risk. The topography along the banks of the Toledo Bend Reservoir varies greatly from the Texas to Louisiana side of the watershed. While the Louisiana side of the river has gradual slope, the Texas side is very susceptible to erosion due to its high banks and cliffs. Soil types present in the Lower Sabine River basin have much higher erosion indexes compared to the northern parts of the basin, making them more susceptible to erosion and geomorphic changes. In Orange County, geomorphic changes to the Sabine River have put public infrastructure such as pump stations at risk of losing function. Major geomorphic changes have also occurred in Smith County including some sizeable meander remnants within the Old Sabine Bottom and the Little Sandy National Wildlife Refuges. These changes occurred prior to the construction of reservoirs Lake Fork, Lake Tawakoni, and Toledo Bend.

2.B.4.b. Development of Future Condition Floodplains

The TWDB defined multiple methods for conducting future condition flood hazard analyses where data was not available, which apply transformations to existing flood hazard data. Per the *Technical Guidelines for Regional Flood Planning*, these methods are described below:

- Method 1: Increase water surface elevation based on projected percent population increase
- Method 2: Utilize the existing condition 0.2% annual chance floodplain as a proxy for the future 1% annual chance floodplain
- Method 3: Combination of Methods 1 and 2 or an RFPG-proposed method
- Method 4: Request TWDB for a Desktop Analysis

In the Sabine Flood Planning Region, Method 2 was selected for implementation. The existing 0.2% annual chance flood hazard area is presented as the future condition 1% annual chance flood hazard area. Based on existing flood hazard data availability, two separate methodologies were used to develop the future 0.2% annual chance flood hazard area. The first methodology utilizes water surface elevation (WSE) data where available; in this region, the BLE study for Toledo Bend Reservoir watershed produced the only available water surface elevation (WSE) dataset. The second method uses a horizontal buffer approach informed by the extents of the existing condition flood hazard areas.

Future Conditions for Areas with Water Surface Elevation Data

A vertical buffer consistent with the difference between the existing 1% and 0.2% annual chance WSE, was determined for the areas throughout the Toledo Bend Reservoir Watershed. The operation of Toledo Bend Reservoir is not expected to change in future conditions. The future 0.2% annual chance WSE was determined by adding the vertical buffer to the future 1% annual chance WSE. This process is illustrated in **Figure 2-9**.

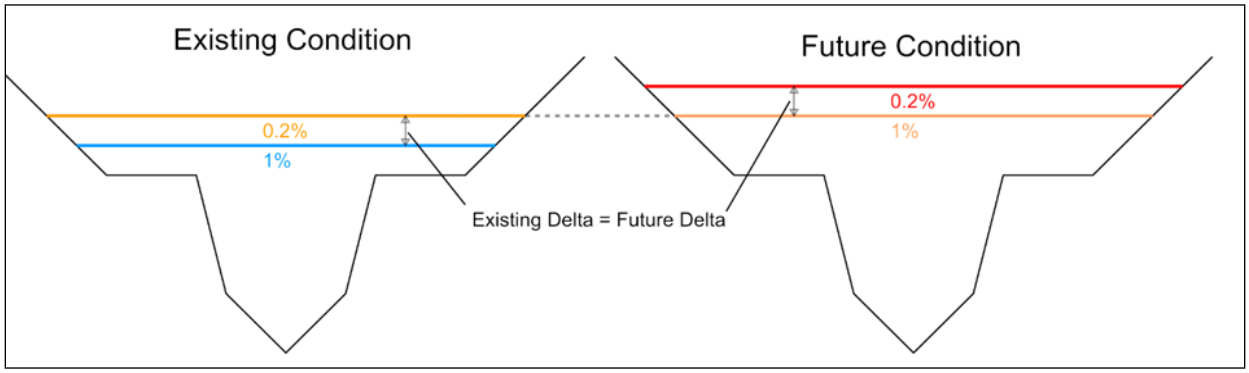

FIGURE 2-9: FUTURE CONDITIONS FLOOD HAZARD 1% AND 0.2% ANNUAL CHANCE WITH WSE DATA

The future 0.2% WSE was applied to the existing topography to determine the additional inundation related to the increase in WSE. This process provides a more representative estimate of the future condition 0.2% annual chance floodplain than a horizontal buffer, as it considers elevation of the topography relative to the water surface. This process was implemented using the WSE data produced by the BLE study in the Toledo Bend Reservoir Watershed and TNRIS LiDAR topography.

Future Conditions for Areas without Water Surface Elevation Data

Typical horizontal buffer widths were estimated in each HUC-8 for rivers, major tributaries, and minor tributaries to determine the distance between the 0.2% annual chance floodplain and the 1% annual chance floodplain. This distance was then applied as a horizontal buffer to the future 1% annual chance floodplain polygon to determine the extents of the future 0.2% annual chance floodplain. The horizontal buffer used varied from 5 meters to 20 meters depending on existing topography. This process is illustrated in **Figure 2-10**.

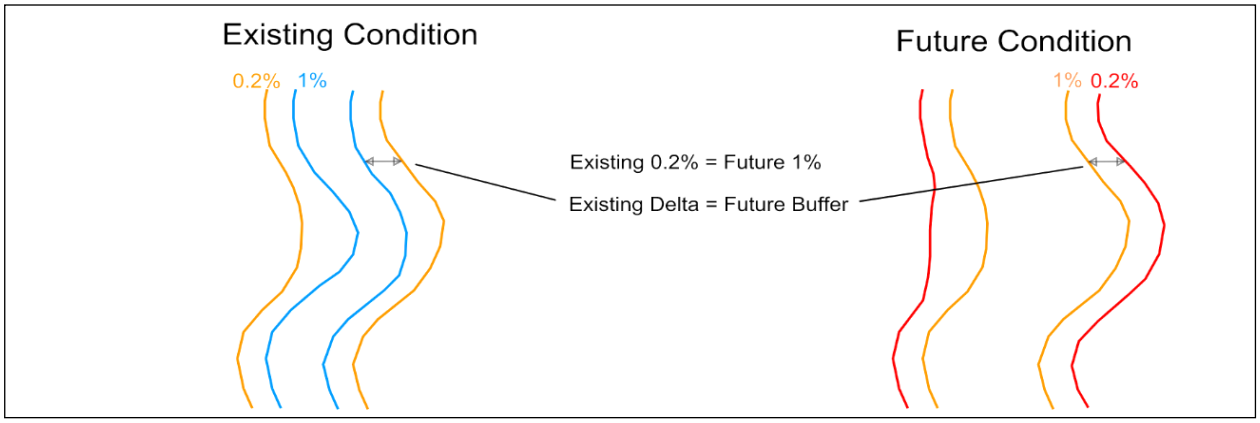

FIGURE 2-10: FUTURE CONDITION FLOOD HAZARD 1% AND 0.2% ANNUAL CHANCE WITHOUT WSE DATA

2.B.4.c. 1% and 0.2% Annual Chance Exceedance Floodplains

Map 8 in **Appendix 2-B** shows future condition flood hazard areas across the planning region and **Map 10**, also located in **Appendix 2-B** shows the changes in flood hazard data from existing to future conditions as a result of the buffering techniques described above. **Table 2-7** below summarizes these changes. **Table 2-6** shows the total land areas in square miles of each flood risk by flood risk type, county, region, and frequency for future conditions.

TABLE 2-6: FUTURE FLOOD HAZARD AREA BY COUNTY IN SQUARE MILES

County	1% ACE	0.2% ACE	Coastal Hazard
Collin	24.16	25.82	0
Franklin	0.00	0.02	0
Gregg	110.38	120.16	0
Harrison	175.95	192.49	0
Hopkins	50.43	60.97	0
Hunt	130.78	154.26	0
Jasper	250.39	272.38	0
Kaufman	55.28	57.27	0
Newton	279.86	329.15	0.17
Orange	245.63	253.80	37.03
Panola	150.84	193.63	0
Rains	19.28	29.41	0
Rockwall	13.63	15.01	0
Rusk	112.37	131.10	0
Sabine	134.01	143.21	0
San Augustine	8.45	9.06	0
Shelby	193.73	203.61	0
Smith	218.42	237.17	0
Upshur	28.43	34.58	0
Van Zandt	112.90	131.28	0
Wood	194.30	220.90	0
Total	**2,509.24**	**2,815.27**	**37.20**

TABLE 2-7: INCREASE IN THE 1% AND 0.2% ACE FLOOD HAZARD AREA FOR FUTURE CONDITION COMPARED TO EXISTING CONDITION

Flood Frequency	Existing Conditions Area (Sq. Mi)	Future Conditions Area (Sq. Mi.)	Increase (Sq. Mi.)	% Increase
1% Annual Chance	2,311	2,487	176	8%
0.2% Annual Chance	2,487	2,815	328	13%

2.B.4.d. Data Gaps and Future Flood Prone Areas

As previously mentioned, no future condition hydrologic and hydraulic models or floodplain mapping were available in the planning region for use in Task 2B. As a result, the entire region is reflected as a gap in inundation boundary mapping in **Map 9** located in **Appendix 2-B**. All data presented for projected future conditions flood risk and flood exposure is for planning purposes only.

2.B.5. Future Condition Flood Exposure Analysis

2.B.5.a. Characterization of Future Population and Development

Population Growth

Population projections were developed by the TWDB for watersheds (HUC 10) and sub-basins (HUC 8) using the earlier decades of the 50-year county and Water User Group (WUG) population projections developed for the 2022 State Water Plan (SWP). Although some Water User Groups cross watersheds and sub-basins, the population projections used in this analysis fall within the planning region. The population within the planning region is projected to grow by 43%, or 266,451 people from 2020 to 2050. Population projections for each water user group in the planning region can be found in **Table 1C-7** in **Appendix 1-C.**

Anticipated Future Development

The future conditions analysis included distributing projected population growth spatially within the planning region. Population projections were provided by TWDB at the WUG Level, the same level used in the State Water Plan. The process to decide where anticipated development would occur took into consideration regional infrastructure, undeveloped land, natural features, existing flood risk, jurisdictions, and current development trends. This effort was undertaking to account for the flood risk to the additional population expected be in the region by 2050. The input factors were combined using local knowledge to represent how likely new development could occur throughout the region.

Future development was distributed within each WUG based on the following factors (in priority order):

- Proximity to recent developments
- Proximity to existing developments
- Proximity to Interstates and Highways
- Proximity to Major Local Thoroughfares
- Proximity to Planned Highways Local Thoroughfares
- Wetlands
- Flood Hazard Areas
- Areas within City Limits or Extraterritorial Jurisdictions (ETJ)

Future development was restricted from the following areas:

- Existing Floodways
- Existing Parks, Cemeteries, Airports, Golf Courses
- Government owned land

- Existing Railroad Right of Way
- Existing Road Right of Way
- Existing Developments

Anticipated population densities shown in **Table 2-8** were informed by the 2020 Census. High population density was assigned to existing urban centers. Medium density was used for all areas within 3 miles of existing urban centers (suburbs). Low density was used for the remaining area in the planning region (rural areas).

TABLE 2-8: APPROXIMATE FUTURE POPULATION DENSITY

Population Density	People per Acre
High	20
Medium	15
Low	4

Future development was distributed within each WUG beginning with the most desirable areas as determined by the factors listed above until all was anticipated population assigned. Often in heavily developed WUGs, population growth exceeded land available to develop; In these scenarios, population in excess of the WUG capacity was transferred to the closest "County-Other" WUG. Areas anticipated to be developed were divided into individual parcels based on population densities from the areas people per household determined in the 2020 Census. A single residential structure was created at the center of each parcel for inclusion in the future conditions flood risk exposure analysis.

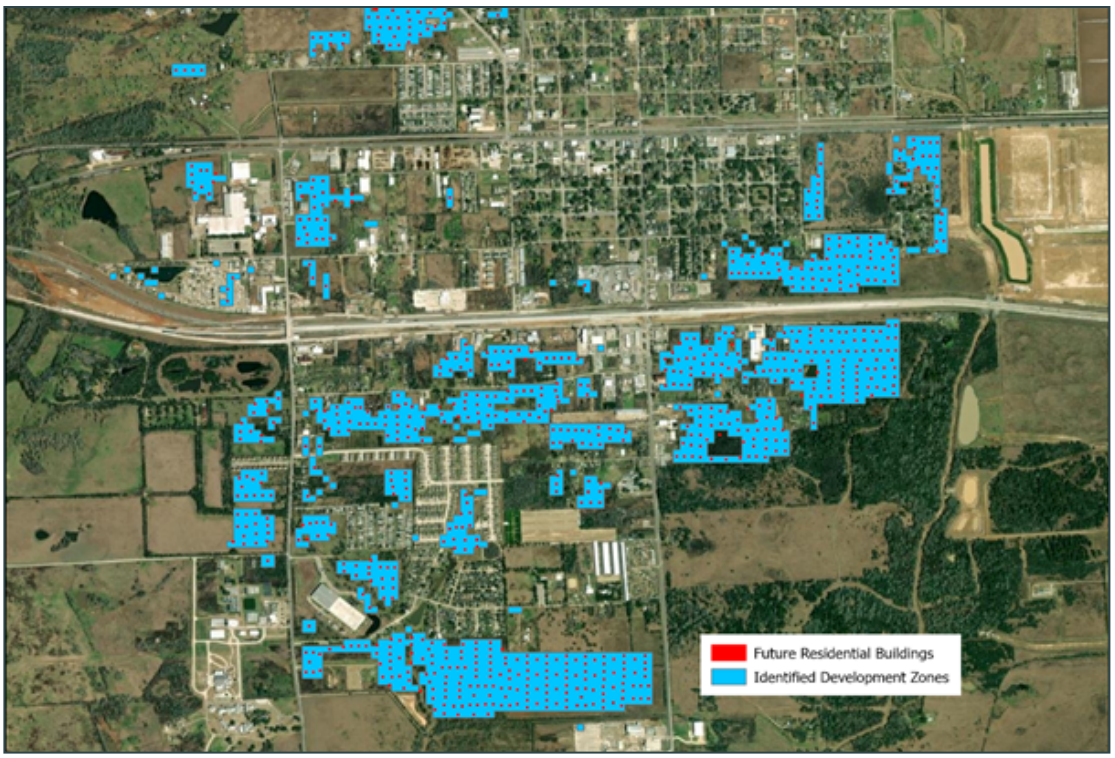

FIGURE 2-11: SAMPLE AREA OF ANTICIPATED FUTURE DEVELOPMENT

Figure 2-11 illustrates the outcome of the process, with cyan representing areas identified for future development, and small red polygons representing future residential structures. The shaded area follows typical development patterns. Undeveloped land near the major thoroughfares and pockets of vacant land within the city have become developed. Additional land on the edge of the existing urban area also become developed. The shaded areas were then divided into potential future structures based on population associated with the development.

2.B.5.b. Future Potential Flood Exposure

Flood exposure for future conditions followed the same methodology as existing conditions using future flood hazard areas. However, residential structures that were created based on projected future development and population projections, were incorporated into the exposure analysis. Existing buildings, roadway crossings, and agricultural areas were maintained in the future conditions analysis. The summary of future flood exposure by county can be found in **Table 5** in **Appendix 2-B** and **Map 11** located in **Appendix 2-B**. The increase in future conditions exposure compared with existing conditions exposure is summarized in **Table 2-9**.

TABLE 2-9: SUMMARY OF INCREASE EXPOSURE IN THE 0.2% ACE FLOOD HAZARD AREA

Exposure Feature Type	Existing Conditions 0.2% ACE	Future Conditions 0.2% ACE	Increase
Structures (#)	48,703	99,250	50,547
Residential Structures (#)	34,839	80,739	45,900
Population (#)	90,557	198,225	107,668
Critical Facilities (#)	470	526	56
Roadway Segments (mi.)	1,897	2,752	855
Roadway Stream Crossings (#)	5,486	7,863	2,377
Agricultural Areas (sq. mi.)	358	430	72

Population data for the future conditions flood risk exposure analysis accounted for population growth, in addition to existing population data. The population associated with existing structures was not altered for the future exposure analysis. The population of new structures was identified using population projections and population density as discussed previously.

Population within Flood Hazard Area

The Sabine Region is expected to grow to 850,000 people by year 2050. Approximately 159,000 people are anticipated to be located within the future 1% annual chance flood hazard, and 198,000 within the future 0.2% flood hazard area or 19%, and 23% of the total population within the region, respectively. Over 75% of increase in population in flood hazard area are located in the five counties shown in **Table 2-10**.

TABLE 2-10: COUNTIES WITH HIGHEST POPULATION EXPOSURE - 0.2% ACE FLOOD HAZARD AREA

County	Existing Conditions Population	Future Conditions Population	Increase
Gregg	14,550	38,580	24,030
Rockwall	885	23,592	22,707
Harrison	6,061	19,931	13,870
Hunt	8,440	20,491	12,051
Orange	42,168	54,061	11,893

The future conditions exposure analysis revealed new flood concerns not found in existing conditions. The northern portion of the planning region is projected to experience significant growth by 2050. If no action is taken to mitigate flood risk, the exposure to flood hazards will increase substantially. Increases to flood risk exposure in the northern part of the basin could be mitigated by adopting floodplain management regulations that are implemented on future development, resulting in resilient communities.

Similar to existing risk, Orange County also has elevated flood risk due to its expansive future floodplains which cover 93% of the county area within the flood planning region. Reducing the flood risk exposure within Orange County would require major flood infrastructure projects in addition to maintaining the current level of floodplain management. More information on the flood infrastructure projects identified can be found in **Chapter 4.**

Structures within Flood Hazard Area

Residential structures make up the majority of exposed structures in the Sabine basin. With 66,000 residential structures at risk of the future 1% annual chance flood event and a total of 81,000 at risk of future 0.2% annual chance flood event. Over 50,000 residential structures in Orange County alone are exposed to the future 0.2% annual chance flood risk. Half of the regional increase in total structural risk occurs in four counties which are shown in **Table 2-11**.

TABLE 2-11: COUNTIES WITH HIGHEST RESIDENTIAL STRUCTURAL EXPOSURE WITHIN THE FUTURE 0.2% ACE FLOOD HAZARD AREA

Counties	Existing Conditions Residential Structures	Future Conditions Residential Structures	Increase
Orange	21,382	26,646	5,264
Gregg	2,026	13,903	11,877
Hunt	1,757	7,699	5,942
Rockwall	199	7,506	7,307

Non-residential structure inventory data included agricultural, commercial, industrial, and public buildings. No additional non-residential structures were included in the analysis due to the uncertainty of where or how many structures could be expected in the future. While the exposure of exiting non-residential structures is anticipated to increase by 132% in future conditions, the exposure of future non-residential structures is anticipated to increase by 34%. **Figure 2-12** summarizes the distribution of structural types for flood exposure in future conditions.

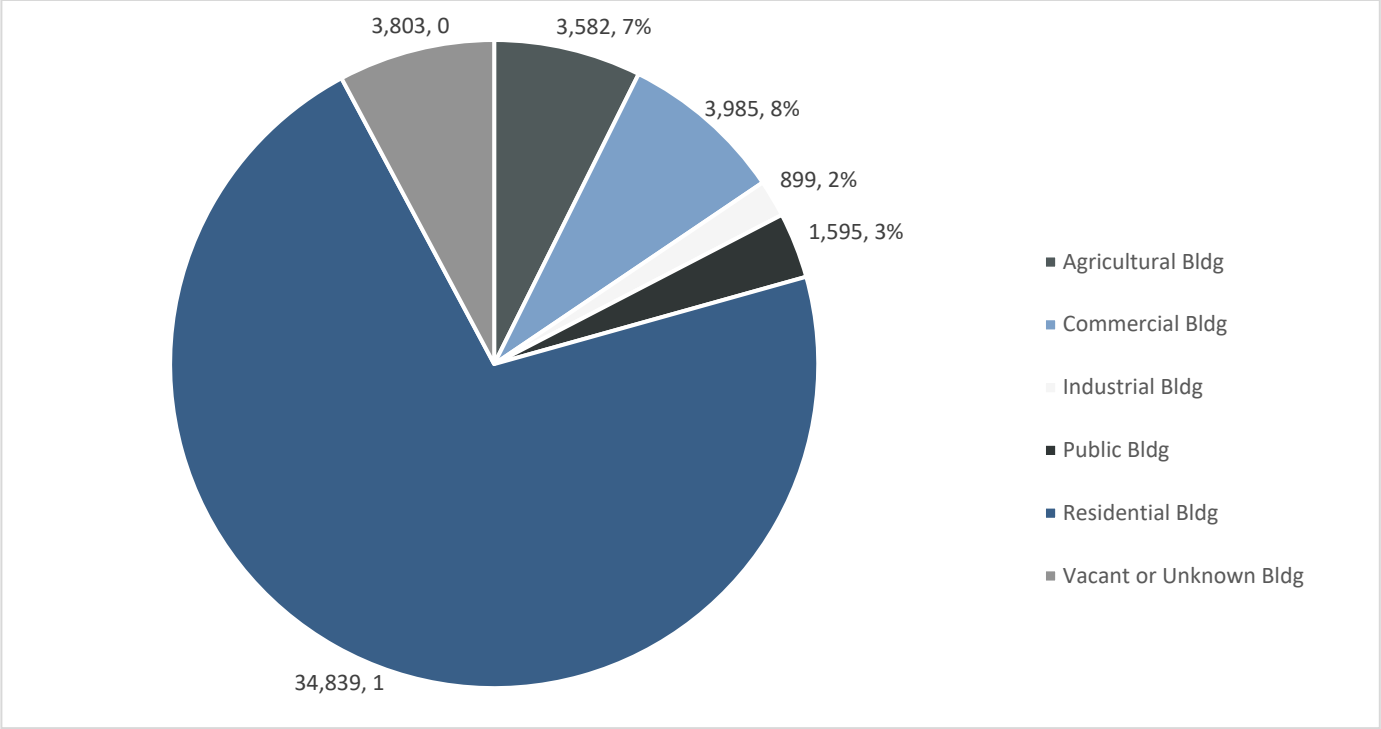

FIGURE 2-12: DISTRIBUTION OF STRUCTURE TYPES IN THE FUTURE 0.2% ACE FLOOD HAZARD AREA

Critical Facilities and Public Infrastructure within Flood Hazard Area

Critical facilities and public infrastructure were analyzed with the future flood hazard areas to determine future flood risk exposure of these features. No additional features were added to the dataset compiled in the existing conditions flood exposure analysis previously described. The future condition scenario assumes that all new critical facilities are constructed outside of the future flood hazard areas and no existing critical facilities are retrofitted to decrease the flood risk exposure. A total of 526 critical facilities were identified in the future condition flood exposure analysis including an additional 56 critical facilities that were not previously identified in existing conditions. Orange County accounted for 63% of the exposed critical facilities in the region.

Roadway Crossings and Roadway Segments within Flood Hazard Area

The future flood risk exposure analysis for roadways used only the existing roadway data available from TxDOT. Without considering additional future roads, the future flood risk exposure resulted in a 43% increase in roadway crossings and 45% increase in miles of inundated roadways. Increases to the flood hazard area has less of an impact to roadway stream crossings as most crossings in the region were identified in the existing conditions analysis. Similar to the existing condition exposure analysis, bridge deck height was not considered in the future condition exposure analysis. Larger flood hazard areas resulted in a significant increase in inundated roadway miles.

Agricultural Area within Flood Hazard Area

Agricultural area in the planning region was also evaluated to determine future flood exposure. The same area determined in the existing exposure analysis as agricultural was used in the future flood risk exposure analysis. Without altering the agricultural land dataset, the future flood risk exposure resulted in a 20% increase in agricultural land in flood prone areas.

2.B.6. Future Condition Vulnerability Analysis

After identifying areas of future risk and the anticipated people and property exposed to that risk the vulnerability of those affected people was studied. The vulnerability assessment used the same methodology as the existing flood risk exposure analysis. All new residential structures developed to account for the projected population was assigned the existing SVI of the census tract. The results of the vulnerability analysis are summarized by county in **Table 5** in **Appendix 2-B**. This information is also shown in **Map 12** in **Appendix 2-B**. **Map 12** also includes the location of critical facilities in the basin identified in the existing conditions flood risk exposure analysis color-coded by their SVI. The highest vulnerability of features in flood prone areas is found in Gregg and Shelby Counties.

CHAPTER 3
FLOODPLAIN MANAGEMENT PRACTICES AND FLOOD PROTECTION GOALS

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CHAPTER 3. FLOODPLAIN MANAGEMENT PRACTICES AND FLOOD PROTECTION GOALS

Chapter 3.A. Evaluation and Recommendations on Floodplain Management Practices

The Sabine RFPG was tasked with evaluating and recommending floodplain management practices (**Task 3A**) and flood mitigation goals (**Task 3B**) within the region. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this task.

The intent of the regional planning process is first to identify and reduce the risk and impact to life and property that already exists. Secondly, this plan seeks to identify possible actions required to avoid increasing or creating new flood risk by addressing future development within the areas known to have existing or future flood risk. Floodplain management practices are crucial to accomplishing these objectives at regional and local levels.

Institutional support for floodplain management comes in multiple forms from the state and local level. Local institutional support includes adequate budgeting for the floodplain administration office, general support from governing boards, departmental support from local public works, and financing. Regional and state institutional support includes agency cooperation, guidance and information sharing, technical guidance on complex matters, and general political support. Floodplain management also relies on external professional services of engineers, surveyors, insurance professionals, environmental planners, and technicians. These subject matter experts are often relied on by developers and individuals to provide the technical materials and understanding to properly complete floodplain development permit applications and execute requirements. The relative volume and accessibility of qualified professionals plays an important role in the efficiency of regulatory compliance.

Floodplain management is defined in Title 31 Texas Administrative Code §361.10 as, “The operation of an overall program of corrective and preventative measures for reducing flood damage.” The nature and implementation of floodplain management practices vary across the region. The following sections will provide a qualitative assessment of regional trends of existing floodplain management practices within the Sabine River basin.

3.A.1. Existing Floodplain Management Practices

Existing floodplain management practices for regulatory entities within the region (municipalities, counties and flood-districts) were collected and assessed. The assessment was limited to entities with flood-related authority as they have the legal authority to establish and enforce flood control and drainage regulations. A total of 134 entities were assessed and are shown in **Table 3-1**.

TABLE 3-1: ASSESSED ENTITIES WITH FLOOD-RELATED AUTHORITY

Municipalities			
Alba	Farmersville	Lakeport	Sulphur Springs
Beckville	Fate	Lindale	Tatum
Big Sandy	Fruitvale	Lone Oak	Tenaha
Bridge City	Gary	Longview	Timpson
Caddo Mills	Gladewater	Marshall	Tyler
Campbell	Grand Saline	Mineola	Union Grove
Canton	Greenville	Nevada	Union Valley
Carthage	Hallsville	New London	Van
Celeste	Hawk Cove	Newton	Vidor
Center	Hawkins	Orange	Warren City
Clarksville City	Hemphill	Overton	West Orange
Como	Henderson	Pinehurst	West Tawakoni
Cumby	Hideaway	Point	White Oak
East Mountain	Huxley	Quinlan	Wills Point
East Tawakoni	Joaquin	Quitman	Winnsboro
Easton	Josephine	Rockwall	Winona
Edgewood	Kilgore	Royse City	Yantis
Emory	Kirbyville	Scottsville	
Counties			
Collin	Jasper	Rockwall	Upshur
Franklin	Kaufman	Rusk	Van Zandt
Gregg	Newton	Sabine	Wood
Harrison	Orange	San Augustine	
Hopkins	Panola	Shelby	
Hunt	Rains	Smith	
Other Entities			
Ark-Tex Council of Governments		Orange County Navigation and Port District	
Caddo Basin SUD		Orange County WCID 1	
Caddo Mills MMD 1		Orange County WCID 2	
Chalk Hill SUD		Panola County FWSD 1	
Combined Consumers SUD		Rockwall County Consolidated MUD 1	
Deep East Texas Council of Governments		Rockwall County MUD 6	
Double R MUD 1		Rockwall County MUD 7	
East Texas Council of Governments		Rockwall County MUD 9	
East Texas MUD		Shelby County FWSD 1	
Franklin County Water District		Smith County Economic Development District	
Gulf Coast Protection District		South East Texas Regional Planning Commission	
Hunt Co MUD 3		South Rains SUD	
Jasper County WCID 1		Sulphur Springs Water District	
Lavon Special Utility District		Sunrise MUD of Hunt County	
Liberty-Danville FWSD 2		Tryon Road SUD	

Little Cypress Utility District	Union Valley Ranch MUD of Hunt County
Mauriceville Municipal Utility District	Upper Jasper County Water Authority
New Hope SUD	Upper Sabine Valley SWMD
North Central Texas Council of Governments	Van Zandt County Waste Disposal District
North Texas MWD	Verandah MUD
Orange County Drainage District	Sabine River Authority

Floodplain management documents available via open-source search were first collected. Parallel to this effort, a web-based survey was sent out to each regulatory entity in the Region to gather additional information. Entities were classified as "Unknown" if data was not provided through the survey or data could not be obtained with the methods outlined above. A general summary of existing floodplain management regulations and practices in the Region is included in **Table 6** in **Appendix 3-B**.

3.A.1.a. National Flood Insurance Program (NFIP)

The National Flood Insurance Program (NFIP) was established in 1968 to provide federally subsidized flood insurance protection. However, participation is voluntary and determined by local governments such as municipalities and counties.

Municipalities and counties that participate in NFIP work with FEMA to establish Base Flood Elevations (BFEs) and Special Flood Hazard Areas (SFHAs) along rivers, creeks and large tributaries that are shown on Flood Insurance Rate Maps (FIRMs). FIRMs define the geographic area for which local floodplain regulations are applicable. They are developed by FEMA via a discovery process that includes input from H&H analysis as well as local stakeholders. Prominent zones defined on FIRMs are Special Flood Hazard Areas (1% annual chance flooding areas), Floodways, 0.2% annual chance areas (also referred to as shaded Zone X), and coastal flooding areas. The spatial accuracy of zones defined on FIRMs, or the degree to which they accurately reflect actual flood risk and associated regulatory conditions for a given point, can vary significantly. Communities use the FIRM, BFE, and SFHA data in their floodplain permitting processes as a requirement for regulating development and construction to ensure new structures are safe from flooding. Insurance agents use FIRMs to determine flood risk, which determines the flood insurance rate for individual properties.

Municipalities and counties have the authority to establish their own policies, standards, and practices to manage land use in and around areas of flood risk. Participating communities have the responsibility and authority to permit development that is reasonably safe from flooding. They can adopt and enforce higher standards than the FEMA NFIP minimum standards to better protect people and property from flooding. Higher standards include but are not limited to restricting fill in flood hazard areas, requiring additional freeboard, and requiring compensatory storage in flood hazard areas. FEMA supports entities who choose to establish higher standards to better protect life and property through the Community Rating System (CRS). The CRS assigns scores to communities based on the degree to which they implement and enforce higher standards, which results in lower premiums for flood insurance policy holders.

Enforcement capabilities come in the form of specific penalties for non-compliance written into local Flood Damage Prevention Orders (FDPOs).

3.A.1.b. Assessment of Existing Floodplain Management Practices

The region has a relatively high (90%) NFIP participation rate based on the entities that were assessed as part of this effort. However, the RFPG recognizes that NFIP participation is a minimum baseline and that existing gaps in flood management practices and policies could prevent the creation of additional flood risks. The RFPG established three levels of existing floodplain management standards are:

- "Low"- Regulations meet minimum NFIP standards
- "Moderate"- Regulations meet NFIP standards and include elevation of structures above the BFE
- "Strong"- Regulations meet NFIP standards, include elevation of structures above the BFE, and community belongs to the FEMA Community Rating System

An "Unknown" category was also created to capture communities for which regulations could not be found or assessed. **Map 13** in **Appendix 3-A** shows the existing floodplain management practices for cities and counties throughout the planning region. A summary of existing floodplain management practices in included in **Table 6** in **Appendix 3-B**.

Low (or Unknown) Floodplain Management Practices

Entities were considered to have "Low" floodplain management practices if current regulations meet the minimum requirements per NFIP standards. "Unknown" classification was assigned to entities from which no data was obtained through the methods discussed above.

Floodplain management criteria for flood-prone areas minimum requirements per Title 44 of the Code of Federal Regulations (44 CFR § 60.3) are summarized below:

- Require permits for all proposed construction in the community to determine whether construction is proposed within flood-prone areas.
- Review proposed development to assure that all necessary permits have been received.
- Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding:
    - If a proposed building site is in a flood-prone area, all new construction and substantial improvements shall be designed to adequately prevent flotation or collapse and be constructed with materials resistant to flood damage.
    - If BFE data is available, provide that all new construction and substantial improvements are elevated to or above the base flood level.
    - If Zone VE or V are present, provide that all new construction is location landward of the reach of mean high tide. Also provide that all new construction and substantial improvements have the space below the lowest floor either free of obstruction or construction with non-supporting breakaway walls.
- Review ***subdivision*** proposals to determine whether such proposals will be reasonably safe from flooding:

    - If a subdivision proposal is in a flood-prone area, any such proposals shall be reviewed to assure that all such proposals are consistent with the need to minimize flood damage within the flood-prone area and:
        - All public utilities and facilities, such as sewer, gas, electrical, and water systems are located and constructed to minimize or eliminate flood damage
        - Adequate drainage is provided to reduce exposure to flood hazards
- Require within flood-prone areas new and replacement water supply systems to be designed to minimize or eliminate infiltration of flood waters into the system.
- Require within flood-prone areas new and replacement sanitary sewage systems to be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters and onsite waste disposal systems to be located to avoid impairment to them or contamination from them during flooding.

Twenty-three (23) out of the 93 entities surveyed within the Region have “Low” floodplain management regulations, while twenty-two (22) out of the 93 were classified as “Unknown”. **Figure 3-1** shows the approximate location of the entities classified as “low” or “unknown” across the region. **Table 3-2** lists the entities with “low” or “unknown" floodplain management regulations.

TABLE 3-2: ENTITIES WITH LOW OR UNKNOWN FLOODPLAIN MANAGEMENT REGULATIONS

Municipalities		Counties
Beckville	Lakeport	Franklin
Big Sandy	Lone Oak	Kaufman
Campbell	Marshall	Panola
Carthage	Nevada	Rains
Celeste	Orange	Rusk
East Mountain	Pinehurst	Sabine
East Tawakoni	Scottsville	San Augustine
Gary	Tatum	Shelby
Hawk Cove	Tenaha	Smith
Huxley	Union Grove	Wood
Joaquin	West Tawakoni	
Kilgore	Winona	

Moderate Floodplain Management Practices

Entities are classified as having “Moderate” floodplain management practices if, in addition to NFIP-compliant regulations, they also enforce the elevation of structures above the BFE as a higher standard. Under this definition, 45 of the 93 entities were classified as “Moderate”. **Figure 3-1** summarizes the classification distribution of floodplain management practices in the region. **Table 3-3** lists the entities with “Moderate” floodplain management practices.

