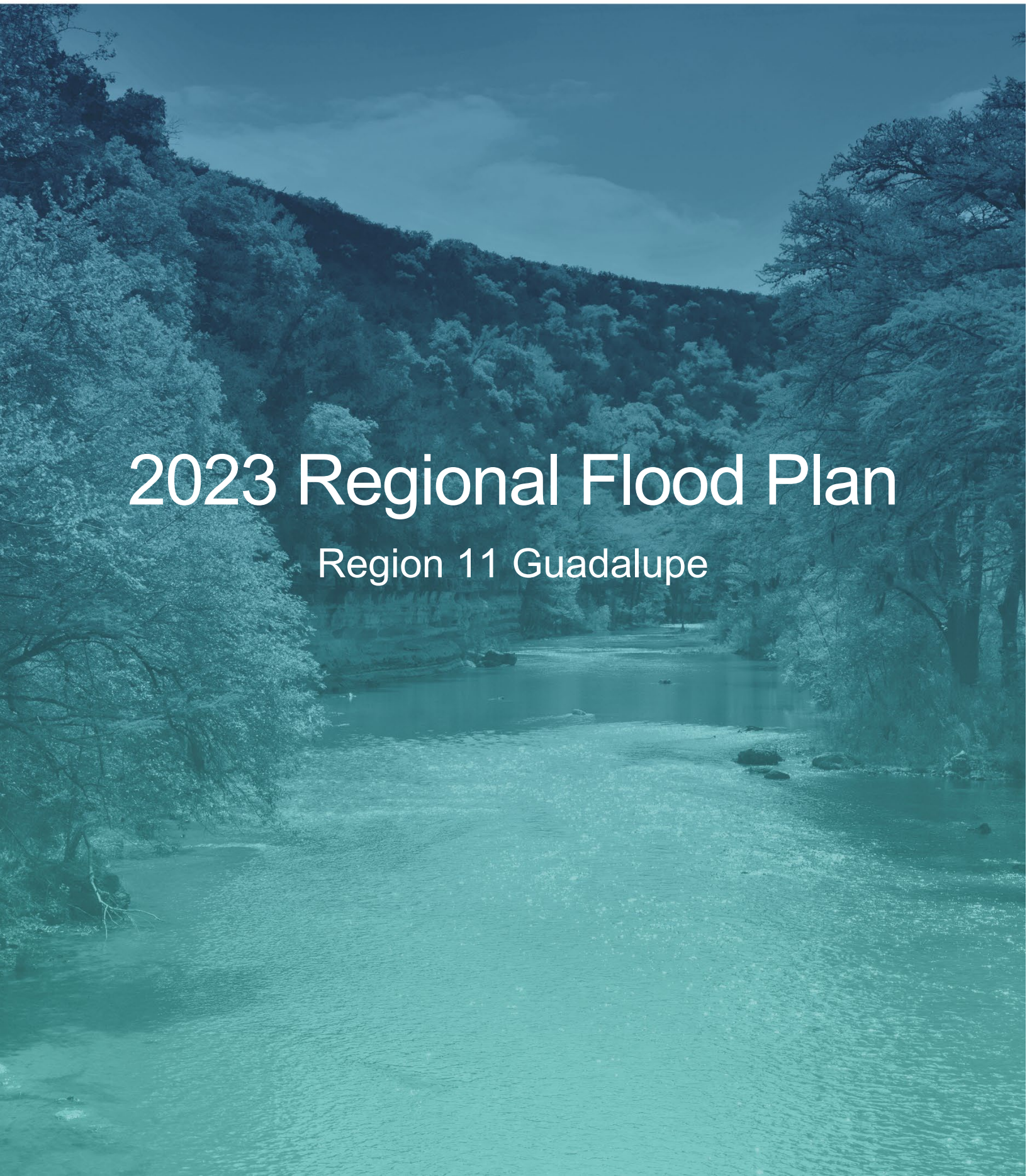
REGION 11 GUADALUPE
REGIONAL FLOOD PLANNING GROUP

Volume 1



2023 Regional Flood Plan

Region 11 Guadalupe

FINAL 2023 REGION 11 REGIONAL FLOOD PLAN

Prepared by:

Region 11 Guadalupe Flood Planning Group

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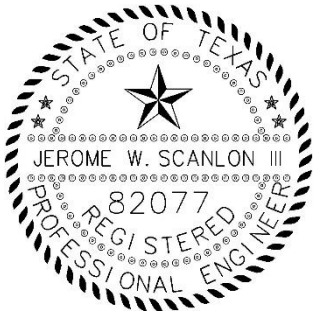

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Acronym	Description
% ACE	Percent of Annual Chance Event
ASDSO	Association of State Dam Safety Officials
BCR	Benefit-Cost Ratio
BFE	Base Flood Elevation
BLE	Base Level Engineering
CDBG-DR	Community Development Block Grant Disaster Recovery
CDBG-MIT	Community Development Block Grant-Mitigation
CIP	Capital Improvement Plan
CRS	Community Rating System
DMP	Drainage Master Plan
EAP	Emergency Action Plan
FAFDS	First American Foundation Data Service
FEMA	Federal Emergency Management Agency
FIF	Flood Infrastructure Fund
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Studies
FMA	Flood Mitigation Assistance
FME	Flood Management Evaluation
FMP	Flood Mitigation Project
FMS	Flood Management Strategy
FPR	Flood Planning Region
GBRA	Guadalupe-Blanco River Authority
GLO	General Land Office
H&H	Hydrologic and Hydraulic Models
HMA	Hazard Mitigation Assistance
HMAP	Hazard Mitigation Action Plans
HMGP	Hazard Mitigation Grant Program
HUC	Hydrologic Unit Code
IA	Individual Assistance
LWC	Low-Water Roadway Crossings
MHI	Median Household Income
MS4	Municipal Separate Storm Sewer System
NFHL	National Flood Hazard Layer

Acronym	Description
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRI	National Resources Institute
NWS	National Weather Service
PA	Public Assistance
PDM	Pre-Disaster Mitigation
PIP	Public Involvement Plan
RFP	Regional Flood Plan
RFPG	Regional Flood Planning Group
RWP	Regional Water Plan
SFHA	Special Flood Hazard Area
SFP	State Flood Plan
SVI	Social Vulnerability Index
SWP	State Water Plan
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
TDEM	Texas Division of Emergency Management
TFMA	Texas Floodplain Management Association
TNRIS	Texas Natural Resources Information System
TPWD	Texas Parks and Wildlife
TPDES	Texas Pollutant Discharge Elimination System
TSSWCB	Texas State Soil and Water Conservation Board
TWC	Texas Water Code
TWDB	Texas Water Development Board
TxDOT	Texas Department of Transportation
UGRA	Upper Guadalupe River Authority
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Service
VPM	Virtual Public Meeting

EXECUTIVE SUMMARY

ES.1 Introduction to the Guadalupe Flood Planning Region

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 11 Guadalupe Regional Flood Plan (RFP), which represents the first-ever regionwide flood plan for the Guadalupe Flood Planning Region (FPR) or Region 11. Region 11 is one of 15 Regional Flood Planning Groups (RFPGs) across the state of Texas tasked with developing a regional flood plan.

The Guadalupe FPR comprises the Guadalupe River and its contributing creeks and streams that flow from the Texas Hill Country as far west as Kerr County into San Antonio Bay. Due to the varying ecoregions and topography, the Guadalupe FPR experiences multiple types of flood risk, including riverine, coastal, and local (urban) flooding. The northern half of the Guadalupe FPR lies within what is known as “Flash Flood Alley.” It is considered one of the most flood-prone areas due to the area’s steep terrain, shallow soil, and unusually high rainfall rates.

The Comal, Blanco, and San Marcos Rivers all feed the Guadalupe River along this region. The adjacent San Antonio River joins the Guadalupe River just before it enters San Antonio Bay and the Gulf of Mexico. Major surface water impoundments, some of which have flood storage, include Canyon Lake, Coleto Creek Reservoir, Lake Dunlap, Lake McQueeney, Lake Placid, Wood Lake, and Lake Gonzales. **Chapter 1** contains an in-depth description of the region.

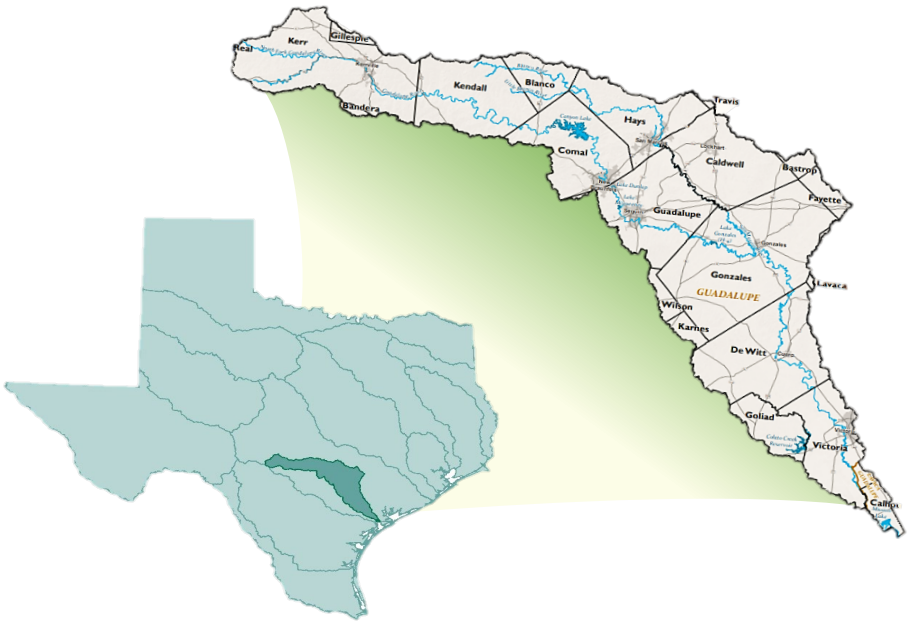


Figure ES-1: Guadalupe Flood Planning Region 11

The Region 11 Guadalupe RFPG is comprised of 15 voting members and 10 non-voting members, volunteers who oversaw and directed the development of this plan. The Guadalupe-Blanco River Authority (GBRA) was selected by the RFPG as the planning group sponsor for Region 11. The RFPG held a public meeting on July 27, 2022, during which they approved the submittal of the Draft Region 11 Guadalupe RFP to TWDB by August 1, 2022. The preliminary draft flood plan was made available to the public on the RFPG's website prior to this meeting. Following the meeting, the consultant team addressed comments received and made necessary revisions before submitting the Draft Regional Flood Plan to TWDB and the public. The draft plan was posted to the RFPG's website and paper copies of the plan were made available at three locations within the region:

- Upper Guadalupe River Authority (UGRA) – 125 Lehmann Drive, Kerrville, TX 78028
- Guadalupe-Blanco River Authority (GBRA) – 933 East Court Street, Seguin, TX 78155
- Victoria Public Library – 302 North Main Street, Victoria, TX 77901

A public hearing was held on September 7, 2022, in Kerrville to present and receive feedback on the draft plan. The public had at least 30 days prior to and 30 days following the public hearing to provide written comments, in addition to providing written and/or oral comments at the public hearing. The RFPG responded and revised the plan, as appropriate, in response to the comments received. The RFPG adopted this Final Regional Flood Plan at their meeting on January 4, 2023, in Seguin, and approved the final plan for submittal to TWDB by January 10, 2023.

ES.2 Chapters Included in the Plan

TWDB developed the scope of work and technical guidelines that adhere to the legislation directing each RFPG to develop its regional flood plan. The plan includes 10 required chapters plus TWDB-required tables and maps. TWDB-required tables and maps are included in various appendices of this plan.

- Chapter 1: (Task 1) Planning Area Description
- Chapter 2: Flood Risk Analyses
    - Task 2A: Existing Condition Flood Risk Analyses
    - Task 2B: Future Condition Flood Risk Analyses
- Chapter 3: Floodplain Management Practices and Flood Protection Goals
    - Task 3A: Evaluation and Recommendations on Floodplain Management Practices
    - Task 3B: Flood Mitigation and Floodplain Management Goals
- Chapter 4: Assessment and Identification of Flood Mitigation Needs
    - Task 4A: Flood Mitigation Needs Analysis
    - Task 4B: Classification of Potential Flood Management Evaluations (FMEs) and Potentially Feasible Flood Management Strategies (FMSs) and Flood Mitigation Projects (FMPs)
- Chapter 5: (Task 5) Recommendation of FMEs, FMSs and Associated FMPs

- Chapter 6: Impact and Contribution of the RFP
    - Task 6A: Impacts of the RFP
    - Task 6B: Contributions to and Impacts on Water Supply Development and the State Water Plan
- Chapter 7: (Task 7) Flood Response Information and Activities
- Chapter 8: (Task 8) Legislative, Administrative, and Regulatory Recommendations
- Chapter 9: (Task 9) Flood Infrastructure Financing Analysis
- Chapter 10: (Task 10) Public Participation and Plan Adoption
- Related Appendices

Please note that Task 4C referred to Technical Memorandum Number 1 and Technical Memorandum Number 2 that were approved by the RFPG and submitted to TWDB in January and March 2022, respectively, to indicate significant progress in the development of this plan. These two memos served as significant milestones in plan development and include outdated information. To reduce confusion, these two memos were not included in the RFP, although much of the content has been incorporated.

The RFPG was responsible for developing this regional flood plan; however, the implementation of specific recommendations and flood mitigation actions included in this plan will require action by local communities in the Guadalupe FPR.

TWDB will merge each of the required tables submitted by all 15 RFPGs to develop the State Flood Plan and corresponding database. TWDB also required specific Geographical Information System (GIS) schema to be submitted electronically as part of this plan. These files were provided directly to TWDB. These files were also shared with the General Land Office (GLO) per TWDB's request to share regional flood data with this state agency that is preparing its own flood mitigation planning along the Texas coast.

ES.3 Key Findings

Flood Risk:

- Though the Guadalupe FPR varies widely in its geographies and characteristics, flood risk is prevalent throughout the region. More than 1,169 square miles of land area (19% of the region) is at risk of flooding, exposing approximately 45,801 buildings, 117,128 people, 3,206 roadway-stream crossings, and 689 square miles of agricultural land to flood risks.
- If current population growth, land development, and flood management practices continue, the amount of land area at risk of flooding is projected to increase by 18% over the next 30 years.

Floodplain Management and Goals:

- A vast majority of communities within the region participate in the National Flood Insurance Program (NFIP) and are required to regulate development within floodplains. However, many communities only adopt minimum flood development standards. Adoption of higher standards and increased enforcement are recommended to avoid increases in future flood risk.
- The RFPG adopted six goals, related to improved low water crossing safety, nature based solutions, adoption of higher floodplain management standards, participation in FEMA's Community Rating System, reduction of structures at flood risk, and increasing local dedicated funding sources for flood-related infrastructure.

Study and Mitigation Needs

- An analysis of flood study and mitigation needs demonstrated that 65% of the Guadalupe FPR has inadequate flood mapping and is in need of updated data and information. The Cities of New Braunfels, San Marcos, Cuero, Gonzales, Victoria, Kerrville and Kyle were identified as those with the greatest known flood risks and mitigation needs; however, there is significant risk across the Guadalupe FPR.

Recommended Flood Projects, Studies, and Strategies

- The RFPG worked with local communities to identify, evaluate, and recommend 138 flood studies (evaluations), 28 flood projects, and 5 regional flood strategies.
- The recommended flood projects would provide for the removal of 1,044 structures from flood risk, protecting approximately 1,566 people, a reduction in flood risk for an additional 9,924 structures, and eliminate or reduce flood risk at 17 low water crossings.
- The flood studies recommended in this plan would provide updated data and information for the region and include planning activities for 95 future flood projects.
- The flood strategies recommended in this plan would advance the region's capabilities and involvement in public outreach, floodplain management, and flood preparedness.

Funding Needs

- This plan identified significant barriers to generating local funding and obtaining available state and federal funds for necessary flood studies and projects.
- Overall, $802,506,951 is required to implement the flood projects, studies, and strategies recommended in this plan, with an estimated $717,406,571 needed from state and federal sources.

Recommendations

- The RFPG recommends a total of 11 legislative, 13 administrative, and 3 regulatory recommendations it considers necessary to facilitate floodplain management and flood mitigation planning and implementation.

ES.4 Existing and Future Flood Risks

Compiling a comprehensive understanding of flood risk as it exists throughout the Guadalupe Flood Planning Region was a critical first step in the creation of this regional flood plan. The current flood risk data served as a keystone in the regional flood planning process upon which many of the subsequent regional flood planning tasks and decisions were based. Proactive planning for flood risk also requires an assessment of how flood risk could be expected to increase in the future. **Chapter 2** presents the findings of the existing condition flood risk analysis and future condition flood risk analysis, based on a no-action scenario of continued development trends, regulations, and population growth during the next 30 years. Flood risks were evaluated for both the 1% annual chance event (ACE) and 0.2% ACE, and incorporated various types and sources of flooding, including riverine, urban, and coastal.