TABLE 3-3: ENTITIES WITH MODERATE FLOODPLAIN MANAGEMENT REGULATIONS

Municipalities				Counties
Alba	Gladewater	Kirbyville	Timpson	Gregg
Bridge City	Grand Saline	Lindale	Tyler	Harrison
Caddo Mills	Hallsville	Longview	Vidor	Hunt
Center	Hawkins	New London	West Orange	Jasper
Clarksville City	Hemphill	Newton	White Oak	Newton
Easton	Henderson	Overton		Orange
Edgewood	Hideaway	Point		
Emory	Josephine	Royse City		

Strong Floodplain Management Practices

Entities are considered to have "Strong" standards if in addition to elevation standards surpassing NFIP minimum, they are participants in the Community Rating System which supports and encourages additional floodplain management practices and outreach to local residents. According to the FEMA Community Status Report for the state of Texas, included in Appendix 3-C, there are no communities within the region that belong to the Community Rating System. Subsequently, no entities are classified as "Strong", following the definition set above.

Table 3-4 lists the entities with strong floodplain management regulations.

TABLE 3-4: ENTITIES WITH STRONG FLOODPLAIN MANAGEMENT REGULATIONS

Municipalities				Counties
Canton	Fruitvale	Rockwall	Warren City	Collin
Como	Greenville	Sulphur Springs	Wills Point	Hopkins
Cumby	Mineola	Union Valley	Winnsboro	Rockwall
Farmersville	Quinlan	Mineola	Yantis	Upshur
Fate	Quitman	Van		Van Zandt

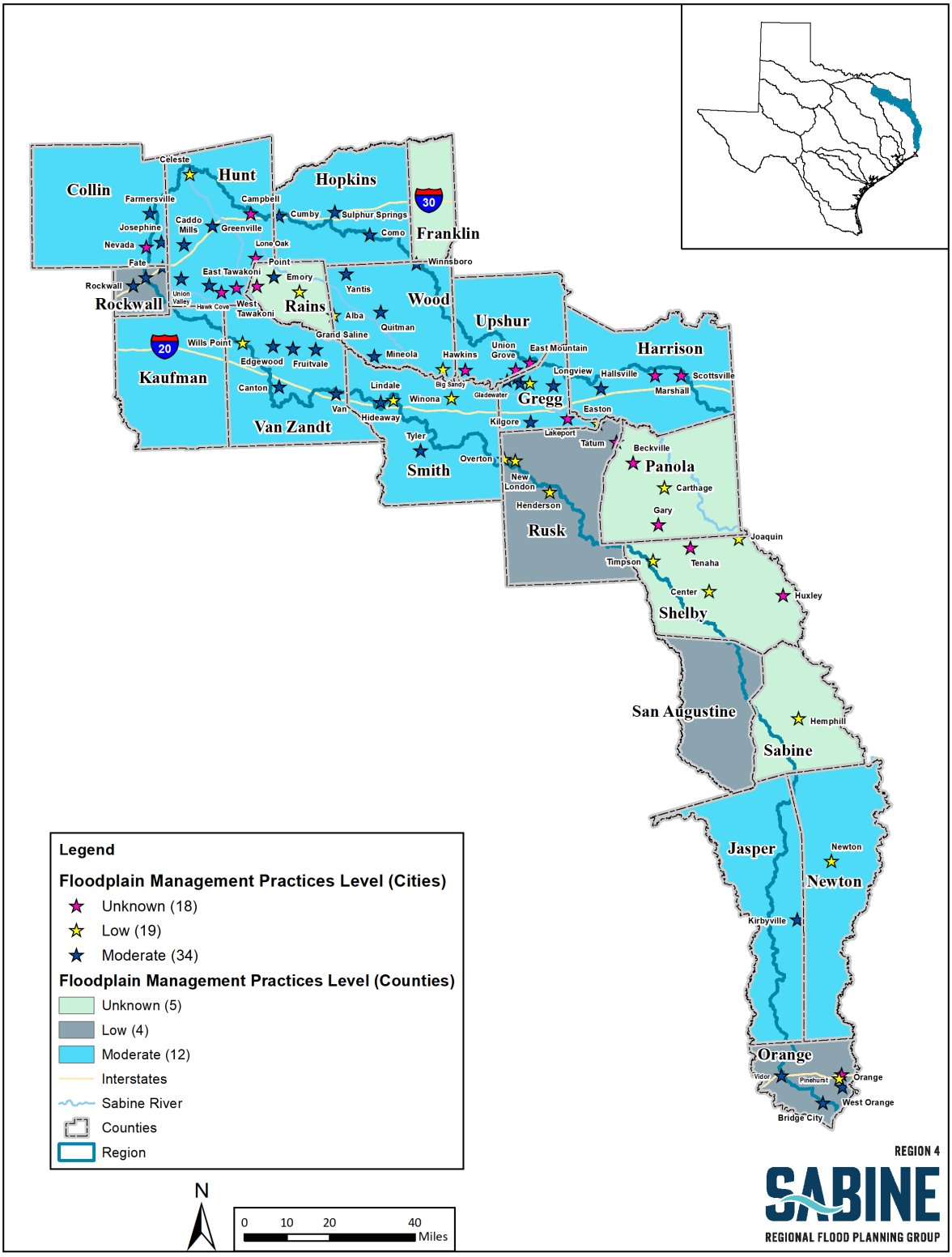

FIGURE 3-1: LEVEL OF FLOODPLAIN MANAGEMENT PRACTICES BY ENTITY

3.A.2. Key Floodplain Management Practices

3.A.2.a. NFIP Participation

General assessment of floodplain management practices indicated that all counties and the majority of cities within the region participate in the NFIP, and many have adopted floodplain protection standards that exceed the minimum requirements as highlighted by the freeboard requirements mentioned in the section above.

By participating in the NFIP, a community must adopt minimum standards that are outlined in Title 44 of the Code of Federal Regulations (44 CFR § 60.3) NFIP participation is a key floodplain management practice because it provides residents of a community the eligibility to purchase flood insurance which reduces the socio-economic impacts of floods, as well as making the community eligible for disaster assistance following a flood event.

FEMA maintains records of community eligibility, in the form of a publicly available *Community Status Book Report* and suspends communities that fail to meet the requirements. From data pulled from the *Community Status Book Report* consulted (included in **Appendix 3-C**) on March 11, 2022, all of the counties in the Sabine basin participate in NFIP while 12 municipalities (14% of entities) are reported as non-participants. It should be noted that non-participating communities are located to the northern portion of the watershed and are generally municipalities with lower population.

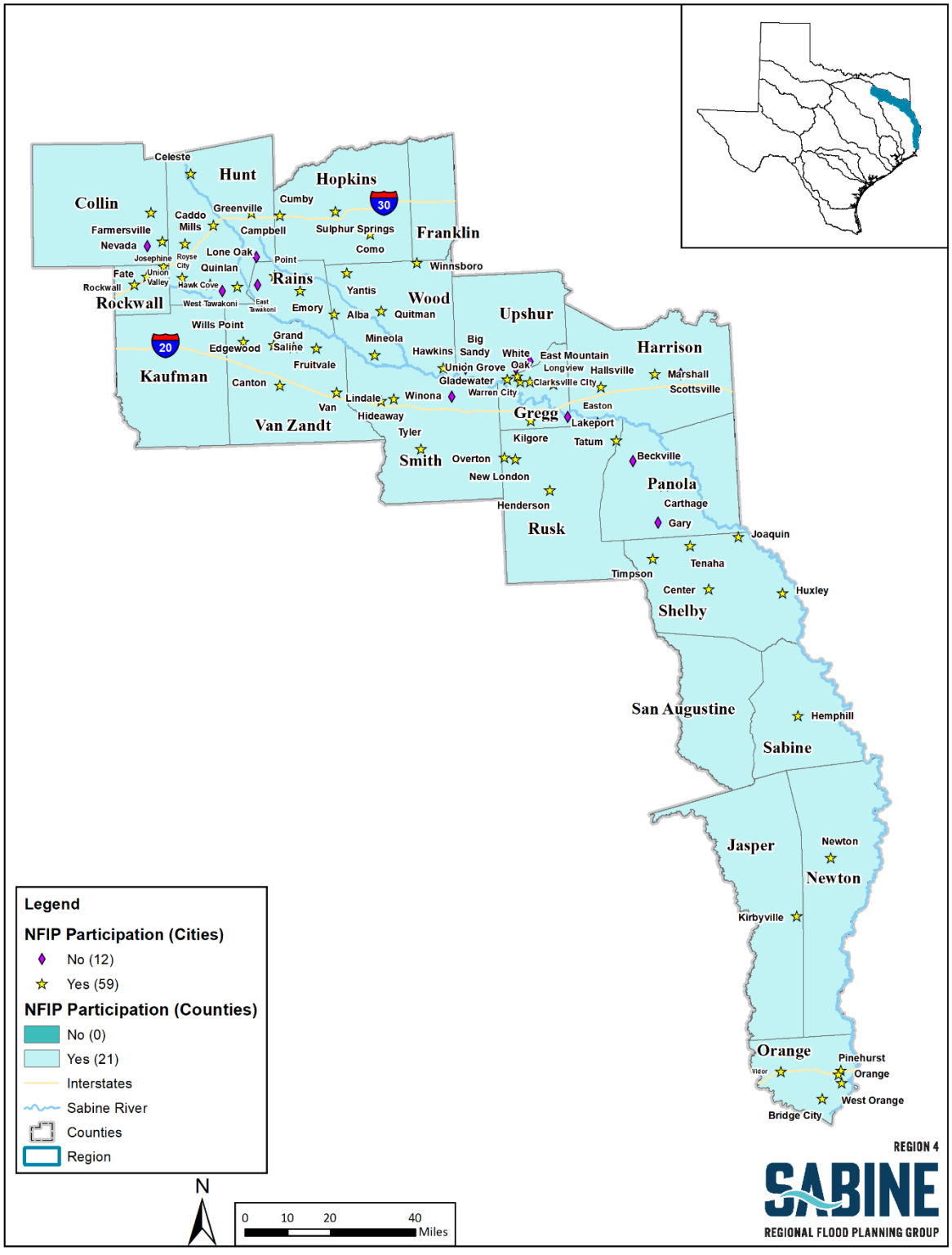

FIGURE 3-2: NFIP PARTICIPATION ACROSS THE SABINE REGION

3.A.2.b. Freeboard Requirements

Standards requiring freeboard, the elevation of structures above the specified BFE, are used as an additional protection measure against flood damage. Freeboard is *not* required by minimum NFIP standards; however, 45 of the 93 entities assessed in the region have freeboard requirements in place ranging from 1 to 2 feet above the BFE as show in **Table 3-5**.

TABLE 3-5: ENTITIES WITH FREEBOARD AS HIGHER STANDARD

Entity	Freeboard Requirement	Feet Above BFE	Entity	Freeboard Requirement	Feet Above BFE
City of Bridge City	Yes	1.0	Collin County	Yes	2.0
City of Caddo Mills	Yes	2.0	Gregg County	Yes	2.0
City of Canton	Yes	1.0	Harrison County	Yes	2.0
City of Clarksville City	Yes	2.0	Hopkins County	Yes	2.0
City of Como	Yes	2.0	Hunt County	Yes	1.0
City of Cumby	Yes	2.0	Jasper County	Yes	2.0
City of Edgewood	Yes	2.0	Kaufman County	Yes	2.0
City of Farmersville	Yes	2.0	Newton County	Yes	2.0
City of Fate	Yes	2.0	Smith County	Yes	2.0
City of Fruitvale	Yes	2.0	Upshur County	Yes	2.0
City of Gladewater	Yes	1.0	Van Zandt County	Yes	2.0
City of Grand Saline	Yes	2.0	Wood County	Yes	2.0
City of Greenville	Yes	1.5	--	--	--
City of Hallsville	Yes	1.0	--	--	--
City of Hideaway	Yes	2.0	--	--	--
City of Josephine	Yes	2.0	--	--	--
City of Kilgore	Yes	1.0	--	--	--
City of Kirbyville	Yes	2.0	--	--	--
City of Longview	Yes	2.0	--	--	--
City of Mineola	Yes	2.0	--	--	--
City of Quinlan	Yes	2.0	--	--	--
City of Quitman	Yes	2.0	--	--	--
City of Rockwall	Yes	2.0	--	--	--
City of Royse City	Yes	2.0	--	--	--
City of Sulphur Springs	Yes	2.0	--	--	--

Entity	Freeboard Requirement	Feet Above BFE	Entity	Freeboard Requirement	Feet Above BFE
City of Tyler	Yes	1.0	--	--	--
City of Union Valley	Yes	2.0	--	--	--
City of Van	Yes	2.0	--	--	--
City of Vidor	Yes	1.0	--	--	--
City of Warren City	Yes	2.0	--	--	--
City of West Orange	Yes	1.0	--	--	--
City of Winnsboro	Yes	2.0	--	--	--
City of Yantis	Yes	2.0	--	--	--

3.A.2.c. Stormwater or Drainage Fees

Stormwater or drainage fees as a floodplain management practice generate revenue which allow communities to implement flood mitigation and floodplain management projects. Orange County Drainage District collects a drainage fee through taxes. The tax rate for maintenance and operations by the Orange County Drainage District for 2021-2022 fiscal year is $0.13410/$100 property value. The City of Longview collects a $0.025 sales tax to fund drainage projects and maintenance. Additional drainage fees may be collected in the region but have not been divulged to the RFPG.

3.A.3. Impacts of Floodplain Management Practices on Population and Property

Existing impact of floodplain management practices is discussed by upper (upstream of Toledo Bend Reservoir) and lower portions (Downstream of Toledo Bend) of the watershed due to differences in geography and nature of major flooding events.

3.A.3.a. Upper Sabine

The upper portion of the Sabine Region is characterized by small to medium sized cities and lower populated counties. Most counties and small municipalities that do not adjoin the Dallas-Fort Worth Metroplex have limited drainage requirements for proposed developments. Since the upper basin consists of rural or low-density development, increases in flood risks caused by each new development may be harder to recognize. If development is allowed to occur without detailed hydraulic analysis or detention requirements to mitigate increase in rainfall runoff, and roadways are only designed only to contain lesser storm events, it could lead to the routine occurrence of flash flooding. These flash floods result in roadway closures, structural flooding, and need for water rescues posing a threat to public safety, damage of public and private property and overburden of public agencies.

Generally, existing trends in floodplain management practices and development regulations can be classified for counties and municipalities. Eight of the fifteen counties reviewed did not have a requirement for roadway drainage or onsite detention, and the remaining counties provide varying

requirements from specific detention regulations to a case-by-case basis as determined by the county.

Typical roadway conveyance design accommodates local runoff from the 2 to 25-year event and occasionally require a 100-year evaluation to ensure no structures will flood. Roadway crossings are typically designed to a 10-to-25-year level of service. Roadways designed to only account for high frequency flooding can result in transportation networks being overwhelmed and vulnerable to more significant rainfall events. Counties with significant population booms close to the Dallas-Fort Worth Metroplex (Hunt, Rockwall, and Collin Counties) have recently adopted more stringent ordinances to minimize additional flood risk caused by increase in development. With these counties projected to continue to grow significantly over the next 20-30 years, there is an intentional push to preserve, protect, and regulate drainageways and flood prone areas. For example, Hunt County has recently passed a drainage ordinance that requires a 200-foot buffer from all floodplains to prevent development from occurring immediately adjacent to the current floodplain and allow room for the floodplain to expand as development occurs and/or more detailed studies become available. Generally, the majority of communities marked as having strong floodplain management standards require structures be built 2-feet above BFE. The region also includes numerous small municipalities with limited staff, resources, and funding, which tend to have few regulations relating to new development. Floodplain ordinances for these municipalities are either based on the minimum NFIP requirements, or too limited to comply; 12 cities in the upper Sabine basin are not NFIP members.

The larger municipalities (Greenville, Longview, Royse City, Fate, Rockwall, Tyler) consist predominantly of development that has been around 30 to 40 years with recent developments of retail and residential use surrounding the core of the community. Most of these cities have adopted new guidelines to regulate the expanding city infrastructure relating to roadway, water, sewer, and storm utilities. The most common stormwater management tool is the “no adverse impact” requirement, in which the engineer of record analyzes the upstream and downstream conditions from the proposed development to determine whether increases in flows or stages will occur if the site is developed. If an adverse impact is determined, detention basins or alternative mitigation measures are typically required.

Overall, there is a marked divide in floodplain management practices between urban/suburban and rural municipalities. Municipalities closer to the Dallas-Fort Worth Metroplex enforce more stringent requirements driven by the increase in population growth. In contrast, rural locations, existing flood management practices typically are structured to meet the minimum requirements set forth in the Texas Water Code, but do not go much beyond those requirements. Updated regulatory base flood information, which is a necessary foundation for floodplain management practices, is not readily available for much of the upper basin, evident by the large share of Cursory Floodplain Data in the existing flood hazard layer in **Chapter 2**.

3.A.3.b. Lower Sabine

The lower portion of the Sabine basin is also characterized by small to medium sized cities and counties with low population densities. Most cities have adopted a flood damage prevention order and issue minimum fines for non-compliance with flood regulations. All counties (Jasper, Newton and Orange) participate in the NFIP and enforce floodplain management practices

The lower Sabine has been particularly affected by major named storm events that have resulted in catastrophic loss of life and property, as discussed in Chapter 1 of this report. In some of these events,

even properties compliant with existing flood regulations were impacted leading to recognize that higher standards could provide additional enhanced protection.

3.A.3.c. Regionwide

Some of the existing floodplain ordinances and commissioners' court orders with higher standards may continue to protect future populations and property as long as they are enforced. However, the gap in key floodplain management practices across the region poses an increasing level of flood risk as population continues to grow. Local floodplain regulations with higher standards need to be adopted and enforced to better protect future population and property.

Future *regulatory* floodplains are uncertain and beyond the scope of this study. However, it is anticipated that the future floodplains will increase in comparison to existing floodplains in some areas within the region. Cities and counties typically develop their future land use plans considering areas of anticipated population growth and development within their communities. However, the existing and future floodplains are not necessarily a component of the future land use plan. Incorporating the existing and future floodplains from this study will provide cities and counties with additional direction as to where population and development should be directed to protect people and property.

3.A.4. Recommendation of Minimum Floodplain Management and Land Use Standards

In Texas, authority for enforcing floodplain management regulations lies with local governments such as cities and counties. It is important to note that RFPGs themselves do not have the authority to enact or enforce floodplain management, land use, or other infrastructure design standards. Any standards recommended by the RFPG in this task would be aimed at encouraging implementation by local entities in the region with flood-related authority.

Based on observations and assessment of the state of current floodplain management practices is the region, it is generally recommended to establish a watershed-scale floodplain management organization utilizing the institutional structure of either River Authorities and/or state established Floodplain Management Regions. Such organization could augment and support floodplain management regulation within the respective watershed. Additionally, the state would benefit from reduced staffing and administrative costs, and more orderly and predictable compliance with NFIP standards

The RFPG encourages cities and counties without floodplain ordinances or court orders to develop, adopt, implement, and enforce floodplain regulations that at least meet the NFIP minimum standard and where appropriate consider adopting higher standards to provide higher levels of protection against loss of life and property due to flooding. Additionally, floodplain management regulatory practices could benefit by being more clear, easily interpretable, broadly understood, realistic, and consistently enforced. Doing so would provide forward guidance on new development of expectations.

Also, education about the economic benefits of floodplain management, at both community and household levels is recommended. And in terms of education and planning, conducting planning processes which focus on identification of locations for future development that is less likely to flood, less ecologically sensitive, and otherwise well located to support future growth and development.

Data collection efforts also highlighted the de-centralized location of floodplain management regulations. Relevant codes and guidelines were found in separate documents such as building codes, infrastructure design manuals and city ordinances. It is recommended that all municipalities prepare and publish a drainage design manual that unifies all relevant drainage and flood-related criteria.

The Sabine RFPG considered the information presented within and proceeded to recommend region-wide floodplain management standards aimed at implementing basic floodplain management practices across the watershed. The recommended standards are included in **Table 3-6**.

TABLE 3-6: RECOMMENDED FLOODPLAIN MANAGEMENT STANDARDS

Recommended Standards	Category
RFPG recommends all roadways be designed such that the 5-year HGL is below the top of curb and the 100-year HGL is no more than 1 foot above the top of curb and the 100YR inundation extent is contained within the right-of-way.	**Roadways**
RFPG recommends all roadways designed without curb and gutter be designed such that the 100YR inundation extent is contained within the right-of-way and at least one navigable lane is maintained.	
RFPG recommends all roadways designated as evacuation routes are designed such that the 100YR inundation extent is contained within the right-of-way and at least one navigable lane is maintained in each direction.	
RFPG recommends all communities have Culvert and Bridge Hydrologic & Hydraulic Analysis Requirements	**Culvert and Bridge Crossings**
RFPG recommends all culverts demonstrate no adverse impact for 100YR storm event.	
RFPG recommends all communities adopt the TxDOT Hydraulic Design Manual most current version; EXCEPT where stricter local standards apply.	
RFPG recommends that all communities require compensatory storage for all fill in the regulatory 100YR floodplain.	**Detention**
RFPG recommends all communities detain proposed condition peak discharge for the 25-year and 100-year event below or equal to the existing condition peak discharge	
RFPG recommends that communities require all new development in Zone A or unmapped areas to provide a hydrologic and hydraulic study and demonstrate no adverse impacts downstream.	
RFPG recommends all habitable structures in coastal communities are designed such that finished floor elevations are 2 feet, or more, above the BFE including the combined riverine and coastal effects, EXCEPT where stricter local standards apply.	**Habitable Structure**

Recommended Standards	Category
RFPG recommends all habitable structures in non-coastal communities are designed such that finished floor elevations are 2 feet above the riverine 100-year WSE, EXCEPT where stricter local standards apply.	
RFPG recommends all critical facilities in coastal communities are designed such that finished floor elevations are 2 foot above the highest elevation of either the riverine 500-year or coastal 100-year WSE including the combined riverine and coastal effects	**Critical Facilities**
RFPG recommends all critical facilities in non-coastal communities are designed such that finished floor elevations are 2 foot above the riverine 100-year WSE.	
RFPG recommends that communities require all dams be designed to TCEQ standards.	**Dams**
RFPG recommends that communities require all earthen embankments and floodwalls be compliant with FEMA 44 CFR 65.10	**Levees**
RFPG recommends that all new construction consider nature-based and sustainable solutions.	**Nature Based Solutions**

Chapter 3.B. Flood Mitigation and Floodplain Management Goals (361.36)

The objective of Task 3B is to define and select a series of goals that will serve as the drivers of the regional flood planning effort. The overarching goal of all regional flood plans must be "to protect against the loss of life and property" as set forth in the Guidance Principles (31 TAC §362.3). This includes the need to:

1. Identify and reduce the risk and impact to life and property that already exists, and
2. Avoid increasing or creating new flood risk by addressing future development within the areas known to have existing or future flood risk.

The RFPG must identify goals that are specific and achievable, and when implemented, will demonstrate progress towards the overarching goal set by the state. Per Texas Water Development Board (TWDB) requirements and guidelines, the goals selected by the RFPG must include the information listed below:

- Description of the goal
- Term of the goal set at 10 years (short-term) and 30 years (long-term)
- Extent or geographic area to which the goal applies
- Residual risk that remains after the goal is met
- Measurement method that will be used to measure goal attainment
- Association with overarching goal categories

3.B.1. Flood Mitigation and Floodplain Management Goals

As such, the Sabine RFPG spent a significant amount of time and resources exploring community values and discussing the development of the best goals for the region. During the September RFPG meeting, the Mentimeter polling system was used to allow the group to identify which goal categories were of highest importance. The proposed goal categories were developed considering RFPG input provided at the regular RFPG meetings, as well as input from other regional stakeholders provided through the data collection survey. A memorandum detailing the complete process to create and approve the goals adopted by the RFPG can be found in **Appendix 3-D**.

Each group member was asked "Which RFPG goal category should be the most important for the Sabine Region (Assign weight out of 100 points)". The results of the poll are shown in **Figure 3-3**.

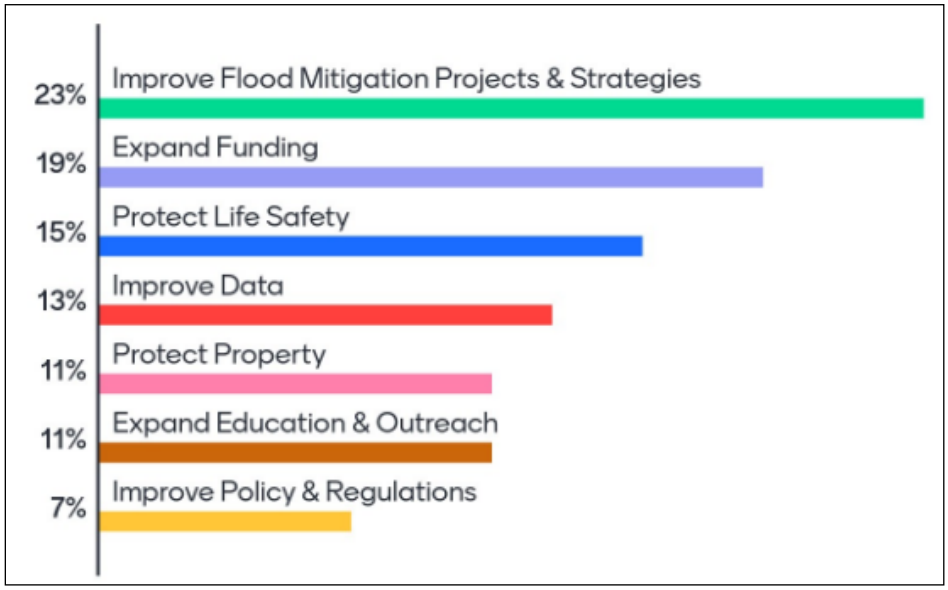

FIGURE 3-3: RFPG PRIORITIZATION OF FLOOD MITIGATION AND FLOODPLAIN MANAGEMENT GOAL CATEGORIES

The poll also gave the planning group the opportunity to rank specific goal topics within each of the broader categories based on importance. The subgoals are more specific and guide ways in which the larger goal categories can be achieved. As an example, subgoals of the larger "Protect Life Safety" goal include "reducing the number of flood related deaths" and "improving emergency access and response". Using the goal category and subgoal ranking, an overall weighted ranking was calculated for each subgoal. The process of polling the RFPG and calculating the weighted ranking value for the subgoals, helped narrow down and establish a slate of draft goals. The development of the flood mitigation and floodplain management goals also considered the current floodplain management and land use approaches the in the region.

3.B.2. Adoption of Flood Mitigation and Floodplain Management Goals

The RFPG utilized the assessment of current floodplain management and land use practices from Task 3A as well as the flood-mitigation needs of the region, as guides for developing and defining the goals. After consideration of these factors, the Sabine RFPG adopted the flood mitigation and floodplain

management goals listed in **Table 3-7**. These specific goals were reviewed and approved by the Sabine RFPG on October 21, 2021, during the RFPG public meeting. The RFPG revisited the discussion on December 1, 2021, during the RFPG public meeting to clarify the language of the adopted goals and approved additional goals to be included. No public input was received regarding the adoption of flood mitigation and floodplain management goals. The adopted goals apply to the entire flood planning region; no sub-regional goals were identified.

These specific goals were reviewed and approved by the Sabine RFPG on October 21, 2021, during the RFPG public meeting. The RFPG revisited the discussion on December 1, 2021, during the RFPG public meeting to clarify the language of the adopted goals and approved inclusion of additional goals. No public input was received regarding the adoption of flood mitigation and floodplain management goals. Included in **Table 3-7** is a column of residual or transformed risk. Transformed risk is defined by U.S. Army Corps of Engineers (USACE) as "the change in the nature of flood risk for some area associated with the presence of flood hazard reduction infrastructure". Residual risk is the risk not avoided or reduced which still remains even if the stated goals are fully met. The last column in the table briefly highlights the residual or transformed risk from meeting the stated goal. This column does not address *all* of the potential transformed or residual risks as they can be numerous. Additional notes are provided in the subsection following the table.

TABLE 3-7: FLOOD MITIGATION AND FLOODPLAIN MANAGEMENT GOALS

Goal ID	Goal	Term of Goal	Residual or Transformed Risk
04000001	Improve 20% of Low Water Crossings to no longer be classified as Low Water Crossing.	Short Term (10 year)	Transformed risk is the reduction in flood risk for a structure with either elevation of a roadway and/or improvements to flow underneath the road deck. Residual risk is that improvements may not fully eliminate overtopping of a roadway in an extreme storm but could alleviate flooding in smaller storms where a bridge used to be overtopped.
04000002	Improve 40% of Low Water Crossings to no longer be classified as Low Water Crossing.	Long Term (30 year)	Transformed risk is the reduction in flood risk for a structure with either elevation of a roadway and/or improvements to flow underneath the road deck. Residual risk is that improvements may not fully eliminate overtopping of a roadway in an extreme storm but could alleviate flooding in smaller storms where a bridge used to be overtopped.
04000003	Improve flood protection for 15% of critical facilities in flood prone areas.	Short Term (10 year)	Transformed risk is the reduction in flood risk to critical infrastructure of a region through improvements or relocation to a less flood prone area. Residual risk is that there will still be critical facilities in flood

Goal ID	Goal	Term of Goal	Residual or Transformed Risk
			prone areas potentially susceptible to flooding.
04000004	Improve flood protection for 25% of critical facilities in flood prone areas.	Long Term (30 year)	Transformed risk is the reduction in flood risk to critical infrastructure of a region through improvements or relocation to a less flood prone area. Residual risk is that there will still be critical facilities in flood prone areas potentially susceptible to flooding.
04000005	Reduce exposure of existing structures in flood prone areas by elevating, acquiring, relocating, or otherwise providing flood protection to 10% of structures.	Short Term (10 year)	Transformed risk is the reduction in the number of structures that are at risk for flooding due to their removal. Residual risk includes the remaining structures which are still at risk to existing flood hazards as well as risk of flooding due to major flood events in excess of a typical design storm.
04000006	Reduce exposure of existing structures flood prone areas by elevating, acquiring, relocating, or otherwise providing flood protection to 20% of structures.	Long Term (30 year)	Transformed risk is the reduction in the number of structures that are at risk for flooding due to their removal. Residual risk includes the remaining structures which are still at risk to existing flood hazards as well as risk of flooding due to major flood events in excess of a typical design storm.
04000007	Advance multiple regional flood infrastructure projects designed for larger storm events.	Short Term (10 year)	Transformed risk includes the reduction in flood risk to structures and infrastructure using projects which help to contain and store stormwater. This will help both small and large storms. Although the goal is to advance multiple projects, not all of them can be constructed within the timeframe due to funding, land acquisition, time to construct the project, etc. Additionally, projects will affect a particular region. Thus, a residual risk that remains is flood risk to structures outside of a project's benefit area and other projects that may not have the funding to proceed forward.

Goal ID	Goal	Term of Goal	Residual or Transformed Risk
04000008	Promote, facilitate and construct multiple regional infrastructure projects designed for the 100-year and larger storm events.	Long Term (30 year)	Transformed risk includes the reduction in flood risk to structures and infrastructure using projects which help to contain and store stormwater. This will help both small and large storms. Although the goal is to advance multiple projects, not all of them can be constructed within the timeframe due to funding, land acquisition, time to construct the project, etc. Additionally, projects will affect a particular region. Thus, a residual risk that remains is flood risk to structures outside of a project's benefit area and other projects that may not have the funding to proceed forward.
04000009	100% of counties to perform public education and awareness campaigns to better inform the public of flood-related risks on an annual basis.	Short Term (10 year)	There is no transformed risk as flood risk still remains because there is no physical change. Residual risk that remains are mistakes that people can make around floods. Awareness and campaigns to educate the public do provide benefit, but they may not reach 100% of people in the community. Thus, there is still risk of potentially driving into flooded areas, not knowing the depth of flooding in an underpass, etc.
04000010	Maintain 100% participation of counties that perform public education and awareness campaigns to better inform the public of flood-related risks on an annual basis.	Long Term (30 year)	There is no transformed risk as flood risk still remains because there is no physical change. Residual risk that remains are mistakes that people can make around floods. Awareness and campaigns to educate the public do provide benefit, but they may not reach 100% of people in the community. Thus, there is still risk of potentially driving into flooded areas, not knowing the depth of flooding in an underpass, etc.
04000011	Increase number of communities with documented, operational, and funded stormwater asset management plan and	Short Term (10 year)	Transformed risk includes the potential reduction of flood risks in an area due to more funding for maintenance as well as a knowledge of flood infrastructure present in each community. Residual risk

Goal ID	Goal	Term of Goal	Residual or Transformed Risk
	maintenance operations to 50%.		that remains is the goal only addresses 50% of the number of communities; thus, risk remains for the other communities which do not have robust maintenance operations.
04000012	Increase the coverage of regulatory flood hazard mapping to at least 50% of the region.	Short Term (10 year)	Transformed risk includes a potential reduction to loss of life and property as knowledge of flooding risks to the community will be more well-known and available. Residual risks that remain are the areas that are either not mapped, or not adequately mapped and infrastructure potentially being put at risk if placed in what should be a regulatory floodplain but is not mapped as one.
04000013	Increase regulatory flood hazard mapping in at least 50% of the areas identified as having out of date flood mapping.	Short Term (10 year)	Transformed risk includes a potential reduction to loss of life and property as knowledge of flooding risks to the community will be more well-known and available. Residual risks that remain are the areas that are either not mapped, or not adequately mapped and infrastructure potentially being put at risk if placed in what should be a regulatory floodplain but is not mapped as one.
04000014	Advance multiple flood protection planning studies and preliminary engineering efforts in flood prone areas including the Sabine Pass to Galveston CSRM.	Short Term (10 year)	Transformed risk includes new knowledge of flooding in particular areas through new studies and engineering efforts. Additional transformed risk will occur when the projects go further to detailed design and construction. Residual risk which remains is areas outside of the immediate benefit area of a project as well as risk for extreme storms in excess of a project's design storm.
04000015	Increase number of monitoring gages and associated real time reporting technology installed and maintained in the region to 1 in 50% of HUC10s.	Short Term (10 year)	Transformed risk includes public education and knowledge with the available information to them. Residual risk for this goal includes roadways which may be susceptible to overtopping would

Goal ID	Goal	Term of Goal	Residual or Transformed Risk
			still be at risk, but with no information available to the public.
04000016	Increase number of monitoring gages and associated real time reporting technology installed and maintained in the region to 1 in 50% of HUC12s.	Long Term (30 year)	Transformed risk includes public education and knowledge with the available information to them. Residual risk for this goal includes roadways which may be susceptible to overtopping would still be at risk, but with no information available to the public.
04000017	Install warning signage at 100% of identified low water crossings in the floodplain and coordinate with TxDOT where applicable.	Short Term (10 year)	Transformed risk includes the potential reduction in the loss of life in areas of low water crossings or flooded roadways or underpasses by the use of signs. Residual risk that remains is
04000018	Increase number of communities with a comprehensive drainage policy and criteria manuals to reduce flood hazard and increase education to include 75% of the region's population.	Short Term (10 year)	Transformed risk includes newly constructed infrastructure to be more resilient to flooding through new policy. Residual risk that remains is the previously constructed infrastructure or new infrastructure in areas which have not yet adopted the latest rainfall may still be susceptible to flood risk.
04000019	Increase the number of communities that utilize the latest and most current precipitation data as a basis for design criteria to cover at least 75% of the region's population.	Short Term (10 year)	Transformed risk includes newly constructed infrastructure to be more resilient to flooding. Residual risk that remains is the previously constructed infrastructure or new infrastructure in areas which have not yet adopted the latest rainfall may still be susceptible to flood risk.