The analyses were performed in three parts:

1. Flood hazard analyses to determine the location, magnitude, and frequency of flooding
2. Flood exposure analyses to identify who and what might be harmed within the region
3. Vulnerability analyses to identify the degree to which communities and critical facilities may be affected by flooding.

Chapter 2 describes in depth the process that was undertaken to determine and quantify flood hazards in the region and presents the results of the hazard, exposure, and vulnerability analyses. **Table ES-1** shows the difference between the flood hazard area under existing and future conditions. **Figure ES-2** shows a region-wide view of the resulting existing flood risks for the 1% and 0.2% ACEs. **Figure ES-3** shows the existing and future condition flood hazard area (square miles) by county.

Population within the Guadalupe FPR is generally projected to continue the high growth rates experienced over the past several decades, with greater concentrations of population expanding outward from the San Antonio and Austin metropolitan statistical areas. The region's population is projected to increase by 62% between 2020 and 2050, with the most significant population increases expected to take place in Bastrop, Hays, Comal, Kendall, Caldwell, and Guadalupe Counties. These are also areas that have historically experienced severe flooding events.

Flooding can impact people, property, critical facilities, infrastructure, agricultural production and more. The flood exposure analysis showed that currently 45,801 buildings, 117,128 people, 3,206 roadway-stream crossings, and 689 square miles of agricultural land are exposed to flood risks. These figures increase significantly under future conditions. **Table ES-2** presents an overview of the existing and future condition flood exposure analysis results. The impacts of

flooding on socially vulnerable populations and a community's ability to recover were also assessed in **Chapter 2**.

Table ES-1: Existing and Future Conditions Flood Hazard Area Comparison

	Flood Hazard Area (in square miles)		
Flood Hazard Frequency	**Existing**	**Future**	**Change (%)**
1%	986	1,169	18.6%
0.2%	183	215	17.5%
Total	1,169	1,384	18.4%

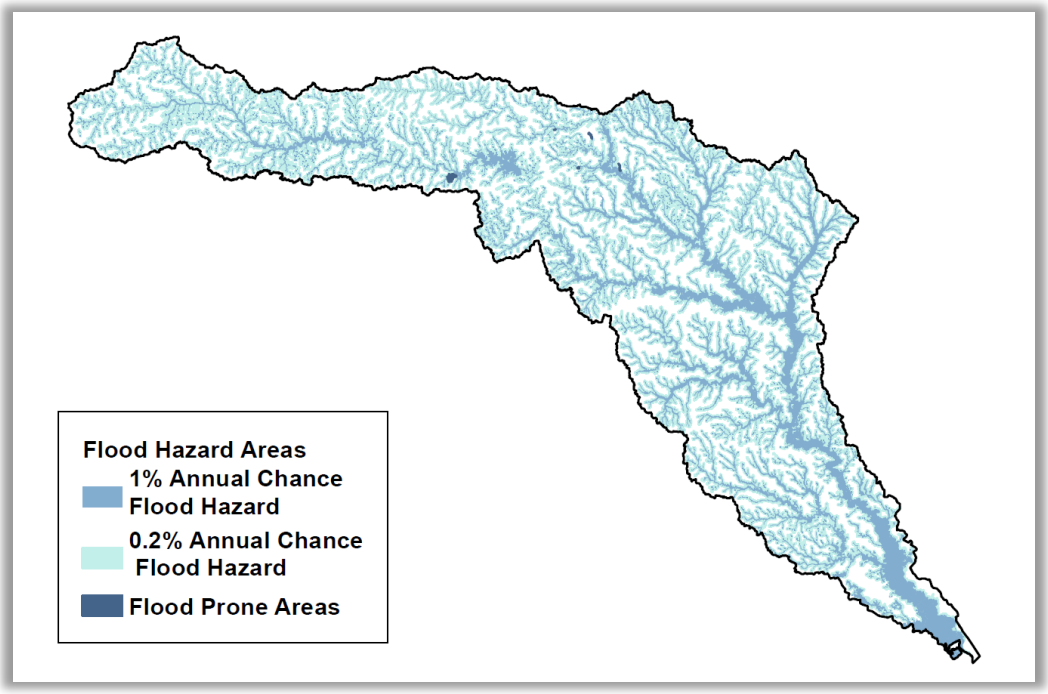


Figure ES-2: Existing Conditions Flood Hazard Areas Overview

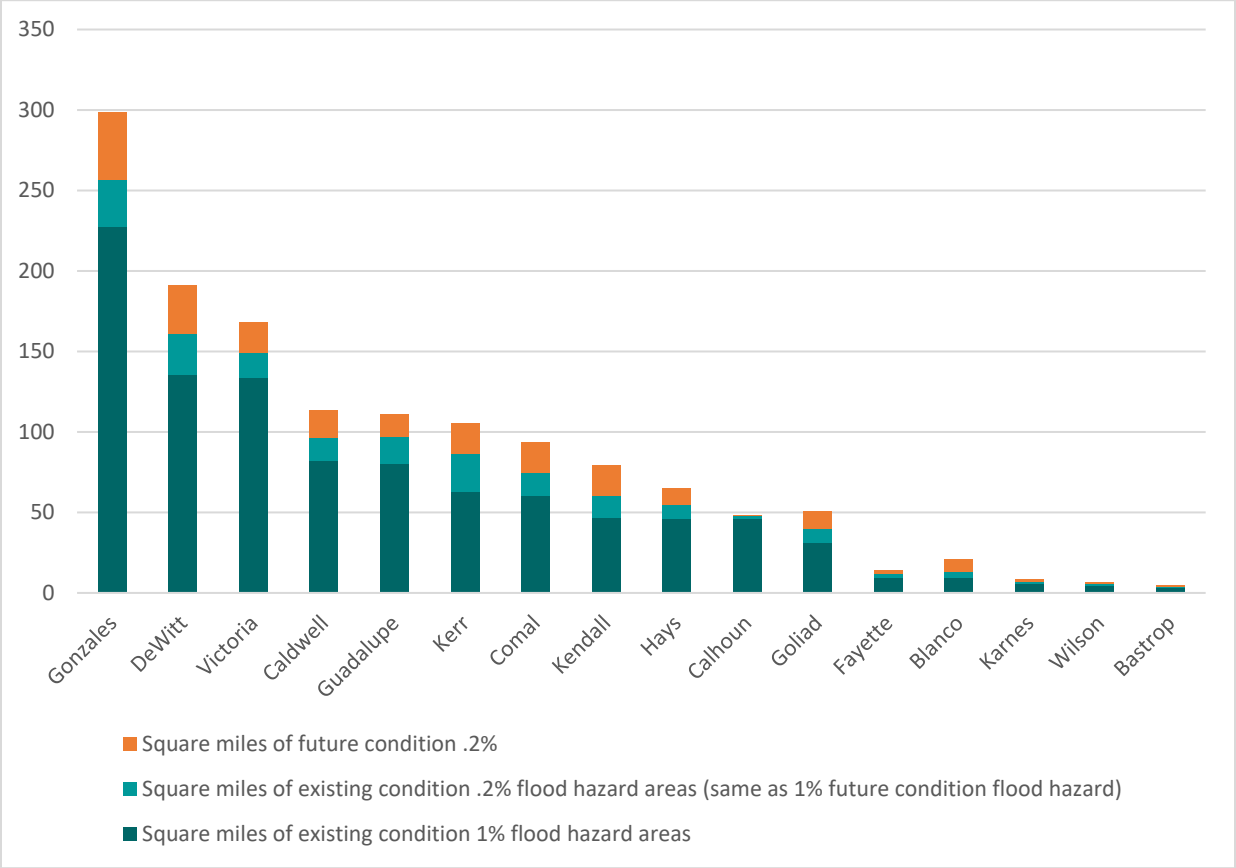


Figure ES-3: Flood Hazard Area by County

Table ES-2: Flood Exposure Results

Exposure Feature Type	TOTAL EXISTING	TOTAL FUTURE	% INCREASE
Total Structures	45,801	71,501	56.1%
Structures: Residential	32,102	53,016	65.1%
Structures: Non Residential	13,699	18,485	34.9%
Critical Facilities	222	310	39.6%
Roadway Stream Crossings (count)	3,206	3,546	10.6%
Roadway Stream Crossings (miles)	1,379.5	1,795.2	30.1%
Agricultural Land (sq miles)	689.6	808	17.2%
Population	117,128	191,176	63.2%

ES.5 Floodplain Management Practices and Flood Protection Goals

Floodplain management, land use, infrastructure design, and other practices play a key role in preventing future increases in flood risk. **Chapter 3** presents a qualitative assessment of current floodplain management practices in the region and recommendations for improvement. Although most of the communities within the Guadalupe FPR participate in FEMA's National Flood Insurance Program (NFIP), which requires participating communities to adopt floodplain management regulations to ensure new development is reasonably safe from flooding, the RFPG considers that many of the communities only adopt minimum flood development standards and are not proactive in their approach to floodplain development. In addition, many entities at the county level are not aware of their authority to implement floodplain development standards higher than NFIP minimums. The RFPG concludes that communities could enhance their policies to minimize the potential of additional flood risks in the future.

The RFPG is tasked with defining and adopting flood mitigation and floodplain management goals for the region that are specific, achievable, and, when implemented, will demonstrate progress toward the overarching goal set by the state of protecting against the loss of life and property. The RFPG's selected goals guided the development and recommendation of the FMEs, FMSs, and FMPs for the planning region, as discussed in **Chapters 4 and 5**.

Each goal has a short-term (10 year) and long-term (30 year) component. **Table ES-3** presents the goals adopted by the Guadalupe RFPG for this plan. For a deeper understanding of the RFPG's recommended practices and goals, see **Chapter 3**.

Table ES-3: Adopted Flood Mitigation and Floodplain Management Goals

Short Term (10 year)	Long Term (30 year)
Improve safety beyond minimal signage at 35% of low-water crossings through automatic flood warning gates and/or flood level passed.	Improve safety beyond minimal signage at 90% of low-water crossings through automatic flood warning gates and/or flood level passed.
Consider incorporating nature-based practices when acreage exceeds one acre (low-impact development [LID], green infrastructure, natural channel design) in 30% of FMPs and FMSs recommended in the RFP.	Consider incorporating nature-based practices when acreage exceeds one acre (LID, green infrastructure, natural channel design) in 100% of FMPs and FMSs recommended in the RFP.
Increase adoption of higher standards to 30% of communities in high-growth counties. Communities = cities and counties High-growth county is considered greater than 50% population growth in 30 years	Increase adoption of higher standards to 70% of communities in high-growth counties. Communities = cities and counties High-growth county is considered greater than 50% population growth in 30 years

Short Term (10 year)	Long Term (30 year)
Increase high-growth community CRS participation to 50% of all high-growth communities. High-growth communities – cities with a population greater than 10,000 people in 2030	Increase high-growth community CRS participation to 75% of all high-growth communities. High-growth communities – cities with a population greater than 10,000 people in 2030
Reduce number of vulnerable buildings/structures/critical facilities within the 1% existing flood hazard layer by 20%.	Reduce number of vulnerable buildings/structures/critical facilities within the 1% existing flood hazard layer by 50%.
Increase percentage of communities with dedicated funding sources for operations and maintenance and implementation of storm drainage systems to 35% of communities.	Increase percentage of communities with dedicated funding sources for operations and maintenance and implementation of storm drainage system to 60% of communities.

ES.6 Assessment and Identification of Flood Mitigation Needs

The RFPG conducted a flood mitigation needs analysis to identify the areas with the greatest gaps in flood risk knowledge and the areas of greatest known flood risk and mitigation needs. This big-picture assessment helped guide the subsequent efforts of identifying FMEs, FMSs, and FMPs. The analysis considered a variety of criteria, including flood risk exposure to buildings, low-water crossings, critical infrastructure, agricultural areas, and other resources; NFIP participation; gaps in flood mapping information; lack of hydrologic and hydraulic models; existing flood risk mitigation plans; flood mitigation projects previously identified; historic flooding reports; and social vulnerability of communities. The Cities of New Braunfels, San Marcos, Cuero, Gonzales, Victoria, Kerrville and Kyle were identified as those with the greatest known flood risks and mitigation needs; however, there is significant risk across the Guadalupe FPR. Approximately 65% of the Guadalupe FPR has inadequate flood mapping and was identified as having significant gaps in flood risk information. These areas are in need of updated data and information to accurately depict flood risk. For more information, see **Chapter 4**.

ES.7 Identification and Selection of Recommended Floodplain Management and Flood Mitigation Actions

To address the identified flood risks in the Guadalupe FPR, the RFPG identified and evaluated FMEs, FMSs, and FMPs. FMEs consist of watershed studies or additional evaluations needed to determine the viability of a project. FMPs are structural or non-structural projects to mitigate flood risk. The FMS category is intended to capture other types of solutions, such as ordinances,

flood early warning systems, and more. **Figure ES-4** illustrates the screening process used by the RFPG's consultant team to confirm that potential actions had been sorted into their appropriate category.

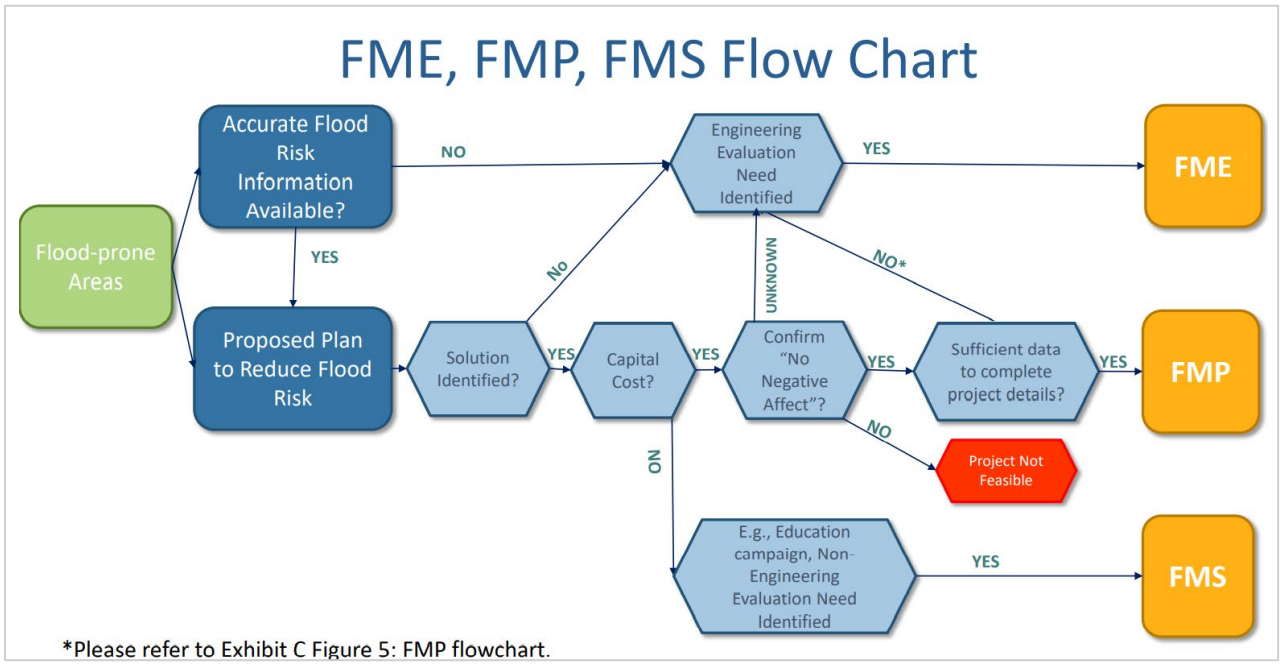


Figure ES-4: Potential Flood Risk Reduction Action Screening Process

Source: TWDB

The Guadalupe RFPG opted to take an inclusive approach to the evaluation and recommendation process. If an FME, FMS, or FMP met TWDB requirements, was aligned with the Guadalupe FPR's flood mitigation and floodplain management goals, and seemed reasonable, the planning group included it in the regional plan. A summary of the FMEs, FMSs, and FMPs recommended in this regional flood plan is found in **Table ES-4**, **Table ES-5**, and **Table ES-6**. For more detailed information about each individual action, see **Chapter 5**. In total, the RFPG worked with local communities to identify, evaluate, and recommend 138 flood studies (evaluations), 28 flood projects, and 5 regional flood strategies.