3.B.3. Transformed and Residual Risk

Flood risk will be reduced by the implementation of the actions and construction of the projects necessary to achieve the identified goals. However, the Sabine RFPG acknowledges that it is not possible to protect against all potential flood risk. Even if projects are designed for the 100-year or even 500-year event, there is always a potential risk for larger rainfall events than what a flood mitigation project or flood infrastructure is designed for. Transformed risk is defined by U.S. Army Corps of Engineers (USACE) as "the change in the nature of flood risk for some area associated with the presence of flood hazard reduction infrastructure". The adopted goal combined with the residual and transformed risk represents the totality of flood risk faced by the Sabine River Basin. The residual and/or transformed risk after the

goal has been achieved and the measurement method that will be used to determine the success of the goal are listed in **Table 3-7** and **Table 11** in **Appendix 3-B**.

While floodplain mapping goals this will cover a significant portion of the area, especially if they are done in the most populated areas, there is still residual risk that remains for the more rural communities. In these instances, BLE data is likely to be adequate for providing residents and businesses information regarding the flooding risks in the area. Other goals include informing the public about flood risk through education. A residual risk is the constant flux of people moving into and out of the region. A campaign to inform the public about flood risks may reach everyone in a particular area at the time it is conducted, but with new people moving into an area, there may be some residual individuals or families that may not have the information.

The amount of transformed risk could be significant, especially in the coastal areas. Ongoing efforts by USACE with the Sabine Pass to Galveston levee project (a regional infrastructure project) will greatly benefit the community with reduced risk for coastal storm surge flooding. In addition, other regional projects like the Flood Infrastructure Fund (FIF) within the region are evaluating regional projects like detention and channel conveyance improvements which can help to reduce the overall flood risk to the community. Additionally, goals such as the removal/reduction of risk at low water crossings can be very beneficial for the immediate area as physical reconstruction of a bridge/culvert crossing or improvements to flood flows in roadways can reduce the likelihood of a bridge being submerged by floodwaters. With a lower susceptibility to flooding, travel by motorists, especially those on major hurricane evacuation routes will be safer and have a positive impact on the region. Goals which target major flood infrastructure projects can also have a massive benefit to communities. As defined, transformed risk is about how a high-risk area can be transformed to a lower risk. The target of these projects is the 100-year event as that is the primary analysis goal for Regional Flood Planning efforts. Detention ponds, channel improvements, and other infrastructure projects can help the 100-year flooding, but it may not be feasible in an area to fully contain floodwaters within channelized systems, storm drains, and detention ponds. An area can certainly benefit from flood risk reduction in extreme storms as well as benefitting from lower frequency storms like the 5-year or 10-year storms which may have previously flooded an area. With large infrastructure improvements, areas can be less susceptible to flooding during more frequent rainfall.

Residual risk will always still remain, regardless of the type of project(s) or strategies performed. These projects, aligned with the goals, will be designed for at least the 100-year storm event per RFP and FIF requirements. But risk will still remain as homes and structures may not be fully taken out of the 100-year flood hazard areas depending on the recommended solution. They may experience a benefit on the 100-year event, but there may still be risk as there is always the possibility for storm events in excess of a 100-year event. Another transformed risk is the reduction for roadway overtopping as a stated goal is to reduce the number of lower water crossings by 20%. This can be done through elevation of the roadway and/or improvements to the areas underneath the bridge to improve hydraulic performance. This will help to reduce the risk for motorists during heavy rainfall events; however, there may still be residual risk as improvements cannot fully guarantee that a roadway does not overtop as there is the possibility for storm events in excess of its design condition.

3.B.4. Goals as a Guide for the Regional Flood Plan

The selected specific goals will guide the development of the Flood Management Strategies (FMSs), Flood Management Evaluations (FMEs), and Flood Mitigation Projects (FMPs) for the Sabine Flood Planning Region. They build upon TWDB regional flood planning guidance and provide a comprehensive framework for future strategy development focused on reducing flood risk to people and property, while not negatively affecting neighboring areas.

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CHAPTER 4
ASSESSMENT AND IDENTIFICATION OF FLOOD MITIGATION NEEDS

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CHAPTER 4. ASSESSMENT AND IDENTIFICATION OF FLOOD MITIGATION NEEDS

The Sabine Regional Flood Planning Group (RFPG) was tasked with assessing and identifying the flood mitigation needs within the basin. This process consisted of an analysis that combined all data collected or generated previously discussed in the plan. The results of that analysis were used to determine areas in the planning region with the highest flood mitigation need. Second, the RFPG collected flood mitigation projects (FMP), flood management strategies (FMS), and flood management evaluations (FME) that had been identified by local stakeholders. Further analysis of these FMPs, FMSs, and FMEs will be discussed in Chapter 5

Chapter 4.A. Flood Needs Analysis

The following sections describe the process adopted by the RFPG to conduct the Flood Mitigation Needs Analysis which identified the areas with the greatest gaps in flood risk information and the areas of greatest known flood risk and areas with significant mitigation needs. This is a high-level assessment guided by TWDB flood planning criteria framework and is intended to guide the subsequent Task 4B effort of identifying FMEs, FMPs, and FMSs.

4.A.1. Process Scoring Criteria

The purpose of this analysis was to identify the areas of greatest flood risk and areas where the greatest flood risk knowledge gaps exist to aid in determining the areas of highest flood mitigation need. A geospatial process was developed that combined information from multiple datasets representing several of the factors listed in Exhibit C, Technical Guidelines for Regional Flood Planning from TWDB and provides a basis for identifying flood mitigation need in the planning region. The analysis was performed using only data that was made available to the RFPG or developed and discussed in previous chapters.

The geospatial assessment was performed at a HUC-12 watershed level across all 196 HUC-12 watersheds within the Sabine River basin, with an average size of 38 square miles. A total of 5 data categories were used in the geospatial assessment, with 9 data sets associated with the items listed on the second column of **Table 4-1.**

TABLE 4-1: FLOOD MITIGATION NEEDS FACTORS CONSIDERED

Categories	Factors Considered
Most Prone to Flooding that Threatens Life and Property	• Buildings • Low Water Crossings • Agricultural Areas • Critical Facilities
Current Floodplain Management and Land Use Policies	• Communities Not Participating in NFIP
Areas Identified as Flood Map Gaps	• Flood Map Gaps
Historical Flood Events	• Disaster Declarations • FEMA Claims
Other Factors	• Social Vulnerability Index (SVI)

For numerical datasets, the scoring range for each category was determined using the percentile distribution of the data, with the top 20th percentile being the highest score and the bottom 20th percentile being the lowest score. A zero value was given a zero score. Non-numerical datasets were assigned scoring ranges based on how each factor impacts flood mitigation need for a community. The scores for each HUC-12 under each category were then added to obtain a total score that was used to reveal the areas of greatest identified or anticipated flood risk.

4.A.1.a. Areas Most Prone to Flooding that Threaten Life and Property

Datasets developed during the existing condition flood hazard analysis (**Section 2.A.2**) were used to score the flood mitigation need related to life and property for each HUC-12. The future conditions flood hazard analysis results were not used in this chapter due to the approximate nature of future conditions. The following sections detail the existing exposure datasets used in the flood mitigation need analysis.

Buildings

Total number of structures exposed to the 1% annual chance event (ACE) flood risk was divided among HUC-12s. The complete buildings dataset was developed by Texas Natural Resources Information System (TNRIS) using Microsoft Buildings and Stratmap LiDAR. The values for all HUC-12 were divided into scoring categories using percentiles. The scoring categories for structural exposure is shown in **Table 4-2**. The count ranged widely in the region as some rural HUC-12s only had 1-2 buildings exposed, while the HUC-12 containing urban areas in Orange County had over 15,000 buildings exposed.

TABLE 4-2: SCORING RANGES FOR BUILDINGS IN 1% ACE FLOOD HAZARD AREA

Score	0 points	1 point	2 points	3 points	4 points	5 points
Exposed Buildings	0	1-13	14-37	38-87	88-177	178+

Low Water Crossings

Low Water Crossings (LWCs) were identified in Chapter 1 and used sites identified by TxDOT provided TNRIS. The total dataset of LWCs were assigned to HUC-12s. The scoring categories for LWCs is shown in **Table 4-3**. After analyzing this dataset, the top 20th percentile for this category included all values greater than or equal to 1 LWC. As with structural exposure, the count ranged widely in the region, as many HUC-12 had 0 LWCs, while the HUC-12 containing urban areas in Orange County had 15 identified LWCs and Rockwall and Collin Counties had 16 identified LWCs.

TABLE 4-3: SCORING RANGES FOR LOW WATER CROSSINGS

Score	0 points	5 points
Low Water Crossings	0	1+

Agricultural Areas

Agricultural areas were identified in the existing condition flood exposure analysis (Section 2.A.2) as land use related to farming or ranching. The total agricultural area exposed to the 1% annual chance event flood risk was divided based on HUC-12s. The scoring criteria for agricultural areas exposed to flood risk are shown in **Table 4-4**. Unlike many other categories, rural HUC-12s scored higher in this category as agricultural impacts due to flooding are more prominent.

TABLE 4-4: SCORING RANGES FOR AGRICULTURAL IN 1% FLOOD HAZARD AREA

Score	0 points	1 point	2 points	3 points	4 points	5 points
Total Impacted Area (sq. mi.)	0	0.01-0.36	0.37-0.97	0.98-0.173	0.174-2.71	2.72+

Critical Facilities

Critical facilities determined in the existing conditions flood exposure analysis (Section 2.A.2) include hospitals, schools, police and fire stations, and shelters. This category is scored based on the total number of critical facilities identified within the existing 1% annual chance flood hazard area. The scoring criteria for critical facilities is shown in **Table 4-5**. While the top 20th percentile is represented by all HUC-12s with 1 or more exposed critical facilities, a few HUC-12s have a significant number of critical facilities exposed. Of the 797 critical facilities exposed to the 1% annual chance flood, the majority of the (349) are in eastern Orange County near the outfall of the Sabine River highlighting the need for flood protection and flood mitigation of these facilities.

TABLE 4-5: SCORING RANGES FOR CRITICAL FACILITIES IN 1% ACE FLOOD HAZARD AREA

Score	0 points	5 points
Critical Facilities	0	1+

4.A.1.b. Current Floodplain Management and Land Use Policies

Communities Not Participating in the NFIP

National Flood Insurance Program (NFIP) participation in the planning region was identified in Chapter 3. If a community was not a participant in the NFIP, all HUC-12s intersected by that community were given

5 points, as shown in **Table 4-6**. These communities were mostly clustered in the mid-basin area, with others dispersed throughout the Region. It is assumed that a participant of the NFIP would likely enforce floodplain management regulations to a greater degree than communities that do not participate in NFIP and may be less prone to flood risks.

TABLE 4-6: SCORING RANGES FOR CRITICAL FACILITIES EXPOSED TO 1% ACE FLOOD RISK

Score	0 points	5 points
NFIP Status	Participant	Non-Participant

4.A.1.c. Areas Identified as Flood Map Gaps

Accurate and effective flood mapping information is necessary for regulatory purposes and as a tool for members of the public to better understand flood risk in their community. The scoring for this category gives points to the HUC-12 based on the flood risk information gap determined in Chapter 2. The varying degrees of adequacy of information in the region is reflected in the scoring criteria shown in **Table 4-7**. Areas without effective floodplain mapping included in the National Flood Hazard Layer (NFHL) have the highest need because residents are unaware of the flood risk in their community. Detailed floodplain mapping provides better available data compared to areas with only approximate mapping available.

TABLE 4-7: SCORING RANGES FOR AVAILABLE FLOODPLAIN MAPPING

Score	0 points	1 point	4 points	5 points
Best Available Data	NFHL Detailed	Partial Coverage of NFHL Detailed	NFHL Approximate Only	No Effective NFHL

4.A.1.d. Historic Flooding Events

Disaster Declarations

Federal disaster declarations occur when a community experiences substantial impact and needs federal aid to recover. The complete list of federal disaster declarations affecting the Sabine River basin can be found in **Table 1C-9** in **Appendix 1-C**. Declarations are made county wide and for this analysis were assigned to HUC-12s without duplicating declarations related to a single event. This dataset compiles all the federal disaster declarations within the Sabine River watershed from 1950 to 2021. The scoring ranges developed using percentiles of total number of disaster declarations is shown in **Table 4-8**.

TABLE 4-8: SCORING RANGES FOR FEDERAL DISASTER DECLARATIONS

Score	0 points	1 point	2 points	3 points	4 points	5 points
Declarations	0	1-10	11	12-15	16-17	18+

FEMA Claims

FEMA NFIP flood claims within the Sabine River basin from 1950 to 2021 were reviewed in **Chapter 1**. The geospatial data available for individual claims was redacted by FEMA and locations were more summarized by local area codes and city information. Therefore, the cities to which the flood claims were assigned was used to divide claims into the HUC-12s that intersected the city limits. The number of

flood claims for each city was divided proportionately amongst the HUC-12s composing each city. The

scoring criteria developed using percentiles of FEMA claims is shown in **Table 4-9**. While 4 claims in a single HUC-12 represents the 80th percentile in the region, nearly half of the 9,300 claims recorded in this dataset occurred in eastern Orange County.

TABLE 4-9: SCORING RANGES FOR FEMA CLAIMS

Score	0 points	1 point	4 points	5 points
# of Claims	0	1	2-4	4+

4.A.1.e. Other Factors

Social Vulnerability Index

Social Vulnerability Index (SVI) refers to the potential negative effects from hazardous events on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks. The higher the SVI, the higher the vulnerability of a community and more difficult it is for that community to recover; the lower the SVI, the higher the resilience of the community to withstand those hazardous events. SVI values are assigned per census tract by the Center for Disease Control (CDC), which were converted to SVI per HUC-12 for this analysis. SVI values were assigned to each HUC-12 based on an area-weighted average. The percent of a census tract that intersects a HUC-12 was multiplied by the SVI for the census tract. This procedure is followed for all census tracts intersecting a HUC-12 boundary, and those weighted SVI values are added together to produce one SVI value for each HUC-12. The SVI ratings vary between 0-1 and were scored according to **Table 4-10**. Overall, the HUC-12s in the middle and lower basins resulted in the highest SVI values.

TABLE 4-10: SCORING RANGES FOR SVI RATING

Score	0 points	1 point	2 points	3 points	4 points	5 points
SVI rating	0	0.01-0.33	0.34-0.43	0.44-0.50	0.51-0.57	0.58+

4.A.2. Flood Mitigation Needs Results

The process and scoring methodology described in Section 4.A.1 was implemented across the entire Sabine River basin. As previously discussed, two separate assessments were performed to address the two goals of Task 4A. The first goal is to identify the areas where the greatest flood risk knowledge gaps exist. These areas are represented per TWDB guidance in **Map 14**. As described in Section 4.A.1, **Map 14** in **Appendix 4-A** was created based on the analysis of the last two categories: Areas That Need Mitigation, and Study Need or Data Gap. Based on the data utilized in this assessment, the entire Sabine watershed is considered inadequately mapped. Note that the green HUC-12s may contain detailed studies that have recently been completed but did not study the entire HUC-12.

The second assessment addresses the second goal: to determine the areas of greatest identified flood risk and flood mitigation needs. These areas are represented per TWDB guidance in **Map 15** in **Appendix 4-A**. For each HUC-12 in the Sabine region, the scores from each of the 9 categories were added together to obtain a total score. All categories have an equal representation in the total score. Higher scores represent a greater need for flood mitigation based on the above-mentioned measures.

The maps resulting from the Task 4A assessment will serve as a guide to the RFPG's subsequent efforts in Task 4B. The red and orange HUC-12s in **Map 14** highlight the areas in the Sabine watershed where potentially feasible flood risk studies (FMEs) should be considered as part of Task 4B. The red and orange HUC-12s in **Map 15** emphasize watersheds where the RFPG should strive to identify and implement FMSs and FMPs as part of Task 4B to reduce the known flood risks within those areas.

Chapter 4.B. Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects

4.B.3. Identification of Potentially Feasible FMPs, FMSs and FMEs

The identification of potential Flood Management Evaluations (FMEs), potentially feasible Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs) began with the development of the Flood Mitigation Needs Analysis discussed previously in Section 4.A.1. After the areas of greatest flood mitigation need were determined, the RFPG developed a list of potential flood risk reduction actions for addressing flood needs in these areas. In addition to the Needs Analysis process, flood mitigation and floodplain management actions were collected from a variety of sources, including unselected federal funding applications, hazard mitigation action plans, and through contributions from the RFPG and other regional stakeholders from sources such as previous flood studies, drainage master plans, and capital improvement programs. In total, over 100 potential flood risk reduction actions were considered to begin the evaluation process. Engagement from stakeholders provided additional action items for the evaluation process that were not otherwise publicly available. Note that the list of FMEs, FMPs, and FMSs identified by the RFPG is not a comprehensive list of all possible flood mitigation and floodplain management actions, and only represents a portion of the overall need in the Sabine basin. All relevant data associated with each FME, FMP, and FMS is presented in **Tables 12**, **13,** and **14**, respectively, in **Appendix 4-B.**

4.B.4. Evaluation of Potentially Feasible FMPs, FMSs, an FMEs

As defined by the TWDB in the Exhibit C Technical Guidelines for Regional Flood Planning, a Flood Mitigation Project (FMP) is a proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring cost and when implemented will reduce flood risk, mitigate flood hazards to life or property. A Flood Management Strategy (FMS) is a proposed plan to reduce flood risk or mitigate flood hazards to life or property. A Flood Management Evaluation (FME) is a proposed flood study of a specific, flood-prone area that is needed to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.

4.B.4.a. Classification of FMPs, FMSs, and FMEs

After the comprehensive list of potential flood risk reduction actions was collected, the feasibility of all potential actions was evaluated to meet the technical requirements. A screening process was performed to sort actions into proper categories in accordance with TWDB guidance. The screening process implemented by the RFPG is shown in **Figure 4-1**. In addition to falling into the general categories of action types outlined in **Figure 4-1**, potential FMPs and FMSs were screened to determine if enough detail was available to be included in the plan.

After the initial classification process, potential FMEs, FMPs and FMSs were identified as potentially feasible. **Table 4-11** lists the two FMPs determined to be potentially feasible. The extents of potential flood mitigation projects are included in **Map 17** in **Appendix 4-A**.

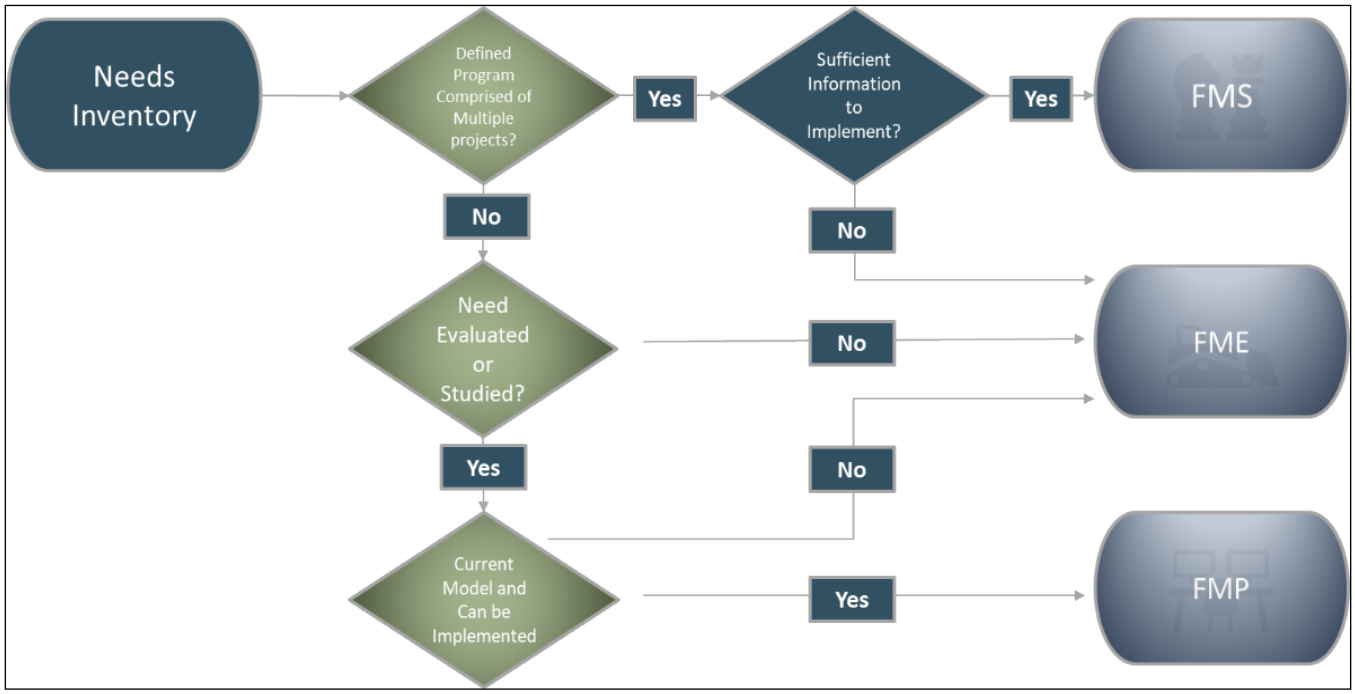

FIGURE 4-1: FLOOD RISK REDUCTION ACTION SCREENING PROCESS

As discussed in the section introduction, Flood Mitigation Project (FMP) is a relatively strict definition per TWDB (and thus only a short list technically qualified). **Table 4-11** below lists the two FMPs which met all the FMP criteria as outlined by TWDB. It is expected that in future iterations this list will grow as FMEs are completed and mature into future FMPs.

TABLE 4-11: LIST OF POTENTIALLY FEASIBLE FMPS

FMP ID	FMP Name	Description	Sponsor	Estimated Project Cost
043000017	Sabine Pass to Galveston Bay Coastal Storm Risk Management Project	Program comprised of improvements and construction of new infrastructure currently being implemented to reduce the risk of storm surge impacts in Orange, Jefferson, and Brazoria Counties in Texas.	Gulf Coast Protection District, Orange County Drainage District	$2,270,099,968
043000018	Kilgore Downtown Storm Sewer Master Plan Improvements	Downtown Storm Sewer Improvements	Kilgore	$2,242,305

Table 4-12 summarizes the 49 potentially feasible FMSs by type. The list of all potentially feasible FMSs is provided in **Table 4-13**. The extent of potential flood management strategies are included in **Map 18** in **Appendix 4-A**.

TABLE 4-12: POTENTIALLY FEASIBLE FMS TYPE DISTRIBUTION

FMS Type	Description	Count
Education and Outreach	Implementation of program to educate the public on the hazards and risks of flooding and the ecological and societal benefits of flooding.	14
Flood Measurement and Warning	Installation and operation of stream gauges, monitoring stations, alert systems to provide flood hazard information.	5
Infrastructure Projects	Improvements to or construction of channels, ditches, stormwater pipes, or any other hydraulic structures to mitigate flooding.	1
Property Acquisition and Structural Elevation	Acquisition and demolition structures and conversion of the land to open space to mitigate flooding.	4
Regulatory and Guidance	Development of ordinances, development criteria, building codes, design standard to prevent new flood risk.	15
Other	Maintenance and inspection of flood infrastructure to ensure it is design level of service in maintained.	10
	Total	**49**

TABLE 4-13: LIST OF POTENTIALLY FEASIBLE FMS

FMS ID	FMS Name	Description	Sponsor	Estimated Project Cost
042000001	Orange County Drainage District Design Criteria	Update Design Criteria	Orange County	$50,000
042000002	Orange County Property Buyouts	Administer program to acquire flood prone/repetitive loss properties and convert to open space, parks, boating access, trails, agricultural projects, and/or as a general community asset.	Orange County	$100,000
042000003	Orange County Drainage District Flood Warning System	Improvement of existing flood warning system	Orange County	$150,000
042000004	Orange County Detention Ponds Throughout County	Series of detention ponds to prevent flooding along IH-10, Hwy 12, Hwy 62, and Hwy 87 – the County's evacuation routes.	Orange County	$44,000,000
042000005	Van Zandt County Wide Floodplain Development Regulations	Incorporate higher standards for flood hazard resiliency in local application of the building code.	Van Zandt	$10,000
042000006	Rockwall Countywide Flood Awareness Program	Develop a public education and awareness website to educate and inform Rockwall County residents/businesses about the natural hazards and the potential ways to mitigate them.	Rockwall	$2,775
042000008	Orange County Emergency Response Staging Area	Staging Area and "lily pads" for use during disaster events.	Orange County Drainage District	$10,000
042000009	Orange County Elevation of Residential Structures Program	Elevations of homes within Floodplains throughout County.	Orange County Drainage District	$50,000
042000010	Orange County Drainage District Additional Gages and Warning Systems	Incorporation of additional rain gauges and flood sensors throughout jurisdiction.	Orange County Drainage District	$200,000
042000011	City of Edgewood Emergency Siren Program	Purchase and install outdoor warning sirens.	Edgewood	$10,000
042000012	City of Edgewood Flood Infrastructure Maintenance	Adopt and implement a program for clearing debris from bridges, drains, and culverts	Edgewood	$100,000
042000013	City of Greenville NFIP Participation	Increase NFIP Participation. Greenville participates in the NFIP program and needs to strongly encourage through education additional residents and businesses to purchase and maintain flood insurance.	Greenville	$10,000
042000014	City of Fruitvale "StormReady" Program	Obtain certification in the National Weather Service StormReady Program.	Fruitvale	$10,000
042000015	City of Fruitvale Flood Emergency Notification System	Implement and enhance an area-wide telephone Emergency Notification System ("Reverse 911").	Fruitvale	$10,000
042000016	City of Van "StormReady" Program	Obtain certification in the National Weather Service StormReady Program.	Van	$10,000
042000017	City of Van Flood Infrastructure Maintenance	Adopt and implement a program for clearing debris from bridges, drains and culverts.	Van	$50,000
042000018	City of Grand Saline "StormReady" Program	Obtain certification in the National Weather Service StormReady Program.	Grand Saline	$10,000
042000019	City of Grand Saline Flood Infrastructure Maintenance	Adopt and implement a program for clearing debris from bridges, drains, and culverts	Grand Saline	$100,000
042000020	City of Wills Point "StormReady" Program	Obtain certification in the National Weather Service StormReady Program.	Wills Point	$10,000
042000021	City of Wills Point Flood Emergency Notification System	Implement and enhance an area-wide telephone Emergency Notification System ("Reverse 911").	Wills Point	$10,200
042000022	City of Wills Point Flood Infrastructure Maintenance	Adopt and implement a program for clearing debris from bridges, drains and culverts.	Wills Point	$51,000
042000023	City of Wills Point Flood Awareness Program	Educate community on the dangers of low water crossings through the installation of warning signs and promotion of "Turn Around, Don't Drown" Program.	Wills Point	$10,200
042000024	City of Fate Flood Access Improvement	Add secondary entry/access roads to existing neighborhoods where possible/enforce two entry/access road requirements in existing code for new construction	Fate	$400,000

FMS ID	FMS Name	Description	Sponsor	Estimated Project Cost
042000025	City of Fate Flood Infrastructure Maintenance	Develop and implement a county-wide pre-disaster debris removal and monitoring contracts	Fate	$100,000
042000026	City of Gladewater Flood Awareness Program	Develop and implement a public education campaign to inform the public about mitigation actions they can take to make their family and home safer. Put information and links to outside resources on city websites and Facebook pages.	Gladewater	$10,000
042000027	City of Gladewater Flood Awareness Program	Develop and implement the "Turn Around, Don't Drown Program"	Gladewater	$10,000
042000028	City of Gladewater Flood Infrastructure Maintenance Program	Implement program to remove debris from drainage culverts when needed to alleviate potential flooding hazards	Gladewater	$20,000
042000029	City of Gladewater Flood Awareness Program	Develop, implement and promote a public education campaign to encourage the public to register for the Nixle warning system; put link on city websites and Facebook pages.	Gladewater	$10,000
042000030	City of Kilgore "StormReady" Program	Obtain awareness materials from Texas Floodplain Management Association for distribution to the public. Post public awareness content on social media platforms prior to and during flooding.	Kilgore	$5,000
042000032	City of Kilgore Flood Infrastructure Inspection and Maintenance Program	Investigate the current condition of culverts, headwalls, and repairs to culverts and headwalls	Kilgore	$30,000
042000033	City of Clarksville City Flood Infrastructure Inspection and Maintenance Program	Monitor flood-prone areas and remove debris from drainage culverts when needed to alleviate potential flooding hazards.	Clarksville City	$20,000
042000034	City of Longview Flood Awareness Program	Promote the "Turn Around Don't Drown" campaign, in partnership with DPS.	Longview	$10,000
042000035	City of Longview Flood Mitigation Training Program	Seek state and FEMA sponsored training in flood mitigation for key personnel.	Longview	$2,000
042000036	Longview Flood Mitigation Floodplain Development Regulations	Improve the long-range management and use of flood-prone areas by the adoption and enforcement of local ordinances to regulate new development within the floodplain. Review and revise ordinances, when needed.	Longview	$0
042000037	City of Longview Online Flood Awareness Program	Place links on local websites to free FEMA training for independent study via the internet, such as 15-271 "Anticipating Hazardous Weather and Community Risk."	Longview	$0
042000038	City of Longview Regulatory Flood Hazard Map Program	Work with state and federal agencies to maintain current flood maps.	Longview	$0
042000039	City of Longview Property Acquisition Program	Implementation of program to purchase properties in floodplain areas to reserve them from development.	Longview	$100,000
042000041	City of Longview Dam Development	Promote FEMA-recommended construction methods for any new dam	Longview	$10,000
042000042	City of Hideaway Flood Awareness Program	Conduct public outreach to educate homeowners on flood mitigation measures for their homes.	Hideaway	$10,500
042000043	City of Hideaway Floodplain Development Regulations	Mandate 2 FT Freeboard on Hideaway Lakes Dams	Hideaway	$10,000
042000044	City of Hideaway Flood Awareness Program	Public Awareness of Evacuation Routes from rising water from dam failure.	Hideaway	$10,500
042000045	City of Hideaway Dam Reliability Program	The city will remove trees from earthen dams on hideaway lakes #2 and #3 to mitigate erosion and assist with soil adhesion.	Hideaway	$60,000
042000046	City of Winona Flood Awareness Program	Conduct public outreach to homeowners and residents on flood mitigation measures for their residents.	Winona	$104,000

FMS ID	FMS Name	Description	Sponsor	Estimated Project Cost
042000047	City of Royse City Floodplain Management Ordinances	Update Flood Prevention ordinance, adopting a “no-rise” in Base Flood Elevation in the 100-year floodplain.	Royse City	$10,000
042000048	City of Royse City "StormReady" Program	Achieve certification by the National Weather Service as a “StormReady” Community.	Royse City	$10,000
042000049	City of Como Flood Awareness Program	Disseminate PSA’s, Newspaper Articles through local media about dangers of flooded county roads and to “Turn Around; Don’t Drown.”	Como	$10,000
042000050	City of Cumby Flood Awareness Program	Develop and implement the "Turn Around, Don’t Drown Program"	Cumby	$0
042000051	City of Cumby Flood Awareness Program	Disseminate PSA’s, Newspaper Articles through local media about dangers of flooded county roads	Cumby	$11,500
042000052	City of Marshall Property Acquisition Program	Encourage development of acquisition and management strategies to preserve open space for flood mitigation and water quality in the floodplain.	Marshall	$50,000

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Table 4-14 summarizes the 59 potentially feasible FMEs by type. The complete list of potential FMEs considered by the Sabine RFPG is included in **Table 4-15**. Chapter 5 details the process taken by the RFPG to recommend FMPs, FMS, and FMEs. The extent of potential flood management evaluations and existing mapping needs are included in **Map 16** in **Appendix 4-A**.

TABLE 4-14: POTENTIAL FME TYPE DISTRIBUTION

FME Type	Description	Count
Watershed Planning	Floodplain mapping update includes hydrologic and hydraulic modeling to determine flood hazard areas.	15
	Drainage master plan includes hydrologic and hydraulic modeling to determine potential flood mitigation alternatives for a county or city.	16
Project Planning	Project planning includes feasibility assessments and impact analyses of potential future flood mitigation projects. Nature based solutions that protect existing stream, riparian areas, and floodplains while reducing flood risk to people will be evaluated.	31
Other	Floodplain mapping for dam failure hydrologic and hydraulic modeling to determine flood hazard areas in the event of a dam breach.	1
	Total	**63**

There are instances where proposed FMEs overlap with existing Flood Infrastructure Fund (FIF) studies which are ongoing. The following FIF Category 1 studies (as of December 2022) are ongoing within the Sabine Region:

- TWDB ID 40058 – Upper Sabine Flood Protection Planning Study (Gregg, Rusk, Smith, Wood, and Harrison Counties)
- TWDB ID 40045 – Lower Sabine Flood Protection Planning Study (Orange, Jasper, and Newton Counties)
- TWDB ID 40019 – Sabine River Relief Ditch and Expansion (Orange, Jasper, and Newton Counties)
- TWDB ID 40027 – Hunt County Countywide Drainage Study

These studies are generally evaluating open channel conditions on a large scale with some evaluation of storm drains, as necessary. Some of the project planning FMEs identified include drainage master plans (DMPs) for municipalities or counties and are anticipated to be much more detailed and evaluate local stormwater issues rather than primarily riverine issues as is expected in the FIF studies. Thus, the FMEs identified as drainage plans have a slightly different purpose than the FIF studies which are ongoing in the area.

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TABLE 4-15: POTENTIAL FMES

FME ID	FME Name	Description	Sponsor	Estimated Study Cost
041000001	Parker Creek Corridor Study	Study of Parker Creek Corridor	Marshall	$380,000
041000002	Newton County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Newton	$2,340,000
041000003	Smith County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Smith	$4,275,000
041000004	Smith County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Smith	$1,900,000
041000005	Harrison County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Harrison	$1,850,000
041000006	Van Zandt County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Van Zandt	$2,230,000
041000007	Upshur County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Upshur	$200,000
041000008	Sabine County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Sabine	$1,100,000
041000009	Sabine County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Sabine	$460,000
041000010	San Augustine County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	San Augustine	$100,000
041000011	San Augustine County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	San Augustine	$50,000
041000012	Shelby County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Shelby	$375,500
041000013	Rusk County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Rusk	$1,850,000
041000014	Panola County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Panola	$3,700,000
041000015	Panola County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Panola	$1,700,000
041000016	Rains County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Longview	$2,100,000

FME ID	FME Name	Description	Sponsor	Estimated Study Cost
041000017	Rains County Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Longview	$600,000
041000018	Wood County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Rockwall	$3,200,000
041000019	Hopkins County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Hopkins	$1,550,000
041000020	Vidor Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Vidor	$1,200,000
041000021	City of Fate Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Fate	$450,000
041000022	Nevada Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Nevada	$100,000
041000023	City of Newton Drainage Master Plan	Perform H&H modeling to identify and define flood risk, develop conceptual alternatives to reduce flood risk, develop OPCC for conceptual alternatives, and rank projects. Conceptual alternatives should evaluate feasibility of nature-based solutions.	Newton	$100,000
041000024	Newton Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Newton	$400,000
041000025	Longview Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Longview	$1,100,000
041000026	Josephine Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Josephine	$100,000
041000027	Kirbyville Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Kirbyville	$600,000
041000028	Marshall Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Longview	$500,000
041000029	Scottsville Drainage Master Plan	Perform study of existing culverts and drainage capabilities in town. Identify upgrades to drainage infrastructure capacity where needed.	Longview	$300,000
041000030	City of Edgewood Stormwater Drain and Culvert Improvement Study	Install and upgrade undersized stormwater drains and culverts	Longview	$100,000
041000031	City of Edgewood Stormwater Detention Study	Increase drainage capacity; add stormwater detention and / or retention basins as deemed necessary to reduce flood risk upstream of Edgewood City Dam	Longview	$100,000
041000032	City of Greenville Critical Facilities Flood Protection Study	Elevation or flood proofing of critical structures and/or the construction of barriers around critical structures	Longview	$300,000
041000033	City of Fruitvale Drainage Infrastructure Improvement Study	Evaluate access and road conditions for response vehicles. Develop and implement options to improve access and/or add redundant access routes in high risk areas.	Longview	$200,000
041000034	City of Canton Drainage Infrastructure Improvements Study	Increase drainage capacity; install French drains or elevate building and upgrade undersized pipe under state Hwy	Canton	$300,000

FME ID	FME Name	Description	Sponsor	Estimated Study Cost
041000035	City of Kilgore Drainage Infrastructure Improvements Study	Improvements to drainage infrastructure in the downtown area by installing new inlets and storm drains	Longview	$300,000
041000036	City of Kilgore Library Drainage Improvement Study	Construct network of underground drainage structures to capture and direct subsurface water away from the library structure	Longview	$400,000
041000037	City of Henderson Flood Instructure Improvements Study	Replace riprap lining with a concrete lining to increase maintenance efficiency and flood protection.	Henderson	$200,000
041000038	City of Henderson Storm Drain Improvement Study	Install new storm drain system to address localized neighborhood drainage issues	Henderson	$100,000
041000039	City of Longview Critical Facilities Flood Protection Study	Ensure that critical facilities owned by the jurisdiction are protected from flood.	Longview	$85,000
041000040	Lone Oak - Dam Inundation Study	Dam inundation study, safety study, and inventory of mitigation activities to implement for the county dams.	Lone Oak	$500,000
041000041	Kirbyville Drainage Improvement Study	Coordinate and improve storm water drainage throughout the county; encourage new development to balance impervious surfaces with adjacent green space	Kirbyville	$100,000
041000042	Feasibility Assessment and Conceptual Design of Dredging of Segments of Adams Bayou	H&H Study and Modeling for Feasibility Assessment of Dredging of Segments of Adams Bayou	Orange County Drainage District	$2,000,000
041000043	Feasibility Assessment and Conceptual Design of Dredging of Segments of Cow Bayou	H&H Study and Modeling for Feasibility Assessment of Dredging of Segments of Cow Bayou	Orange County Drainage District	$600,000
041000044	Feasibility Assessment and Conceptual Design of Dredging of Segments of Little Cypress Bayou	H&H Study and Modeling for Feasibility Assessment of Dredging of Segments of Little Cypress Bayou	Orange County Drainage District	$1,000,000
041000045	Feasibility Assessment and Conceptual Design of Constructing a Stormwater Detention Pond Adjacent to Cow Bayou near Claiborne Park	H&H Study and Modeling for Feasibility Assessment of Construction of a Stormwater Detention Pond Adjacent to Cow Bayou near Claiborne Park	Orange County Drainage District	$600,000
041000046	Feasibility Assessment and Conceptual Design of Increasing the Size of Culverts and Railroad Trestles on Major Drainage Structures	H&H Study and Modeling for Determination of Need and Feasibility Assessment for Increase in Size of Culverts and Railroad Trestles on Major Drainage Structures Throughout Orange County	Orange County Drainage District	$500,000
041000047	Feasibility Assessment and Conceptual Design of Increasing Capacity of Drainage Ditches and Channels that Convey Stormwater from Neighborhoods	H&H Study and Modeling for Determination of Need and Feasibility Assessment of the Capacity of Drainage Ditches and Channels that Convey Stormwater from Neighborhoods Located Within Orange County	Orange County Drainage District	$1,000,000
041000048	City of Fate Culvert Improvement Study	Culverts improvements to meet 100-YR fully developed conditions	Fate	$100,000
041000049	Newton County Flood and Drainage Study	Reconstructing bridges and culverts in a major drainage basin flowing into the Sabine River in Newton County.	Newton	$600,000
041000050	Orange County Drainage Improvements at Kinard Estates Study	First-time sewer service, detention pond, and other drainage improvements to reduce flooding and environmental impacts.	Orange County Drainage District	$250,000
041000051	West Orange Drainage Improvements Study	West Orange Drainage Improvements Study to quantify benefits, evaluate impacts, and begin design.	Longview	$350,000
041000052	Adams Bayou Detention Ponds Study	Flood Protection Planning Study Cow Bayou & Adams Bayou Alternative	Orange County	$600,000

FME ID	FME Name	Description	Sponsor	Estimated Study Cost
			Drainage District	
041000053	Cole Creek Detention Ponds Study	Flood Protection Planning Study Cow Bayou & Adams Bayou Alternative	Orange County Drainage District	$600,000
041000054	Cow Bayou Detention Ponds Study	Flood Protection Planning Study Cow Bayou & Adams Bayou Alternative	Orange County Drainage District	$600,000
041000055	North Airport Retention Pond	Feasibility Study of North Airport Retention Pond	Longview	$640,000
041000056	Parker Creek Detention Pond	Feasibility Study of Parker Creek Detention Pond	Longview	$380,000
041000057	Terry Bayou Detention Pond Study	Flood Protection Planning Study Cow Bayou & Adams Bayou Alternative	Orange County Drainage District	$600,000
041000058	Gregg County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Gregg	$2,200,000
041000059	Hunt County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Hunt	$4,000,000
041000060	Jasper County Flood Hazard Mapping	Complete a detailed study within the county extent to delineate an updated flood hazard area, which can be used for regulatory purposes.	Jasper	$700,00
041000061	Elevation of Feeder Road Bridge Along IH-10 at Cole Creek Feasibility Study	Elevation of Feeder Road Bridge Along IH-10 at Cole Creek Feasibility Study	Orange County Drainage District	$500,000
041000062	Lawrence Road Detention Pond Feasibility Study	Lawrence Road Detention Pond Feasibility Study	Orange County Drainage District	$400,000
041000063	Diversion Channel Cow Bayou Feasibility Study	Diversion Channel Cow Bayou Feasibility Study	Orange County Drainage District	$5,209,500

Potentially feasible FMEs came from flood risk action items that have not been studied/developed enough to be classified as an FMP, flood study requested by sponsor, or flood mitigation/flood information gap study identified that is meant to address the need found in Task 4A. In addition to finding FMEs through data collection and stakeholder survey, the RFPG was also responsible for creating FMEs to address needs related to flood risk information and flood mitigation. To support this activity, the Flood Mitigation Needs Analysis conducted during Task 4A to the identified HUC-12 watersheds with flood risk knowledge gaps and greatest overall flood risk.

Some flood risk actions were determined to be infeasible for inclusion in the plan at this stage of evaluation. Many identified flood mitigation actions have not been thoroughly evaluated such that benefits can be demonstrated. These actions items have been included as potential project planning FMEs. The list of potential FMEs and potentially feasible FMSs and FMPs were further evaluated to determine impact and benefits.

Some actions that were initially considered for FMSs and FMPs that did not meet these requirements were considered for recommendation as FMEs. However, some potential flood risk reduction actions were determined to be infeasible if:

- Action has implementation issues related to permitting, acquisition, utilities, or transportation
- Action does not align with the flood mitigation goals adopted by the RFPG
- Action does not align with the guidance principles set forth by TWDB
- Action does not demonstrate benefits at a scale appropriate for inclusion in a regional plan
- Action duplicates the benefits of other action(s) included in the plan

The list of infeasible FMSs and FMPs can be found in **Table 4C-1**, in **Appendix 4-C**.

4.B.4.b. No Negative Impact

All FMS and FMPs must demonstrate that implementation will not negatively affect a neighboring area, based on best available data. Demonstrations of no negative impact must reference 1% annual change water surface elevations (WSEs) and peak discharges in pre-project and post-project conditions. The criteria listed below does not have any regulatory implications at a local, state, or federal level due to the approximate nature of flood planning. For the purposes of flood planning effort, a determination of no negative impact can be established if a project or strategy does not increase flood risk of infrastructure such as residential and commercial buildings and structures. Additionally, all of the following requirements, per TWDB Technical Guidelines, should be met to establish no negative impact, as applicable:

1. Stormwater does not increase inundation in areas beyond the public right-of-way, project property, or easement
2. Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
3. Maximum increase of 1D Water Surface Elevation must round to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section.
4. Maximum increase of 2D Water Surface Elevations must round to 0.3 feet (< 0.35ft) measured at each computational cell.

5. Maximum increase in hydrologic peak discharge must be < 0.5% measured at computational nodes (sub-basins, junctions, reaches, reservoirs, etc.). This discharge restriction does not apply to a 2D overland analysis.

Non-structural FMPs can be determined to have no negative impact on neighboring areas by default. These projects do not propose physical changes to the floodplain and resulting flood hazard areas, which eliminates the potential for increases in 1% annual chance event discharges or WSEs. Instead, these project types reduce flood exposure by removing individuals and property from flood hazard areas. In the Sabine planning region, FMSs that implement Flood Early Warning Systems mitigate flood risk by enabling individuals to make well-informed decisions during flood events. Similarly, Voluntary Property Acquisition FMSs reduce flood risk by removing structures from areas prone to flooding.

FMSs can also be determined to have no negative impact on adjacent areas without a detailed analysis due to these items being non-structural in nature. These types of FMSs are listed below:

- Education and Outreach
- Flood Measurement and Warning
- Property Acquisition and Structural Elevation
- Regulatory and Guidance
- Other; includes maintenance, restoration, land use policies, sign installation, etc.

For the purposes of demonstrating no negative impact at a planning level, restoration, preservation, and maintenance activities encompassed by the “Other” strategy type will be assumed to retain the present function of natural or built flood infrastructure. Therefore, these strategies demonstrate no adverse impact on the basis of not significantly altering the physical environment.

For Structural FMPs and FMSs, signed and sealed reports were checked for certified statements that the associated project or strategy would not cause negative impacts upstream, downstream, or within the project area in events up to and including the 1% annual chance flood event. For FMPs and FMSs that certified statements could not be located for, existing H&H models were reviewed for negative impacts as defined above.

4.B.4.c. Estimated Benefits of FMPs, FMSs, and FMEs

The benefit analysis performed for FMPs, FMSs, and FMEs focused on existing flood risk in the project service area and reduction in flood risk due to the project. For FMPs, estimated benefits were determined using existing and proposed condition provided as part of the source documentation. A comparison of existing and proposed conditions was used to determine the flood risk reduction benefits associated with each FMP. Other benefits that were analyzed for the FMPs include the change in level of service, or capacity from existing conditions to proposed (constructed or mitigated) conditions, and estimated reduction in fatalities or injuries if the project or strategy was implemented. However, these metrics were difficult to determine with the modeling results. Unless stated directly in the source documentation, these items were left unidentified for many of the FMPs. To ensure consistency, each component of the assessment was approached in the same manner such that the estimated benefits associated with the individual FMPs, FMSs, and FMEs are comparable. Some of the FMSs or FMEs may be refined further in future cycles to become future FMPs.

Updates to regulations, public outreach and education efforts are FMSs that do not have flood risk reduction benefits directly associated with decreased flood hazard areas. Because of this, most of the FMS evaluations resulted in little information regarding flood risk reduction and evaluation of flood risk reduction was limited to FMPs. A summary of existing flood risk within each project service area and reduction in flood risk benefits resulting from project implementation were determined using available information from previous studies is included in **Table 4-16**.

TABLE 4-16: FMP FMS, AND FME BENEFIT ANALYSIS

Category	Existing Flood Risk	Reduction in Flood Risk
Structures	Estimated number of structures in 1% ACE Flood Hazard Area	Number of structures with reduced exposure to 1% ACE Flood Hazard Area
		Number of structures removed from 1% ACE Flood Hazard Area
		Number of structures removed from 0.2% ACE Flood Hazard Area
	Residential structures in 1% ACE Flood Hazard Area	Residential structures removed from 1% ACE Flood Hazard Area
	Critical facilities in 1% ACE Flood Hazard Area	Critical facilities removed from 1% ACE Flood Hazard Area k
Population	Estimated population in 1% ACE Flood Hazard Area	Estimated population removed from 1% ACE Flood Hazard Area
Roads	Number of low water crossings at flood risk	Number of low water crossings removed from 1% ACE Flood Hazard Area
	Estimated number of road closures	Estimated reduction in road closure occurrences
	Estimated length of roads 1% ACE Flood Hazard Area (mi)	Estimated length of roads removed from 1% ACE Flood Hazard Area (mi)
Agricultural Land	Estimated farm & ranch land 1% ACE Flood Hazard Area (ac)	Estimated farm & ranch land removed 1% ACE Flood Hazard Area (ac)

4.B.4.d. Estimated Cost of FMPs, FMSs. And FMEs

For FMPs and FMSs, cost estimates were provided by the engineering reports associated with each one. Cost estimates were adjusted to account for inflation and other changes in price of labor and commodities that had taken place since the publication date of the original reports. The cost estimates listed in Table 13 and Table 14 in **Appendix 4-B** are expressed in September 2020 dollars. Some FMS sources from Hazard Mitigation Action Plans did not include cost estimates. Cost estimates developed for FMSs and FMEs do not include the cost of recurring annual operations and maintenance or increases in staffing costs.

The cost assumptions for FMSs are expressed in 2020 dollars and were developed based on engineering experience and are comparable to similar projects. FMS costs do not include land acquisition, direct construction cost, buyouts, or contingency. **Table 4-17** summarizes the assumptions used to develop cost estimated for FMS.

TABLE 4-17: FMS ESTIMATED COST ASSUMPTIONS

FMS Type	FMS Description	Cost Estimate Range
Education & Outreach	Implementation of program to educate the public on the hazards and risks of flooding.	$50,000 - $300,000
Flood Measurement & Warning	Installation and operation of stream gauges, monitoring stations, alert systems to provide flood hazard information.	$10,000 - $200,000
Property Acquisition	Administration of program to acquire and demolish structures and convert the land to open space to mitigate flooding.	$50,000 - $100,000
Regulatory and Guidance	Development of ordinances, development criteria, building codes, design standard to prevent new flood risk.	$10,000 - $50,000
Infrastructure	Improvements to or construction of channels, ditches, stormwater pipes, or any other hydraulic structures to mitigate flooding.	$500,000
Other	Maintenance and inspection of flood infrastructure to ensure it is design level of service in maintained.	$100,000 - $250,000

Cost estimates for FMEs were developed at a planning level based on engineering experience and comparisons to similar previous studies. Estimated costs for watershed planning include hydrologic & hydraulic modeling, mapping, identification of potential flood risk reduction solutions, BCA, and alternative analyses. Estimated costs for project planning include project design and construction engineering. **Table 4-18** summarizes the estimated cost per square mile for FMEs. The cost for dam failure study FMEs was estimated as a single value.

TABLE 4-18: FME ESTIMATED COST ASSUMPTIONS

FME Type	FME Description	Cost Estimate
Project Planning	Feasibility assessments and impact analyses of potential future flood mitigation projects.	$1,500 /mi^2
Watershed Planning	Floodplain Mapping Updates	$8,000 /mi^2
	County Drainage Master Plan – Urban	$4,500 /mi^2
	County Drainage Master Plan – Rural	$3,500 /mi^2
	City Drainage Master Plan	$40,000 /mi^2
	Regional Watershed Study	$2,000 /mi^2
	Dam Failure Study	$50,000

4.B.4.e. Benefit-Cost Ratio for FMPs

Benefit-Cost Ratio (BCR) is a concise way to compare and prioritize proposed projects and strategies which measures the benefits that a project or strategy achieves compared to the implementation cost required. BCRs greater than 1 indicate that there are more associated benefits than costs over the life of

the proposed project. The TWDB provided a benefit-cost analysis (BCA) tool to be used for consistent and equitable comparison of projects across flood planning regions. The benefits provided to commercial and residential structures, critical facilities, streets, utilities, agriculture, water supply, and recreation are balanced by the construction cost, right-of-way acquisition costs, utility relocation costs, operation and maintenance costs, and the lifespan of the proposed project to determine if the benefits outweigh the costs. Environmental benefits provided by FMPs were also considered in the BCA.

Structural flood risk reduction was determined using the results of the hydraulic modeling associated with each FMP. The pre-project flood depth rasters provided by the modeling results were intersected with the structures database provided by TWDB to determine the level of flooding a structure experiences during a flood event. To account for the elevation of the top of slab of a typical finished floor elevation above the adjacent grade, 6-inches of flood depth was removed from each structure. The same process was performed using the post-project flood depth information provided by the modeling results. The pre-project to post-project flood depth difference was used to estimate the reduction of damages to the structure using the damage costs provided by the TWDB BCA tool.

Residential structures were grouped into small, medium, and large sized structures to match the BCA tool classifications. Each structure was categorized based on the measured square footage of each structure shape as provided in the structure database. Non-residential structures were generalized into broad categories of type of industry the building serves (commercial, industrial, public, etc.).

A similar process was performed for agricultural land; however, duration or depth of flooding was not considered. Agricultural land classification was also provided by the TWDB as a raster dataset. This dataset included two agricultural regions: farmland and ranch land. Approximate dollar per acre estimates were associated with each type of land. Farmland was considered a low-value crop based on the average crop type for the region (corn, rice, sorghum, etc.) and ranchland was considered a hay-type value crop. Values for each are based on the average crop yield values for each category taken from the Texas Almanac. Ranchland was assumed to be a hay-type value crop based on the primary assumption that, during a flooding event, livestock can be transported away from flood risk.

The calculated benefits depend on broad assumptions—as stated above—regarding the value of structures, value of agricultural land and other factors. The costs and BCRs developed as part of this plan and provided in Table 13 of **Appendix 4-B** are for high-level planning purposes only. Further evaluation and modeling will be required to develop a more extensive and detailed BCR for each FMP.

4.B.4.f. Emergency Need

The Sabine RFPG defined the term “emergency need” in the Sabine region as any areas included in at least one of the following criteria:

- Areas with outdated mapping
- Areas with a history of severe and/or repetitive flooding
- Areas with critical infrastructure within the 1% ACE flood hazard area
- Areas with structures within the 1% ACE flood hazard area with SVI greater than 0.75
- Areas with identified deficient infrastructure
- Areas with evacuation routes within the 1% ACE flood hazard area

After evaluation, the number of FMEs, FMPs, and FMEs identified as an action with an emergency need were tabulated and are presented in **Table 4-19** below.

TABLE 4-19: FMPS, FMSS, FMES IN AREAS WITH EMERGENCY NEED

Type	Actions in Areas with Emergency Need	Actions in Areas without Emergency Need	Total Actions
FMP	1	1	2
FMS	7	42	49
FME	48	15	63

4.B.4.g. Funding Sources

Potential funding sources were gathered for FMEs, FMSs, and FMPs. Funding related to each individual flood mitigation action will be assessed in Chapter 9. The Sabine RFPG considered the funding mechanisms listed in **Table 4-20** to encompass the widest variety of needs:

TABLE 4-20: FUNDING SOURCES AVAILABLE FOR FMES, FMSS, AND FMPS

Level	Agency	Funding Source
Local	Local Sponsor (City, County, Drainage District)	General Fund
		Bonds
		Stormwater or Drainage Utility Fee
		Special Purpose District Taxes and Fees
State	Texas Water Development Board (TWDB)	Flood Infrastructure Fund (FIF)
		Clean Water State Revolving Fund (CWSRF)
Federal	Federal Emergency Management Agency (FEMA)	Hazard Mitigation Grant Program (HMGP)
		Building Resilient Infrastructure and Communities (BRIC)
		Flood Mitigation Assistance Grant Program (FMA)
	Department of Housing and Urban Development (HUD)	Community Development Block Grant – Disaster Recovery (CDBG-DR)
		Community Development Block Grant – Mitigation (CDBG-MIT)
	United States Army Corps of Engineers (USACE)	Partnerships with USACE, funded through Continuing Authorities Program (CAP), Water Resources Development Acts (WRDA), Civil Works Budget, or other legislative vehicles

4.B.4.h. Residual Risk

It is expected that the implementation of recommended FMPs will reduce current and future levels of flood risk in the region. However, it is not possible to protect against all potential flood risks and there is potential for future increases in flood risk due to lack of maintenance or even a catastrophic failure. Residual and future risks for the potential FMPs could be characterized as follows:

1. Flood events may exceed the level of service for which infrastructure is designed.
2. Potential failure or overtopping of dams and levees.
3. Communities depend on future funding and program priorities to maintain, repair, and replace flood protection assets. Routine maintenance of infrastructure is required to maintain its design capacity. Maintenance is sometimes overlooked due to budget, staff, and time constraints.
4. In our representative government, policy changes that adversely impact budgets, prior plans, assets, and standards is always a possibility.
5. Human behavior is unpredictable, people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons.

The engineering studies that provide the supporting data for the potential FMPs were reviewed to identify the residual, post-project and future risks associated with each FMP. Additionally, routine maintenance of infrastructure is required to maintain its design capacity. Failure to adequately maintain the infrastructure could increase the flooding risk throughout the project area.

4.B.4.i. Flood Mitigation or Floodplain Management Goals

The potential FMPs, FMSs, and FMEs were reviewed to determine connection to the short-term flood mitigation or floodplain management goals adopted by the RFPG. More information on these goals is included in Chapter 3. All short-term goals adopted by the RFPG are connected to potential FMP, FMS, or FME that will in part help to achieve the goal. **Table 4-21** summarizes the short-term goals and the number of potential FMP, FMS, and FME connected to each goal.

TABLE 4-21: FLOOD MITIGATION OR FLOODPLAIN MANAGEMENT GOALS ADDRESSED BY POTENTIAL FMP, FMS, AND FME

Goal ID	Goal	FMP	FMS	FME
04000001	Improve 20% of Low Water Crossings to no longer be classified as Low Water Crossing.	0	0	1
04000003	Improve flood protection for 15% of critical facilities in flood prone areas.	0	0	1
04000005	Reduce exposure of existing structures in flood prone areas by elevating, acquiring, relocating, or otherwise providing flood protection to 10% of structures.	0	4	1
04000007	Advance multiple regional flood infrastructure projects designed for larger storm events.	2	1	22
04000009	100% of counties to perform public education and awareness campaigns to better inform the public of flood-related risks on an annual basis.	0	30	0
04000011	Increase number of communities with documented, operational, and funded stormwater asset management plan and maintenance operations to 50%.	0	11	0

Goal ID	Goal	FMP	FMS	FME
04000012	Increase the coverage of flood hazard data in areas identified as having current gaps in flood mapping.	0	0	47
04000013	Improve flood hazard data in areas identified as having out of date flood mapping.	0	0	46
04000014	Advance flood protection planning studies and preliminary engineering efforts in flood prone areas.	0	0	49
04000015	Increase number of monitoring gages and associated real time reporting technology installed and maintained in the region to 1 in 50% of HUC10s.	0	5	0
04000017	Install warning signage at 100% of identified low water crossings in the floodplain and coordinate with TxDOT where applicable.	0	1	0
04000018	Increase number of communities with a comprehensive drainage policy and criteria manuals to reduce flood hazard encouragement and education.	0	14	0
04000019	Increase the number of communities that utilize latest and most appropriate precipitation data as a basis for design criteria.	0	1	0

CHAPTER 5
RECOMMENDATION OF FLOOD MANAGEMENT EVALUATIONS AND FLOOD MANAGEMENT STRATEGIES AND ASSOCIATED FLOOD MITIGATION PROJECTS

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CHAPTER 5. RECOMMENDATIONS OF FLOOD MANAGEMENT EVALUATIONS, FLOOD MANAGEMENT STRATEGIES AND ASSOCIATED FLOOD MITIGATION PROJECTS

The goal of this task is for the Sabine RFPG to recommend flood mitigation projects (FMP), flood management strategies (FMS), and flood management evaluations (FME) for inclusion in the regional flood plan. Chapter 4 details the process to identify areas of high flood need and potentially feasible FMPs, FMSs, and FMEs. The actions recommended by the Sabine RFPG are not generally anticipated to be performed by the Sabine RFPG during the same regional flood planning cycle during which they are identified. All flood management goals set by the Sabine RFPG, discussed in **Chapter 3**, are connected to at least one recommended FME, FMS, or FMP.

After analysis of potential projects, studies, and possible mitigation areas as described in **Chapter 4**, a list of FMEs, FMSs, and FMPs, colloquially known collectively as FMXs, were identified, and presented to the Sabine RFPG for review, discussion, and approval. Ultimately, all of the potential FMEs and potentially feasible FMSs and FMPs were recommended by the Sabine RFPG. The alignment of identified and recommended FMEs, FMSs, and FMPs with RFPG goals is detailed in **Table 4-19** in **Chapter 4**.

Chapter 5.A. Flood Management Evaluations (FME)

5.A.1. Recommendation Process

Flood Management Evaluations (FMEs) are defined as a proposed flood study for a specific, flood-prone area to assess flood risk and/or determine whether a flood management strategy (FMS) or flood mitigation project (FMP) are feasible in that area. Recommended FMEs are required to be in alignment with at least one regional floodplain management and flood mitigation goal outlined and described in **Chapter 3**. Each recommended FME will identify and evaluate at least one solution to mitigate the 1% annual chance flood utilizing H&H modeling while also supporting the Sabine RFPG flood mitigation and/or floodplain management goals. Given the number of FMEs in the region and the estimated funding, time, and resources required to complete them, not all FMEs may be completed during the same planning cycle. Specific project recommendations/designs identified in these FMEs are not defined at this time, but a major goal of completing the FMEs is to identify potentially feasible FMPs which meet TWDB requirements.

Some areas in the region began the regional flood planning process with more flood risk, flood planning, and flood project information than others. The recommended FMEs in areas with less prior information will serve to inform the next planning cycle, or any interim amendments to the regional flood plan, with better flood risk information and potential FMPs. The Sabine RFPG identified and recommended three primary types of FMEs: Watershed Planning, Project Planning, and Other and utilized the following criteria to ensure that resources are directed efficiently to implement those flood studies and technical evaluations:

- High Existing Flood Need
- Sponsor Coordination

- Existing Flood Risk Information
- Align with RFPG Goals
- Community Vulnerability (SVI)

5.A.2. Recommended FMEs

Following the process detailed above, the Sabine RFPG voted to recommend FMEs on Tuesday, June 21, 2022. All of the 59 FMEs identified in **Chapter 4** as potentially feasible were recommended by the RFPG. The list of recommended FMEs is included in **Table 15** in **Appendix 5-B**. The extent of the recommended FMEs is shown in **Map 19** in **Appendix 5-A**. Additionally, one-page summaries for each recommended FME were created and delivered to each member of the Sabine RFPG for ease in review of the benefit area, overview of the project, and high-level cost estimate and potentially affected structures. These summaries are included in **Appendix 5-C**. **Table 5-1** shows the different types of FMEs recommended by the Sabine RFPG. The majority of the number recommended FMEs are "Project Planning," which are studies needed to be performed to develop projects beyond a planning level; however, the majority of the total cost are flood hazard mapping efforts. The cost associated with recommended FMEs that extend beyond the Sabine Flood Planning Region boundary were split based on coordination with bordering flood planning regions.

Base Level Engineering (BLE) models are available for reference for all recommended FMEs. https://webapps.usgs.gov/infrm/estbfe/ FMEs will produce models with a higher level of detail compared to BLE models. Where ongoing flood mitigation studies overlap recommended FMEs, the recommended FME is intended to identify additional flood mitigation projects, study additional streams, or add detail to previous project evaluations. The overlap between ongoing flood mitigation studies and recommended FMEs is shown in **Map 19** in **Appendix 5-A**.

TABLE 5-1: RECOMMENDED FME BY EVALUATION TYPE

FME Type	Description	Count	Estimated Cost
Watershed Planning	Floodplain mapping update includes hydrologic and hydraulic modeling to determine flood hazard areas.	15	$31,570,500
	Drainage master plan includes hydrologic and hydraulic modeling to determine potential flood mitigation alternatives for a county or city.	16	$9,760,000
Project Planning	Project planning includes feasibility assessments and impact analyses of potential future flood mitigation projects. Nature based solutions that protect existing stream, riparian areas, and floodplains while reducing flood risk to people will be evaluated.	31	$19,094,500
Other	Floodplain mapping for dam failure hydrologic and hydraulic modeling to determine flood hazard areas in the event of a dam breach.	1	$500,000
	Total	**63**	**$60,925,000**

Chapter 5.B. Flood Management Strategies (FMS)

Flood Management Strategies (FMSs) are proposed plans, strategies, or actions to reduce or mitigate flood hazards to life and/or property. The Sabine RFPG recommends FMSs to reduce the potential impacts of flooding and RFPG goals that mitigate for flooding associated with the 1% annual chance event where feasible or avoid creating additional flood risk (also known as no negative impact). Many of the FMSs recommended by the Sabine RFPG are non-structural.

5.B.3. Recommendation Process

A total of 49 FMSs were gathered through publicly available documents from counties and municipalities as well as stakeholder outreach surveys done in 2021. All FMSs collected were recommended based on the identification, analysis, and comparison of alternatives that the Sabine RFPG determined would provide reductions in or avoidance of flood impacts in support of the RFPG's specific flood mitigation and/or floodplain management goals. For recommending FMSs, the Sabine RFPG set the following criteria to ensure that resources are directed efficiently to implement those strategies:

- No Negative Impact for Neighboring Communities and Water Supply
- High Existing Flood Need
- Regional Benefit (1.0 square mile)
- Existing Flood Risk to Critical Facilities or Transportation Routes
- Existing Floodplain Management Regulations
- Align with RFPG Goals

5.B.4. Recommended FMSs

Following the process detailed above, the Sabine RFPG voted to recommend FMSs on Tuesday June 21, 2022. All of the 49 FMSs identified in **Chapter 4** as potentially feasible were recommended by the RFPG. The list of recommended FMSs is included in **Table 17** in **Appendix 5-B.** The extent of the recommended FMEs is shown in **Map 21** in **Appendix 5-A**. Additionally, one-page summaries for each recommended FMP are included in **Appendix 5-C**.

Table 5-2 shows the distribution of recommended type of strategy. The largest categories of recommended FMS by number of projects are “Education and Outreach” and “Regulatory and Guidance”. Recommended FMSs summarized by the “Other” type include emergency flood response and a dam reliability program. The cost associated with recommended FMSs that extend beyond the Sabine Flood Planning Region boundary were split based on coordination with bordering flood planning regions.

TABLE 5-2: RECOMMENDED FMSS BY STRATEGY TYPE

FMS Type	Description	Count	Cost
Education and Outreach	Implementation of program to educate the public on the hazards and risks of flooding and the ecological and societal benefits of flooding.	14	$204,475
Flood Measurement and Warning	Installation and operation of stream gauges, monitoring stations, alert systems to provide flood hazard information.	5	$380,200
Infrastructure Projects	Improvements to or construction of channels, ditches, stormwater pipes, or any other hydraulic structures to mitigate flooding.	1	$44,000,000
Property Acquisition and Structural Elevation	Administration of program for acquisition and demolition structures and conversion of the land to open space to mitigate flooding.	4	$300,000
Regulatory and Guidance	Development of ordinances, development criteria, building codes, design standard to prevent new flood risk.	15	$552,000
Other	Maintenance and inspection of constructed flood infrastructure to maintain design level of service.	10	$541,000
	Total	**49**	**$45,977,675**

Chapter 5.C. Flood Mitigation Projects (FMP)

A Flood Mitigation Project (FMP) is a proposed structural or non-structural project which would reduce flood risk and mitigate flood hazards to life and property upon implementation. The Sabine RFPG recommended FMPs that reduce the potential impacts of flooding, align with RFPG goals, and mitigate for the 1% annual chance of occurrence flood.