The Guadalupe RFPG evaluated the overall impacts of the Regional Flood Plan, not only to areas at risk of flooding, structures and populations in the floodplain and number of low water crossings, but also water supply, the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation. The recommended flood projects would provide for the removal of 1,044 structures from flood risk, protecting approximately 1,566 people, provide for a reduction in flood risk for an additional 9,924 structures, and eliminate or reduce flood risk at 17 low water crossings. The flood studies recommended in this plan would provide updated data and information for the region and include planning activities for 95 future flood projects. The flood strategies recommended in this plan would advance the region's capabilities and involvement in public outreach, floodplain management, and flood preparedness. There are no known negative impacts from any of the recommended flood risk

reduction actions on any of these areas. For more detailed information on the impact and contribution of this Regional Flood Plan, see **Chapter 6**.

Table ES-4: Summary of FME Types

FME Type		Description	Number
Watershed Planning	Drainage master plans, other community-scale plans	Supports the development and analysis of H&H models to evaluate flood risk within a given jurisdiction, evaluates potential alternatives to mitigate flood risk, and develops CIPs.	21
	H&H modeling, regional watershed studies	Supports the development and analysis of H&H models to define flood risk or identify flood-prone areas OR large-scale studies that are likely to benefit multiple jurisdictions.	12
	Flood mapping updates	Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Creates FEMA mapping in previously unmapped areas and updates existing FEMA maps as needed.	3
Project Planning	Engineering project planning	Evaluates a proposed project to determine whether implementation would be feasible; OR provides initial engineering assessment, including conceptual design, alternative analysis, and up to 30% engineering design.	95
Preparedness	Studies on Flood Preparedness	Encourages preemptive evaluations and strategies to better prepare an area in the event of flood.	7

Table ES-5: Summary of FMP Types

FMP Type	General Description	Number of FMPs Recommended
Stormwater Infrastructure Improvements	Improvements to stormwater infrastructure, including channels, ditches, ponds, and stormwater pipes	7
Roadway Drainage Improvements	Improvements to roadway drainage infrastructure, including side ditches, culvert crossings, and bridge crossings	5
Regional Detention Facilities	Runoff control and management via detention facilities	9
Property Acquisition	Voluntary acquisition of flood-prone structures	1
Flood Warning Systems	Installation of gauges, sensors, or barricades to monitor streams and low-water crossings for potential flooding and to support emergency response	2
Emergency Generators	Purchasing and installing emergency generators at critical facilities	4

Table ES-6: Summary of FMS Types

FMS Type	General Description	Number of FMSs Recommended
Education and Outreach	Activities not limited to implementing/improving flood education and awareness programs for residents, elected officials, and real estate agents/developers; and flood insurance campaigns to reduce flood risk and increase NFIP participation.	1
Flood Measurement and Warning	Develop or implement programs to increase flood warning including reverse 911 systems; evacuation/emergency management plans and personnel training; NOAA all-hazards radios, and programs to increase safety at low water crossings (signs, flashers, gages)	1
Infrastructure Projects	Develop programs to preserve system functionality (storm drains, culverts, bridges); enhance riparian corridors & preserve floodplain capacity: and infrastructure improvements programs that identify and prioritize flood risk reduction projects	1
Property Acquisition and Structural Elevation	Develop and implement a voluntary buyout or structural elevation assistance programs to eliminate repetitive loss structures and implementing programs to purchase/preserve open space to protect riparian corridors.	1
Regulatory and Guidance	Regularly review and update floodplain ordnances, land use/zoning, development criteria, and enforcement. Develop and implement higher standards, green infrastructure program, and use best available data (eg. BLE) to manage floodplains	1

ES.8 Legislative, Administrative, and Regulatory Recommendations

This planning process provides an opportunity for the RFPG to make recommendations to the state of Texas to improve floodplain management and mitigation within the region. The RFPG recommends a total of 11 legislative, 13 administrative, and 3 regulatory recommendations, which are summarized in Tables **ES-7, ES-8,** and **ES-9**. Additional explanation and rationale for each recommendation is included in **Chapter 8**.

Table ES-7: Legislative Recommendations

ID Number	Recommendation
8.1.1	Continue recurring biennial appropriations to Flood Infrastructure Fund (FIF) for Study, Strategy, and Project implementation.
8.1.2	State adoption of higher flood standards, for example, establish a minimum floor elevation two feet above the base flood elevation to account for potential changes in future rainfall depths and flood elevations. Enact legislation updating the state building code to a more recent edition (e.g., the 2018 edition of the International Building Code and International Residential Code).
8.1.3	Promote, develop and allocate State funding to assist dam owners (public and private) with the costs associated with repair and maintenance of dams
8.1.4	Expand the ongoing program and funding to enhance flood early warning system implementation on a regional basis (especially in rural areas)
8.1.5	Provide guidance and funding for "buy out" programs to remove repetitive loss structures and potentially convert flood prone neighborhoods into green space/parkland as an alternative to large-scale construction projects. Importantly, funding should consider factors other than benefit-to-cost ratio (BCR). Funding should continue and be expanded for both pre- and post-disaster buyout programs.
8.1.6	Continue and expand funding to improve safety at low water crossings through structural improvements and/or flood warning systems or other enhanced safety measures.
8.1.7	Provide counties with the authority to require commercial outfitters, landowners, and parks to safely park recreational vehicles and recreational equipment outside of the floodplain. Develop and promote educational materials such as flood warning or evacuation planning to help guide businesses and parks.
8.1.8	Provide funding to increase the number of conservation easements for riparian areas and land in the 100-year floodplains.
8.1.9	Modify the enabling legislation for Green DeWitt Drainage District to allow them expand to watershed boundaries rather than political (Municipal or County) boundaries.
8.1.10	Modify CDBG-MIT funding rules to eliminate the need for an eligible recipient to sign a waiver to allow funding to pass down to sub-recipients if those sub-recipients are also eligible for funding.
8.1.11	Clarify existing legislation (perhaps through issuing guidance or administrative rule) that provides counties the authority to regulate floodplains to regulate floodplains including development of land use plans and regulatory authorities such as permitting.

Table ES-8: Administrative Recommendations

ID Number	Recommendation
8.2.1	Develop model ordinances for general law cities (building codes, Low Impact Design/Development, Green Infrastructure, other)
8.2.2	Continue and expand funding to support ongoing education/ training regarding floodplain management
8.2.3	Modify the selection process for flood projects so that project selection is not scored or awarded only on a traditional benefit-cost ratio
8.2.4	Continue and increase funding and/or technical assistance to develop updated floodplain maps
8.2.5	Develop a statewide database and tracking system to document flood-related fatalities and provide a public website/dashboard that conveys map-based statistical information regarding these fatalities
8.2.6	Continue and increase funding for stream monitoring at high-risk flood prone areas.
8.2.7	Provide incentives to local governments to participate in the FEMA Community Rating System (CRS) program.
8.2.8	TWDB, TFMA, river authorities, and local governments should provide Green Infrastructure training to agencies, local governments, engineers, planners and encourage this practice in flood mitigation efforts.
8.2.9	TWDB Flood Infrastructure Fund (FIF) project selection process should place additional emphasis on social vulnerability, sustainability, environmental resilience, etc. in addition to benefit cost analysis to guide the funding and implementation of multi-dimensional projects that can provide water supply and other benefits beyond flood mitigation.
8.2.10	TWDB/TFMA or others should develop a riparian management guidance document that addresses vegetation management purpose, timing, and location within the floodplain and floodway
8.2.11	Encourage counties to exercise their existing authority to manage new and existing development, and fund projects to mitigate existing flooding.
8.2.12	Encourage communities to work together to enhance program/project efforts to improve funding and implementation opportunities
8.2.13	TWDB should work with FEMA and other regulatory agencies to develop a more effective way to measure/calculate flood damages including the number of structures, and financial cost of damages.

Table ES-9: Regulatory Recommendations

ID Number	Recommendation
8.3.1	TxDOT design criteria should include stormwater detention requirements to not increase downstream flooding from new highway projects
8.3.2	Statewide detention and/or verification of no downstream impact from new development for design storms ranging from the 2-year to the 100-year storm
8.3.3	State should provide guidance and/or authority to local governments to manage proposed RV parks in the floodplain

ES.9 Cost of the Draft Plan

TWDB requires that each RFPG assess and report on how sponsors propose to finance recommended FMEs, FMSs, and FMPs. A primary aim of this survey effort is to understand the funding needs of local sponsors and propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs. **Overall, there is an estimated $802,506,951 required to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. Of that amount, approximately $717,406,571 in state and federal funding is projected to be needed (89.4%).** 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, recommended 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 Guadalupe FPR.

Overall, a combination of increased local capabilities to self-fund flood-related activities and projects and increased funding from state and federal sources are needed to address the flood risk reduction needs identified through this regional planning process and documented in this plan.

ES.10 Public Participation and Outreach

The Guadalupe RFPG made a commitment to develop the 2023 Guadalupe RFP through a transparent process in which public input and participation is welcomed and encouraged. The technical consultant team prepared a Public Involvement Plan (PIP) for the RFPG to supplement the legally required efforts with opportunities to encourage and obtain meaningful public and stakeholder input throughout the planning process. The Guadalupe RFPG encouraged public input and comment in a manner that exceeded the requirements in state laws and regional flood planning rules. Highlights of the public involvement and outreach strategies employed are listed below. Some are described further below, and all are described in detail in **Chapter 10**.

- Development of a Public Involvement Plan (PIP)
- Development of an extensive public and stakeholder contact list.

- Development and implementation of an interactive mapping tool to place on the Guadalupe RFPG website to gather information about flood-prone areas and existing flood management efforts using forms and surveys.
- Identification and evaluation of opportunities to enhance available information on the Guadalupe RFPG website.
- Use of social media accounts to post messages about upcoming Guadalupe RFPG meetings and activities.
- Development and implementation of a Virtual Public Meeting (VPM) tool to supplement the second in-person Guadalupe RFPG pre-planning meeting.
- Routine review and reporting of all public comments received through either the Guadalupe RFPG website or the Guadalupe RFPG email account.

The public and stakeholder involvement efforts emphasized two-way communication between the public and stakeholders and the Guadalupe RFPG. The Guadalupe RFPG maintained proactive communication and information dissemination during the planning process so that the public and stakeholders were informed and provided a process for how they could provide input, share data, or have their comments, questions, or concerns addressed.

The Guadalupe RFPG held regular monthly meetings during the timeframe of 2020 – 2023. These meetings included presentation of materials, discussions, deliberations, voting on specific measures, and public comment. **Chapter 10** provides a summary of all the Guadalupe RFPG public meetings, which includes regular meetings and executive committee meetings. **Photos ES-1, ES-2, and ES-3** depict some of the RFPG's meetings.

Photo ES-1: August 4, 2021,
Pre-Planning Meeting,
Wimberley, Texas.

Photo ES-2: May 10, 2022
Regular Guadalupe RFPG Meeting
Seguin, Texas.

Photo ES-3: June 27, 2022,
Regular Guadalupe RFPG Meeting,
Seguin, Texas.

Chapter 1: Planning Area Description

1.1 Introduction – The Regional Flood Plan in Context

1.1.1 Overview of Establishing Legislation

In Texas, the billion-dollar disaster is becoming a typical occurrence. Flooding caused almost $5 billion in damages to Texas communities between 2015 and 2017. As the state grappled with how to better manage flood risk and decrease the loss of life and property from future disasters, the 85th Texas Legislature directed the Texas Water Development Board (TWDB) to develop the state's first flood assessment. After extensive stakeholder involvement, TWDB published the State Flood Assessment in 2019. The assessment described Texas' flood risks and provided an estimate of potential flood mitigation costs and a summary of stakeholder views on the future of flood planning. This assessment was created because:

- Flood risks, impacts, and mitigation costs had never been assessed at a statewide level.
- Flood risks pose a danger to lives and livelihoods.
- Much of Texas is unmapped or uses outdated maps (Lake, 2019).

Later in 2019, the Legislature adopted changes to Texas Water Code §16.061 through Senate Bill 8, which established a regional and state flood planning process led by TWDB. The legislation provided funding to improve the State's floodplain mapping efforts and to develop regional plans to mitigate the impact of future flooding. A mandate required TWDB to facilitate the creation of regional flood planning groups (RFPG) for each of the state's 15 major river basins. The groups were tasked with developing regional flood plans by January 10, 2023. Updates are required every five years thereafter (TWDB Flood Planning Frequently Asked Questions, 2021). The overarching intent of the plans is to document strategies and projects that:

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

1.1.2 Overview of the Planning Process

The regional flood planning process follows a similar region-driven "bottom-up" approach that has been used for water supply planning in Texas for the past 20 years. Fifteen flood planning regions have been established based on river basins. The first regional flood plans will be delivered from RFPGs to TWDB by January 10, 2023. TWDB will combine the regional flood plans into a single State Flood Plan to be delivered to the Legislature by September 1, 2024.

Who Prepared the Plan?

TWDB established RFPGs for each region and provided them with the funds necessary to prepare their plans. TWDB administers each regional planning process through a contract with a planning group sponsor, chosen by the RFPG for their significant role within the river basin. The sponsor provides support for meetings and communications and manage the contract of the technical consultant, once determined by the RFPG. The Guadalupe-Blanco River Authority (GBRA) was selected as the planning group sponsor for Region 11. Freese and Nichols, Inc. was selected by the RFPG to be the technical consultant to assist with the development of the Guadalupe Regional Flood Plan (RFP).

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

- Agriculture
- Industry
- Small businesses
- Counties
- Municipalities
- Water districts
- Electric generation utilities
- The public
- Flood districts
- Water utilities
- Environmental interests
- River authorities

The RFPG also includes seven non-voting members from the following state agencies: Texas Commission on Environmental Quality, General Land Office, Parks and Wildlife Department, Department of Agriculture, State Soil and Water Conservation Board, Texas Division of Emergency Management, and a dedicated TWDB Planner who provides ongoing support to the group. Liaisons from neighboring Region 10 Lower-Colorado Lavaca and Region 12 San Antonio RFPGs also represent their respective groups on the Guadalupe RFPG.

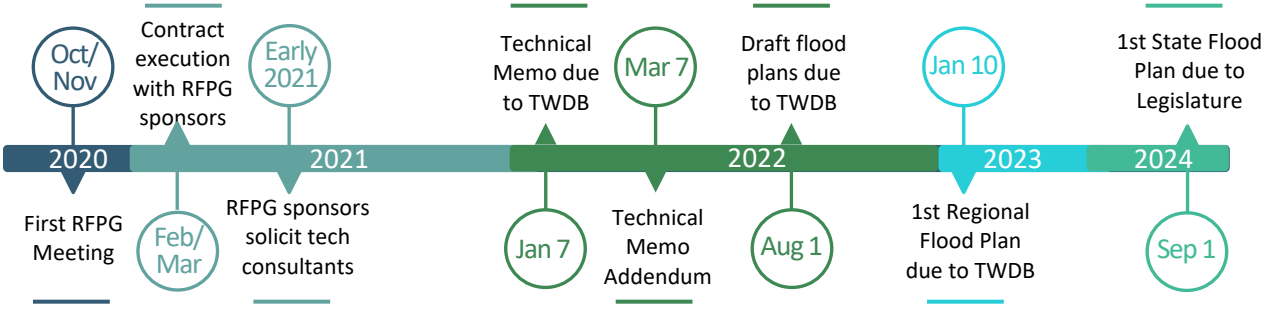


Figure 1-1: Regional Flood Plan Timeline

1.1.3 Funding Sources

The Legislature created a new flood financial assistance fund to fund projects identified by these plans and charged TWDB with managing it. The Texas Infrastructure Resiliency Fund, as approved by Texas voters in November 2019, is being used to finance the preparation of these plans and will also be used to finance flood-related implementation projects. Projects, studies, and strategies recommended in this regional flood plan will be eligible for financial assistance in the form of Flood Infrastructure Fund (FIF) loans and grants from TWDB.

1.2 Characterization – The Guadalupe Flood Planning Region

The Guadalupe Flood Planning Region (FPR) (Region 11) comprises the Guadalupe River and its contributing creeks and streams that flow from the Texas Hill Country as far west as Kerr County into San Antonio Bay. The Comal, Blanco, and San Marcos Rivers all feed the Guadalupe along this region. The adjacent San Antonio River joins the Guadalupe just before it enters San Antonio Bay and the Gulf of Mexico. Major surface water impoundments, some of which have flood storage, include Canyon Lake, Coleto Creek Reservoir, Lake Dunlap, Lake McQueeney, Lake Placid, Wood Lake, and Lake Gonzales. There are also several smaller impoundments in the upper basin that have an impact on flood storage as well.