5.C.5. Recommendation Process

For consideration and recommendations as an FMP, a project must be defined in a sufficient level of detail to meet the technical requirements of the flood planning project's Technical Guidelines for Regional Flood Planning (Exhibit C) developed by the TWDB as part of the flood planning process.

Recommendations are based upon the identification, analysis, and comparison of alternatives that the RFPG determines will provide measurable reductions in flood impacts in support of the RFPG's specific flood mitigation and/or floodplain management goals. Additionally, recommended FMPs are contingent upon meeting a variety of required items from TWDB as part of the flood planning process. Updated construction cost estimates and estimates of project benefits must also be available to define a benefit-cost ratio (BCR) for each recommended FMP. The TWDB recommends that proposed projects have a BCR greater than one, but the RFPG may recommend FMPs with a BCR lower than one with proper justification. All potentially feasible FMPs that had the necessary data and/or detailed H&H modeling results or data available to populate these technical requirements were considered for recommendation

by the RFPG. For recommending FMPs, the Sabine RFPG set the following criteria to ensure that resources are directed efficiently to implement these projects:

- No Adverse Impact for Neighboring Communities and Water Supply
- High Existing Flood Need
- Quantifiable Flood Risk Reduction Benefits
- Regional Benefit (1.0 square mile)
- Existing Flood Risk to Critical Facilities or Transportation Routes
- Align with floodplain management and flood mitigation goals outlined in Chapter 3.

5.C.6. Recommended FMPs

Following the process detailed above, the Sabine RFPG voted to recommend FMPs on Tuesday June 21, 2022. Both of the FMPs identified in **Chapter 4** as potentially feasible were recommended by the RFPG. Information from previously studied detention pond projects in Orange County did not meet TWDB's FMP requirements and therefore are listed as FMEs and collectively as a county-wide FMSs to capture the anticipated construction costs.

The list of recommended FMPs is included in **Table 16** in **Appendix 5-B**. The extent of the recommended FMPs is shown in **Map 20** in **Appendix 5-A**. Additionally, one-page summaries for each recommended FMP are included in **Appendix 5-C**. **Table 5-3** lists the flood mitigation projects (FMP) recommended by the Sabine RFPG as well as the total estimated cost for its implementation. In the instance of the Orange County Levee Project, the cost shown is being split to 65% federal government funding and 35% non-federal funding share. A table of supporting models is included as **Table 5B-1** in **Appendix 5B**.

TABLE 5-3: RECOMMENDED FLOOD MITIGATION PROJECTS

FMP Name	Verification of No Adverse Impact	Sponsor	Cost
Sabine Pass to Galveston Bay Coastal Storm Risk Management Program – Orange County Project	Memorandum for Record on Hydraulic Design Criteria for the Interior Area of the Sabine Pass to Galveston Bay Orange CSRM Levee (Appendix 5F)	USACE, GCPD, Orange County, OCDD	$2,270,099,968
Kilgore Downtown Storm Sewer Master Plan Improvements	SWMM Model (Model ID: 040000000003)	City of Kilgore	$2,242,305

5.C.6.a. Sabine Pass to Galveston Bay Coastal Storm Risk Management Program – Orange County Project

This FMP consists of the U.S. Army Corps of Engineers (USACE) Orange County Elements of the Sabine Pass to Galveston Bay Coastal Storm Risk Management (CSRM) Program. The Gulf Coast Protection District (GCPD) is the non-federal sponsor of this project and will operate and maintain the system after construction. USACE and GCPD have engaged Orange County and Orange County Drainage District (OCDD) throughout the development of this project. This project provides coastal storm surge

protection and flood damage risk reduction for the people and property within existing coastal flood

hazard areas in Orange County. While the new levee system will help Orange County become more resilient to future storm events by reducing the risk of coastal surge, no levee (or any project) fully eliminates flood risk. Within Orange County, USACE has proposed a system of new earthen levees, concrete floodwalls, gravity drainage structures, and closure structures located at road and railroad crossings. The project alignment, as of March 2022 also includes two navigable sector gates, with adjacent vertical lift gates, at Adams and Cow Bayous and multiple new pump stations, providing interior drainage for areas behind the levee/floodwall. The project also consists of coastal marsh and forested wetlands restoration as mitigation of environmental impacts. **Figure 5-1** shows the project alignment, as of March 2022 in comparison to the previous alignment from the 2017 Feasibility Report completed by USACE.

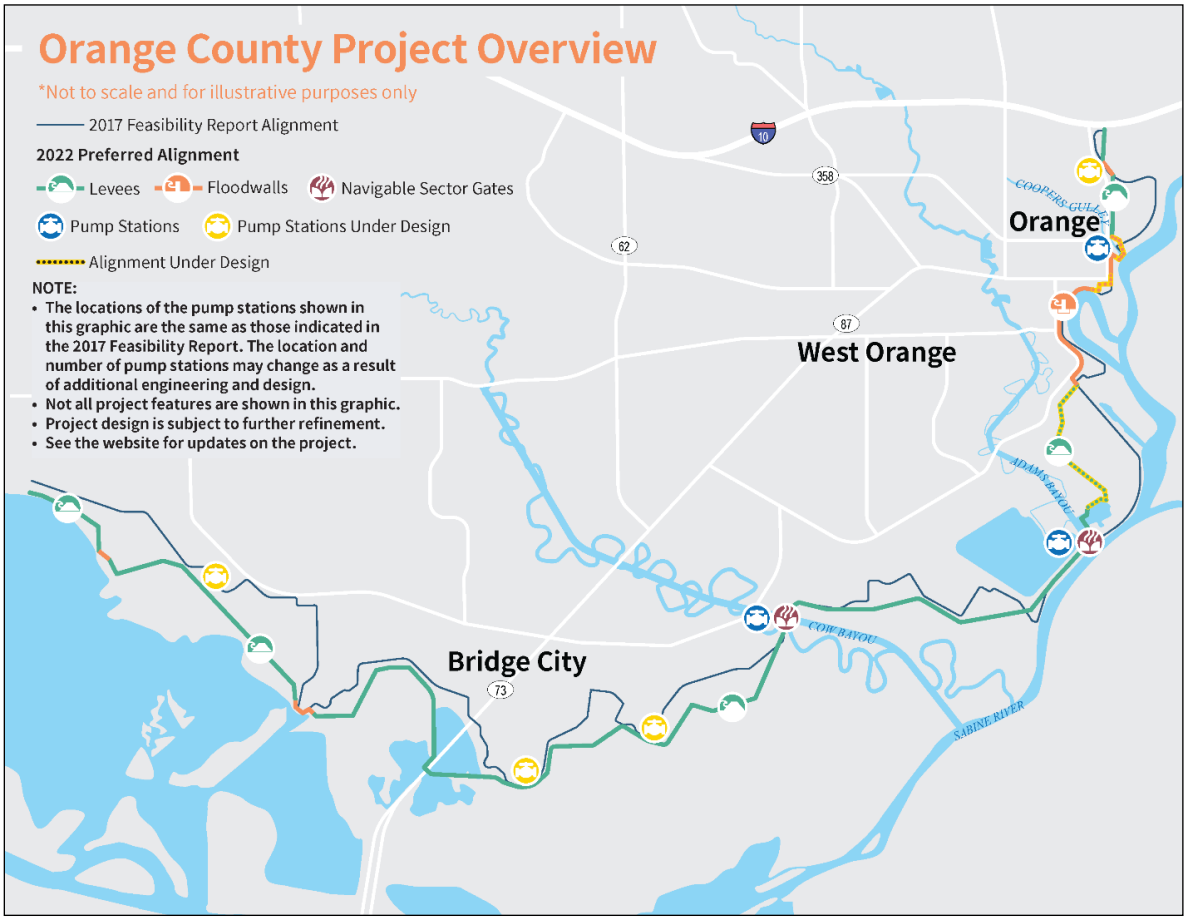

FIGURE 5-1: SABINE PASS TO GALVESTON BAY – ORANGE COUNTY PROJECT OVERVIEW

This project is in the pre-construction engineering and design (PED) phase and the project alignment may be further refined before construction. USACE maintains a website with updated project details, https://www.swg.usace.army.mil/S2G/OrangeCounty/ . **Table 5-3** includes the references used to verify that no adverse impact will be produced by the Sabine Pass to Galveston Bay CSRM project within Orange County. The signed memorandum from USACE certifies that the final design of elements within Orange County will have no adverse impact. The complete memorandum and feasibility report are includ

ed in **Appendix 5F**. Within the memorandum, USACE conveys that the goal of the final design is to have 0.0 ft rise in water surface elevation.

This project extends beyond the Sabine Flood Planning Region boundary into the Neches Region (Region 5). The total cost of this project ($2,390,000,000) was split between regions proportional to the benefit areas within each region. The majority (95%) of the Orange County levee benefit area is within the Sabine region; thus, the Sabine Region's cost was updated to $2,270,099,968 while the Neches Region (Region 5) has a cost of $119,900,000 to sum to the total $2.39B project cost.

5.C.6.b. Kilgore Downtown Storm Sewer Master Plan

This FMP consists of the implementation of the Kilgore Downtown Storm Sewer Master Plan. The downtown storm sewer system consists mainly of pipe systems and a few open channels. There are five main trunklines (North Main, North Subsystem A, North Subsystem B, South Main and South Subsystem) with several laterals. There are two open channels located in Kilgore City Park, one open channel between residential properties southwest of North Street, and the main outfall channel is located east of U.S. Highway 259 and north of Kay Street.

The U.S. Environmental Protection Agency's Storm Water Management Model version 5.0.018 (EPA-SWMM) was used for the hydrologic and hydraulic analysis of the downtown area. This model was used to verify that the implementation of the proposed improvements will not cause an adverse impact. It was determined that proposed conditions water surface elevations are below existing conditions water surface elevations.

Map 22 in **Appendix 5-A** shows the extent of model coverage. This software was used for its capabilities in analyzing pipe flow, channel flow, and street flow simultaneously. The alignments of the proposed improvements, level of service, and cost estimates are shown in **Figure 5-2**. The complete engineering report for the Kilgore Downtown Storm Sewer Master Plan is included in **Appendix 5E**.

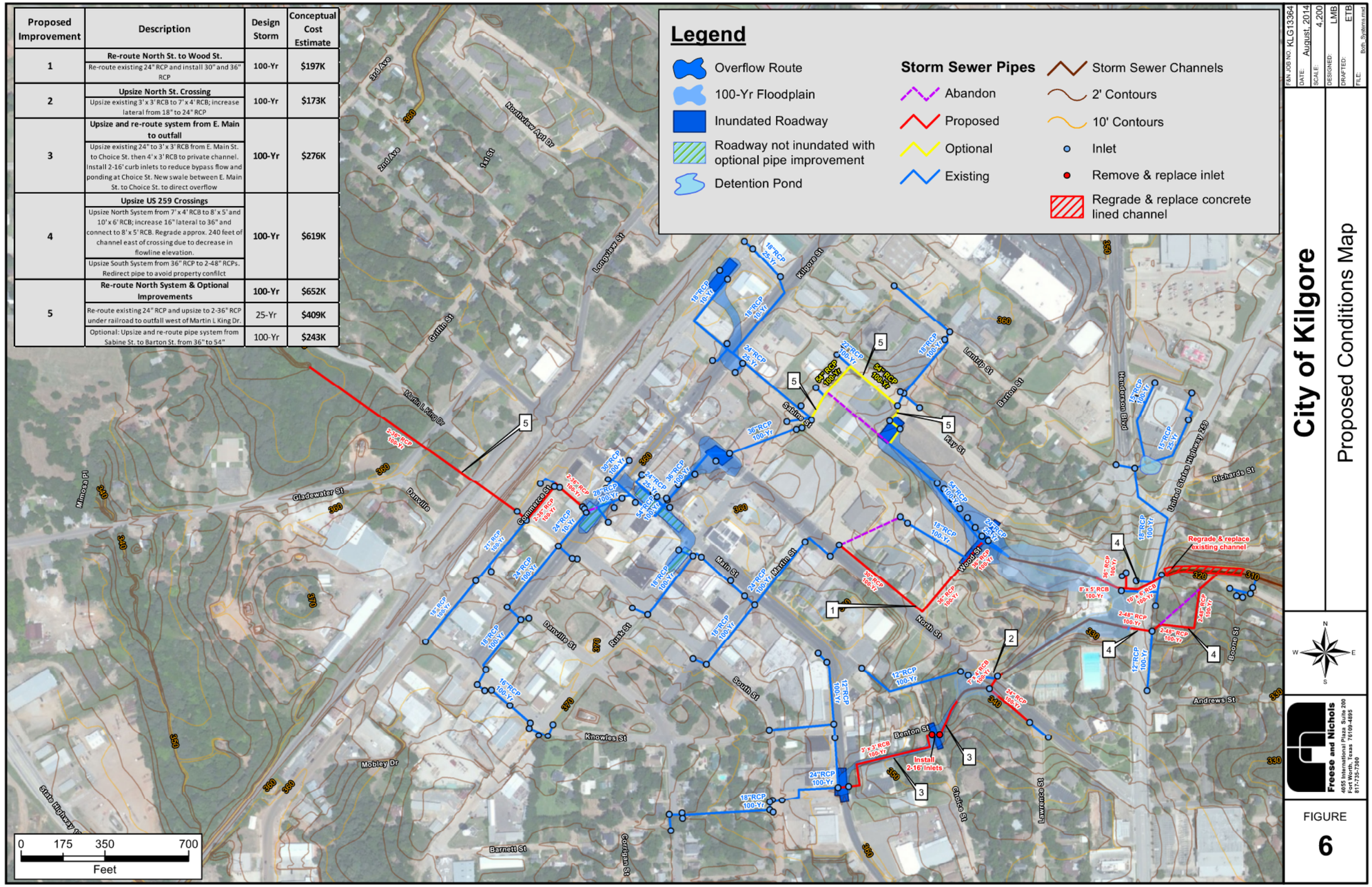

FIGURE 5-2: KILGORE DOWNTOWN STORM SEWER MASTER PLAN PROPOSED CONDITIONS

Figure adapted from Kilgore Downtown Storm Sewer Master Plan, Complete Report included in Appendix 5E

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5.C.7. Project Details

TWC 16.061 requires the development of a statewide ranked list of ongoing and proposed flood mitigation projects which is outlined in TWDB's Exhibit C Technical Guidelines for Regional Flood Planning Section 3.9, Project Details. The FMPs identified and recommended by the Sabine RFPG will be included in Texas's first State Flood Plan in a single statewide ranked list. To rank the recommended projects in a single list, the RFPGs provided projects details for each identified project. All of the evaluations noted below, and others outlined in the Technical Guidelines have a score between 0 and 10 where higher scores represent a greater need for the flood mitigation project or achieve the greatest benefits for that category. The specific criteria and associated weighting to be used in the state ranking will be determined during the State Flood Planning phase via a transparent process with public input. General project details that may be used in the final ranking criteria developed by TWDB include:

- Project Type
- Pre-Project Depth of Flooding
- Water Supply Benefit
- Mobility
- Estimated Cost
- Life and Safety: Injury/Loss of Life
- Implementation Obstacles
- Environmental Impact
- Environmental Benefit
- Benefit-Cost Ratio (BCR)
- Operations and Maintenance
- Critical Facilities Damage Reduction
- Estimated Cost
- Nature-Based Solution
- Social Vulnerability
- Community Need
- Flood Risk Reduction

As mentioned above, the criteria and scoring for each item are detailed in TWDB's Exhibit C Technical Guidelines for Regional Flood Planning Section 3.9. The complete list of project details for each of the Sabine region's FMPs is included in **Appendix 5-D**. In addition to providing project details, the Sabine RFPG classified recommended FMPs based on two criteria: FIUP (Flood Intended Use Plan) Project Category and Rural Applicant Classification. The definitions and classification process for both of these can be found in the TWDB 2020 Flood Intended Use Plan and are briefly described below.

FIUP Project Category describes the development stage of a project or study.

- Category 1: Planning of entire watersheds to inform the development of structural and non-structural mitigation strategies.
- Category 2: Planning, acquisition, and design efforts in relation to an identified flood mitigation project.
- Category 3: Projects that have already received federal funding contingent on matching with local funds.
- Category 4: Projects that can be implemented quickly and will immediately protect life and property.

The Kilgore Downtown Storm Sewer Master Plan Improvements project is a Category 2 project. The Orange County Element of the Sabine Pass to Galveston CSRM is a Category 3 project.

A project classifies as a Rural Applicant if any of the following conditions are met:

- All entities within the project benefit area are outside metropolitan statistical areas and have populations < 10,000.
- A district or municipality with a service area of 10,000 or less in population.
- A county in which no urban area exceeds 50,000 in population.

The locations where the FMPs are located (Orange County, and Gregg/Rusk County) do not have any municipalities greater than 50,000 people, therefore, both FMPs are classified as rural applicants.

CHAPTER 6
IMPACTS AND CONTRIBUTION OF THE REGIONAL FLOOD PLAN

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CHAPTER 6. IMPACT AND CONTRIBUTION OF THE REGIONAL FLOOD PLAN

The Regional Flood Planning Group (RFPG) was tasked with summarizing the impacts and contributions the regional flood plan (RFP) is expected to have if the plan is implemented as recommended. The following sections describe the impacts and contributions of this plan to various aspects of water resources. Implementation of the plan as recommended assumes that all flood mitigation projects (FMP), flood management strategies (FMS), and flood management evaluations (FME) outlined in **Chapter 5** are fully funded and completed. Additionally, avoidance of future flood risk due to policy recommendations and potential future recommendations of all identified projects, strategies, and evaluations is described in this chapter since most FMPs, FMSs, and FMEs only require sponsor approval to be recommended by the Sabine RFPG.

Chapter 6.A. Impacts of Regional Flood Plan

The overall impacts of the Regional Flood Plan include potential impacts to areas at risk of flooding; structures and populations in the floodplain; low water crossings; water supply; and impacts on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this effort.

The impact of the plan also includes how additional, future flood risk will be avoided through implementation of recommended improvements to the region's floodplain management policies. Direct and indirect benefits of other FMPs, FMSs, and FMEs not currently recommended are also discussed. These details are provided to highlight the importance of stakeholder involvement and support in maximizing the plan's effectiveness during amendment periods and future cycles.

6.A.1. Relative Reduction in Flood Risk

The impacts of the plan on existing conditions were determined based on a before-and-after (regional flood plan implementation) comparison of the same type of information provided under the **Chapter 2** existing flood risk analysis. The quantitative comparison of 1% and 0.2% annual chance exceedance (ACE) data with and without the plan illustrates how much the region's existing flood risk will be reduced through implementation of the plan as recommended by the RFPG.

6.A.1.a. Reduction in Flood Risk Identification

In Chapter 2, 100% of HUC-12 watersheds and 99% of the region area by area were identified as locations needing better flood hazard information or updates to existing flood risk information. After the completion of recommended FMEs, only 1 percent of the region area will be in need of riverine flood risk identification which is a reduction of 7,351 square miles (99%). The 1% of the region represents presents small portions of counties which touch the Sabine basin but are not significantly within the basin. It is noted that performing all of the recommended FMEs does not constitute detailed study of all flood risk as there is additional risk that can be studied from local issues like roadside ditches, storm sewers, curb inlets, etc. The flood risk from these local drainage issues can be covered by the many

county and city-wide master drainage plans which were also identified as FMEs in this Regional Flood Plan. The recommendation of FMEs for these areas were left to the discretion of RFPGs of the regions the predominately cover these areas. With the completion of these recommended FMEs, identified flood risk exposure is anticipated to increase across the region. While an increase in quantified exposure may not indicate progress in fulfilling the plan's stated goals at a first glance, identification of new flood exposure through state-of-the-art studies is a critical step in proposing solutions in the form of FMPs. The avoidance of future flood risk begins with identifying flood risk exposure through new studies. Beyond addressing the immediate need of closing knowledge gaps, execution of regional watershed studies created by the region will provide a foundation for effective FMP identification and recommendation in future planning cycles.

6.A.1.b. Reduction in Flood Risk Exposure

When implemented, flood mitigation projects (FMPs) positively impact flood risk exposure by removing or reducing population and property from flood risk. The Sabine RFPG recommended two FMPs for implementation. **Table 6-1** summarizes the estimated reduction in flood risk exposure to structures, population, and lower water crossings (LWCs) in 1% and 0.2% annual% floodplains if the regional flood plan is implemented as recommended. Some actions initially considered to be potential FMPs, such as the Orange County detention projects, did not have quantified benefits due to the current level of study detail available. These projects were recommended as FMEs for further evaluations and may be included as an FMP in a future plan once benefits and impacts can be quantified.

TABLE 6-1: REDUCTION IN FLOOD RISK EXPOSURE DUE TO RECOMMENDED FMPS

Flood Exposure Region-wide	Existing Conditions		After Implementation		Reduction in Exposure	
	1% ACE	0.2% ACE	1% ACE	0.2% ACE	1% ACE	0.2% ACE
Total Structures	34,592	48,703	32,974	46,539	1,618 (-4.7%)	2,164 (-4.4%)
Residential Structures	24,066	34,839	23,283	33,011	783 (-3.3%)	1,828 (-5.2%)
Critical Facilities	401	470	392	461	9 (-2.2%)	9 (-1.9%)
Population	65,006	90,557	62,631	86,801	2,375 (-3.7%)	3,756 (-4.1%)
Low Water Crossings	107	132	106	131	1 (-0.9%)	1 (-0.8%)
Road Length (Miles)	1,518	1,897	1,489	1,840	29 (-1.9%)	57 (-3.0%)

All remaining flood risk exposure is considered to be a residual risk of the Regional Flood Plan. As shown in the reduction column, after the implementation of the Regional Flood Plan there is significant residual risk suggesting there is significant work and funding that is needed in the Sabine basin to identify, study, and construct more flood mitigation projects help further reduce exposure. Additionally, another reason the reduction in flood risk exposure is relatively small because there are only 2 FMPs that meet all of the requirements to be considered an FMP which also highlights the need for additional funding for

engineering studies to be completed to identify more flood mitigation projects to reduce the exposure even further.

6.A.1.c. No Adverse Impact

As proposed, the recommended FMPs, when implemented, do not appear to negatively affect neighboring areas located within or outside of the flood planning region. All recommended FMPs were previously modeled to ensure "no negative flood impact" on upstream, downstream, or neighboring areas. These impact analyses were conducted outside of the flood planning process and were performed at a planning level. The local sponsor will ultimately be responsible for ensuring the final project design has no negative flood impact prior to initiating construction. FMPs were recommended by the Sabine RFPG only if they were accompanied by evidence of no negative impact by a qualified engineer or other applicable professional.

6.A.2. Avoidance of Future Flood Risk

The following sections illustrate how additional, future flood risk (that might otherwise arise if no changes were made to floodplain policies etc.) will be avoided through implementation of the regional flood plan. Impacts of the plan on existing flood risk that also impact future flood risk are not included in the discussion.

Floodplain management recommendations and goals were established by the Sabine RFPG in **Chapter 3**. While most of the regional flood plan focuses on the current cycle, **Chapter 3** establishes a long-term vision for target metrics that subsequent cycles of the plan should achieve. Of the 19 goals set forth by the RFPG, the floodplain management goals presented in **Appendix 3-B**, goal 04000018 listed below, will be most impactful in helping communities in the region avoid increases in flood hazard exposure.

"Increase the number of communities with a comprehensive drainage policy and criteria manuals to reduce flood hazard encouragement and education."

Based on the future flood hazard analysis from **Chapter 2**, over 135,000 new residential structures are projected to be constructed across the region to accommodate population growth over the next 30 years. The potential flood risk of new structures can be reduced, and resiliency could be increased for many of these structures by communities adopting higher floodplain management criteria and standards. Regulation of development, implementation of higher standards, and use of best available data are all interdependent strategies for avoiding potential increases in flood exposure over time. The goal listed above will be realized through execution of FMSs recommended in this plan and in future planning cycles.

Table 6-2 lists the recommended FMSs that will contribute to achieve the RFPG's floodplain management goals in the current planning cycle. Through these development regulations, the Regulatory and Guidance FMSs have the potential to reduce flood risk for newly constructed buildings in the Sabine River Basin.

TABLE 6-2: FLOODPLAIN MANAGEMENT POLICY IMPACTS DUE TO RECOMMENDED FMSS

FMS ID	FMS Name	FMS Description
042000001	Orange County Drainage District Design Criteria	Update Design Criteria
042000005	Van Zandt County Wide Floodplain Development Regulations	Incorporate higher standards for flood hazard resiliency in local application of the building code.
042000036	Longview Flood Mitigation Floodplain Development Regulations	Improve the long-range management and use of flood-prone areas by the adoption and enforcement of local ordinances to regulate new development within the floodplain. Review and revise ordinances, when needed.
042000043	City of Hideaway Floodplain Development Regulations	Mandate 2 feet of freeboard on Hideaway Lakes Dams
042000047	City of Royse City Floodplain Management Ordinances	Update Flood Prevention ordinance, adopting a “no-rise” in Base Flood Elevation in the 100-year floodplain.

6.A.3. Other Impacts

The sections below describe the anticipated impacts of the plan on each of the following categories: environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation.

6.A.3.a. Socioeconomic Impacts

Flooding not only results in damaged infrastructure and property, but also has an adverse social impact on citizens affected. The impacts both short-term and long-term on physical and mental health result in negative effects on the livelihoods of affected citizens (either by loss of a job or inability to adequately perform a job) thereby causing a greater socioeconomic disparity.

Natural and constructed infrastructure within the Sabine Planning Region including rivers, streams, and reservoirs generate significant economic benefits to not only the Sabine region, the southeast Texas, statewide, and also on a national level. Economic benefits include, but are not limited to employment, taxable industrial infrastructure, taxable goods and services (sales tax as well as P & I) and taxable residential development. Furthermore, goods and services produced in along the coast are used to The Sabine Pass to Galveston Bay Coastal Storm Risk Management Project (043000017) will provide economic benefits by protecting the infrastructure in the Sabine Planning Region. Protecting the infrastructure within Orange County, particularly along the intercoastal waterway us if strategic national importance.

Residential and industrial development form a symbiotic relationship. The protection of residential infrastructure is crucial to maintaining the industrial infrastructure. Likewise, the protection of the industrial infrastructure is crucial to maintaining the employment of the residential population and the taxable value of the residential infrastructure. The Sabine Pass to Galveston Bay Coastal Storm Risk Management Project (043000017) will provide economic benefits by removing or reducing flood risk to residential and industrial structures.

Many of the recommended FMSs and FMEs (whether municipal, county-wide, or across the region) create benefits to the socially vulnerable population in the form of reduced risk and quick and effective post-disaster recovery. Watershed planning can contribute to the region's ability to prepare for, respond to, and recover from flood events. Reducing socioeconomic disparities through the implementation of measures to create equity can be initiated through planning. This is done by ensuring that vulnerable populations have the same access to resources and social infrastructure as those unaffected by flooding.

With the implementation of all recommended FMSs and FMEs, all areas of high vulnerability in the planning region will be benefited through additional flood risk information and flood awareness.

6.A.3.b. Environmental Impacts

The property acquisition FMSs mentioned above will remove structures from flood risk through demolition, and by doing so, would benefit the environment by eliminating the release of pollutants associated with flooded homes such as viruses, bacteria, and mold. Although it is unknown what the cities' intended use for the land is after demolition, one possible use would be as local park space, which would benefit the environment by promoting the development of habitats for native plant and animal species.

The USACE completed a thorough environmental impact mitigation plan to offset any impacts due to the Sabine Pass to Galveston Bay (S2G) Coastal Storm Risk Management (CSRM) elements in Orange County to local wetlands over the course of a 50-year period of analysis. The mitigation plan is included in **Appendix 6-A.** Based on engineering judgement, it was determined that all FMSs and FMPs recommended by the Sabine RFPG align with the Texas Conservation Action Plan (TCAP). The TCAP outlines actions to protect and manage Species of Greatest Conservation Need (SGCN) and important habitats which include freshwater and riparian ecosystems.

6.A.3.c. Agricultural Impacts

Flooding or excess precipitation can wash nutrients downstream or result in loss of crops. Livestock can be swept away, drowned, injured by flood waters, or exposed to contaminated flood waters which can result in health issues. As shown in **Table 6-3**, 3 square miles of agricultural land is anticipated to be removed from the 1% annual chance flood hazard area as a result of recommended FMPs in Orange County.

TABLE 6-3: REDUCTION IN AGRICULTURAL LAND EXPOSURE

Flood Exposure Region-wide	Existing Conditions		After Implementation		Reduction in Exposure	
	1% ACE	0.2% ACE	1% ACE	0.2% ACE	1% ACE	0.2% ACE
Agricultural Land (sq. mi.)	325	358	323	347	3 (+0.1%)	11 (+3.1%)

6.A.3.d. Recreational Impacts

Using natural or man-made water bodies for recreation is highly valued in the Sabine region and throughout Texas. Indeed, entire industries depend upon the recreational use of these bodies of water for long-term economic stability and growth. State and local governments rely upon sales tax revenue as

well as ad valorem taxes which are based upon the taxable value of property including property situated adjacent to such bodies of water. This tax revenue is essentially to provide essential services to the population within its jurisdiction as well as the State of Texas.

Many waterfront parks are spaces that are designed to be flooded with minimal damage during storm events. These floodplains and wetlands can support tourism, recreation, and freshwater fisheries. Recreational benefits can also accompany flood mitigation projects. Along the Sabine River, many water supply reservoirs are utilized for recreation including boating and fishing. The FMPs and FMSs recommended by the RFPG will not impact the recreational use in these areas.

Erosion prevention efforts included in the regional flood plan also provide recreational benefits, since all land within the streambed is state-owned property and can be used for camping, fishing, or picnicking. The recommended FMS within the City of Hideaway (042000045) provide recreational benefit by protecting streambeds and adjacent communities from erosion.

Additionally, the list of recommended FMSs includes the development of property acquisition programs in the City of Longview, City of Marshall and Orange County, which could provide recreational benefit by opening opportunities for creation of common gathering spaces for the respective communities, such as parks. While parks and camping areas are a valuable asset to the region, there are potential disadvantages to using the floodplain and waterfront parks for recreation. If flooding were to occur at these waterbodies, they can become dangerous to recreational users. Therefore, consideration must be made to include adequate warning systems for individuals using these facilities.

6.A.3.e. Water Quality Impacts

Water-quality concerns within the flood planning region are high nutrient loads, high bacterial and salinity levels, and low dissolved oxygen. The list of recommended FMEs also includes many detention ponds in Orange County. An ancillary benefit of detention ponds is the increased retention time for runoff which flows directly into or diverts into detention basins. Longer retention times allow contaminants and particulates to settle before the water is discharged back into the waterway and allowed to flow downstream. Another benefit of flood risk reduction projects is reduced risk to water treatment plants and wastewater treatment plants, and settling ponds associated with local industry. Reduced flood risk lowers the likelihood of potential flooding and overflow from these treatment plants which will improve the overall water quality.

The Sabine Pass to Galveston Bay Coastal Storm Risk Management Project (043000017) will have water quality benefits related to the release of industrial pollutants on account of the flooding of industrial infrastructure. This project will remove or reduce flood risk to petrochemical and papermaking industrial facilities. These facilities have settling ponds and other such holding areas that if flooded, can release contaminated water that flow into adjacent lakes and streams.

6.A.3.f. Erosion and Sedimentation Impacts

The list of recommended FMSs includes “City of Hideaway Dam Reliability Program”, which will remove trees from earthen dams on Hideaway Lakes #2 and #3 to mitigate erosion and assist with soil adhesion. Implementation of this strategy will reduce erosion and sedimentation in the City of Hideaway and

potentially avoid significant future losses to public infrastructure, buildings, and vulnerability. The regional flood plan does not include any impacts to erosion on the Sabine River.

Furthermore, Best Management Practices (BMPs) which will be utilized during construction of FMPs have erosion and sediment control as a primary or secondary benefit. Furthermore, many bridge studies, especially those performed on TxDOT typically often require an erosion and scour assessment as part of the design. Detention ponds, which are identified as FMEs and could become future FMPs, will also have smaller design elements like backslope interceptor structures and potentially baffled aprons on outfall structures to reduce the potential for erosion around these elements. Any new storm sewer or culvert designed as part of an FME, or FMP will also typically be required by local design criteria to be designed within a minimum and maximum slope criterion. The minimum slope criteria is enforced to ensure the pipe has enough slope to reduce potential sedimentation within the pipe/box while the maximum slope is enforced, especially at the outfall, such that velocities at the entrance or exit of the pipe/box aren't excessive causing scour and erosion related issues.

6.A.3.g. Navigation Impacts

The Sabine-Neches Waterway is the second longest inland waterway on the Gulf Coast. Sabine-Neches Navigation District serves as a local liaison for the US Army Corps of Engineers (USACE) and industries along the Sabine-Neches Waterway. The implementation of recommended FMPs and FMSs in the regional flood plan will not impact navigation on the Sabine River or Sabine-Neches Waterway.

Chapter 6.B. Contributions to and Impacts on Water Supply

Regional flood plans must include a region-wide summary and description of the contribution that the regional flood plan would have to water supply development, including positive and negative impacts of the flood plan on the state water plan. The Sabine Flood Planning Region encompasses the Northeast Texas (Region D), East Texas (Region I), and Region C Water Planning Regions. **Figure 6-1** shows all Water Planning Areas and the Sabine Flood Planning area.

The Sabine RFPG coordinated with these planning groups as a part of the flood planning process. There are no flood mitigation projects (FMP) or flood management strategies (FMS) recommended in the Sabine Regional Flood Plan that, if implemented, would measurably contribute to and/or negatively impact water supply in any of the water planning regions.

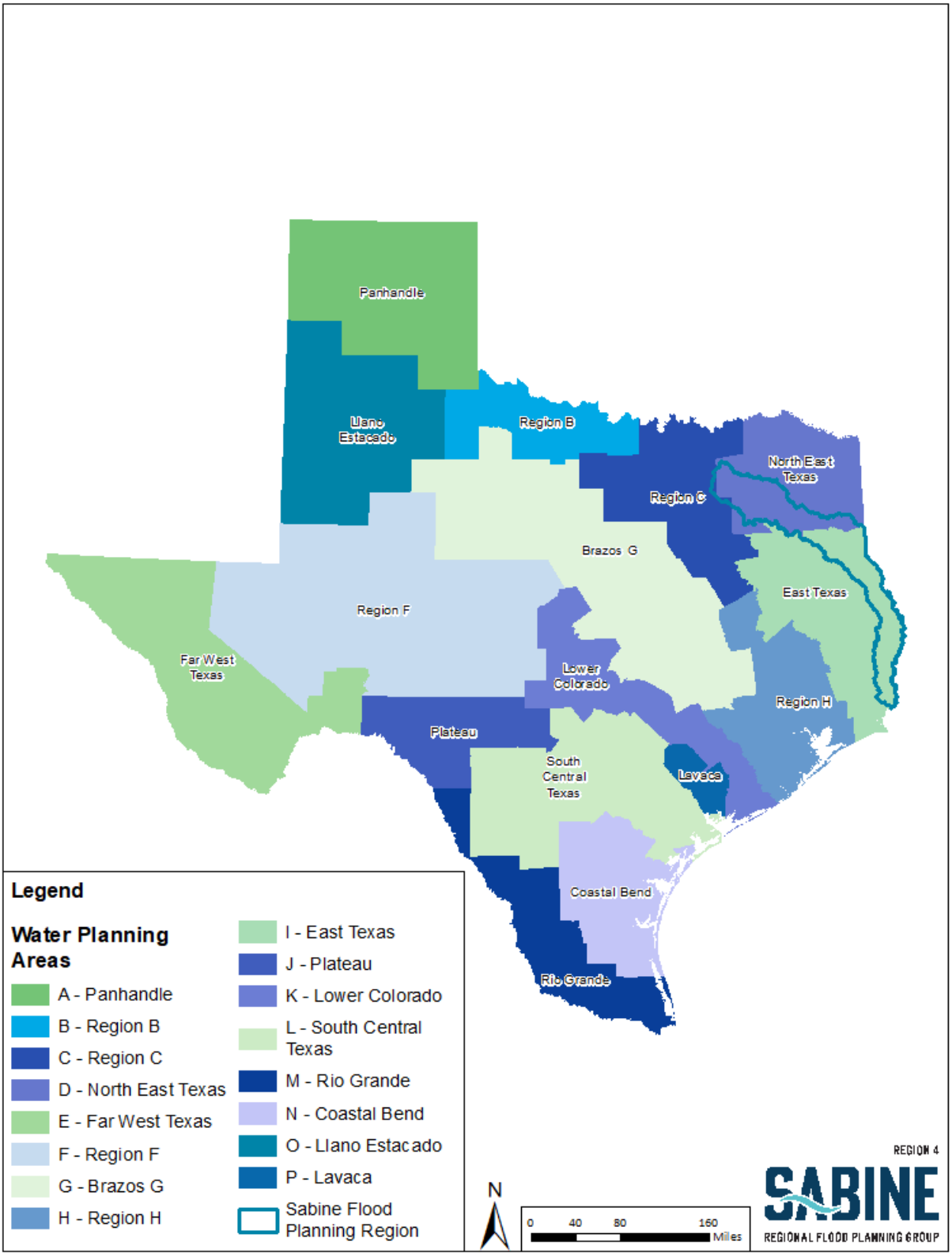

FIGURE 6-1: WATER PLANNING AREAS AND SABINE FLOOD PLANNING REGION

CHAPTER 7

FLOOD RESPONSE INFORMATION AND ACTIVITIES

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CHAPTER 7. FLOOD RESPONSE INFORMATION AND ACTIVITIES

Chapter 7.A. Emergency Management

The Sabine Regional Flood Planning Group (RFPG) summarized the nature and types of flood response preparations within the flood planning region (FPR). The following sections summarize the current flood preparedness, flood response, and flood recovery practices in the Sabine River Basin. Chapter 4 and Chapter 5 detail the identification and recommendation of flood management evaluations (FME), flood management strategies (FMS), and flood mitigation projects (FMP) in the region. Federal Emergency Management Agency (FEMA) recognizes four phases of emergency management which are list below. **Figure 7-1** shows how the four phases relate as a cycle of emergency management.

- **Flood Mitigation:** The implementation of structural and non-structural actions to reduce flood risk and protect against the loss of life and property.
- **Flood Preparedness:** Actions, aside from mitigation, which are taken before flood events to prepare for flood response activities.
- **Flood Response**: Actions which are taken during and in the immediate aftermath of a flood event.
- **Flood Recovery**: Actions taken after a flood event necessary to return to pre-event conditions.

FIGURE 7-1: FOUR PHASES OF EMERGENCY MANAGEMENT

7.A.1. Flood Mitigation

The mitigation phase of emergency management includes any sustained action taken to reduce or eliminate the lasting risk to life and property from hazardous events. Mitigation is an on-going process that occurs before, during, and after disasters and looks to break the cycle of loss and damage in at-risk areas. Flood mitigation is the primary focus of the regional flood planning process and plan development efforts. The Flood Mitigation Projects (FMPs) identified in Chapters 4 and 5 highlight the flood reduction benefits of each of those items.

Furthermore, the FMEs also identified in the earlier chapters can lead to new projects or further development of existing ones which can provide additional flood mitigation for the Sabine region. It is noted that while the projects identified in this plan are aimed at flood mitigation for the 1% annual chance flood, flood mitigation projects have greater benefits, especially for lesser storm events. In areas where coastal flooding has a major impact and may dominate the FEMA mapped floodplains, mitigation projects can help lessen the effects of flooding from local rainfall runoff providing benefit to the community.

7.A.2. Flood Preparedness

Before an emergency occurs, emergency management steps should be taken for preparedness including reviewing disaster preparedness plans, assessing potential vulnerabilities, performing drills and exercises, and gathering essential supplies. The Sabine RFPG identified and recommended an FMS sponsored by Orange County to plan and prepare emergency response staging areas. The many FMSs which were identified and recommended related to emergency notification systems, flood awareness programs, and public outreach projects.

A total of thirteen Hazard Mitigation Action Plans were collected from the Sabine region. These plans were reviewed, and the following mitigation actions were identified by communities in the region:

- Buyout/Acquisition/Elevation projects
- Drainage Control & Maintenance
- Education & Awareness for Citizens
- Equipment Procurement for Response
- Erosion Control Measures
- Flood Insurance Education
- Installation/Procurement of Generators
- Natural Planning Improvement
- Outreach and Community Engagement
- Technology Improvement
- Flood Study/Assessment
- Infrastructure Improvement

In 2021, a web-based survey was sent out as a part of this Regional Flood Planning effort to each regulatory entity in the Region to gather additional information. The survey indicated that several types of floodplain management activities were in place including reactive maintenance following complaints or damages after a storm, utilizing Emergency Alert Systems, and ordinance enforcement. Based on survey responses, flood response measures in the region include:

- Public facing websites
- Portable traffic message boards
- Outdoor siren/message speakers
- Swift water rescue team
- Public Emergency Alert System
- Crew(s) setting up barricades or closing gates

Many of the mitigation and preparatory actions are done in conjunction with the relevant entities who put these actions into practice.

7.A.3. Flood Response

Disaster plans are implemented during the emergency management response phase. These typically include the following items:

- Activating emergency operations centers as well as essential personnel
- Evacuation of citizens from hazardous areas
- Conducting search and rescue operations, as needed
- Closing transportation routes when low water crossings become impassable
- Maintaining communications with citizens using a combination of public notifications and reverse 911 emergency warning system.

Note that with the implementation of the identified emergency notification systems, more communities in the planning region will have the ability to communicate directly with citizens who are determined to be in hazardous areas.

7.A.3.a. Local Government Roles and Activities

Shown in **Table 7-1** are the 94 political subdivisions in Region 4 with flood related authority.

TABLE 7-1: POLITICAL SUBDIVISIONS WITH FLOOD RELATED AUTHORITY

Counties					
Collin	Franklin	Gregg	Harrison	Hopkins	Hunt
Jasper	Kaufman	Newton	Orange	Panola	Rains
Rockwall	Rusk	Sabine	San Augustine	Shelby	Smith
Upshur	Van Zandt	Wood			
Municipalities					
Alba	Beckville	Big Sandy	Bridge City	Caddo Mills	Campbell
Canton	Carthage	Celeste	Center	Clarksville City	Como
Cumby	East Mountain	East Tawakoni	Easton	Edgewood	Emory
Farmersville	Fate	Fruitvale	Gary	Gladewater	Grand Saline
Greenville	Hallsville	Hawk Cove	Hawkins	Hemphill	Henderson
Hideaway	Huxley	Joaquin	Josephine	Kilgore	Kirbyville
Lakeport	Lindale	Lone Oak	Longview	Marshall	Mineola
Nevada	New London	Newton	Orange	Overton	Pinehurst
Point	Quinlan	Quitman	Rockwall	Royse City	Scottsville
Sulphur Springs	Tatum	Tenaha	Timpson	Tyler	Union Grove
Union Valley	Van	Vidor	Warren City	West Orange	West Tawakoni
White Oak	Wills Point	Winnsboro	Winona	Yantis	

Other	
Ark-Tex Council of Governments	Orange County Navigation and Port District
Caddo Basin SUD	Orange County WCID 1
Caddo Mills MMD 1	Orange County WCID 2
Chalk Hill SUD	Panola County FWSD 1
Combined Consumers SUD	Rockwall County Consolidated MUD 1
Deep East Texas Council of Governments	Rockwall County MUD 6
Double R MUD 1	Rockwall County MUD 7
East Texas Council of Governments	Rockwall County MUD 9
East Texas MUD	Sabine River Authority
Franklin County Water District	Shelby County FWSD 1
Gulf Coast Protection District	Smith County Economic Development District
Hunt Co MUD 3	Southeast Texas Regional Planning Commission
Jasper County WCID 1	South Rains SUD
Lavon Special Utility District	Sulphur Springs Water District
Liberty-Danville FWSD 2	Sunrise MUD of Hunt County
Little Cypress Utility District	Tryon Road SUD
Mauriceville Municipal Utility District	Union Valley Ranch MUD of Hunt County
New Hope SUD	Upper Jasper County Water Authority
North Central Texas Council of Governments	Upper Sabine Valley SWMD
North Texas MWD	Van Zandt County Waste Disposal District
Orange County Drainage District	Verandah MUD

Cities, or Municipalities, generally take responsibility for parks and recreation services, police and fire departments, housing services, emergency medical services, municipal courts, transportation services (including public transportation), and public works (streets, sewers, snow removal, signage, etc.). There are 71 municipalities within the Sabine region. In an emergency, these entities must work with state and federal agencies while communicating with citizens. Cities or municipalities often have Emergency Action Plans (EAPs) that detail the continuance of local government in various emergency scenarios.

The major responsibilities of the 21 County governments in the Sabine Region include providing public safety and justice, holding elections at every level of government, maintaining Texans' most important records, building and maintaining roads, bridges and in some cases, county airports, providing emergency management services, providing health and safety services, collecting property taxes for the county and sometimes for other taxing entities, issuing vehicle registration and transfers, and registering voters. The role of county governments in an emergency is similar to that of cities except in larger emergencies, county officials are responsible for coordinating with localized entities in addition to state and federal agencies.

7.A.3.b. State and Regional Agencies' Roles and Activities

The mission of the Texas Water Development Board (TWDB) is to lead the state's efforts in ensuring a secure water future for Texas and its citizens. TWDB accomplishes this mission by providing water supply planning, flood planning, data collection and dissemination, financial assistance, and technical assistance services to the citizens of Texas. TWDB facilitates various flood infrastructure funding mechanisms.

A Drainage District is a political subdivision created by either the Texas Legislature or upon petition to a Commissioner's Court. It may be governed by the Commissioner's Court or an independently elected Board of Directors. It is a government agency established to reduce the effects of flooding. The only drainage district in the Sabine River basin – Orange County Drainage District (OCDD) – was created by statute and is governed by a Board of Directors and then selects and employs a General Manager. This manager is then responsible for managing the District to be consistent with its goals, directives, and implementing its policies.

The Texas Division of Emergency Management (TDEM), a division of the Texas Department of Public Safety (DPS), coordinates state and local responses to natural disasters and other emergencies in Texas. TDEM supports local agencies during the response and recovery phases of emergency management. There are six TDEM regions within Texas, The Sabine Flood Planning Region is split between TDEM Regions 1 and 2 as shown in **Figure 7-2**. In those regions are Assistant Chiefs and District Coordinators. They serve as the Division's field response personnel stationed throughout the State. They have a dual role as they carry out emergency preparedness activities and coordinate emergency response operations. TDEM assists local agencies implement emergency management plans and perform exercises to train local officials in emergency response.

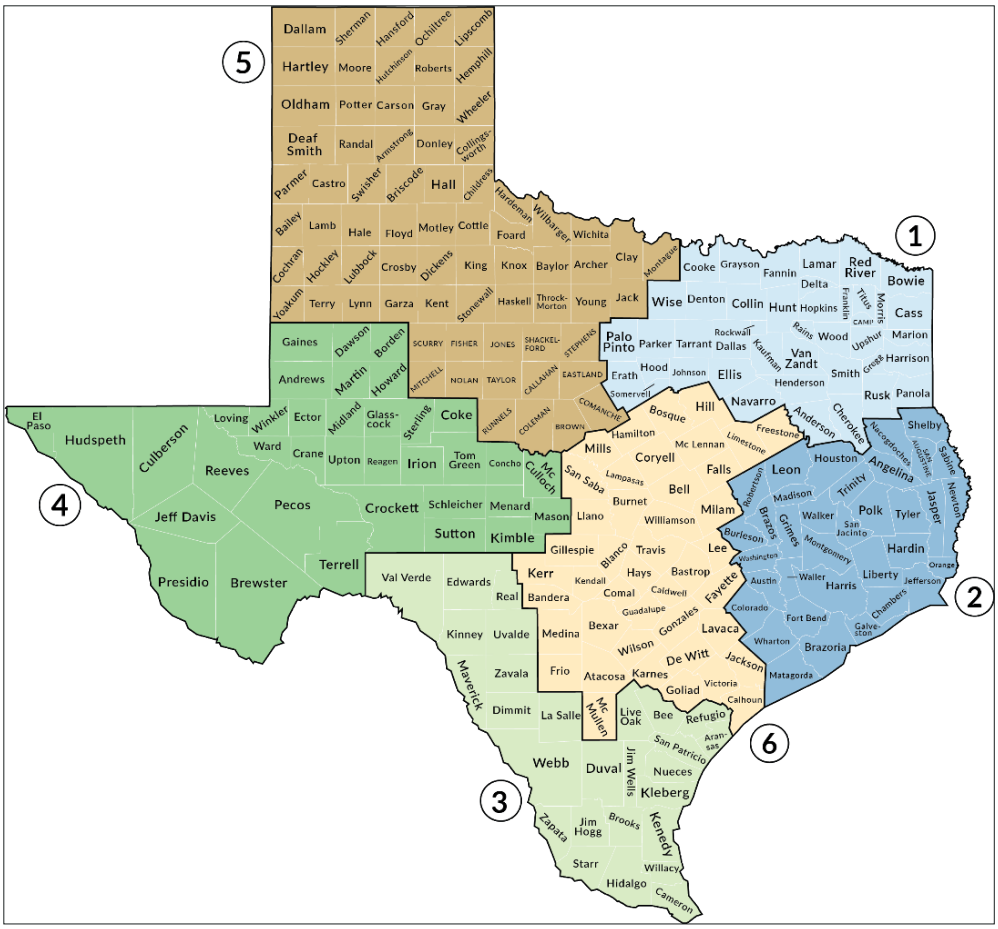

FIGURE 7-2: TDEM REGIONS

Source: Texas Department of Emergency Management

The Texas Department of Transportation (TxDOT) is a governmental agency in the State of Texas and participates in emergency management by providing road closure and low water crossing information during a flood event. Real time updates of road closures due to construction, damage, floods, or other incidents can be viewed at https://drivetexas.org/.

River Authorities or Districts in the State of Texas are public agencies established by the Legislature with the authority to develop and manage the waters of the State of Texas. Sabine River Authority of Texas (SRATX) has the responsibility to store, control, preserve, utilize, and distribute the waters of within its jurisdiction for the benefit of the public. SRATX controls and operates many reservoirs for water supply and hydroelectric power.

7.A.3.c. Federal Agencies Roles and Activities

The Federal Emergency Management Agency (FEMA) is an agency of the United States Department of Homeland Security (DHS), initially founded in 1979. While on-the-ground support of disaster recovery efforts is a major part of FEMA's charter, the agency also provides state and local governments with funding assistance for rebuilding efforts. FEMA provides funding to local agencies for infrastructure repairs and directly to individuals through the National Flood Insurance Program (NFIP). FEMA facilitates

emergency management trainings for local and state officials through the Center for Domestic Preparedness (CDP), the Emergency Management Institute (EMI), and the National Training and Education Division (NTED).

The mission of the U.S. Army Corps of Engineers (USACE) is to deliver vital engineering solution and reduce disaster risk. USACE is involved in wide range of flood mitigation projects and emergency operations. USACE is composed of several districts in which Sabine Flood Planning Region is in the Southwestern Division, and in the Galveston and the Fort Worth Districts. The USACE Flood Risk Management Program (FRMP) works to reducing overall flood risk through the design, operations, and maintenance of structures such as levees and floodwalls. Flood risk management efforts from FRMP help to reduce the risk to people and property, reduce long-term economic, and improve the natural environment.

The National Weather Service (NWS) mission is to provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property and enhancement of the national economy. NWS provides flash flood indicators through watches, warnings, and emergency notices. The NWS defines these severe weather awareness categories as follows:

- Flash Flood WATCH is issued when conditions look favorable for flash flooding and is typically covers several counties.
- Flash Flood WARNING is issued when dangerous flash flooding is happening or will happen soon and typically covers a more specific area.
- Flash Flood EMERGENCY is issued for the exceedingly rare situations when extremely heavy rain is leading to a severe threat to human life and catastrophic damage from a flash flood is happening or will happen soon.

The National Oceanic and Atmospheric Administration (NOAA) within the United States Department of Commerce forecasts weather and monitors oceanic and atmospheric conditions. NOAA provides historical data that can help communities determine their future probability of flood events and is key in the planning and mitigation process. Daily river forecasts are issued by the thirteen NOAA National Weather Service (NWS) River Forecast Centers (RFCs) using hydrologic models based on rainfall, soil characteristics, precipitation forecasts, and several other variables. The forecasts can provide essential information on the river levels and conditions. The NWS has river forecasts at the following sixteen locations in the Sabine River basin:

- Sabine River at Orange (ORNT2)
- Sabine River at Near Hawkins (HAKT2)
- Sabine River at Burkeville (BRVT2)
- Lake Fork Creek near Quitman (QTMT2)
- Sabine River at Burkeville (BRVT2)
- South Fork Sabine River at Quinlan (QLAT2)
- Sabine River at Bon Weir (BWRT2)
- Sabine River at Mineola (MLAT2)
- Sabine River at Deweyville (DWYT2)
- Sabine River near Gladewater (GDWT2)
- Big Sandy Creek near Big Sandy (BSNT2)
- Rabbit Creek near Kilgore (KLGT2)
- Cowleech Fork Sabine River at Greenville (GNVT2)
- Bayou Anacoco near Rosepine, LA (RPIL1)
- Sabine River below Longview (LONT2)
- Sabine River near Beckville (BEKT2)
- Sabine River at Logansport (LPTL1)

7.A.3.d. Emergency Information

In addition to the National Weather Service, local news stations or radio stations are vital components in relaying real time information to local residents of inclement weather and flooding. They can also alert residents to low water crossing closings, dam or levee breaches, and other potential dangers. They can also broadcast information about flood watches, warnings, and emergency notifications.

The Southeast Texas Regional Alerting & Information Network (SE Texas R.A.I.N.) is a web-based public informational resource which compiles and presents information necessary to make important preparedness and response decisions during threatening weather conditions. This regional project was conceived in the aftermath of Hurricane Harvey in 2017, with a geographic scope that includes the southern portions of the Neches and Sabine River Flood Planning Regions. The SE TEXAS RAIN website displays rainfall, streamflow, and stream and reservoir levels from USGS and NWS Gulf Coast River Forecast Center. The system relies on a network of river and reservoir gaging stations to present river stage and site condition information to be used by emergency managers and the public. This information assists Emergency Management Offices, county governments and local and regional governments to advise the public of hazardous flood conditions.

Reverse 911 systems across the region allow an agency to define an area and send phone messages to persons in hazardous areas to alert them of emergency situations.

7.A.4. Flood Recovery

The recovery phase of emergency management begins after immediate needs of those in hazardous areas have been addressed. Communities begin to evaluate the extent of flood damage and remove debris left from flood waters. Public officials take note of high-water marks, document affected areas, and begin the rehabilitation of damaged structures. In severe disaster events that exceeded the combination of state and local resources, the Governor of Texas can request federal emergency assistance. If the President decides federal assistance is needed an emergency declaration allows a community to access funding for individuals and public infrastructure. The FEMA disaster assistance programs listed below are only available after a federal disaster declaration has been determined.

- **Individual Assistance** - Assistance to individuals and households.
- **Public Assistance** - Assistance to state and local governments and certain private nonprofit organizations for emergency work and the repair or replacement damaged facilities resulting from disasters.
- **Hazard Mitigation Assistance** – Assistance to state and local governments and certain private nonprofit organizations to prevent or reduce long term risk to life and property from natural hazards.

In addition to FEMA sponsored flood recovery activities, in the aftermath of particularly catastrophic disasters the Department of Housing and Urban Development (HUD) may be authorized by Congress to distribute funds related to disaster recovery under the Community Development Block Grant for Disaster Recovery (CDBG-DR). These funds carry a distinct emphasis on recovery for unmet housing needs for low-moderate income households following a disaster, but also allow for infrastructure activities which support housing recovery. Among other requirements, qualification for an activity

requires demonstrating that a potential project has a direct tie-back to the specific disaster, and also a detailed analysis of environmental considerations for the potential use of funds.

Table 1C-9 in **Appendix 1-C** lists all federal disaster declarations in the planning region and the impacted communities.

7.A.4.a. Flood Response Activities

As discussed in Chapter 1, the Sabine region drains more volume of water per square mile compared to the other 14 regions in the state of Texas and is frequently affected by high intensity rainfall events, with the most severe caused by tropical storms hitting the coastal portion of the region. In many instances, these tropical disturbances travel inland and result in excessive rainfall far away from the coast. While both the coastal and inland portions of the region are exposed to flood risk from riverine or local sources, the coastal portion has to prepare for storm surge and the flooding of a naturally wide floodplain, the inland portion is more significantly affected by flash floods.

Local entities have taken actions to respond and prepare for flooding emergencies. Select examples of past flood response and preparedness activities are included in **Table 7-2**.

TABLE 7-2: EXAMPLES FLOOD RESPONSE AND RECOVERY ACTIVITIES

Activity Description	Category	Entity
2017 Flood Response Incident Command at Orange County EOC	Incident Command	TXDPS, TSG, TDEM, TPW, local law enforcement
2017 Flood Response Incident Command at Jasper County EOC	Incident Command	TXDPS, TSG, TDEM, TPW, local law enforcement
2017 Flood Response Staging Area at Orange County EOC	Search and Rescue, Area Closures, Law Enforcement, and Evacuation	TXDPS, TSG, TDEM, TPW, local law enforcement
2017 Flood Response Staging Area at Deweyville High School	Search and Rescue, Area Closures, Law Enforcement, and Evacuation	TXDPS, TSG, TDEM, TPW, local law enforcement
2016 Flood Response Incident Command at Orange County EOC	Incident Command	TXDPS, TSG, TDEM, TPW, local law enforcement
2016 Flood Response Incident Command at Jasper County EOC	Incident Command	TXDPS, TSG, TDEM, TPW, local law enforcement
2016 Flood Response Staging Area at Orange County EOC	Search and Rescue, Area Closures, Law Enforcement, and Evacuation	TXDPS, TSG, TDEM, TPW, local law enforcement
2016 Flood Response Staging Area at Deweyville High School	Search and Rescue, Area Closures, Law Enforcement, and Evacuation	TXDPS, TSG, TDEM, TPW, local law enforcement

FEMA is the primary agency that provides funding and support for recovery efforts after severe flooding emergencies within the region. Cities, counties, and individuals coordinate rebuilding efforts through FEMA, which are aided by relief funds and low-interest loans.

The most common flood recovery activity within the region is housing clean-up and repair. Housing repairs typically start with FEMA and are then typically continued TX-GLO to provide funding and support for recovery efforts after severe flooding emergencies within the region. Cities, counties, and individuals coordinate rebuilding efforts through GLO, which are aided by relief funds and SBA low-interest loans.

During the most recent five-years, recovery efforts for flood damaged housing and infrastructure has been a major undertaking in the Sabine Flood Planning. Funding for recent flood recovery efforts has been provided by the U.S. Department of Housing and Urban Development (HUD) and administered statewide by the Texas General Land Office Community Development and Revitalization division (TX-GLO-CDR).

Using 2017 Hurricane Harvey as a prime example, HUD allocated $5.024 billion in disaster recovery funds to the State of Texas in 2018. According to HUD federal financial tracking, as of June 2022 approximately 48% of the State's $5 billion allocation has been utilized, predominantly based on expenditures for housing recovery. Infrastructure funding expenditures is tracking at roughly 10% implementation as of June 2022.

Roughly 2% of the statewide total disaster recovery allocation for Hurricane Harvey, or $85 million, was allocated to the Sabine region. Nearly half of this total was allocated to disaster recovery activities in unincorporated Orange County and incorporated cities in its eastern and southern portions. As of June 2022, these housing recovery projects have been predominantly focused on housing reconstruction and repair and have been implemented primarily in southern portions of the Sabine Flood Planning Region.

Disaster recovery funds dedicated to infrastructure recovery are primarily utilized for drainage and flood control improvements, water system repairs, and emergency equipment repair. **Table 7-3** includes an overview of Hurricane Harvey disaster infrastructure recovery allocations for Region 4.

TABLE 7-3: HURRICANE HARVEY INFRASTRUCTURE DISASTER RECOVERY

County	Total
Orange County	$40,770,159
Newton County	$1,609,719
Jasper County	$1,598,067
Sabine County	$160,124
San Augustine County	$101,103

Sources: SETRPC CDBG-DR Harvey MOD, DETCOG CDBG-DR Harvey MOD

Tracking disaster recovery to include both 2016 and 2017 floods,

Table 7-4 provides an outline of specific examples of infrastructure repair projects in the Sabine Flood Planning Region over the most recent 5-year period (certain projects still ongoing).

TABLE 7-4: INFRASTRUCTURE DISASTER RECOVERY EXAMPLES 2016 AND 2017 FLOODS

Activity Description	Agency	Disaster Year
Spillway Channel Repairs at Toledo Bend Dam	SRA	2016
Highway 63 Bridge Repair	TxDOT	2016
Timber Rock Rail Line Repair	TIBR	2016
Deweyville Middle School Relocation	Deweyville ISD	2016
Sub-Courthouse Relocation	Newton County	2016
Kansas City Southern Rail Line Repair	KCS	2016
Pumping Station Repairs at Gulf Coast Division	SRA	2016
Fire Truck Replacement	Orange FD	2017
Coopers Gully Channel Lining Extension	Orange	2017
Radio Tower	SETRPC	2017
FM 105 Culvert Repairs	Orange	2017
Drainage Repairs	OCDD	2017
Road Repairs	Newton County	2017

7.A.5. State and Regional Plans

The State Hazard Mitigation Plan is an effective instrument to decrease losses by reducing the impact of disasters upon people and property. Although mitigation efforts cannot completely eliminate impacts of disastrous events, the plan endeavors to reduce the impacts of hazardous events to the greatest extent possible. The plan evaluates, profiles, and ranks natural and human-caused hazards effecting Texas as determined by frequency of event, economic impact, deaths, and injuries. The State Hazard Mitigation Plan:

- Assesses hazard risk,
- Reviews current state and local hazard mitigation and climate adaption capabilities, and
- Develops strategies and identifies state agency (and other entities) potential actions to address needs.

7.A.6. Local Plans

In the Sabine Region's data collection effort and survey in 2021, the region requested local emergency management and emergency response plans that were publicly available. Some emergency plans are protected by law and are not available for public review. Most portions of local Emergency Operations Plans (EOPs) are in a category of information considered "For Official Use Only" and governed by rules which limit dissemination to the broader public. Certain EOP annexes, or Emergency Service Functions have higher levels of classification than others which prohibit distribution to non-official sources.

In addition to the plans provided by local entities, the region also obtained Emergency Management plans, Hazard Mitigation Plans and other regional and local flood planning studies from County and local jurisdictions. **Table 7-5**

Table 7-5 lists the Hazard Mitigation Plans made available to the flood planning process.

TABLE 7-5: HAZARD MITIGATION ACTION PLANS

Jurisdiction	Year	Jurisdiction	Year		
Collin County	2011	Hunt County	2013	Smith County	2018
Franklin County	2016	Orange County	2016	Van Zandt County	2019
Gregg County	2018	Rains County	2012	Wood County	2017
Harrison County	2019	Rockwall County	2016	Orange County Drainage District (OCDD)	2018
Hopkins County	2015	San Augustine County	2018		

CHAPTER 8
ADMINISTRATIVE, REGULATORY, AND LEGISLATIVE RECOMMENDATIONS

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CHAPTER 8. ADMINISTRATIVE, REGULATORY, AND LEGISLATIVE RECOMMENDATIONS

As part of the process of developing this plan, the Sabine RFPG is directed to develop and include recommendations for legislative, regulatory, and administrative improvements that they consider necessary to facilitate floodplain management and flood mitigation planning and implementation. The TWDB asks for:

- Legislative recommendations that they consider necessary to facilitate floodplain management and flood mitigation planning and implementation
- Other regulatory or administrative recommendations that they consider necessary to facilitate floodplain management and flood mitigation planning and implementation.
- Any other recommendations that the RFPG believes are needed and desirable to achieve its regional flood mitigation and floodplain management goals
- Recommendations regarding potential, new revenue-raising opportunities, including potential new municipal drainage utilities or regional flood authorities, that could fund the development, operation, and maintenance of floodplain management or flood mitigation activities in the region.

These recommendations may address items that benefit and/or can be implemented at the local, regional, or state level. Recommendations, in general, are anticipated to be aimed at supporting flood risk reduction and supporting implementation of the regional flood plans. Recommendations include suggested changes to the flood planning process for the Texas Water Development Board (TWDB) to consider when implementing the next cycle of regional and state flood planning.

Recommendations in this chapter were developed with input from various sources including discussions with RFPG members during monthly meetings and additional conversations and input from stakeholders. Recommendations were based on observations and lessons learned while developing this plan. These recommendations are categorized into four (4) major classifications based on the path that would be required to enact them: legislative, regulatory, administrative, and flood planning recommendations. It is recognized that legislative recommendations are the most difficult to enact but at the same time they are potentially the most impactful actions to flood risk reduction. The next classification, regulatory and administrative recommendations, can be enacted typically by state level agencies such as TxDOT and are considered to take somewhat less effort and time to enact while still providing very impactful improvements to flood risk policy across the state.

Recommendations regarding the last category, the flood planning process itself, were developed after review of proposed project scoring guidelines and data requirements detailed in Exhibit C – Technical Guidelines for Regional Flood Planning (April 2021). The proposed project scoring system will be used by the TWDB to rank FMPs. Many of the recommendations in this category are focused on developing scoring criteria that are equitable to all community types and sizes.

Chapter 8.A. Legislative Recommendations

8.A.1. Continued support and appropriations to the Flood Infrastructure Fund (FIF)

Senate Bill 7, established by the 86th Texas Legislature in 2019, created the Flood Infrastructure Fund (FIF). The FIF program, approved by Texas voters through a constitutional amendment, provides financial assistance in the form of loans and grants for flood control, flood mitigation, and drainage projects. As outlined in the Intended Use Plan (IUP), FIF eligible projects will fall under one of four categories:

- Category 1: Flood Protection Planning for Watersheds
- Category 2: Planning, Acquisition, Design, Construction, Rehabilitation
- Category 3: Federal Aware Matching Funds
- Category 4: Measures Immediately Effective in Protecting Life and Property

Political subdivisions (cities, counties, and districts or authorities created under the Texas Constitution as well as legislative action) are eligible to apply for the FIF program for flood mitigation projects. The Texas Legislature approved a one-time appropriation of $793 million. According to TWDB's State Flood Assessment, statewide flood mitigation costs over the next 10 years are estimated to be more than $31.5 billion; however, that estimate is derived from limited stakeholder data. Therefore, the Sabine RFPG recommends continued support and appropriations to the FIF program which will further fund flood mitigation projects that are needed state-wide enhancing public safety and helping to achieve the Regional Flood Plan and State Flood Plan goals of reducing the risk and impact to life and property.

8.A.2. Increase state funding for technical assistance to develop accurate watershed models and floodplain maps

Chapter 4 highlights that much of the Sabine Flood Planning Region does not have adequate flood inundation maps. A large portion of the region either has no floodplain maps, outdated floodplain maps, or maps that approximate the floodplain with no detailed study to define the flood risk more accurately. Similarly, according to TWDB's State Flood Assessment, much of Texas is either unmapped or uses out-of-date flood insurance rate maps, leading to widespread misunderstanding about true flood risk. Therefore, the Sabine RFPG recommends that the State Legislature continue to provide funding/support to local governments to allow them to update their floodplain maps to better quantify and show the flood risk to the public.

8.A.3. Allow counties the opportunity to establish drainage utilities and to collect drainage utility fees in unincorporated areas.

As defined by the Texas Constitution Local Government Code, Title 13, Subtitle A, Chapter 552, municipalities have the statutory authority to establish public utilities to provide services to their residents, including drainage. Subchapter C establishes the "cost of service" for drainage systems and

includes acquisition, construction, repair, maintenance, project implementation, and administration. Although counties have floodplain management responsibilities, they do not have the authority to establish drainage utilities, and fees. This limits their ability to fund drainage related activities. Therefore, the Sabine RFPG recommends that the State grant counties the authority to enhance their role in floodplain management and much of the ongoing development in Texas, much of which takes place outside of municipal city limits.

8.A.4. Incentivize jurisdictions to work together to provide regional flood mitigation

The Regional Flood Planning process has illustrated that flooding occurs within watersheds that span multiple jurisdictions. This requires cooperation and coordination with multiple stakeholders across different local governments and regional entities. Additionally, large scale mitigation projects are necessary to reduce flood risks within multiple communities, thus requiring jurisdictions to work together on implementing these projects. The Sabine RFPG recommends that the TWDB should incentivize and encourage watershed management planning and project implementation to enhance flood safety and manage costs. One way to do this is to add points to the TWDB, General Land Office (GLO), and other agency project evaluation processes. Another is the creation of regional drainage districts.