The northern half of the Guadalupe FPR lies within what is known as “Flash Flood Alley.” It is considered one of the most flood-prone areas due to the area’s steep terrain, shallow soil, and

unusually high rainfall rates. Additionally, the karst terrain associated with the Trinity and Edwards Aquifers is sensitive to increases in impervious cover. Flash flood events can occur throughout the year but are most common during the spring and fall. Much of the Guadalupe FPR, particularly the lower coastal areas, are exposed to tropical storms and hurricanes with flooding caused by heavy areawide rainfall and coastal storm surge.

The Guadalupe FPR has a population of 618,874 people, with approximately 40% of the population coming from the San Marcos Hydrologic Unit Code (HUC) 8 watershed (U.S. Census Bureau, 2020). The Guadalupe FPR's population is projected to increase by 62% by 2050. In terms of land use, much of the Guadalupe FPR is rural with small- and medium-sized towns and cities interspersed throughout. The Guadalupe FPR is also home to several public agencies with flood control and drainage responsibilities, including the Guadalupe-Blanco River Authority (GBRA), Upper Guadalupe River Authority (UGRA), water conservation districts, utility districts, and drainage districts.

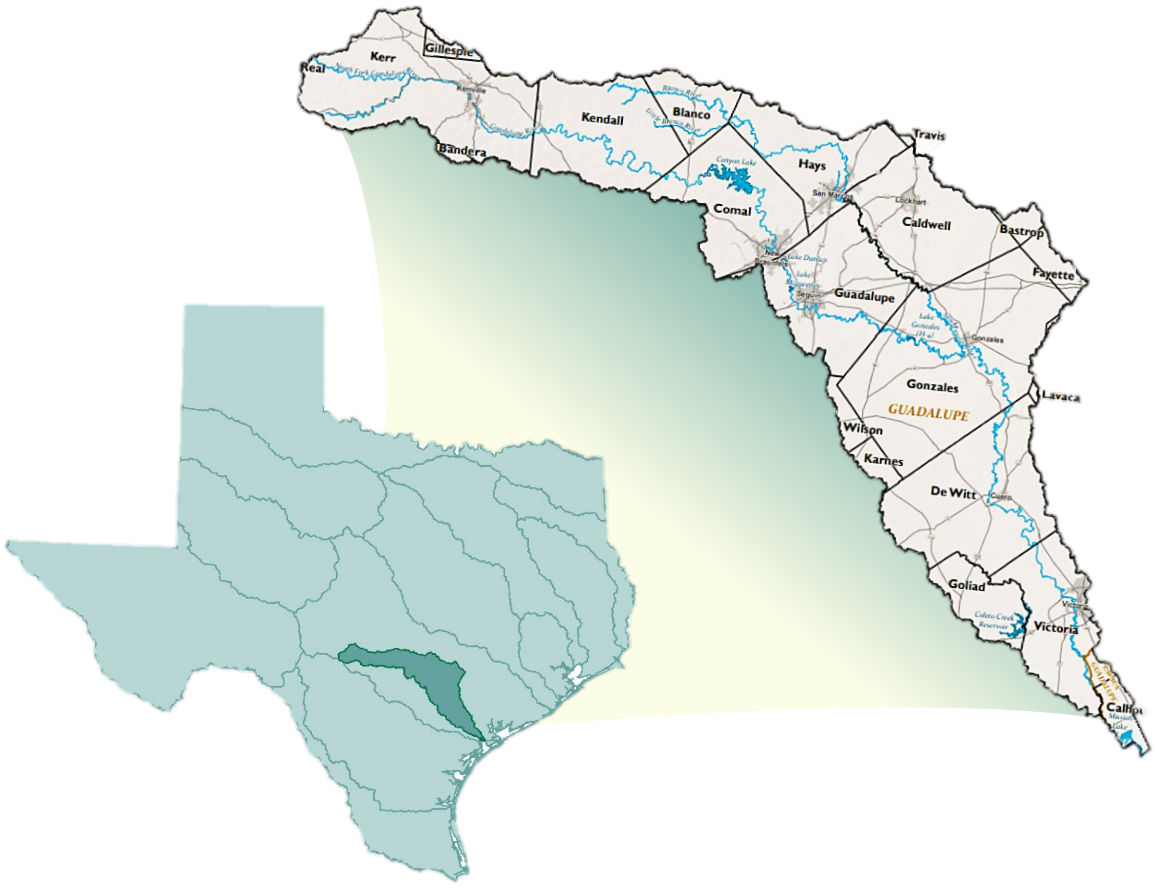


Figure 1-2: Guadalupe Flood Planning Region 11

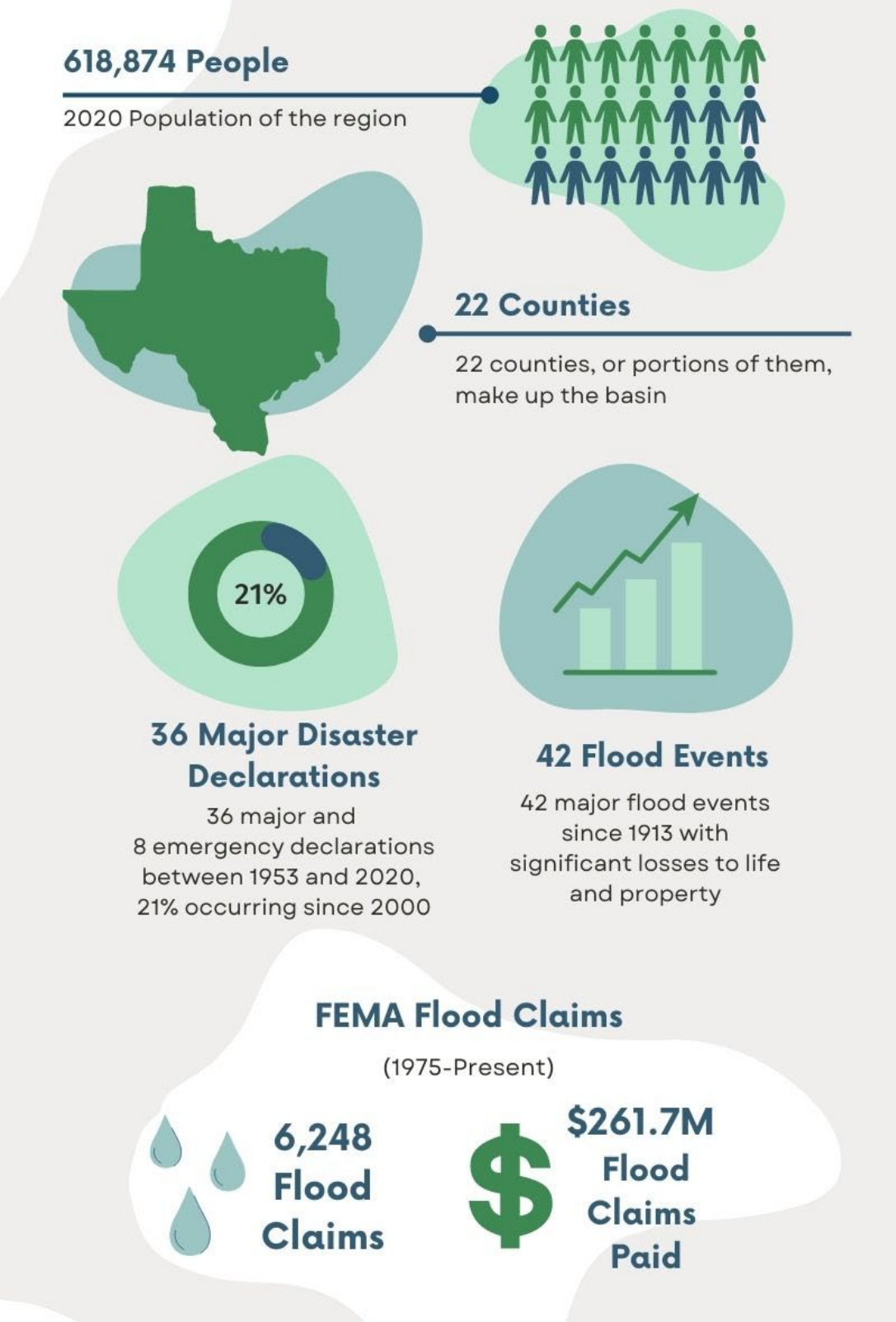


Figure 1-3: Region 11 Quick Facts

1.2.1 Social and Economic Character

Many communities in the Guadalupe FPR are near river corridors or tributary waterways, and this access to water has likely enhanced economic growth and development in these areas for centuries. However, living and working close to water also brings its share of risks, such as loss of life and property through flooding from hurricanes, storm surges, flash flooding, and heavy rainfall. Flooding is one of the most common natural disasters in Texas and, in some cases, it can be deadly and costly. Severe flooding can endanger public health, disrupt businesses, and intensify existing inequalities. In addition to the devastating effects on individuals and communities, flooding also strains financial resources and impacts economies.

As land use continues to change from rural to urban and population density increases in outwardly expanding metropolitan areas, there will be a greater need for adequate flood control systems. Flood risk and exposure may increase in certain areas with higher vulnerability for impacts during flood events and disasters—especially as open space is replaced by impervious surfaces, leading to decreased absorption of precipitation. These areas will experience an increasing need to develop strategies for investing in flood-resilient infrastructure. With the new statewide flood planning process in Texas, communities are able to work with local, state, and federal government agencies to build flood-resilient infrastructure that can also directly benefit their local economies.

To evaluate the potential economic risk from flood events in the Guadalupe FPR, it is important to identify the economic sectors with the highest potential for flood impacts. Industries like healthcare and social assistance, professional technical services and other services, and retail have a large footprint in the Guadalupe FPR.

The Guadalupe FPR encompasses an area of 6,030 square miles across 22 counties. It is important to note that the river basins do not conform to county boundaries. As a result, all 22 counties in the Guadalupe FPR lie partially within the Guadalupe FPR and partially within other flood planning regions (**Table 1-1**).

Table 1-1: Region 11 Counties

Region 11 Counties					
Bandera*	Blanco*	Bastrop*	Caldwell*	Calhoun*	Comal*
DeWitt*	Fayette*	Gillespie*	Goliad*	Gonzales*	Guadalupe*
Hays*	Karnes*	Kendall*	Kerr*	Lavaca*	
Real*	Refugio*	Travis*	Victoria*	Wilson*	

**Indicates this county is partially within this flood planning region and is represented by at least one other flood planning region.*

Source: Texas Water Development Board - Flood Data Hub. February 2022.

Current Population

Texas is the second-most populous state in the United States, with a population exceeding 29 million residents (U.S. Census Bureau). The Guadalupe FPR consists of subregions, both urban and rural, with diverse economic industries and land uses. Hays County, Comal County, and Guadalupe County are at the center of the Guadalupe FPR and are home to rapidly growing IH 35 and IH 10 corridor cities, such as New Braunfels, San Marcos, and Seguin. The Guadalupe FPR is situated in between the two major metropolitan areas of San Antonio, population 1,434,625, and Austin, population 961,855 (U.S. Census Bureau), which continue to grow as significant economic hubs for Texas. It is projected that the central portion of the Guadalupe FPR will continue to accommodate growth and urban infrastructure as the population and economies of the major metropolitan statistical areas (Austin, San Antonio) continue to expand.

The current population for the Guadalupe FPR is 618,874 people, which is approximately 2.1% of the total population of Texas (U.S. Census Bureau 2020). The northwestern portion of the Guadalupe FPR consists of the Texas Hill Country eco-region, with a geography that is characterized by sparsely populated rural small towns, as indicated in **Figure 1-4** and **Figure 1-5**. In the central portion of the Guadalupe FPR, Hays County and Comal County have larger populations growing at a faster rate than the surrounding counties in the Guadalupe FPR. The southeastern portion of the Guadalupe FPR consists of Post Oak Savannah and Gulf Coast Prairie eco-regions, with geography characterized by smaller population centers embodied within rural counties.

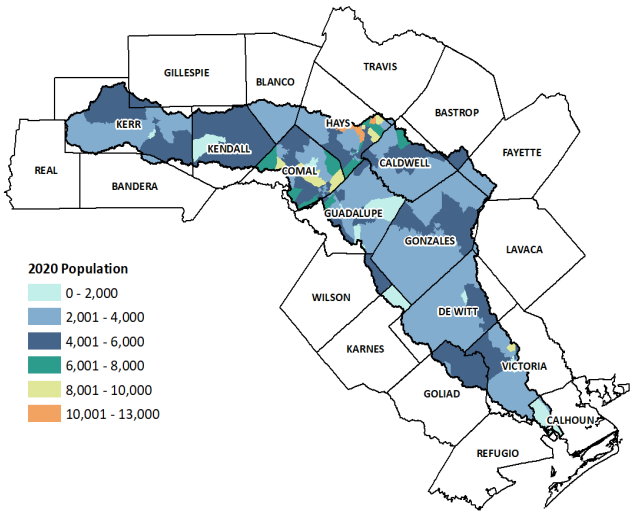


Figure 1-4: 2020 Population by Census

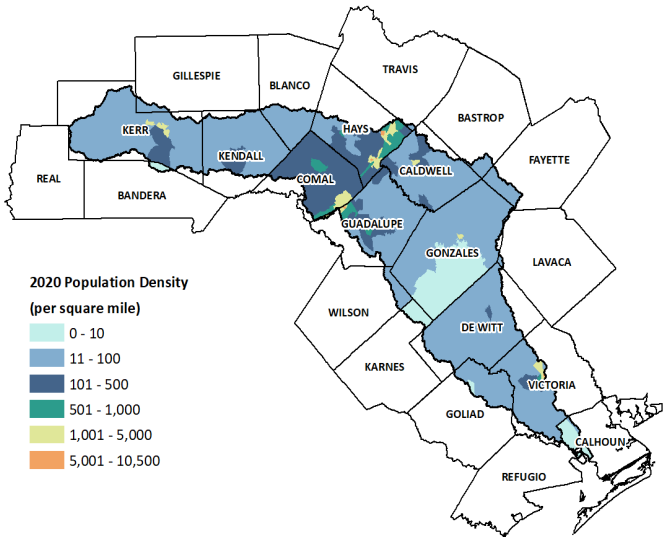


Figure 1-5: 2020 Population Density by Census

Source: U.S. Census Bureau 2020

Table 1-2: Population Ranges in Cities

Population Ranges in Region 11	
2020 Population Range	**Number of Cities**
50,001 – 100,000	3
10,001 – 50,000	7
100 – 10,000	31

Most of the 41 cities that are primarily within the Guadalupe FPR fall within a population range of 100 to 10,000 people, which is characteristic of rural or transitioning rural areas. **Table 1-3** shows the 20 most populated cities in the Guadalupe FPR. The 2020 population represents each city's entire population, not just the population found within the Guadalupe FPR. The city with the largest population in the northwestern portion of the Guadalupe FPR is Kerrville (Kerr County, 24,278). New Braunfels (Comal County, 90,403) is the city with the largest population in the central portion of the Guadalupe FPR, and Victoria (Victoria County, 65,534) is the city with the largest population in the southeastern portion of the Guadalupe FPR (U.S. Census Bureau 2020).

Table 1-3: Most Populated Cities in Guadalupe Flood Planning Region

	City	2020 Population		City	2020 Population
1	New Braunfels	90,403	11	Cuero	8,128
2	San Marcos	67,553	12	Gonzales	7,165
3	Victoria	65,534	13	Luling	5,599
4	Kyle	45,697	14	Garden Ridge	4,186
5	Schertz	42,002	15	Redwood	4,003
6	Canyon Lake	31,124	16	Wimberley	2,839
7	Seguin	29,433	17	McQueeney	2,397
8	Kerrville	24,278	18	Nixon	2,341
9	Buda	15,108	19	Comfort	2,211
10	Lockhart	14,379	20	Bloomington	2,082

Population Density and Character of Development

The location of population centers and the concentration of population density depict a form and character of development within the Guadalupe FPR that is mostly rural, with the exception being the urbanization located along the IH 35 corridor in Hays County and Comal County. **Figure 1-4** shows that the southeastern part of the Guadalupe FPR has the lowest density of development (lowest population density per square mile), and the northwestern portion is slightly denser but remains predominantly rural. Various rural counties show small pockets of denser development, mostly located around the downtown areas of rural communities that serve as county seats. The central portion of the Guadalupe FPR, particularly around New Braunfels and San Marcos, has the densest population.

As depicted in **Figure 1-8**, the form and character of development changes across rural, urban, suburban, and coastal communities. Each of these areas exhibits different flood risks, socioeconomic characteristics, and resource needs related to flood prevention and mitigation. In sparsely populated rural areas, flooding often impacts rural roadways, low-water crossings, and town centers with proximity to major watercourses, such as in the cities of Comfort, Luling, and Seguin. Rural economies are often tied to agriculture or resource extraction types of industries, with agricultural operations being particularly vulnerable to flooding disasters. Flood events can create poor conditions for crops and cause injury or loss of livestock. Although population and infrastructure are less concentrated in rural areas, many rural communities may be considered especially vulnerable to a variety of hazards, including flooding, given their social and economic composition. These areas also tend to lack adequate resources to prepare for and respond to disasters, therefore making them vulnerable. Rural communities that are downstream and closer to the coastal regions often are the recipient of post-flood event floodwaters.