8.A.5. Incentivize buy-out programs to convert frequently flooded properties/ neighborhoods into natural beneficial use areas

A common strategy to address repeated flooding are property buyout programs. These programs acquire private lands through purchase and the land is maintained in an undeveloped state for public use. Buyout programs are usually funded by federal entities such as the Federal Emergency Management Agency (FEMA) or the Department of Housing and Urban Development (HUD). These funds are typically administered by the state or local governments. Once a property is acquired, the land is maintained as an open space for the conservation of natural floodplain functions. The upfront cost of property acquisition and structure removal is offset over the long term by reduced flood damage costs and insurance claims paid out by FEMA through the National Flood Insurance Program (FNIP). Generally allowable land uses as indicated in Title 44 of the Code of Federal Regulations (CFR) Part 80 include:

- Parks for outdoor recreation
- Wetlands management
- Nature reserves
- Unimproved, unpaved parking lots

Often, buyout programs can create several economic challenges for communities such as reduced investment, development, and economic activity. Therefore, the Sabine RFPG recommends that programs are designed to incentivize the conversion of buyout properties into neighborhood parks to provide value to residents and municipalities.

Chapter 8.B. Regulatory and Administrative Recommendations

8.B.1. Develop model floodplain management standards and ordinances

As illustrated in Chapter 3, there is little consistency in the variability in common floodplain management standards and ordinances across the Sabine FPR. These standards and ordinances are effective tools that communities can use to help prevent the loss of life and property. TWDB, FEMA, state agencies, and other organizations like the Texas Floodplain Management Association (TFMA) to support professional education, training, and technical assistance programs. Programs can be crafted to include model ordinances that illustrate the value of enhanced standards (sometimes referred to as higher standards), criteria, and regulations (stormwater detention, buffer zones, etc.) to minimize development in the floodplain and protect existing downstream property owners from unmanaged development. Therefore, the Sabine RFPG recommends that floodplain management standards and ordinances are developed and enforced across the region.

8.B.2. Provide support for ongoing education/training for floodplain management

The TWDB could partner with floodplain management organizations such as the Texas Floodplain Management Association (TFMA) to develop and promote public flood risk education and outreach materials. Some of TFMA's initiatives include flood awareness calendars, the "Turn Around, Don't Drown" campaign for flooded roadway safety, and other training modules.

Public outreach that provides opportunities for flood risk education and awareness helps to support public safety and flood mitigation measures in a variety of ways. A well-informed public can make better informed choices in their personal lives on issues that involve flood risk and more likely to support public policies and mitigation measures to reduce that risk. These outreach materials and education can reach an even wider audience by partnering with organizations like Texas Association of Counties that have broader reaches to smaller communities and those that may not have dedicated Floodplain Administrators with technical backgrounds.

Additionally, many of the floodplain administrators in the smaller communities across the region are supporting multiple roles aside from being a floodplain administrator. Providing resources in the form of low, or no cost educational training to these individuals and communities will help to assist them better with floodplain management, regulation, and enforcement.

8.B.3. Provide technical assistance to smaller jurisdictions

There are a total of 71 municipalities within the Sabine region, with 62 having a population less than 10,000. Often time these smaller communities do not have the technical, administrative, or financial resources to effectively pursue flood management evaluations, flood mitigation projects, flood management strategies, or even apply for funding. Creating applications for project funding can be challenging, especially for smaller communities without the resources that a larger community may have. Therefore, the Sabine RFPG recommends that technical assistance is available and provided to

these smaller jurisdictions so they can address flooding needs within their communities. Technical assistance can include:

- Assistance in preparing funding applications
- Assistance in developing items needed for funding application requirements
- Expanding consideration and priority for FMEs that establish initial FEMA effective floodplains where no floodplains exist or update those communities with primarily approximate (Zone A) floodplains.
- Provisions of a funding mechanism for smaller communities to acquire funds for studies that help identify flood mitigation projects and flood mitigation strategies
- Revisit scoring criteria for funding stormwater and flood-related projects to assure equitable distribution to rural, less populated areas of the state

8.B.4. Establish a process to take BLE data to regulatory information

During the analysis of the RFP, much of the flood risk information available within the Sabine FPR was cursory floodplain information from Fathom. After the completion of flood risk analyses, complete regional coverage of Base Level Engineering (BLE) data became available. BLE is an efficient modeling and mapping approach that aims to provide technically credible flood hazard data at various geographic scales such as community, county, watershed, and/or state level. Currently the state and FEMA are heavily investing in BLE across the state and there is a need to clearly communicate to local jurisdictions how to make this data regulatory or, if desired, improve upon it to make it eligible for incorporation into a detailed study on a Flood Insurance Rate Map (FIRM). The steps for both paths remain unclear to many local jurisdictions and this large investment could be further leveraged, especially in the RFP process. Therefore, the Sabine RFPG recommends that a process be established to leverage the BLE data and allow communities to adopt it as best available data and use it for regulating development within the floodplains.

8.B.5. Review and Update TxDOT design criteria

In addition to including state agencies like TxDOT within the RFP process as outlined above, it is recommended during the design of infrastructure to consider local governing criteria which may be more restrictive compared to the TxDOT design criteria.

TxDOT's Hydraulic Design Manual dated September 12, 2019, notes in Chapter 2, Section 6 that "TxDOT is not generally obligated to design or meet local agency requirements that may differ from or be more stringent than state or federal requirements. Certain situations may lead to TxDOT's acceptance of local requirements. […] At the discretion of the District Engineer or other designated District personnel, TxDOT may choose to accommodate criteria different or more restrictive than those customary for TxDOT."

The Sabine RFPG recommends that TxDOT utilize local higher standards within its designs allowing those local communities to manage flooding better and to prevent undesirable outcomes that could potentially lead to more flooding and hardship for a community which could be avoided if the more restrictive local design criteria is followed. The state roadways and interstate highways are often used

for emergencies and as evacuation routes and are a vital part of the community. Thus, it is important they be designed with local criteria in mind, even if it is more restrictive than TxDOT's design manual, to aid in the safety of residents and commuters using these roads. The RFPG recommends both criteria be evaluated and the more stringent of the two criteria be applied in that design scenario. The RFPG recommends TxDOT's criteria acknowledge and require this or note that a design be satisfactory to the local area's higher standards, if applicable. Communities must regulate to the 100-year (1-percent annual chance flood); however, TxDOT's criteria typically goes up to only the 50-year event. The RFPG also recommends TxDOT utilize drainage criteria for new and reconstructed roads to be designed for the 100-year event with the latest rainfall values at that time.

Chapter 8.C. Flood Planning Recommendations

This section contains recommendations for the TWDB to consider implementing during future cycles of the Flood Planning process.

8.C.1. Develop guidance and a process for emergency needs

Currently, the TWDB left the determination of an "emergency need" up to the discretion of each individual planning group. There is no guidance, definitions, or consistency for what constitutes a project having an emergency need; thus, it is wide open to interpretation from region to region with potential for little consistency. If this item is considered critical in scoring criteria or selection of future items/projects, having a consistent methodology, guidance, and criteria based upon the impact on the health, safety, and welfare of the citizens, coupled with consideration for the preservation of the tax base as well as the potential for future economic development that is applied across the state would would create an equitable process.

8.C.2. Utilize alternative statewide Social Vulnerability Index (SVI) than the one developed by the U.S. Center for Disease Control (CDC)

This initial flood planning cycle is utilizing the U.S. Center for Disease Control (CDC) and Prevention SVI metrics to evaluate the regions vulnerability and resilience. The Social Vulnerability Index (SVI) is used as a proxy for resilience for this initial flood planning cycle. It is a measure of the capacity to weather, resist, or recover from the impacts of an external hazard in the long term as well as the short term. This is a metric that identifies the negative effects on people and communities and depends upon many factors such as land use, extent and type of construction, the nature of populations (mobility, age, health), and warning of impending hazardous events and willingness and ability to take responsive actions. The higher the SVI value, the higher the vulnerability of people in that community to recover from these hazardous events.

The metric TWDB is using for designating an area as having a high SVI is a value of 0.75 or above. There is only 1 county (Shelby County) out of 21 in the Sabine region that has an average SVI of 0.75 or above. Additionally, SVI doesn't appear to take into account the severity of the floods which varies quite heavily within the Sabine region. Flooding in the southern portion of the system in the Orange County area – where it is significantly flatter in terrain compared to the rest of the region – is very different than flooding in other areas which have steeper terrain and more defined drainage corridors. Additionally,

the rainfall runoff in the northern portion of the basin must drain through the southern portion where Orange County is located until it reaches Sabine Lake and the gulf. The flat terrain combined with the higher susceptibility of tropical systems, heavier rainfall, and upstream water draining through the southern portion of the basin accentuates the amount of water volume (highlighted in Chapter 1) which passes through Orange County. Compared to other areas of the watershed, these factors make it very susceptible to extreme flooding issues which may not be accounted for within SVI.

The Sabine RFPG does not feel that the current dataset to measure vulnerabilities is representative of the region's ability to recover from flood events. Therefore, the Sabine RFPG recommends that an alternative statewide SVI index other than the current one is used to evaluate populations vulnerability and also takes into account the total volume of water which passes through an area to aid in determining an area's susceptibility to flooding and how well it can recover.

8.C.3. Reassess requirements for potentially feasible Flood Mitigation Projects (FMP)

The technical consultant gathered approximately 25 potential FMPs which were close to design and construction in its initial screening. However, because of the minimum requirements set as part of this planning process, that number had to be reduced to just 2 FMPs as a majority of these studies were missing a benefit-cost analysis (BCA). Other criteria such as no negative impact, detailed H&H modeling, preliminary or conceptual design had been performed already.

Other regions may experience the same struggles and the initial regional flood planning cycle is not likely to include a significant number of identified or recommended FMPs. This is largely due to the strict requirements that must be met for a project to be included in the plan outlined in Exhibit C of the Technical Guidelines for Regional Flood Planning, dated April 2021 from TWDB. While it is understood that TWDB is focused on funding projects that are well developed, consideration should be given to well-developed and beneficial projects for regions where project and study funding is not as widely available as more data rich and well-funded regions. This recommendation is not to diminish the requirements for what constitutes an FMP, but rather open additional avenues for projects benefitting the local community to be considered as an FMP when it may not have had the funding capabilities or resources as other regions did and are merely missing single non-critical items which can be determined during the final design stage.

8.C.4. Consider prioritizing FMEs which establish FEMA effective floodplains for a community

Development and creation of FEMA floodplains, which have a high quality standard, is crucial for the success of floodplain management, flood mitigation, and development regulation to ensure people are not developing in high risk areas. In the development of these floodplains, more flood related information such as Base Flood Elevations (BFEs), flood profiles, data tables, etc. will be generated which aid in the management of a community's floodplains. Furthermore, development of floodplains in an area which does not currently have any will aid in identifying flood-prone areas which would help to pinpoint potential areas for future Flood Mitigation Projects (FMPs).

8.C.5. Develop publicly available, statewide database of all the GIS deliverables associated with the development of the State Flood Plan

A large component of the RFP process consists of electronic geospatial data deliverables. These deliverables include entities, watersheds, streams, existing flood infrastructure (wetlands, ponds, lakes, dams, levees, sea barriers, tunnels, pipes, culverts, etc), existing flood hazards within the region, gaps in inundation boundary mapping, high-level, region-wide flood exposure identifying who and what might be harmed within the region. This is the first time a region wide data collection effort has been done and this information should be made accessible to the local communities across the state. Therefore, the Sabine RFPG recommends TWDB develop an online dashboard of all the GIS deliverables associated with development of the State Flood Plan.

8.C.6. Incorporate State and Federal Agencies in the Regional Flood Planning process as non-voting RFPG members

The RFP process engages a variety of different audiences including the public, community officials and leaders, drainage districts, river authorities, and other state agencies. One area that is lacking involvement is from federal agencies such as FEMA. FEMA is a critical components of floodplain management and provides tools and resources to help communities navigate the National Flood Insurance Program (NFIP) requirements and implement higher standards of floodplain management. Incorporating FEMA into the RFP process will help shape some of the discussions related to floodplain management practice recommendations, goals, and assessments of flood management evaluations, strategies, and projects. It will also help strengthen the relationship with the local community. Another federal agency which can have a significant impact is the US Army Corps of Engineers (USACE) as their mission is to collaboratively deliver engineering solutions to reduce disaster risk. They are a vital piece of the Sabine region with assisting in the design and construction of the proposed levees along the gulf coast.

Additionally, state agencies like TxDOT are important to include in the planning process and RFPG meetings as recommendations made in this plan can impact their plans and processes. The RFPG adopted goals as part of Chapter 3 can impact state roadways maintained by TxDOT. Incorporating those agencies will help them to prioritize and allocate their funding and budget for the current or next year which could support both their organizations as well as supporting the regional flood plan.

8.C.7. Update Future Population Projections

Future population projections are prepared by TWDB as part of the Regional Water Planning process. Population projections, particularly in the lower Sabine region, are not representative of the current growth occurring. This is likely attributed to the fact that Texas is leading the nation in population growth. TWDB should revisit the future population projection estimates and verify they are capturing current growth trends within the state and FPRs.

Chapter 8.D. Revenue Raising Opportunities

There are opportunities within the Sabine basin for revenue raising opportunities to fund drainage projects and activities, several of which are already being utilized. One of the primary revenue raising funding sources is a drainage fee or a small portion of sales tax that municipalities and drainage district can apply to generate consistent and ongoing source of funding. This funding can either be held for capital improvement projects or operation and maintenance (O&M) activities. As an example of this, the City of Longview has employed a 0.25 cent sales tax since 1992.

Ad valorem taxes, or a locally assessed portion of property taxes levied to property owners, are also an option for raising funding for projects. These taxes are based on the value of a property and are collected annually. Several entities in the state of Texas already utilize ad valorem taxes to fund drainage projects. However, ad valorem taxes must be carefully considered. If taxpayers in a political subdivision are already taxed at a high rate by the city and county, the ability of a district to increase the tax burden can be limited. Furthermore, if too extreme, taxpayers have the ability to call a rollback election (also known as a tax rate election).

Impact Fees can be assessed by a political subdivision to new development to generate revenue for funding or recouping capital improvement costs or facility expansions that are necessitated and attributable to new development. In some examples, a capital project is constructed with funding from the local municipality and serves a particular area for regional drainage and flood control purposes and is often designed for future conditions or anticipated future development. When a portion of the service area is developed, the municipality may consider offering credits to the developer to purchase in lieu of constructing mitigation within the confines of the property being developed. This is a potential benefit to both parties as capital costs can be offset by the purchase of these credits, new development brings in a new source of revenue via an increased tax base and an increase in the local economy. In addition, by offsetting mitigation in a flood control area that has already been constructed, there is incentive for the developer who now has additional land to develop rather than utilizing a portion of that land for flood mitigation activities. This does not diminish the need for flood mitigation or allow a developer to not have any mitigation – through these kinds of programs there is opportunity for mitigation to be purchased in a nearby location which has already be designed to account for the anticipated development.

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CHAPTER 9
FLOOD INFRASTRUCTURE FINANCING ANALYSIS

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CHAPTER 9. FLOOD INFRASTRUCTURE FINANCING ANALYSIS

The goal of this task for RFPGs is to indicate how sponsors propose to finance recommended FMPs, FMSs, and FMEs. The Sabine RFPG surveyed local government, regional authorities, and other political subdivision that were identified as potential sponsors of recommended flood mitigation projects (FMP), flood management strategies (FMS), or flood management evaluations (FME). The complete list of actions recommended by the Sabine RFPG is included in Chapter 5.

Section 9.A presents an overview of common sources of funding for flood mitigation planning, projects, and other flood management efforts. The methodology and results of the financing survey are presented in Section 9.B. Underlined items are links to governmental websites and documents for more information on each respective topic and funding avenue.

Chapter 9.A. Flood Infrastructure Funding Sources

Communities across the state utilize a variety of funding sources for their flood management efforts, including local, state, and federal funding sources. This section discusses some of the most common avenues of generating local funding and discusses various state and federal financial assistance programs available to communities.

Table 9-1 summarizes the local, state, and federal sources discussed in this chapter, and characterizes each by the following three key parameters:

- the state and federal agencies which are involved, if applicable
- whether these agencies offer grants, loans, or both; and
- whether they are classified as regularly occurring opportunities or are only available after a disaster.

Through the RFPG's initial stakeholder outreach efforts, the Sabine RFPG sought to understand the landscape of local funding for flood efforts in the planning region. Many communities, particularly smaller and more rural communities, reported that they did not have any local funding sources for flood management activities. Those communities that did report having local funding indicated the following primary sources: general fund or dedicated fees, such as stormwater or drainage utility fees.

This section primarily focuses on the funding mechanisms available to municipalities and counties, as a large majority of the FME, FMS, and FMP Sponsors are these types of entities. Special purpose districts are briefly discussed as there may be opportunities to create more of these types of districts in the region. Funding avenues for other types of local and regional entities, such as river authorities, are not discussed in detail herein as the aim of this chapter is to identify funding sources for potential sponsors of the identified FMEs, FMPs, and FMSs.

A community's general fund (for cities or counties) revenue stems from sales, property, and other taxes and is typically the primary fund used by a government entity to support most departments and services such as transportation, police, fire, parks, trash collection, and local government administration. Due to the high demands on this fund for many local needs, there is often not a significant amount available for funding flood projects out of the general fund.

TABLE 9-1: COMMON SOURCES OF FLOOD FUNDING IN TEXAS

Source	Federal Agency	State Agency	Program Name	Grant (G)	Loan (L)	Post-Disaster (D)
Federal	FEMA	TDEM	**Hazard Mitigation Grant Program (HMGP)**	G		D
	FEMA	TWDB	**Flood Mitigation Assistance (FMA)**	G		
	FEMA	TDEM	**Building Resilient Infrastructure and Communities (BRIC)**	G		
	FEMA	TCEQ	**Rehabilitation of High Hazard Potential Dam Grant Program**	G		
	FEMA	*TBD*	**Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM)**		L	
	FEMA	TDEM	**Public Assistance (PA)**	G		D
	HUD	GLO	**Community Development Block Grant – Mitigation (CDBG-MIT)**	G		D
	HUD	GLO	**Community Development Block Grant Disaster Recovery Funds (CDBG-DR)**	G		D
	HUD	TDA	**Community Development Block Grant (TxCDBG) Program for Rural Texas**	G		
	USACE		**Partnerships with USACE, funded through Continuing Authorities Program (CAP), Water Resources Development Acts (WRDA), or other legislative vehicles***			
	EPA	TWDB	**Clean Water State Revolving Fund (CWSRF)**	G**	L	
State		TSSWCB	**Structural Dam Repair Grant Program**	G		
		TWDB	**Flood Infrastructure Fund (FIF)**	G	L	
		TWDB	**Texas Water Development Fund (Dfund)**		L	
		TSSWCB	**Operation and Maintenance (O&M) Grant Program**	G		
		TSSWCB	**Flood Control Dam Infrastructure Projects - Supplemental Funding**	G		
Local			**General fund**			
			Bonds			
			Stormwater or drainage utility fee			
			Special-purpose district taxes and fees			

*Opportunities to partner with USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction.
**The CWSRF program offers principal forgiveness, which is similar to grant funding.

Dedicated fees such as stormwater or drainage fees are an increasingly popular tool for local flood-related funding. Municipalities can establish a stormwater utility (sometimes called a drainage utility), which is a legal mechanism used to generate revenue to finance a city's cost to provide and manage stormwater services and are strictly governed by state law. To provide these services, municipalities assess fees to users of the stormwater utility system. Impact fees, which are collected from developments to cover a portion of the expense to expand storm water systems needed to serve the new development to mitigate potential adverse impacts, can also be used as a source of local funding for flood-related efforts.

Another source for local funding to support flood management efforts includes special districts. A special district is a political subdivision established to provide a single public service (such as water supply, drainage, levee improvement districts, or sanitation) within a specific geographic area. Examples of these special districts include Water Control and Improvement Districts (WCID), Municipal Utility Districts (MUD), Drainage Districts (DD), Levee Improvement Districts (LID), and Flood Control Districts (FCD). Each of the different types of districts are governed by different state laws, which specify the authorities and process for creation of a district. Districts can be created by various entities, from the Texas Legislature or the Texas Commission on Environmental Quality to county commissioners' courts or city councils. Depending on the type of district, the districts may have the ability to raise revenue through taxes, fees, or issuing bonds to fund flood and drainage-related improvements within a district's area.

Lastly, municipalities and counties have the option to issue debt through general obligation bonds, revenue bonds, or certificates of obligation, which are typically paid back using any of the previously mentioned local revenue mechanisms.

Overall, local governments have various options for raising revenue to support local flood-related efforts; however, each avenue presents its own unique challenges and considerations. It is important to note that municipalities have more authority to establish various revenue options in comparison to counties. Of the communities that do have access to local funding, the amount available is generally much lower than the total need, leading local communities to seek out state and federal financial assistance programs.

9.A.1. State Funding

Today, communities have a broader range of state and federal funding sources and programs available due to new grant and loan programs that didn't exist even five years ago. There are two primary state agencies currently involved in providing state funding for flood projects: the TWDB and the Texas State Soil and Water Conservation Board (TSSWCB). It is important to note that state and federal financial assistance programs discussed herein are not directly available to homeowners and the general public. Local governments apply on behalf of their communities to receive and implement funding for flood projects in their jurisdiction.

The TWDB's Flood Infrastructure Fund (FIF) is a new funding program passed by the Texas Legislature and approved by Texas voters through a constitutional amendment in 2019. The program provides financial assistance in the form of low or no interest loans and grants (cost match varies) to eligible political subdivisions for flood control, flood mitigation, and drainage projects. FIF rules allow for a wide range of flood projects, including structural and non-structural projects, planning studies, and pr

eparedness efforts such as flood early warning systems and fall under one of the following four categories which were outlined in Chapter 5, Section 5.C.7. In the initial round of funding, the Sabine region received just 5 of the 127 selected FIF projects (4%) and 4 of the 5 were Category 1 FIFs as shown in **Table 9-2**.

TABLE 9-2: SABINE REGION FIF PROJECTS

Sabine FIF Project	Category	TWDB Funding
Hunt County Countywide Drainage Study	1	$191,250
Flood Protection Planning for Watersheds – Upper Sabine Basin	1	$750,000
Flood Protection Planning for Watersheds – Lower Sabine Basin	1	$1,914,047
Sabine River Relief Ditch - Extension and Expansion	1	$1,500,000
Sabine River Basin Gauges	4	$174,000
TOTALS		**$4,529,297**

As noted on TWDB's reporting dashboard website for the FIF program and shown in **Table 9-3** below, there were 127 projects that received committed funding with a total amount of $433,283,323. The majority of that funding (81.5%) was committed for Category 2 projects, or those work towards a more final design for construction. The Sabine region received just 5 projects (4% of the total number) and only 1% of the overall funding from the first round of the FIF program. More importantly, the Sabine region received Category 1 funding to help identify potential flood mitigation projects. This study funding will be beneficial to better quantify flood risk and identify mitigation opportunities and strategies, but as noted throughout this Regional Flood Plan, the Sabine region is in need of construction funding to build mitigation projects for a more resilient basin to flood risk.

TABLE 9-3: TWDB OVERALL FIF FUNDING FOR SABINE REGION

FIF Project	No. of Projects	TWDB Funding	Count of Projects Funded	Sabine Region Funding	Percentage of Funding
Category 1	46	$72,227,735	4	$4,355,297	6%
Category 2	67	$353,377,006	0	$0	0%
Category 3	7	$5,967,628	0	$0	0%
Category 4	7	$1,710,954	1	$174,000	10%
TOTALS	**127**	**$433,283,323**	**5**	**$4,529,297**	**1%**

After the first State Flood Plan is adopted, only projects included in the most recently adopted state plan will be eligible for funding from the FIF. FMEs, FMSs, and FMPs recommended as part of Chapter 5 in this regional flood plan will be included in the overall state flood plan and will thus be eligible for this funding source.

The TWDB also manages the Texas Water Development Fund (Dfund) program, which is a state-funded streamlined loan program that provides financing for several types of infrastructure projects to eligible political subdivisions. This program enables the TWDB to fund projects with multiple eligible components (water supply, wastewater, or flood control) in one loan at low market rates. Financial assistance for flood control may include structural and nonstructural projects, planning efforts, and flood warning systems.

The Texas State Soil & Water Conservation Board (TSSWCB) has three state-funded programs specifically for flood control dams: the Operation and Maintenance (O&M) Grant Program; the Flood Control Dam Infrastructure Projects - Supplemental Funding program; and the Structural Repair Grant Program. The O&M Grant Program is a grant program for local soil and water conservation districts (SWCD) and certain co-sponsors of flood control dams. This program reimburses SWCDs 90% of the cost of an eligible operation and maintenance activity as defined by the program rules; the remaining 10% must be paid with non-state funding. The Flood Control Dam Infrastructure Projects - Supplemental Funding program was newly created and funded in 2019 by the Texas Legislature. Grants are provided to local sponsors of flood control dams, including SWCDs, to fund the repair and rehabilitation of the flood control structures, to ensure dams meet safety criteria to adequately protect lives downstream. The Structural Repair Grant Program provides state grant funds to provide 95% of the cost of allowable repair activities on dams constructed by the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS), including match funding for federal projects through the Dam Rehabilitation Program and the Emergency Watershed Protection (EWP) Program of the Texas NRCS.

9.A.2. Federal Funding

Federal funding currently accounts for a large share of total available funding for flood projects throughout the state and is available from several different programs as outlined below. The funding initially originates from the federal government; however, state agencies typically play a major role in the program's management. Furthermore, many of these programs usually have a local share in the funding of the project as well. Each program will have eligibility requirements such as NFIP participation, requirement in having an approved Hazard Mitigaion Plan, or having a benefit-cost ratio of 1.0 or higher indicating the project provides greater benefits than its cost to implement. More information regarding each program and these details can be found at the links below.

9.A.2.a. Federal Emergency Management Agency (FEMA)

Common FEMA-administered federal flood-related funding programs include Flood Mitigation Assistance (FMA), Building Resilient Infrastructure and Communities (BRIC), Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM), Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, Hazard Mitigation Grant Program (HMGP), the Public Assistance (PA) program, and the Cooperating Technical Partners (CTP) Program.

Flood Mitigation Assistance is a nationally competitive grant program that provides funding to states, local communities, federally recognized tribes, and territories. FMA is administered in Texas by the Texas Water Development Board (TWDB). Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. Funding is typically a 75% federal grant with a 25% local match. Projects mitigating Repetitive Loss and Severe Repetitive Loss properties may be funded through a 90% federal grant and 100% federal grant, respectively. FEMA's FMA program now includes a disaster initiative called Swift Current. The program was released as a pilot initiative in 2022 and explored ways to make flood mitigation assistance more readily available during disaster recovery. Similar to traditional FMA, the program mitigates repetitive losses and substantially damaged buildings insured under the NFIP. Swift Current's pilot initiative made funding

available in Louisiana, Mississippi, New Jersey, and Pennsylvania and the Infrastructure Investment and Jobs Act (IIJA) is expected to provide funding nationwide in the future.

The Building Resilient Infrastructure and Communities (BRIC) is a new nationally competitive grant program implemented in 2020. The program supports states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is administered in Texas by the Texas Division of Emergency Management (TDEM). Funding is typically a 75% federal grant with a 25% local match. Small, impoverished communities and U.S. Island territories may be funded through a 90% federal grant and 100% federal grant, respectively.

Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) is a new revolving loan program enacted through federal legislation in 2021 to provide needed and sustainable funding for hazard mitigation projects. The program is designed to provide capitalization grants to states to establish revolving loan funds for projects to reduce risks from disaster, natural hazards, and other related environmental harm. At the time of the publication of this plan, the program does not yet appear to be operational and has not yet been implemented in Texas.

FEMA's Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, administered in Texas by the Texas Commission on Environmental Quality (TCEQ), provides technical, planning, design, and construction assistance in the form of grants for rehabilitation of eligible high hazard potential dams. The cost share requirement is typically no less than 35% state or local share.

Under the Hazard Mitigation Grant Program (HMGP), FEMA provides funding to state, local, tribal, and territorial governments so they can rebuild from a recent disaster in a way that reduces, or mitigates, future disaster losses in their communities. The program is administered in Texas by TDEM. Funding is typically a 75% federal grant with a 25% local match. While the program is associated with Presidential Disaster Declarations, the HMGP is not a disaster relief program for individual disaster victims or a recovery program that funds repairs to public property damaged during a disaster. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster.

FEMA's FEMA Public Assistance (PA) program provides supplemental grants to state, tribal, territorial, and local governments, and certain types of private non-profits following a declared disaster so communities can quickly respond to and recover from major disasters or emergencies through actions such as debris removal, life-saving emergency protective measures, and restoring public infrastructure. Funding cost share levels are determined for each disaster and are typically not less than 75% federal grant (25% local match) and typically not more than 90% federal grant (10% local match). In Texas, FEMA PA is administered by TDEM. In some situations, FEMA may fund mitigation measures as part of the repair of damaged infrastructure. Generally, mitigation measures are eligible if they directly reduce future hazard impacts on damaged infrastructure and are cost-effective. Funding is limited to eligible damaged facilities located within PA-declared counties.

The Cooperating Technical Partners (CTP) program is an effort launched by FEMA in 1999 to increase local involvement in developing and updating Flood Insurance Rate Maps (FIRMs), Flood Insurance Study reports, and associated geospatial data in support of FEMA's Risk Mapping, Assessment and Planning (Risk MAP) Program. To participate in the program, interested NFIP-participating communities, state or regional agencies, universities, territories, tribes, or nonprofits must complete training and execute a pa

rtnership agreement. Working with the FEMA regions, a program participant can develop business plans and apply for grants to perform eligible activities.

9.A.2.b. Housing and Urban Development (HUD)

HUD administers the following three federal funding programs: Community Development Block Grant – Disaster Recovery (CDBG-DR), Community Development Block Grant – Mitigation (CDBG-MIT), and Community Development Block Grant (TxCDBG) for Rural Texas.

Following a major disaster, Congress may appropriate funds to the Department of Housing and Urban Development (HUD) under the Community Development Block Grant – Disaster Recovery (CDBG-DR) program when there are significant unmet needs for long-term recovery. Appropriations for CDBG-DR are frequently very large, and the program provides 100% grants in most cases. The CDBG-DR is administered in Texas by the Texas General Land Office (GLO). The special appropriation provides funds to the most impacted and distressed areas for disaster relief, long term-recovery, restoration of infrastructure, housing, and economic revitalization.

The Community Development Block Grant – Mitigation (CDBG-MIT) is administered in Texas by the GLO. Eligible grantees can use CDBG Mitigation (CDBG-MIT) assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks. The primary feature differentiating CDBG-MIT from CDBG-DR is that unlike CDBG-DR which funds recovery from a recent disaster to retore damaged services, systems, and infrastructure, CDBG-MIT funds are intended to support mitigation efforts to rebuild in a way which will lessen the impact of future disasters.

The Community Development Block Grant (CDBG) program provides annual grants on a formula basis to small, rural cities and to counties to develop viable communities by providing decent housing and suitable living environments, and expanding economic opportunities principally for persons of low- to moderate-income. Funds can be used for public facilities such as water and wastewater infrastructure, street and drainage improvements, and housing. In Texas, the CDBG program is administered by the Texas Department of Agriculture (TDA).

9.A.2.c. U.S. Army Corps of Engineers (USACE)

The USACE works with non-Federal partners (States, Tribes, counties, or local governments) throughout the country to investigate water resources and related land problems and opportunities and, if warranted, develop civil works projects that would otherwise be beyond the sole capability of the non-Federal partner(s). Partnerships are typically initiated or requested by the local community to their local USACE District office. Before any project or study can begin, USACE determines whether there is an existing authority under which the project could be considered, such as the US Army Corps of Engineers Continuing Authorities Program (CAP), or whether Congress must establish study or project authority and appropriate specific funding for the activity. New study or project authorizations are typically provided through periodic Water Resource Development Acts (WRDA) or via another legislative vehicle. Congress will not provide project authority until a completed study results in a recommendation to Congress of a water resources project, conveyed via a Report of the Chief of Engineers (Chief's Report) or Report of the Director of Civil Works (Director's Report). Opportunities to partner with USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction. USACE also has technical assistance opportunities,

incl

uding Floodplain Management Services and the Planning Assistance to States program, available to local communities.

9.A.2.d. U.S. Environmental Protection Agency (EPA)

The Clean Water State Revolving Fund (CWSRF) provides financial assistance in the form of loans with subsidized interest rates and opportunities for partial principal forgiveness for planning, acquisition, design, and construction of wastewater, reuse, and stormwater mitigation infrastructure projects. Projects can be structural or non-structural. Low Impact Development (LID) projects are also eligible. The CWSRF is administered in Texas by the TWDB.

9.A.2.e. U.S. Department of Agriculture (USDA)

The USDA's Natural Resources Conservation Service (NRCS) provides technical and financial assistance to local government agencies through the following programs: Emergency Watershed Protection Program, Watershed Protection and Flood Prevention Program, Watershed Surveys and Planning, and Watershed Rehabilitation. The Emergency Watershed Protection (EWP) program, a federal emergency recovery program, helps local communities recover after a natural disaster by offering technical and financial assistance to relieve imminent threats to life and property caused by floods and other natural disasters that impair a watershed. The Watershed Protection and Flood Prevention Program helps units of federal, state, local and tribal government protect and restore watersheds. This includes preventing erosion, floodwater, and sediment damage, as well as advancing the conservation development, use and disposal of water, and the conservation and proper use of land in authorized watersheds. The focus of Watershed Surveys and Planning program is funding watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance aimed at identifying solutions that use land treatment and nonstructural measures to solve resource problems. Lastly, the Watershed Rehabilitation Program helps project sponsors rehabilitate aging dams that are reaching the end of their design lives. This rehabilitation addresses critical public health and safety concerns. The USDA also offers various Water and Environmental grant and loan funding programs, which can be used for water and waste facilities, including stormwater facilities, in rural communities.

9.A.2.f. Special Appropriations

On occasion and when the need is large enough, Congress may appropriate funds for special circumstances such natural disasters or pandemics (COVID-19). A few examples of recent special appropriations from the federal government that can be used to fund flood-related activities are discussed in this section.