In the rapidly growing suburban areas between New Braunfels and San Marcos, development and sprawl are expected to continue to convert previously open lands and natural areas into paved impervious surfaces. In areas where there is a decrease in natural spaces that previously could absorb floodwater, coupled with a concentration of densely populated development, there is an increased flood exposure and risk vulnerability. This is especially true with respect to development in the karst areas around San Marcos and New Braunfels. Suburban areas characterized by new development and growth may offer opportunities to design and construct multi-

Figure 1-6: Historic District in Comfort, Texas
Source: Texas Hill Country

functional flood control mechanisms, such as green infrastructure like rain gardens or parks with stormwater retention basins. These can be used as tools to reduce flooding and create green spaces.

Figure 1-7: Big Joshua Creek Road, Comfort, Texas
Source: Texas Hill Country

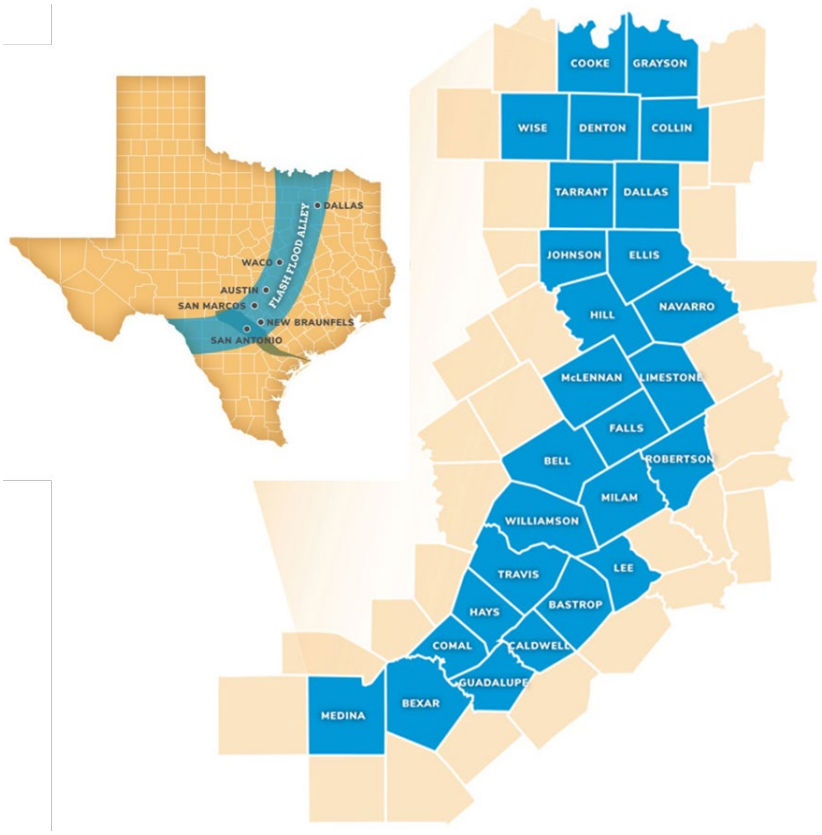
Urbanization generally increases the size and frequency of floods and may expose communities to increasing flood hazards. Urban centers are highly prone to flooding because impervious spaces, like streets, parking lots, and buildings, channel water at a faster rate, often inundating aging or outdated stormwater infrastructure (Konrad, 2016 USGS). In some cases, infrastructure may not have sufficient capacity or may not have been designed or built to handle a higher frequency of significant storm events. Impacts from flood and storm events may increase in both existing and newly developed areas in the future. For those reasons, governing bodies must establish a multilevel approach to flood risk management and ensure resiliency when designing infrastructure.

Urban areas are also major economic centers for industry and business. When flood events occur, these areas can experience serious impacts on business and commerce. Floods may have unique social consequences for urban communities and individuals in terms of risk exposure and recovery from flooding. Urban centers often support segments of the population with socioeconomic variability and social vulnerability that can be contributing factors for susceptibility to serious impacts from flood events.

Figure 1-8: Character of Development and Flood Risk

Much of the southeastern portion of the Guadalupe FPR is predominantly rural. In particular, rural communities in the lower coastal areas, such as Seadrift and Bloomington, are exposed to tropical storms and hurricanes with flooding caused by heavy areawide rainfall and coastal storm surges. These communities are located at the farthest downstream point of the Guadalupe River Basin, and thus eventually receive floodwaters from all upstream flood events. With these geographic characteristics, such areas have the potential to experience both river flooding and coastal flooding and therefore could see more intense impacts during tropical storm events.

The central portion of the Guadalupe FPR lies within the flood-prone "Flash Flood Alley" (**Figure 1-9**). Flash Flood Alley stretches from Del Rio in southwest Texas, east to San Antonio, and follows the IH 35 corridor north through the Dallas-Fort Worth Metroplex. Heavy rainfall and drainage of this landscape, also known as the Balcones Escarpment, combine to make this part of Texas one of the most flood-prone regions in North America.



In this region, major storms and flood events can occur at any time but are most common in the spring and fall, when many historic floods have occurred in Texas.

The geography of the Texas Hill Country is characterized by steep terrain, shallow soils, and karst topography that channelizes water and sends runoff quickly downhill. The result is fast-moving water with great destructive potential. These destructive forces have the potential to impact communities downstream as the floodwaters move the large debris, cause structural damage, and threaten lives and property throughout the basin. The immediate impacts of flooding can include loss of human life, destruction of crops, loss of livestock, impacts to natural ecosystems, and deterioration of public health conditions due to waterborne diseases. As communication links and infrastructure, such as power plants, roads, and bridges, are damaged and disrupted, some economic activities may come to a standstill, people may be forced to leave their homes and normal life is in disarray. Damage to infrastructure can also cause long-term impacts, such as disruptions to supplies of clean water, wastewater treatment, and electricity.

Flooding can impact water sources and increase the risk of contamination to drinking water wells or community water systems. Stormwater and sanitary sewer systems can become surcharged during storms and flood events, causing sewer backups in homes and the discharge of untreated wastewater into streams.

In many natural systems, floods provide an important role in maintaining key ecosystem functions and biodiversity. Floods can connect waterways with the land surrounding them, recharge groundwater systems, fill wetlands, increase the connectivity between aquatic habitats, and move both sediment and nutrients around the landscape and into the marine environment. In addition, floods can play a role in recharging the alluvium, which provides base flow to the river during low-flow periods, provides the seasonal sediment and flow regimes that help maintain ecological biodiversity in the river and floodplain, and provides the necessary flushing of accumulated organic substances and vegetation to maintain and restore the ecological health of the river.

Natural systems are often resilient to the effects of floods; however, areas that have been highly modified by human activity tend to see more negative effects from flooding. Floods tend to further degrade already degraded systems. Removing vegetation in and around rivers, increasing channel sizes, constructing dams and levee banks, and clearing catchment areas all contribute to degraded hill-slopes, rivers, and floodplains. These practices also lead to an increase of the erosion and transfer of both sediment and nutrients. While the cycling of sediments and nutrients is essential to a healthy system, too much sediment and nutrients entering a waterway have negative impacts on downstream water quality.

The negative impacts of flooding can also include potential impacts on the habitat of endangered and threatened species found in the basin. For example, scouring and the deposition of gravel/cobble from floodwaters can cause extensive damage to the aquatic vegetation found along the Comal and San Marcos rivers. This vegetation is a habitat for the fountain darter (*Etheostoma fonticola*), which is listed as endangered by the U.S. Fish and Wildlife Service. While sedimentation issues can occur during flood events, managing sedimentation is an ongoing challenge for endangered species' habitats in the San Marcos River. In 2015, the Edwards Aquifer Habitat Conservation Plan noted that post-flood mapping and observations of the aquatic vegetation indicated significant scouring effects in many locations along the stream bottom in the San Marcos River system (EAA 2016).

Other long-term negative effects can include loss of habitat, the release of pollutants, lower fish production, loss of wetlands function, and loss of recreational areas. The negative effects of floodwaters on coastal marine environments are mainly due to the introduction of excess sediment and nutrients, as well as pollutants, such as chemicals, heavy metals, and debris. These can degrade aquatic habitats, lower water quality, reduce coastal production, and contaminate coastal food resources (Queensland 2011).

Population Growth

The current growth patterns in the Guadalupe FPR are generally projected to continue over the next several decades, with greater concentrations of population expanding outward from the

San Antonio and Austin metropolitan statistical areas. **Table 1-4** reflects data from the 2022 State Water Plan that shows many of the counties in this Guadalupe FPR are projected to experience significant population growth during the next 50 years. The values represent each county's entire population, not just the population found within the Guadalupe FPR. The projections show that the most significant population increases are expected to take place in Bastrop County, Hays County, Comal County, Kendall County, Caldwell County, and Guadalupe County. These are also areas that have historically experienced severe flooding events.

Table 1-4: Projected Population by County

County	2020	2030	2040	2050	2060	2070	Projected % Increase over 50 years
Bastrop	95,487	125,559	164,648	217,608	289,140	384,244	302.40%
Hays	238,862	313,792	398,384	474,801	593,384	728,344	204.92%
Comal	152,499	193,188	234,515	276,239	317,682	357,464	134.40%
Kendall	42,185	52,213	62,807	73,308	84,028	94,549	124.13%
Guadalupe	182,693	235,318	276,064	315,934	356,480	396,261	116.90%
Caldwell	47,008	57,553	67,955	78,243	88,639	98,754	110.08%
Wilson	54,266	66,837	79,044	90,016	100,411	109,771	102.28%
Travis	1,298,624	1,538,784	1,767,636	1,936,583	2,075,875	2,233,259	71.97%
Wilson	54,266	66,837	79,044	90,016	100,411	109,771	102.28%
Gonzales	21,751	23,921	25,963	28,330	30,738	33,256	52.89%
Fayette	28,373	32,384	35,108	37,351	39,119	40,476	42.66%
Blanco	13,015	15,475	16,917	17,672	18,175	18,472	41.93%
Gillespie	26,795	28,852	30,548	32,536	34,365	36,142	34.88%
Goliad	8,427	9,519	10,239	10,545	10,759	10,884	29.16%
Victoria	93,857	100,260	105,298	109,785	113,470	116,522	24.15%
Bandera	24,991	28,780	30,881	31,742	32,265	32,537	23.19%
Kerr	52,644	55,407	57,044	58,665	59,830	60,725	15.35%
DeWitt	20,855	21,555	21,900	22,216	22,425	22,572	8.23%
Refugio	7,687	7,929	7,985	8,119	8,175	8,213	6.84%
Karnes	15,456	15,938	15,968	15,968	15,968	15,968	3.31%
Lavaca	19,263	19,263	19,263	19,263	19,263	19,263	0.00%
Real	3,329	3,329	3,329	3,329	3,329	3,329	0.00%

Source: Texas Water Development Board 2022 State Water Plan

Table 1-5 illustrates the 30-year projected population growth by watershed in each of the HUC 8 watersheds located within the Guadalupe FPR. The analysis for this section was undertaken using HUC 8 watershed population projections provided to each region by the TWDB from the

State Water Plan. From 2020 to 2050, the entire Guadalupe FPR is projected to have a population increase of almost 62%.

Consistent with today's general population distribution, the largest concentration of the population is expected to remain in the San Marcos Watershed and Middle Guadalupe Watershed. These watersheds include the areas of New Braunfels, San Marcos, Seguin, and Lockhart. As shown in **Table 1-5**, the watersheds with the greatest projected population growth in terms of percentage of increase are the San Marcos Watershed (84% or +204,963 people) and Middle Guadalupe Watershed (62% or +123,049 people). These population growth estimates mean that the Guadalupe FPR's greatest increases in population between 2020 and 2050 will continue to be near or adjacent to the metropolitan areas with the largest and most dense pockets of the population within the Guadalupe FPR.

Figure 1-10 shows a multi-unit residential complex under construction in San Marcos between the San Marcos and Blanco Rivers. The area experienced severe flooding during the 2015 Memorial Day weekend. As depicted in **Figure 1-11** and **Table 1-5**, the San Marcos HUC 8 watershed is projected to have the largest concentration of population (almost 450,000 people) by 2050.

Figure 1-10: Memorial Day Flood
Source: Stephen Ramirez

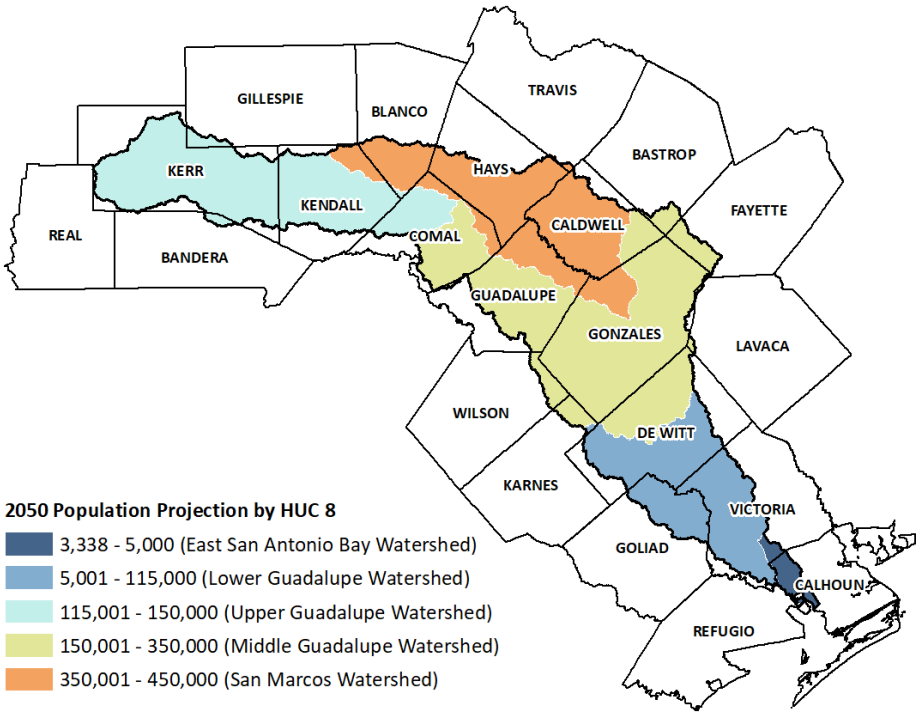


Figure 1-11: 2050 HUC8 Watershed Population Projections

Source: Texas Water Development Board Flood Data Hub 2022

Table 1-5: Existing and Projected Population by HUC 8 Watershed

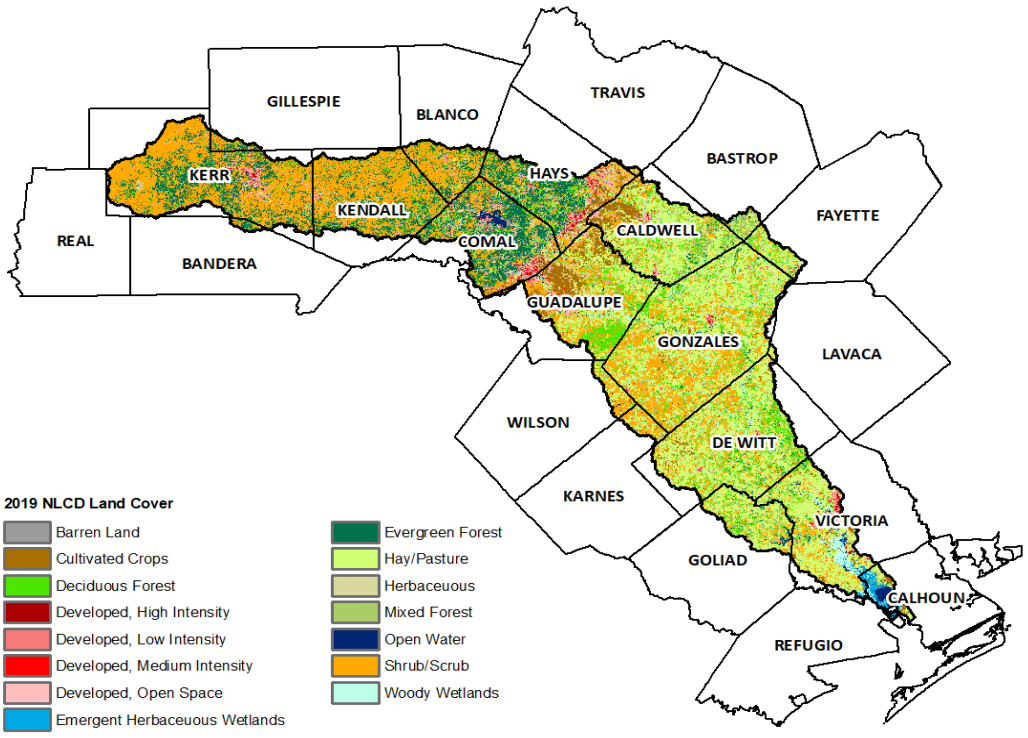
HUC 8 Name	HUC 8 ID	2020 Density (People/ Square Mile)	2020 Population	2050 Population	Population Change
Upper Guadalupe	12100201	67.31	96,438	136,966	42%
Middle Guadalupe	12100202	92.41	197,689	320,738	62%
San Marcos	12100203	180.1	244,797	449,760	84%
Lower Guadalupe	12100204	76.43	77,101	89,035	15%
East San Antonio Bay*	12100403	5.47	2,849	3,338	17%
Region Totals		**84.34**	**618,874**	**999,837**	**62%**

**This HUC 8 watershed is partially within the Guadalupe FPR and is also partially within the San Antonio and Lower Colorado-Lavaca flood planning regions.*

Source: Texas Water Development Board - Flood Data Hub 2022

Land Cover and Use

The predominant land cover in the Guadalupe FPR is shrub/scrub at approximately 33% of the Guadalupe FPR (**Figure 1-12)**. While found throughout the basin, it is the major land cover for much of the upper portion of the Guadalupe FPR. The upper portion also contains most of the Guadalupe River Basin's deciduous and evergreen forests, which occur in 21.3% of the Guadalupe FPR. About 2.1% of the Guadalupe FPR is developed at a low, medium, or high intensity. Development is primarily along the IH 35, IH 10, and US 281 highway corridors, and is expected to rapidly increase in the coming years. Associated with development in these areas will be increased impervious surfaces that, without effective planning, can increase the potential for flooding. Hay/pasture makes up around 26% of the Guadalupe FPR and is mainly located within the lower portion of the basin. Primarily found in Guadalupe County and Caldwell County, 3.6% of the basin is covered with cultivated crops.



According to the United States Department of Agriculture (USDA) National Agricultural Statistics Land Use data, the rural areas in the Guadalupe FPR contribute to the economy of the Guadalupe FPR through farming, ranching, and range/pasture. **Figure 1-13** displays the USDA land use classifications in the Guadalupe FPR. The largest land use classification is range/pasture at approximately 61% of the Guadalupe FPR, followed by ranching at close to 23%. A small portion of the Guadalupe FPR falls under the urban development land use classification at 6.5%.

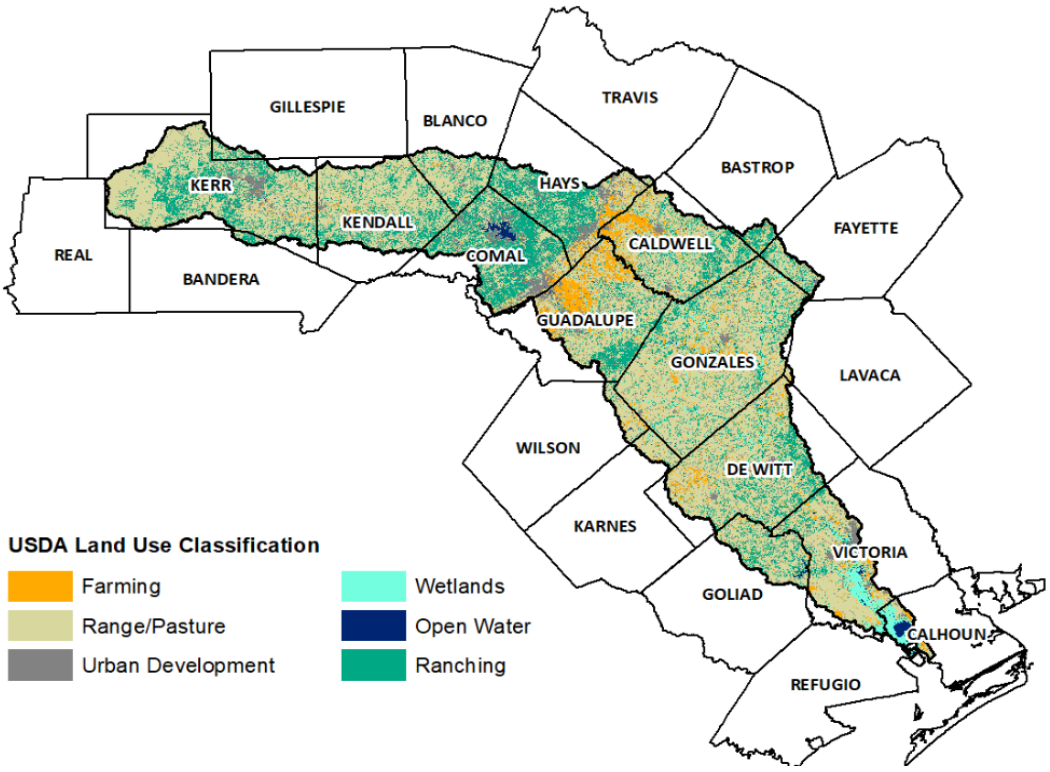


Figure 1-13: Land Use

Ranching is a significant land use type that occurs throughout the basin. Population growth in the basin has contributed to land fragmentation, as large ranches are divided into smaller parcels. The central portions of the basin are popular for a host of water-based recreational activities, from the Guadalupe River headwaters downstream to Canyon Lake. This area is prone to flash-flooding events due to areas of impervious cover, the karst geology of the Texas Hill Country, and the intensity of rain events.

The largest concentration of urban development is along the IH 35 corridor and includes the cities of San Marcos and New Braunfels. IH 35 serves as a major transportation link to move goods and services to and from Mexico, and directly connects the large metropolitan areas of Austin and San Antonio. The Comal and San Marcos Rivers are popular recreation destinations, as well as habitats for several endemic species of concern. Like the upper basin, land use in this Guadalupe FPR is changing due to population pressures leading to land fragmentation, an increase in impervious cover, an increased risk of flooding, and a higher potential for flood damage.

While also experiencing population growth, the lower part of the basin remains largely rural. The Blackland Prairies of Guadalupe County and Comal County continue to support an active farming community. Ranching and rangeland are the predominant uses in Gonzales, DeWitt, Victoria, and Calhoun Counties, with Gonzales County accounting for more than half of all agricultural production within the basin. Though flash flooding is less of a concern in the lower

basin, flooding of the Guadalupe River and its tributaries remains a threat to agricultural production, as well as the lower Guadalupe FPR's urban areas.

Economic Activity

The Guadalupe FPR contains various industries, including health care and social assistance; professional, scientific, and technical services; wholesale trade, manufacturing, and tourism; and recreation. These industries contribute to the gross domestic product (GDP) of the Guadalupe FPR and support the local and state economies. The sum of sales, value of shipments, or revenue for the counties in the basin totaled more than $238 billion in 2017, approximately 5% of the total sales or revenue generated by all firms and businesses in Texas (U.S. Census Bureau 2017). Mitigating the impacts of flooding can help these businesses and the residents that they employ become more economically resilient.

To better understand the economic risk the Guadalupe FPR faces from flood events, this section identifies the most significant industries within the Guadalupe FPR based on three factors:

- Number of establishments
- Annual payroll
- Total annual revenue

Data from the 2017 5-Year American Community Survey Economic Census was utilized and industries were divided by the North American Industry Classification System (NAICS), which classifies all business establishments to facilitate the publication of statistical data related to the United States economy (U.S. Census Bureau 2017).

Number of Establishments

Based on the number of establishments (firms or businesses), the largest industry in the basin is health care and social assistance, which comprises 19% of the establishments in the Guadalupe FPR (**Figure 1-14**; U.S. Census Bureau 2017). Professional, scientific, and technical services encompass 16% of the establishments in the basin, and other services (except public administration) make up 13% of the establishments. A variety of other industries are present in the basin as well, including recreation and tourism.

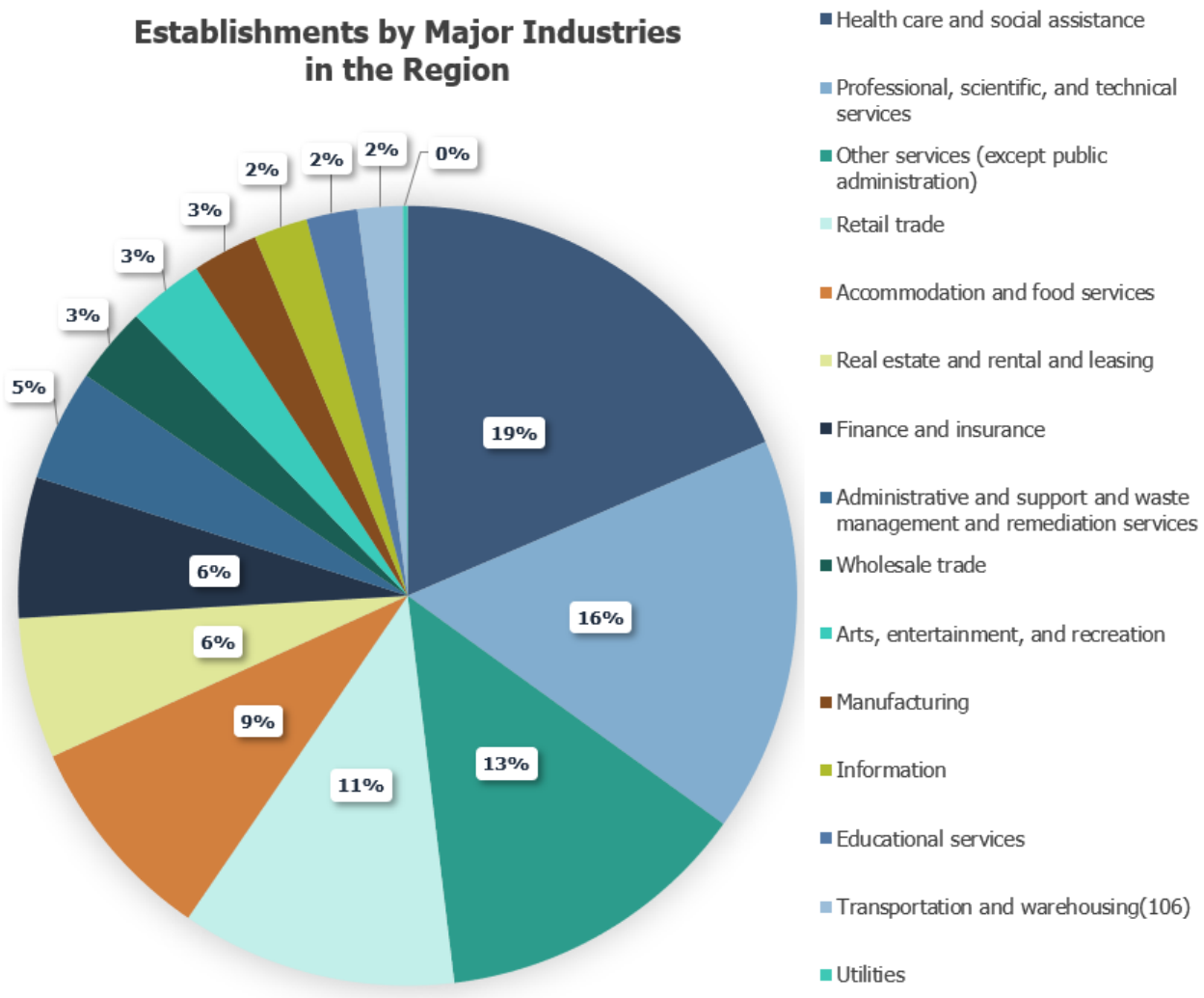


Figure 1-14: Establishment Percentages for Major Industries

Source: U.S. Census 2017 5-Year American Community Survey 2017

The health care and social assistance industry also utilize the most employees in the basin, with 227,972 people (U.S. Census Bureau 2017). The professional, scientific, and technical services industry employs fewer people (102,913 employees) than the accommodation and food services industry and retail trade (116,568 and 114,970, respectively). The other services (except public administration) industry employs 59,457 people.

Annual Payroll

The total annual payroll for counties in the Guadalupe FPR is $47,647,440,000 (U.S. Census Bureau 2017). As shown in **Figure 1-15**, the largest industry by payroll in the Guadalupe FPR is health care and social assistance. The sum of annual payroll for the health care and social assistance industry is $10,627,175,000, approximately 22% of the total for the Guadalupe FPR. The information industry has the next largest share in the Guadalupe FPR, for a total of $9,206,166,000 or 19%. The other industries in the basin make up less than 10% of the annual payroll for these counties.

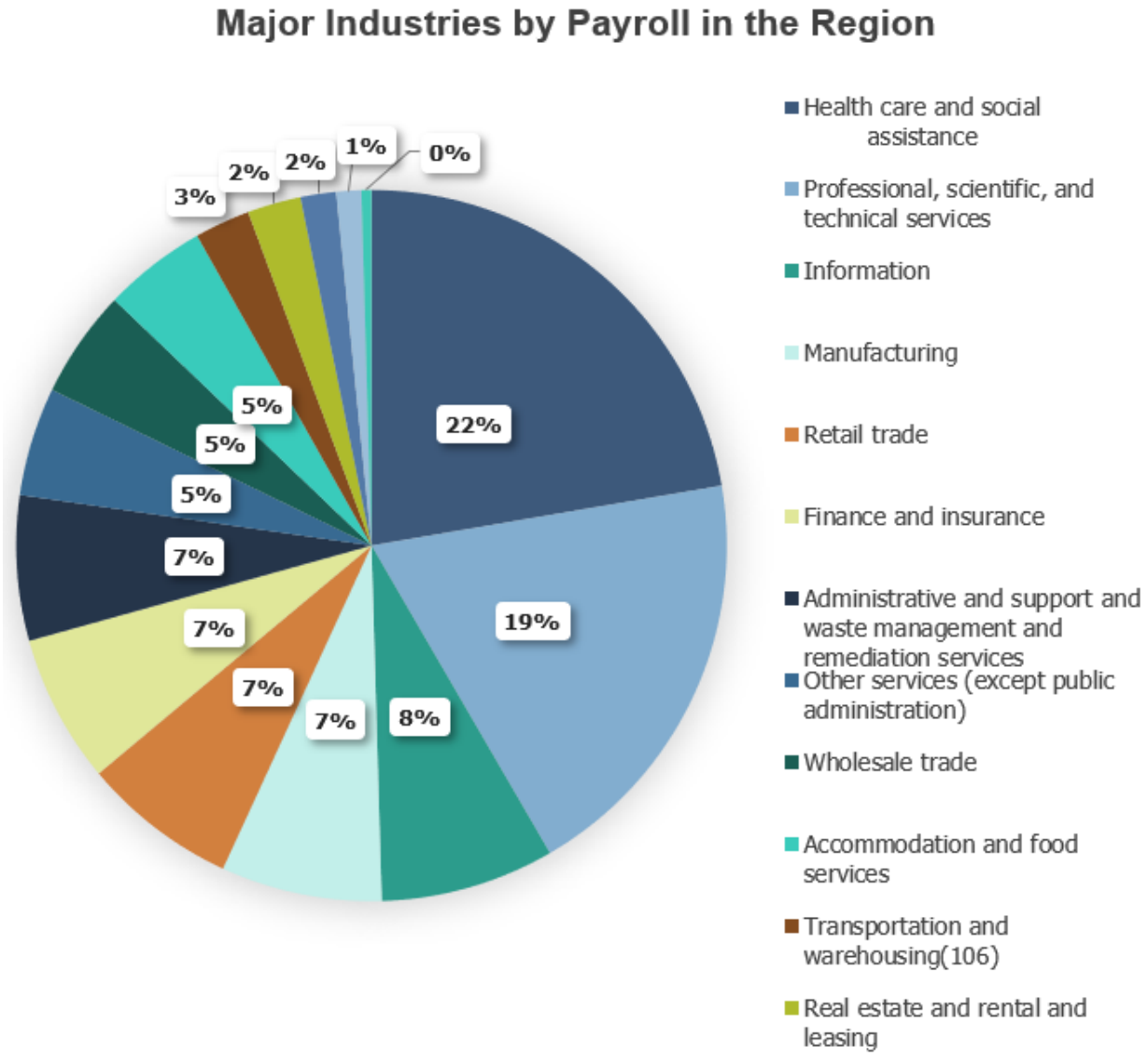


Figure 1-15: Payroll Percentages for Major Industries

Source: U.S. Census 2017 5-Year American Community Survey 2017

Total Annual Revenue

The sum of sales, value of shipments, or revenue can be used as an indicator of the industries that have the greatest economic impact in the Guadalupe FPR. It can also provide information on the counties within the basin that produce the largest amount of commercial activity. These statistics can be used in evaluating the potential economic disruption of a major flood event by industry and by county.