In 2021, the American Rescue Plan Act (ARPA) provided for a substantial infusion of resources to eligible state, local, territorial, and tribal governments to support their response to and recovery from the COVID-19 pandemic. Coronavirus State and Local Fiscal Recovery Funds (SLFRF), a part of ARPA, delivers $350 billion directly to state, local, and tribal governments across the country. Some of the authorized uses include improving stormwater facilities and infrastructure. Although not a direct appropriation to local governments like ARPA, the 2021 Infrastructure Investment and Jobs Act (IIJA), also called the Bipartisan Infrastructure Law (BIL), authorizes over $1 trillion for infrastructure spending across the U.S.

and provides for a significant infusion of resources over the next several years into existing federal financial assistance programs as well as creating new programs.

9.A.2.g. Barriers to Funding

Local communities in the Sabine region identified several barriers to accessing or seeking funding sources for flood management activities, including lack of knowledge of funding sources, lack of expertise to apply for funding, and no local funds available for local match requirements. As opposed to some other types of infrastructure, flood projects do not typically generate revenue and many communities do not have steady revenue streams to fund flood projects, as discussed in Section 9.1.1.

Consequently, communities struggle to generate funds for local match requirements or loan repayment. Complex or burdensome application or program requirements as well as prolonged timelines also act as barriers to accessing state and local financial assistance programs. Often, the ability to levy more taxes is limited where the political subdivision has overlapping jurisdiction with one or more other entities. For instance, a special district may have coterminous jurisdiction with a county that contains several cities. In calculating the levy, the political subdivision is under considerable political pressure to examine the impact an additional or increased levy has on the taxpayer's overall tax burden. In the end, the political subdivision can propose a large increase, but such an increase is subject to the taxpayer's right to call a rollback election. So, for example, if the taxpayers in a city are already burdened with a high city and county ad valorem tax rate, the ability of a district to further increase that tax burden is somewhat limited. Of those communities able to overcome these barriers, apply for funding, and generate local resources for match requirements, the high demand for state and federal funding, particularly for grant opportunities, means that need outstrips supply, leaving many local communities without the resources they need to address flood risks.

In regard to FEMA and HUD mitigation funding in particular, the application process for these federal programs often requires local sponsors to compile disaster impact data that federal agencies currently restrict access to. This dilemma could be overcome by developing data sharing methods which preserve privacy considerations for individual citizens, while at the same time providing the necessary information and analysis required for project funding applications. Examples of programs where improved data sharing is advisable are FEMA-IA, FEMA-PA, FEMA-NFIP, SBA-DL.

Chapter 9.B. Flood Infrastructure Financing Survey

This task required obtaining relevant information from Sponsors of the recommended FMEs, FMSs, and FMPs that have capital costs, for example, in the form of a survey to collect the required information. The primary aim of this survey effort was to understand the funding needs of local Sponsors and then propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs.

The RFPG collected information from Sponsors by sending a PDF tabular list of FME, FMS and FMPs currently identified for their respective entity via e-mail merge. Contact information for Sponsors was gathered through entity websites and FEMA's Floodplain Manager contact list.

During the mail merge process, a personalized table of recommended FMEs, FMSs, and FMPs was generated for each Sponsor. The table included the identification number, type, name, description, and total estimated cost for each FME, FMS, and FMP listed. The Sponsors were asked to complete the

columns titled 'Anticipated Source of Funding', 'Percent Funding to be Financed by Sponsor' and 'Other Funding Needed' columns for each FME, FMS, and/or FMP.

9.B.1. Flood Infrastructure Financing Survey Results

The Flood Infrastructure Funding survey was sent to the 39 entities identified as Sponsors of FMEs, FMSs, and FMPs. The primary aim of this survey effort was to understand the funding needs of local Sponsors and then propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs. Of the 39 entities surveyed, only one responded with sufficient information. Orange County Drainage District responded that the district may be able to finance up to 25% of cost FMPs, FMSs, and FMEs with tax revenue and potential contributions by other local entities. This represents a response rate of 2.5%. **Table 9-4** summarizes the survey results for all flood mitigation actions. **Tables 9A-3** through **9A-5** in **Appendix 9-A** present the results of the survey for each FME, FMS, and FMP. Due to the low response rate, the survey does not represent a significant percentage of respondents and therefore does not accurately represent the total need for state and federal funding in the Sabine basin. Without confirmation from project sponsors/entities it cannot be determined how much a local sponsor could fund the project. To assess the remaining need, it was estimated that 100% of total costs are required from state and federal sources in the form of loans and grants. With additional time provided in the amendment period of this first Regional Flood Planning cycle it is anticipated that a greater response rate may be obtained. This is representative of the high level of financial support needed captured in the responses to the initial stakeholder outreach which confirmed that many communities, particularly smaller and more rural communities, do not have any dedicated local funding for flood management activities. Those communities that did report having local funding indicated relatively little local funding available in relation to overall need.

TABLE 9-4: FLOOD INFRASTRUCTURE FINANCING SURVEY SUMMARY

Flood Mitigation Action	Other Funding Needed (State/Federal)	Potential Funding to be Financed by Local Sponsor	Total Flood Mitigation Action Cost
FME	$61,093,500	$1,750,000	$62,843,500
FMS	$65,547,775	$0	$65,547,775
FMP	$1,840,218,375	$1,627,005,775	$2,272,016,500
Total	**$1,966,859,650**	**$1,628,755,775**	**$2,400,407,775**

Overall, there is an estimated $2,400,407,775 in total funding and $1,628,755,775 in state and federal funding projected to be needed to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. It is noted that the vast majority of the total funding noted above is tied to the Sabine to Galveston levee project in Orange County. This number does not represent the amount of funding needed to mitigate all risks in the region and solve flooding problems in their totality. This number simply represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. Future cycles of regional flood planning will continue to identify more projects and studies needed to further flood mitigation efforts in the Sabine region.

Financing information is also available on the Sabine Pass to Galveston Bay, TX Coastal Storm Risk Management (CSRM) Project (FMP 043000017). USACE report dated August 28, 2020 details the division federal and non-federal costs, is included in **Appendix 9-B**. The project, which includes the construction of a new levee and associated pump stations in Orange County, is planned to be funded 65% by federal

financing. The remaining 35% of cost, or $836,500,000, is expected to be funded from state or local financing.

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CHAPTER 10
ADOPTION OF PLAN AND PUBLIC PARTICIPATION

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CHAPTER 10. ADOPTION OF PLAN AND PUBLIC PARTICIPATION

This chapter describes the various public participation, information, outreach, and education activities conducted by the Sabine Regional Flood Planning Group (RFPG). All activities and events discussed in this section were performed in direct support of the regional flood planning effort and demonstrate the RFPG's commitment to ensuring that the public is provided with timely, accurate information regarding the flood planning process and that opportunities to provide input are available as often as possible. The chapter also details the plan adoption process followed by the RFPG. The process explains the required hearing, receipt of comment, comment response, and final adoption of the Regional Flood Plan (RFP).

10.A.1. Sabine RFPG Website

A website was developed for the first planning cycle of the Sabine Regional Flood Plan in order to maintain contact with the public and to provide members of the RFPG with resources for plan development. The site, Sabine Regional Flood Planning Group (Region 4) (https://www.sabine-rfpg.org/), provides visitors with an overview of the regional planning process in Texas and specific information on the Sabine Flood Planning Region and Planning Group. The site also provides information and announcements for meetings of the Sabine RFPG, meeting materials, and downloads of past meeting materials and meeting minutes.

10.A.2. Texas Water Development Board Website

The Texas Water Development Board (TWDB) provides information on the regional flooding planning process, including background information, current planning documents, and relevant rules and statutes, on its regional planning webpage (https://www.twdb.texas.gov/flood/planning/index.asp). Upcoming meetings, minutes of previous meetings, and contact information are available as well.

10.A.3. Planning Group Activities

As required by 31 TAC §361.21, the Sabine RFPG conducted all business in meetings posted and held in accordance with the Texas Open Meetings Act, Public Information Act, and Texas Government Code Chapter 551 and 552 of the Texas Government Code (Texas Public Information Act and Texas Open Meetings Act). The Sabine RFPG posted all materials presented or discussed at regular meeting for public inspection prior to and following public meetings. Additional notice requirements specific to regional flood planning referenced in 31 TAC §361.21 were also followed. The plan was developed in accordance with 31 TAC §361.50 and §361.50-.61 the flood planning guidance principles 31 TAC §361.20 (31 TAC §362.3) and includes an explanation of how the plan satisfies each of the guidance principles including that the plan will not negatively affect a neighboring area. **Table 10-1** details where each of the guidance principles are satisfied in the RFP.

The Sabine RFPG has accommodated public participation throughout the planning process and will vote to adopt the RFP after all public comments have been addressed. The RFPG will address public comments in the final RFP and indicate whether changes to the plan were made in response to comments, during the plan adoption process in accordance with all administrative rules, the Contract, statute and the RFPG bylaws. The draft plan will be available for public review online (https://www.sabine-rfpg.org/) and a hard copy of the draft plan will be available for public inspection in

at

least three publicly accessible locations in the Sabine watershed. These three locations will be posted on the Sabine RFPG website. Public meetings will be held to receive comment on the draft plan and hard copies will be available for review least 30 days prior to the first meeting and 30 days following the first public meeting.

Table 10-1 outlines the guidance principles for the Regional Flood Plan which was provided by TWDB. The last column in the table identifies where each of the items can be found within the report.

TABLE 10-1: TWDB REGIONAL FLOOD PLANNING GUIDANCE PRINCIPLES

	Guidance Principle ("The regional and state flood plans…")	RFP Section(s)
1	shall be a guide to state, regional, and local flood risk management policy	Chapter 3, Chapter 8
2	shall be based on the best available science, data, models, and flood risk mapping	Chapter 2
3	shall focus on identifying both current and future flood risks, including hazard, exposure, vulnerability and residual risks; selecting achievable flood mitigation goals, as determined by each RFPG for their region; and incorporating strategies and projects to reduce the identified risks accordingly	Chapter 2, Chapter 3, Chapter 4, Chapter 5
4	shall, at a minimum, evaluate flood hazard exposure to life and property associated with 0.2 percent annual chance flood event (the 500-year flood) and, in these efforts, shall not be limited to consideration of historic flood events	Chapter 2
5	shall, when possible and at a minimum, evaluate flood risk to life and property associated with 1.0 percent annual chance flood event (the 100-year flood) and address, through recommended strategies and projects, the flood mitigation goals of the RFPG (per item 2 above) to address flood events associated with a 1 percent annual chance flood event (the 100-year flood); and, in these efforts, shall not be limited to consideration of historic flood events	Chapter 2, Chapter 4, Chapter 5
6	shall consider the extent to which current floodplain management, land use regulations, and economic development practices increase future flood risks to life and property and consider recommending adoption of floodplain management, land use regulations, and economic development practices to reduce future flood risk	Chapter 2, Chapter 3
7	shall consider future development within the planning region and its potential to impact the benefits of flood management strategies (and associated projects) recommended in the plan	Chapter 1, Chapter 2, Chapter 6
8	shall consider various types of flooding risks that pose a threat to life and property, including, but not limited to, riverine flooding, urban flooding, engineered failures, slow rise flooding, ponding, flash flooding, and coastal flooding, including relative structure sea level change and storm surge	Chapter 2
9	shall focus primarily on flood management strategies and projects with a contributing drainage area greater than or equal to 1.0 (one) square miles except in instances of	Chapter 4, Chapter 5

	Guidance Principle ("The regional and state flood plans…")	RFP Section(s)
	flooding of critical facilities or transportation routes or for other reasons, including levels of risk or project size, determined by the RFPG	
10	shall consider the potential upstream and downstream effects, including environmental, of potential flood management strategies (and associated projects) on neighboring areas. In recommending strategies, RFPGs shall ensure that no neighboring area is negatively affected by the Regional Flood Plan	Chapter 4, Chapter 5
11	shall include an assessment of existing, major flood mitigation infrastructure and will recommend both new strategies and projects that will further reduce risk, beyond what existing flood strategies and projects were designed to provide, and make recommendations regarding required expenditures to address deferred maintenance on or repairs to existing flood infrastructure	Chapter 1, Chapter 4, Chapter 5
12	shall include the estimate of costs and benefits at a level of detail sufficient for RFPGs and sponsors of flood mitigation projects to understand project benefits and, when applicable, compare the relative benefits and costs, including environmental and social benefits and costs, between feasible options	Chapter 4, Chapter 5
13	shall provide for the orderly preparation for and response to flood conditions to protect against the loss of life and property and reduce injuries and other flood-related human suffering;	Chapter 7
14	shall provide for an achievable reduction in flood risk at a reasonable cost to protect against the loss of life and property from flooding	Chapter 4, Chapter 5, Chapter 6
15	shall be supported by state agencies, including the TWDB, General Land Office, Texas Commission on Environmental Quality, Texas State Soil and Water Conservation Board, Texas Parks and Wildlife Department, and the Texas Department of Agriculture, working cooperatively to avoid duplication of effort and to make the best and most efficient use of state and federal resources	Executive Summary, Chapter 10
16	shall include recommended strategies and projects that minimize residual flood risk and provide effective and economical management of flood risk to people, properties, and communities, and associated environmental benefits	Chapter 4, Chapter 5, Chapter 6
17	shall include strategies and projects that provide for a balance of structural and nonstructural flood mitigation measures, including projects that use nature-based features, which lead to long-term mitigation of flood risk	Chapter 4, Chapter 5, Chapter 6
18	shall contribute to water supply development where possible	Chapter 6
19	shall also follow all regional and state water planning guidance principles (31 TAC §358.3) in instances where recommended flood projects also include a water supply component	Chapter 6

	Guidance Principle ("The regional and state flood plans…")	RFP Section(s)
20	shall be based on decision-making that is open to, understandable for, and accountable to the public with full dissemination of planning results except for those matters made confidential by law	Chapter 10
21	shall be based on established terms of participation that shall be equitable and shall not unduly hinder participation	Chapter 10
22	shall include flood management strategies and projects recommended by the RFPGs that are based upon identification, analysis, and comparison of all flood management strategies the RFPGs determine to be potentially feasible to meet flood mitigation and floodplain management goals	Chapter 4, Chapter 5
23	shall consider land-use and floodplain management policies and approaches that support short- and long-term flood mitigation and floodplain management goals	Chapter 3
24	shall consider natural systems and beneficial functions of floodplains, including flood peak attenuation and ecosystem services	Chapter 1, Chapter 3
25	shall be consistent with the National Flood Insurance Program (NFIP) and shall not undermine participation in nor the incentives or benefits associated with the NFIP	Chapter 3
26	shall emphasize the fundamental importance of floodplain management policies that reduce flood risk	Chapter 3
27	shall encourage flood mitigation design approaches that work with, rather than against, natural patterns and conditions of floodplains	Chapter 3, Chapter 4, Chapter 5
28	shall not cause long-term impairment to the designated water quality as shown in the state water quality management plan as a result of a recommended flood management strategy or project	Chapter 6
29	shall be based on identifying common needs, issues, and challenges; achieving efficiencies; fostering cooperative planning with local, state, and federal partners; and resolving conflicts in a fair, equitable, and efficient manner	Chapter 10
30	shall include recommended strategies and projects that are described in sufficient detail to allow a state agency making a financial or regulatory decision to determine if a proposed action before the state agency is consistent with an approved regional flood plan	Chapter 4, Chapter 5
31	shall include ongoing flood projects that are in the planning stage, have been permitted, or are under construction	Chapter 1

	Guidance Principle ("The regional and state flood plans…")	RFP Section(s)
32	shall include legislative recommendations that are considered necessary and desirable to facilitate flood management planning and implementation to protect life and property	Chapter 8
33	shall be based on coordination of flood management planning, strategies, and mitigation projects with local, regional, state, and federal agencies projects and goals	Chapter 3, Chapter 10
34	shall be in accordance with all existing water rights laws, including but not limited to, Texas statutes and rules, federal statutes and rules, interstate compacts, and international treaties	Chapter 6
35	shall consider protection of vulnerable populations	Chapter 2, Chapter 4
36	shall consider benefits of flood management strategies to water quality, fish and wildlife, ecosystem function, and recreation, as appropriate	Chapter 6
37	shall minimize adverse environmental impacts and be in accordance with adopted environmental flow standards	Chapter 6
38	shall consider how long-term maintenance and operation of flood strategies will be conducted and funded	Chapter 9
39	shall consider multi-use opportunities such as green space, parks, water quality, or recreation, portions of which could be funded, constructed, and or maintained by additional, third-party project participants	Chapter 4, Chapter 5

10.A.4. Regular Regional Planning Group Meetings

The Sabine RFPG held monthly meetings to obtain updates from the Technical Consultant team, discuss proposals, and provide approval of components of the draft Sabine Regional Flood Plan. These meetings were open to the public in accordance with the Texas Open Meetings Act. A majority of the regular Sabine RFPG meetings were held at the Sabine River Authority of Texas' (SRATX) office in Orange Texas, with all meetings having a virtual option. The only exception to this was the August 2021 RFPG meeting which was held in Center, TX which also had a virtual option. In addition, RFPG meetings provided at least a 3-day posting prior to each meeting. Pre-planning public meetings and meetings that discussed the flood mitigation and floodplain management goals or the process to identify potential FMEs and potentially feasible FMSs and FMPs provided at least a 7-day posting prior to the meeting. These meetings were held on May 10, 2021 at SRA's Lake Fork office near Quitman, TX and May 13, 2021 at the Orange County Convention and Expo Center in Orange, TX.

Table 10-2 summarizes the RFPG meeting dates, key discussions, and votes held at each meeting. Furthermore, the meeting minutes, documents, and recordings can be accessed under the 'MEETINGS' tab on the Sabine Regional Flood Planning Group website (https://www.sabine-rfpg.org/).

TABLE 10-2: SUMMARY OF RFPG MEETINGS

Meeting Date	Key Discussion Items	Votes Held
October 27, 2020	• Authorized SRATX to apply for grant funds and enter a contract with the TWDB on behalf of the RFPG. • Additional voting and non-voting positions that may be needed to ensure adequate representation from the interest in the region.	• Adopted Sabine RFPG By-Laws. • Elected Sabine RFPG Members. • Selected Bill Hughes as Chair. • Authorized SRATX to apply for grant funds and enter a contract with the TWDB on behalf of the RFPG.
November 19, 2020	• Opened the floor to public comments. No public comments were given. • Steps regarding the Request for Applications for Regional Flood Planning Grants. • TWDB Request for Applications for Regional Flood Planning Grants material. • The SRATX ability to develop an RFPG website.	• Selected Jeff Rogers as Secretary of the RFPG. • Selected the members-at-large to serve on the Executive Committee. • Selected Johnny Trahan as Vice Chair.
December 14, 2020	• Opened the floor to public comments. No public comments were given. • Task list, budget, and scope of work for the TWDB grant application. • Funding allocation to tasks, member review of the draft grant application. • Consideration of SRATX proposal by which the RFPG will host a public website (required per §361.21(b)).	• Selected Don Carona as liaison to the Region 5 Neches RFPG. • Approved to move forward with website development. • Approved to move forward with accepting written public comments. • Approved the collection of requests from persons or entities who wish to be notified of RFPG activities.
January 7, 2021	• Opened the floor to public comments. No public comments were given. • SRATX will include agendas and approved minutes on the web site. • TWDB provided RFP guidance for selection of Technical Consultants.	• Approved to finalize the Regional Flood Planning Grant document. • Approved to finalize the RFQ with corrections. • Approval of scoring criteria based on any minor changes and that any proposed changes be sent to SRATX. • Executive Committee be the interviewing and scoring group on behalf of the whole group. • Approval to revise the previous motion.

March 4, 2021	• Opened the floor to public comments. No public comments were given. • Neches RFPG has interviewed engineering firms and selected Freese and Nichols, Inc (FNI). • Discussion regarding planning group member training on Public Information Act and Open Meetings Act.	• Selected FNI as Technical Consultant.
April 14, 2021	• Opened the floor to public comments. No public comments were given. • TWDB Grant Contract.	• Selected Johnny Trahan as Sabine RFPG Chair. • Selected Don Carona Interim Vice Chair.
May 26, 2021	• Opened the floor to public comments. No public comments were given. • Updates regarding the Freese and Nichols contract and pre-planning meeting held on May 10th and May 13th. • Updates regarding technical guidelines on website and subconsultant contracts. • Flood infrastructure Fund (FIF).	• Selected replacement for SRATX representative. • Selected Travis Williams as Vice Chair.
July 14, 2021	• Opened the floor to public comments. No public comments were given. • Existing floodplain data available in the region. • Public survey: questions to be included, close of survey. • Flood management recommendations.	• No votes held.
August 11, 2021	• Opened the floor to public comments, no public comments were given. • TWDB received the survey determining how much funding each RFPG will be receiving. • Updates from the consulting team on the RFP schedule and to the public & stakeholder survey. • Updates on Task 1, Task 2 approach, public meetings, and existing conditions flood risk.	• No votes held.
September 21, 2021	• Opened the floor to public comments, no public comments were given. • Updates on Task 1, Task 2, Task 3, and Task 4 • Goals for the Regional Flood Plan.	• No votes held.

October 21, 2021	• Opened the floor to public comments, no public comments were given. • Public survey, public meetings, Task 3A. • Goals and the FME/FMS/FMP Process.	• Approved Goals 1A, 1B, 1C, 1D, 1E, 1F, 2A. • Disapproved Goal 2B and Goal 2C. • Approved Goal 3D. • Approved the FME/FMS/FMP Process (Task 4B).
December 1, 2021	• Opened the floor to public comments, no public comments were given. • Mentioned the meeting turnout held in Orange County. • TWDB has given the groups 3 additional tasks for the Regional Flood Plans, noted as Task 11, 12, and 13. • Revised adopted goals. • FME/FMS/FMP identification process.	• Approval for SRATX to negotiate with TWDB for Task 11, 12, 13 contract. • Approval to authorize SRATX to negotiate an amendment to the RFPG subcontract with the Technical Consultant, FNI, to incorporate additional funding for the first cycle of regional flood planning. • Approved second and third Goals.
December 16, 2021	• Opened the floor to public comments, no public comments were given. • The online GIS data dashboard FNI created to show the flood related data associated with the Regional Flood Plan. • Task 2 related to the existing and future floodplain.	• Approved the Tech Memo with the requested changes to the FMP list.
January 19, 2022	• Opened the floor to public comments, no public comments were given. • Section 1 and Section 2 of the Region 4 Sabine RFPG bylaws. • Public outreach meeting last week. • Current approach and graphics depicting the different floodplain delineations. • The hierarchy of usable data was highlighted noting that FEMA data would be the highest priority followed by BLE, FEMA Zone A, and finally Cursory Floodplain Data. • Discussion to provide a memo to the group with outlines from the sources of the floodplain data, strategies, and dates of detailed modeling that FNI is recommending to the group. • Draft chapters provided to the group in phases for review.	• Selected Travis Williams Chair. • Selected Johnny Trahan as Vice Chair. • Selected Jeff Rogers as Secretary. • Selected two Executive Committee members-at-large.

February 23, 2022	• Opened the floor to public comments, no public comments were given. • Updates regarding the existing conditions flood hazard layer (Task 2A). • Updates on the future conditions flood hazard outlining the horizontal buffer process being used (Task 2B). • Recommended floodplain management standards (Task 3A).	• No votes held.
March 23, 2022	• Opened the floor to public comments, no public comments were given. • Updates regarding Floodplain Management Goals (Task 3B), Flood Mitigation Need Analysis (Task 4A).	• No votes held.
April 26, 2022	• Opened the floor to public comments, no public comments were given. • Public meetings regarding the proposed levee in Orange County, alignment, real estate, pump station, and drainage. • Presented topics including Task 4A, Task 4B, Task 6A, Task 6B, Task 7, Task 8, and Task 9 • Task 12 and future public meetings.	• No votes held.
May 23, 2022	• Opened the floor to public comments, no public comments were given. • Public meeting regarding proposed USACE Sabine Pass to Galveston Bay levee and flood walls in Orange County. • Updates regarding summaries for all the FMXs, Task 5, and Task 12.	• No votes held.
June 22, 2022	• Opened the floor to public comments, no public comments were given. • Presented the proposed FME/FMP/FMS identification. • Presented on Task 12 considerations. • Presented on items related to flood preparedness, flood response activities, flood recovery, and flood mitigation (Task 7). • Presented legislative, regulatory, and administrative recommendations for the RFP (Task 8).	• Approved the recommended FMEs, FMSs, and FMPs.

July 27, 2022	• Opened the floor to public comments, no public comments were given. • Presented timeline of major deliverables to TWDB through July 2023 • Presented on coordination on Task 12 items, specifically related to the 2 detention ponds in the City of Marshall and City of Greenville. • Clarification made regarding the official route to make changes to the RFP between the draft submittal and the final plan. Changes can only occur through a submitted comment. • Clarification regarding future FIF funding would be dependent on the 2024 State Flood Plan and not dependent on the draft plan submittals in January 2023.	
August 10, 2022	• Opened the floor to public comments, no public comments were given.	• Approved draft Sabine Regional Flood Plan
September 14, 2022	• Opened the floor to public comments, no public comments were given. • Discussion of public meetings in September 2022 and schedule for the next submittal. • Discussion about Chapter 8 recommendations compared to other regions • Additional outreach performed • Discussion of 4 new FMEs • Discussion of plan for upcoming work on amended plan	• Approved 4 new FMEs to be added to the plan • Approved list of FMEs to be studied using the additional appropriated funds from TWDB
November 16, 2022	• Opened the floor to public comments, no public comments were given. • Discussion on comments made to the Draft Plan's goals (Chapter 3) and necessary revisions per TWDB comments • Updating RFPG members on additional work as part of the Amendment (2023).	• Approved revisions to some goals in Chapter 3 based on TWDB comments on Draft Plan. • Approved shifting of unused funds in Tasks 1 through 9 to Tasks 10 and 12.
December 14, 2022	• Draft Plan comments and how they were addressed • Schedule regarding Final Plan delivery to TWDB and upcoming schedule for the amendment period in 2023. • Task 12 modeling update	• Unanimously adopted the first Sabine Regional Flood Plan and approved Freese and Nichols to submit to TWDB.

The next step of the Regional Flood Planning process is to submit the Final Plan to TWDB no later than January 10, 2023. Beyond that submittal, the Plan will undergo additional effort to evaluate FMEs to turn them into new FMPs for the plan. This will occur during an amendment period in spring 2023 and an amended plan will be adopted in early summer 2023 and submitted to TWDB no later than July 14, 2023. From this date, TWDB will compile all 15 of the Regional Flood Plans into the first State Flood Plan

by September 2024. The Regional Flood Plans, similar to the state's water plan, are intended to occur on 5-year cycles; thus, the next cycle will occur in 2023 working toward a 2028 flood plan.

10.A.5. Interregional Coordination

Throughout the Regional Flood Planning process, there was ongoing communication between the Sabine RFPG and other RFPGs. The TWDB facilitated interaction through Technical Consultant calls. Four calls were hosted by the TWDB throughout the planning process to provide additional guidance and allow time for questions and discussion between the flood planning regions and the TWDB. The discussion facilitated by these calls allowed for an opportunity for regions to coordinate and discuss shared problems and solutions.

During monthly Sabine RFPG meetings, flood planning group members provided updates on the progress of the Neches RFP (Region 5). These updates helped facilitate discussions concerning timelines

and different approaches being used across other flood planning regions. In addition, it provided an opportunity for the group members to express any concerns over inequities experienced between different regions, allowing for the Technical Consultant team to consider different methodologies or further coordination with other regions.

10.A.6. Public Input Meetings

All RFPG meetings were public meetings under Texas Open Meetings Act. Meetings were held in person with a virtual component. Thus, the public had continual access and ability to provide comments on the plan's development. Separate public input meetings were held to identify flood risk in the region. These meetings were utilized to receive feedback and gather information, general suggestions, and recommendations from the public regarding issues and changes that should be considered or addressed, or provisions that should be considered and potentially included in the regional flood planning cycle. Several public input meetings have been held, as follows:

- May 10, 2021 (Quitman, TX) and May 13, 2021 (Orange, TX) – pre-planning meeting to allow public to provide information for the sponsor and technical consultant.
- October 26, 2021, (West Orange, TX) with an attendance of 25 people and November 4, 2021, (Longview, TX) with an attendance of 1 person to present existing conditions flood hazards and allow for public input on flood-prone areas.
- September 26, 2022 (Longview, TX) and September 27, 2022 (Orange, TX) to allow input and comments from the public on the draft plan submitted to TWDB on August 1, 2022, for inclusion in the January 2023 submittal to TWDB.

A web-based public survey, including questions and map input was conducted, to obtain public input and also utilized during the second public meetings in late 2021. The public had access to the survey and an interactive map on the Sabine Regional Flood Plan website through which to provide input and locate problematic flooding areas for the Technical Consultant to consider. It is important to note that most of the public information received was from Orange County, but there was also data received from Newton County and Gregg County. In addition, all public input was reviewed and considered while drafting the regional flood plan. Public input on recommended FMEs, FMSs, and FMPs will be received along with comments on the draft plan.

Figure 10-1 shows the distribution of web map survey responses received and an example response indicating a flood prone area. The complete survey made available to the public is included in **Appendix 10-C**.

Once the Draft Regional Flood Plans were submitted to TWDB on August 1, 2022, copies of the draft Regional Flood Plan were placed in 3 separate locations across the Sabine region for access to the public. The public comment period was open for at least 2 months during the months of August, September, and October 2022.

- Sabine River Authority's Lake Tawakoni Office - 169 Rains CR 1480, Point, TX 75472
- City of Longview Development Services Building – 410 S. High Street, Longview, TX 75601
- Sabine River Authority's Office – 12777 TX-87, Orange, TX 77632

In addition to being physically available for review, the draft plan was also posted online on the Sabine RFPG website for viewing. Comments from the public could be done in person at the September 2022 public meetings, via email, or via posted mail to Sabine River Authority's office in Orange, TX. Public comments were documented All comments on the draft Regional Flood Plan will be considered and included in final Regional Flood Plan in January 2023.

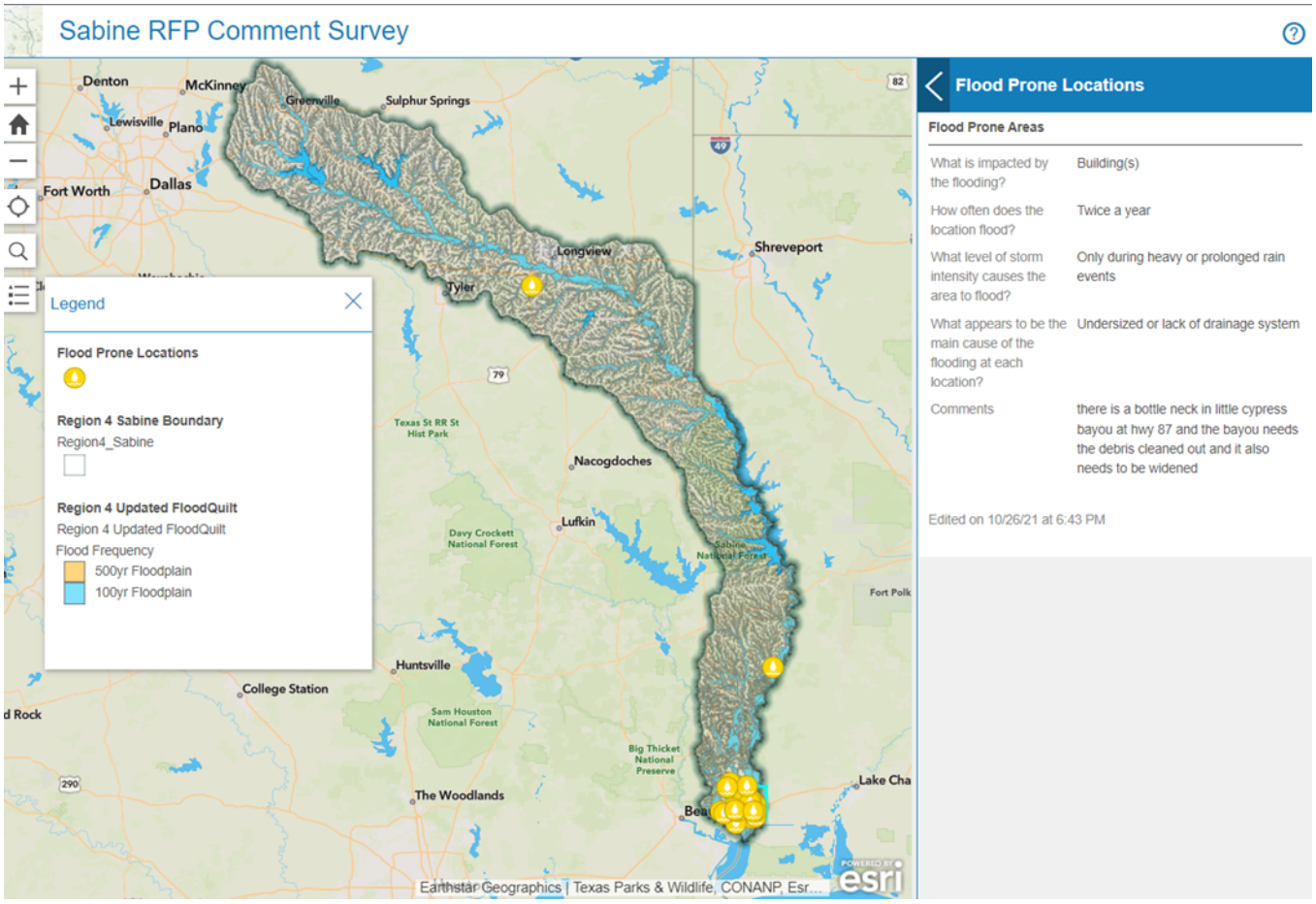

FIGURE 10-1: PUBLIC SURVEY COMMENTS

10.A.7. Statement regarding Texas Open Meetings Act (TOMA)

The Region 4 Sabine Regional Flood Planning Group (RFPG) posted meeting notices and meeting materials in accordance with Title 31 of the Texas Administrative Code (TAC) Chapters 361 and 362 and with the Regional Flood Planning Public Notification Quick Reference distributed by the Texas Water Development Board. All meeting notices and subsequent meeting minutes were posted on the Sabine RFPG website (www.sabine-rfpg.org) and with the Secretary of State.