Table 1-6 provides a summary of the four counties in the Guadalupe FPR with the highest revenues. It also indicates the number of firms and businesses, number of employees, and the largest industry therein. Travis County, which includes the Austin metropolitan area, has the largest number of total sales, value of shipments, or revenue in the Guadalupe FPR, at $178.5 billion (U.S. Census Bureau 2017). It also contains the greatest number of firms and businesses in the Guadalupe FPR, at 32,575, and employees, at 656,424. The wholesale trade industry is the largest industry sector in the county, at $80.5 billion. A small portion of Travis County lies within the Guadalupe FPR, with much of the county residing within the Lower Colorado Basin.

Hays, Comal, and Guadalupe Counties hold the next largest shares of revenue in the basin, in descending order (**Table 1-6**; U.S. Census Bureau 2017). These three counties generate between $9.2 and $11.5 billion and contain between 2,114 and 4,079 firms and businesses. The total number of employees in these three counties ranges from 33,368 to 62,908. Retail trade generates the highest total sales, value of shipments, or revenue in Hays County and Comal County. In comparison, manufacturing is the largest industry sector in Guadalupe County.

Table 1-6: Counties with Highest Revenue in the Guadalupe FPR

County	Total Sales, Value of Shipments, or Revenue (in billion dollars)	Total Number of Firms and Businesses	Total Number of Employees	Largest Industry Sector
Travis	$178.5	32,575	656,424	Wholesale Trade
Hays	$11.5	4,079	62,908	Retail Trade
Comal	$9.7	3,377	59,196	Retail Trade
Guadalupe	$9.2	2,114	33,368	Manufacturing

Economic Status of the Population

The term Household Income refers to the combined gross income of all household members greater than 15 years of age in the preceding 12 months (U.S. Census Bureau 2019). The Median Household Income (MHI) for a region is determined by dividing the income distribution into two equal parts, with one-half of the cases falling below the median income and one-half above the median income. MHI is affected by many factors, including technological changes, geographic location, and economic opportunity (Horowitz et al, 2020).

Data from the 2019 American Community Survey 1-Year Estimates Income in the Past 12 Months was utilized to evaluate MHI in the Guadalupe FPR. The MHI in the Guadalupe FPR is summarized by county in **Table 1-7** and displayed in **Figure 1-16**. Much of the basin has an MHI between $50,001 and $75,000 (U.S. Census Bureau 2019). The highest MHI in the Guadalupe FPR is $84,747 in Kendall County, followed by $79,936 in Comal County, in the upper portion of the basin. The lowest MHI in the Guadalupe FPR is in Real County, also in the upper portion of the basin, at $35,862. The second lowest MHI in the Guadalupe FPR, $50,076, is in Refugio County, along the Gulf Coast.

Table 1-7: Median Household Income per County in the Guadalupe FPR

County	Median Household Income (dollars)	County	Median Household Income (dollars)
Kendall	$84,747	Calhoun	$58,776
Comal	$79,936	Bandera	$58,661
Wilson	$76,692	Victoria	$56,834
Travis	$75,887	Karnes	$56,127
Guadalupe	$74,496	Kerr	$55,990
Hays	$68,717	DeWitt	$55,357
Blanco	$66,390	Lavaca	$54,403
Bastrop	$64,597	Caldwell	$54,152
Goliad	$60,690	Gonzales	$53,577
Fayette	$60,189	Refugio	$50,076
Gillespie	$59,155	Real	$35,862

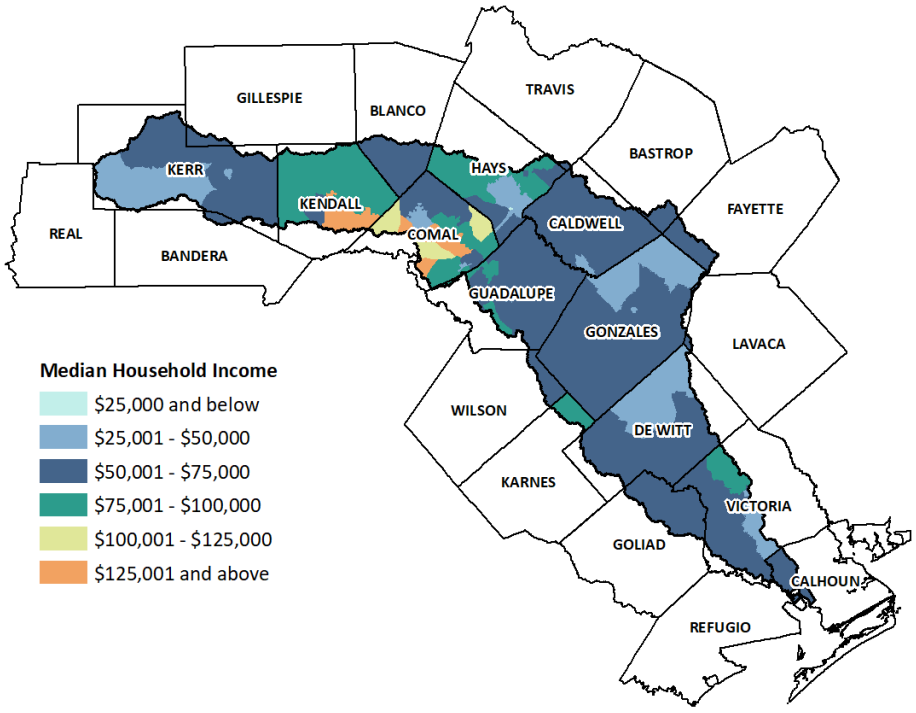


Figure 1-16: Median Household Income

Source: U.S. Census Bureau 2019

1.2.2 Flood Prone Areas and Flood Risks to Life and Property

A strong baseline understanding of exposure and vulnerability is needed for Texas to better manage flood risk to mitigate the loss of life and property from flooding. This is a critical step in decreasing the vulnerability of the Guadalupe FPR's people and places to future flooding. **Chapter 2** presents the results of in-depth current and future condition flood risk analyses for the Guadalupe FPR. Some highlights from **Chapter 2** are presented in this section.

Identification of Flood Prone Areas

According to current available mapping, over 16% of the Guadalupe FPR's total area is at risk of flooding during the 1% annual chance event (ACE) and 19% is within 0.2% ACE. This can otherwise be described as facing between a 1% to 0.2% annual risk of loss. However, this does not provide a comprehensive accounting for all flood risks, as not all of the floodplains within the Guadalupe FPR have been recently modeled and mapped in detail. While developing a comprehensive flood risk model of the Guadalupe FPR is beyond the scope of this planning effort, TWDB floodplain quilt dataset used in this plan is "sewn" together from various sources of data, such as the National Flood Hazard Layer, base level engineering, and other sources, to provide comprehensive coverage of all known existing statewide flood hazard information.

In the absence of a unified flood map that applies throughout the Guadalupe FPR, the subsequent chapters of this assessment will piece together an intricate flood quilt, combining

numerous data layers from the Federal Emergency Management Agency (FEMA), including effective maps, preliminary maps, base level elevation (BLE) maps, and data from other federal agencies and local and regional studies. **Chapter 2** provides additional details regarding these datasets.

Types of Flood Risk

Figure 1-17 shows the initial floodplain quilt information provided by TWDB that serves as Region 11's starting point, providing an approximation of region-wide flood risk data currently available. This data was provided by TWDB to provide the RFPGs with a common starting point for their own compilation of flood risk data in their regions. In subsequent chapters, additional detail will be provided about the floodplain quilt and how it lays the foundation for larger flood risk, policy, and mitigation strategy evaluation (TWDB, 2021).

A general definition of flood is an overflow onto land not normally covered by water and which has three general characteristics: 1) the inundation is temporary; 2) the land is adjacent to and inundated by overflow from a river, stream, or creek, or an ocean, sea, lake or other body of standing water; and 3) damages or destruction of property and loss of life can occur. Adverse effects include damages to buildings, bridges, and other man-made structures; potential loss of life; inundation of roadways; backwater in sewers or local drainage channels; creation of unsanitary conditions; streambank erosion and deposition of materials during a recession; a rise of groundwater coincident with the increased streamflow; and other related problems. Due to the varying ecoregions and topography, the Guadalupe FPR experiences multiple types of flood risk.

- **Local (Urban) Floods:** Local floodplains are those flood-prone areas that are located outside of mapped effective FEMA flood zones, designated Special Flood Hazard Areas (SFHA), shown on Flood Insurance Rate Maps (FIRM). Typically, urban communities identify local flooding as being roadways, subsurface infrastructure, and areas conveyed upstream of storm drainage inlets. Nationwide, these flood zones have several names, including "urban floodplains," "residual floodplains," and "local floodplains," and are in developed or developing areas. Because local drainage floodplains are not mapped on FIRMs, some communities have begun taking steps to better define and understand local flooding risks in their community, using strategies such as local knowledge, historical events, approximate or detailed local flood modeling studies, drainage master planning, local neighborhood analysis, and large scale 2-D hydraulic modeling. Although not regulated by the FEMA criteria, these areas often represent a significant portion of known flood hazards within a city and account for an inordinate proportion of federal flood insurance claims. The Guadalupe RFPG's Interactive Map Tool attempted to capture some of these locations and yielded some areas identified as "flood-prone."

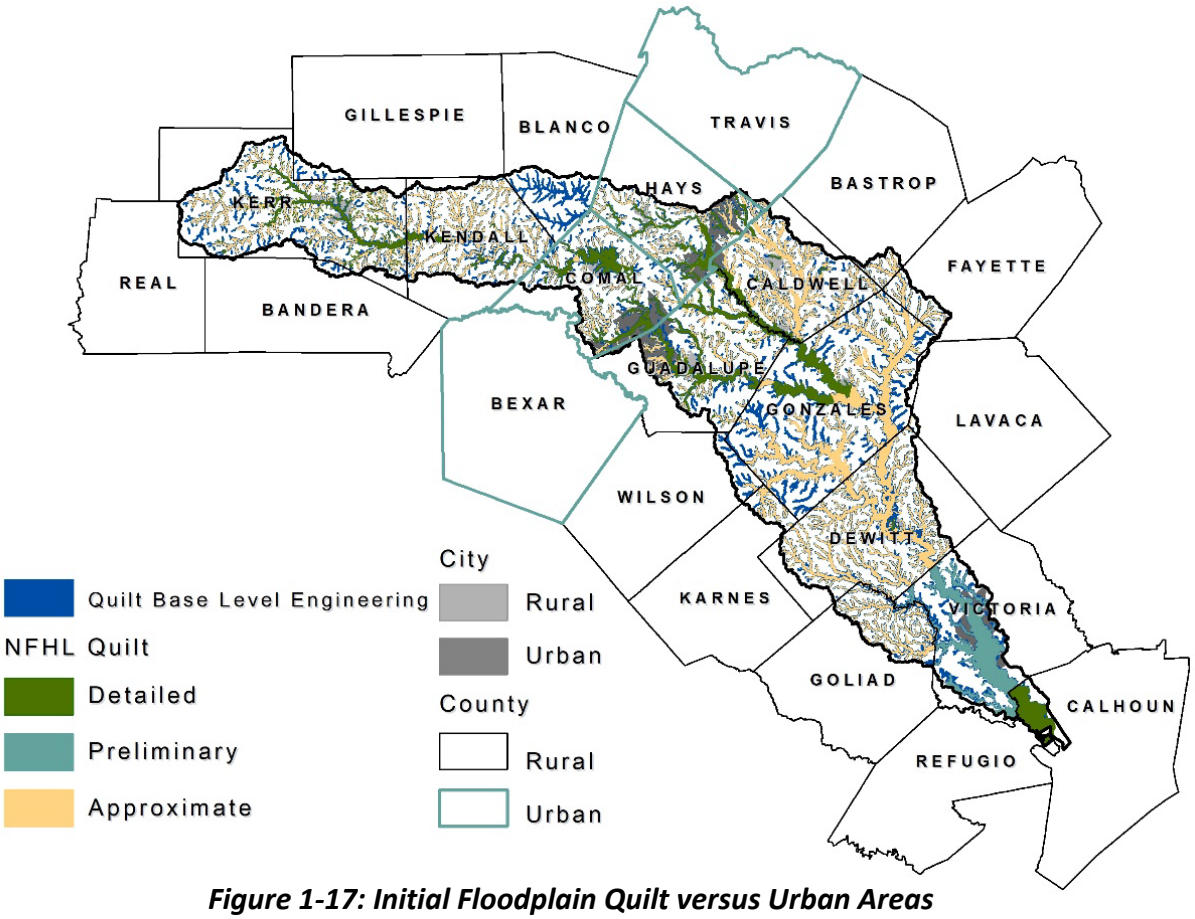


Figure 1-17: Initial Floodplain Quilt versus Urban Areas

- **Riverine Floods:** Riverine flooding is very common in the Guadalupe FPR as many communities have developed near rivers or streams to take advantage of the aesthetic and recreational benefits they provide. Riverine flooding occurs when excessive rainfall over an extended period causes a river, stream, or creek to exceed its channel capacity. Overbank flooding occurs when the water rises and overflows over the edges of a river or stream. This is the most common and can occur in any size channel, from small creeks to huge rivers. One specific form of flooding is the "flash flood," which is characterized by an intense, high-velocity torrent of water that occurs in an existing river channel with little or no warning time. Flash floods are very dangerous and destructive because of the force of the water, and the debris that is often swept up in the flow. Floods on larger river basins are as destructive and dangerous, but normally develop over a long period and allow for significant warning and preparation, such as the evacuation of flood-prone areas.

  The severity of a riverine flood is determined by the amount of precipitation in an area, how long it takes for precipitation to accumulate, previous saturation of local soils, and the terrain that exists in the watershed or catchment area. In flatter areas, floodwater tends to rise more slowly and is generally shallow and may remain longer. In hilly areas,

floods can occur within minutes after a heavy rain/flash flood event. To determine the probability of river flooding, hydrologic and hydraulic models consider past precipitation, forecasted precipitation, current river levels, the effectiveness of flood control structures, and other related factors. Riverine flooding depicted on the community's FIRM is intended to show the extent of riverine floodplains in a community. Thus, updating FIRMs that are outdated, modeling areas that have never been mapped, and performing detailed studies where there currently are none would improve the definition of riverine flood risk.

- **Coastal Floods**: Coastal surge flooding occurs in the southern portion of the Guadalupe FPR along the Gulf coast. It is typically the result of extreme tidal conditions caused by severe weather. Storm surge, produced when high winds from hurricanes and other storms push water onshore, is the leading cause of coastal flooding and often the greatest threat associated with a tropical storm. In this type of flood, water overwhelms low-lying land and often causes devastating loss of life and property.

  The severity of a coastal flood is determined by several factors, including the strength, size, speed, and direction of the storm. The onshore and offshore topography also plays an important role. To determine the probability and magnitude of a storm surge, coastal flood models consider this information in addition to data from historical storms that have affected the area, as well as the density of nearby development. The area of the Guadalupe watershed impacted by coastal flooding is relatively small compared to the amount impacted by riverine flooding.

- **Structural Failure Floods**: Historically, structural failure flooding has rarely occurred in Texas. Failure of flood infrastructure, such as dams and levees, may occur when excessive rainfall for an extended period causes an uncontrolled release of floodwaters. The severity of structural failure flooding is determined by the extent of failure, downstream topography, and downstream hazards (for example, people, properties, and roadways).

Flood Exposure

An initial assessment of exposure to flood risk can be observed utilizing building footprints with the region-wide existing condition of 1% ACE floodplain. **Figure 1-18** shows the number of structures within the 1% ACE floodplain by density in the Guadalupe FPR. The results of the current and future condition flood exposure analyses are discussed in depth in **Chapter 2**.

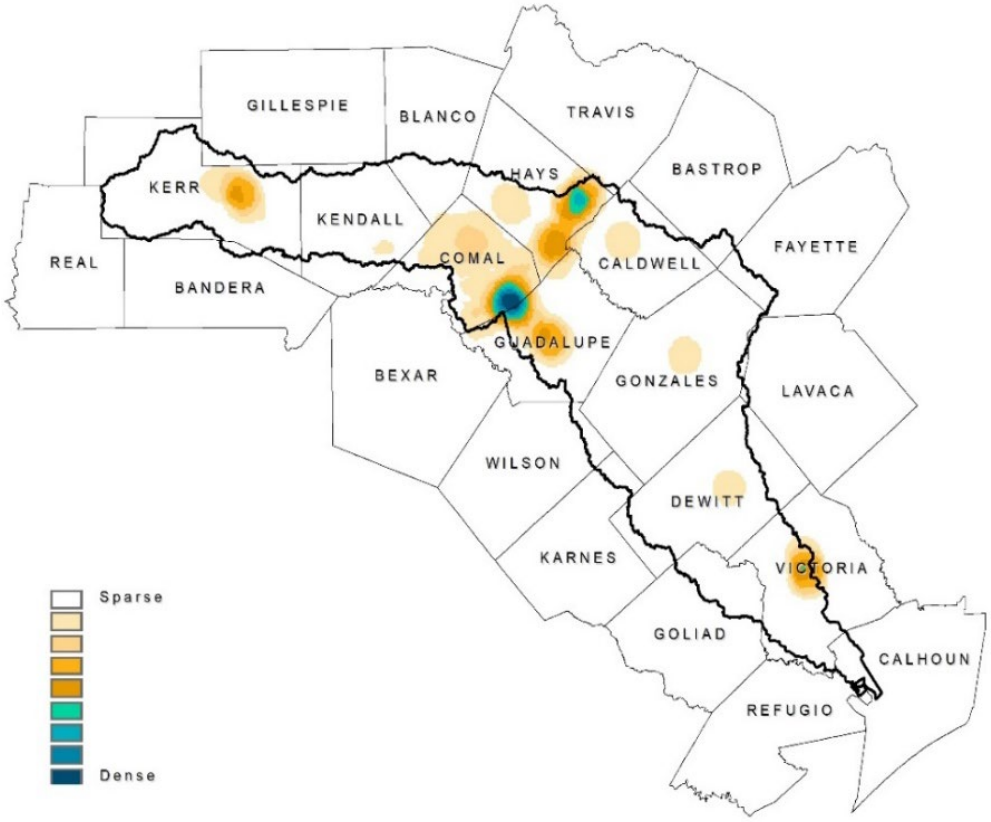


Figure 1-18: Structures Heat Map

Source: Building heat map derived from existing condition 1% ACE floodplain with TWDB-provided building footprints

Changes in Rainfall Data

On September 27, 2018, the National Oceanic and Atmospheric Administration (NOAA) published new precipitation frequency values for Texas. This new publication, *NOAA Atlas 14 Precipitation-Frequency Atlas of the United States, Volume 11 Version 2.0: Texas*, is a reassessment of historical rainfall data up to 2017, adding 20 years of records to the previous USGS publications (Perica et al. 2018).

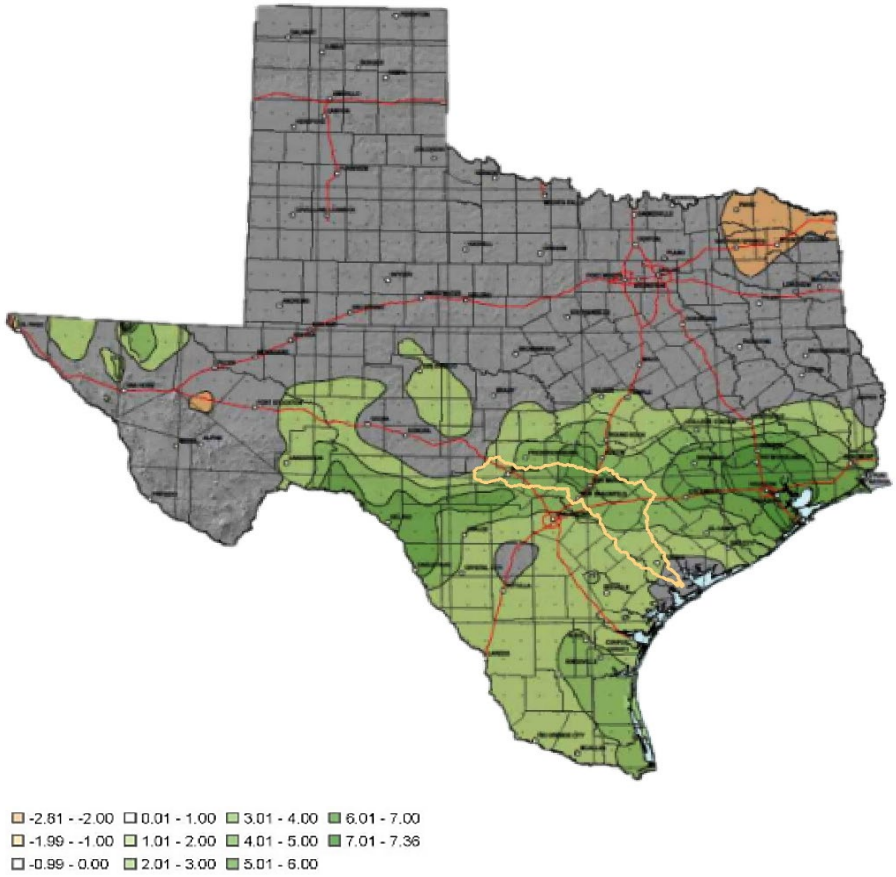


Figure 1-19: NOAA Atlas 14 Precipitation Frequency Atlas

Rainfall data is commonly used to predict flood risk and as an input to analyze and design flood protection and mitigation infrastructures, such as bridges, culverts, channels, storm drainage systems, detention facilities, and others.

The Atlas 14 publication indicates that the 1% annual chance of a 24-hour rain event may be greater than what was previously considered in many areas. The greatest rainfall changes occurred in Central Texas and along the Texas coast. Outlined in yellow in **Figure 1-19** is Region 11. The green areas in the map indicate areas where rainfall depth increased compared to the previous USGS publications. There are minimal changes in the upper portion of the basin with

the greatest increases (approximately 3-4 inches) near San Marcos. While three inches may not seem significant, it expanded the extent of the 100-year floodplain dramatically for the area.

Key Historical Flood Events

From the year 1953 to 2020, eight flood-related Emergency Declarations and 36 flood-related Disaster Declarations were declared within the Guadalupe FPR (FEMA, 2021). A Presidential Major Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities. An Emergency Declaration is more limited in scope and without the long-term federal recovery programs of a Major Disaster Declaration. Generally, federal assistance and funding are provided to meet a specific emergency need or to help prevent major disaster damages from occurring again.

Public Assistance (PA) is FEMA's largest grant program, providing funds to assist communities responding to and recovering from major disasters or emergencies declared by the President. The program provides funding for emergency assistance to save lives and protect property. It also offers funding assistance to permanently restore community infrastructure affected by a federally declared incident. Supplementally, PA funds can be categorized for emergency work, such as PA-A for debris removal and PA-B for emergency protective measures. The Individual Assistance (IA) programs are made available under emergency declarations and are limited to supplemental emergency assistance to provide immediate and short-term assistance essential to saving lives; protecting public property, health, and safety; or lessening or averting the threat of a catastrophe to the affected state, territory, or tribal government. All IA programs may be authorized once a major disaster has been declared by the President. The approval of IA under a Major Disaster Declaration may also activate assistance programs provided by other federal agencies based on specific disaster needs. **Table 1-8** represents the total number of unique disaster and emergency declarations for the Guadalupe FPR.

Table 1-8: Disaster Declarations and Emergency Declarations by County

County	Disaster Declarations	Emergency Declarations
Bandera	6	2
Bastrop	10	2
Blanco	7	2
Caldwell	10	2
Calhoun	12	7
Comal	10	4
DeWitt	10	4
Fayette	10	2
Gillespie	6	2
Goliad	8	6
Gonzales	10	2
Guadalupe	10	3
Hays	10	2
Karnes	7	2
Kendall	8	2
Kerr	6	2
Lavaca	7	4
Real	7	2
Refugio	13	8
Travis	13	6
Victoria	13	7
Wilson	6	3
TOTAL DISASTER/EMERGENCY DECLARATIONS FOR ENTIRE REGION FROM 1953 TO 2020	**36**	**8**

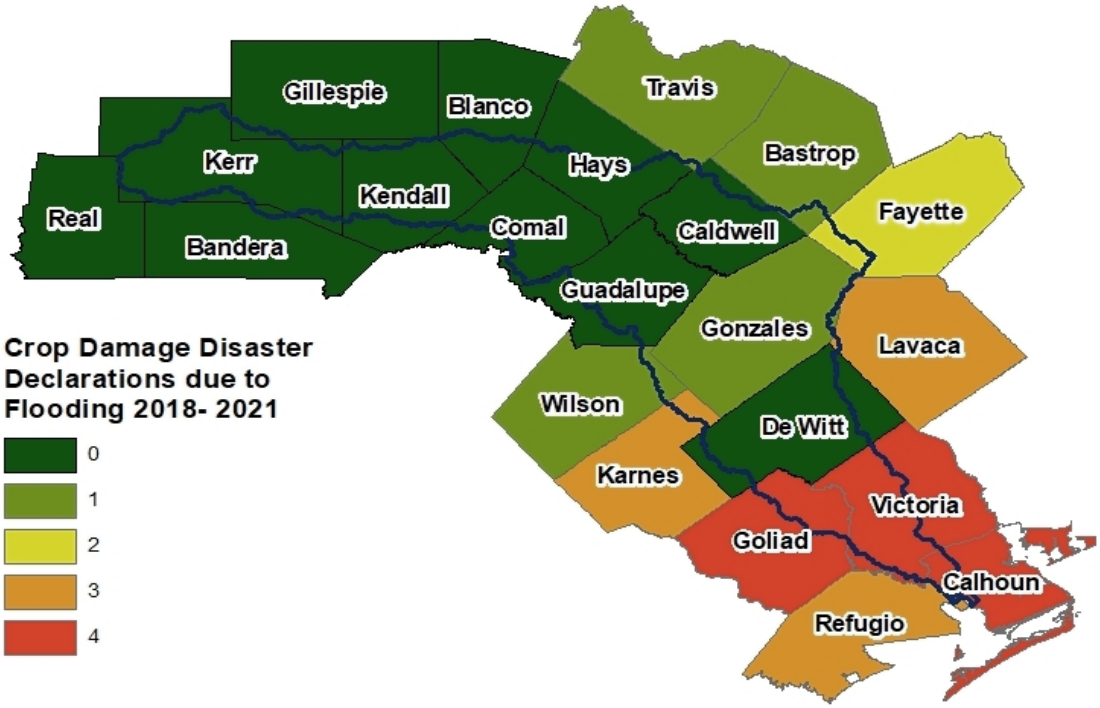


Figure 1-20: Crop Damage Disaster Declarations

Source: USDA Farm Service Agency Disaster Designation Information

Figure 1-20 represents the total number of disaster declarations with crop damage between 2018 and 2021 for each county. Within the Guadalupe FPR, the counties with the most declared disasters with crop damage were Calhoun, Goliad, and Victoria Counties, with a total of four disaster declarations with crop damages in each county. During this time, the counties located in the southeast have experienced more total crop disasters than the rest of the Guadalupe FPR. This information was found on the USDA Farm Service Agency Disaster Designation Information site.

Some of the most significant flood events are listed as follows. FEMA provides a search tool found here to search for more information on Emergency Declarations or Disaster Declarations: https://www.fema.gov/disaster/declarations.

May 11, 1972	Heavy rain began falling over eastern Comal County close to 8 p.m. on May 11, 1972, and by midnight, a center of 16.5 inches was measured on the Guadalupe River, exactly halfway between New Braunfels and Canyon Lake Dam. This storm's highest rainfall totals occurred in an area almost exactly within the Guadalupe River drainage below Canyon Dam. Homes washed downstream in New Braunfels and Seguin, and many were seriously damaged or destroyed in the floodplains along with Lakes Dunlap and McQueeney. More than 100 homes flooded. Fifteen people drowned, eight along the Comal River, and seven on the Guadalupe in New Braunfels.
August 1, 1978	Catastrophic floods occurred in Central Texas on August 1-4, 1978, caused by intense rainfall initiated by the remnants of Tropical Storm Amelia and compounded by other meteorologic factors. Torrential rain fell over the Hill Country, with more than 48 inches of rainfall in some places, setting a new record of extreme point rainfall for 72 hours. Major flooding occurred on the Medina and Guadalupe Rivers, with severe to minor flooding on the Brazos, Llano, Pedernales, and Nueces Rivers. Floods reached the 100-year event stage, and peak discharges were observed at several streamflow stations. In all, 33 people lost their lives, and total damages exceeded $110 million (1978 USD).

Figure 1-21: Photo from the 1987 Flood
Source: National Weather Service

July 16, 1987 — During the late evening of July 16, 1987, and into the next morning, thunderstorms developed and moved slowly eastward through the Hill Country of South Central Texas. The storms produced a training effect, one following another, and a large area of 5 to 10 inches of rain fell in the upper headwaters of the Guadalupe River Basin. The heavy rainfall was triggered by a mid-level low interacting with a weak cold front and copious amounts of moisture from the Gulf of Mexico. As much as 11.50 inches of rain occurred 9 miles west of Hunt, Texas. This resulted in a massive flood wave that traveled down the Guadalupe River through the Cities of Ingram, Kerrville, and eventually Comfort during the morning hours of July 17. Hundreds of other people along the Guadalupe River and its tributaries had to be evacuated that night and the next morning. The 1987 Guadalupe Flood is unfortunately known for the tragic loss of 10 teenagers' lives and 33 other injuries when a bus and van leaving a church camp encountered the floodwaters.

December 18-23, 1991 – Christmas Flood	This was not a historic event in terms of large rainfall totals. Yet, in terms of the total rain volume that fell from the sky in a single event, this was one of the largest in Texas' recorded history, if not the largest. The Guadalupe River had severe flooding. Two homes flooded near the City of Cuero, and downstream, near the City of Thomaston in the River Haven subdivision, three homes flooded.
Texas Floods of 1998	On the weekend of October 17, 1998, two hurricanes over the Eastern Pacific and a nearby stationary cold front led to disastrous flash flooding along the Guadalupe River. As the storm complex inched slowly east and south, heavy rains of 5 to 15 inches covered downstream portions of Southeast Texas and the Coastal Bend Saturday night into Sunday. At the same time, upstream flood waves were beginning to move into those areas. By Saturday afternoon, homes along the Guadalupe River from Canyon Lake to Seguin were being washed off their foundations. More than 30 inches of rain was estimated over a small area south of San Marcos in 36-hours. Especially hard hit among the downstream communities was the City of Cuero, which saw its downtown area inundated by diverted floodwaters that were more than 2.5 miles away from the main Guadalupe River channel. The event claimed 31 lives and produced $750 million (USD 1998) in property losses. Many of the lives lost were from motorists driving through low-water crossings.

Figure 1-22: Photo from 1998 Floods
Source: Victoria Advocate

DR-1425-TX South Central Texas Floods of 2002	An eight-day heavy rain event began on June 30, 2002, across a broad area of Central and South Central Texas. The heavy rain pattern developed when a low-pressure system over the northern Gulf of Mexico moved onshore into Central Texas and became stationary as deep tropical Gulf moisture continued to feed into the area of instability for several days. High flows along the Guadalupe River produced the first-ever flows over the emergency spillway at Canyon Lake since its construction in 1968. Many of the residents that lost homes along the Guadalupe River in 1998 had rebuilt, only to see their homes carried downstream in 2002. 18 counties within the Guadalupe FPR were issued a Disaster Declaration.
R-1606-TX and EM-3261-TX, September 2005 (Hurricane Rita)	Hurricane Rita was the most intense tropical cyclone on record in the Gulf of Mexico. It moved westward through the Florida Straits, where it entered an environment of abnormally warm waters. Moving west-northwest, it rapidly intensified, achieving Category 5 status on September 21, 2005. It weakened to a Category 3 hurricane before making landfall in Johnson's Bayou, Louisiana, between Sabine Pass, Texas, and Holly Beach, Louisiana. The timing of Hurricane Rita, following on the heels of Hurricane Katrina, compounded the disaster, as Texas was still sheltering evacuees across the Guadalupe FPR when Rita made landfall. Due to the extensive damage, both a Disaster Declaration and an Emergency Declaration were made for all Guadalupe FPR counties.

Figure 1-23: Memorial Day Flood Photo

DR-4223-TX, The Memorial Day Floods, May 2015

In spring 2015, the Guadalupe River Basin experienced several rounds of severe weather, culminating in supercell thunderstorms, dubbed the Memorial Day floods of 2015. Heavy rainfall leading up to the Memorial Day event saturated the soil, intensifying flooding. Between 6 to 8 inches of rain fell in the Hill Country with 10 to 13 inches falling in Blanco County. While the flash flooding event was short-lived, its cumulative impacts, coupled with Tropical Storm Bill, taxed the basin's rivers and lakes. Several reservoir levels came within inches of breaking all-time crest records recorded from a period of record spanning more than 110 years. Another round of severe rainfall and subsequent flooding came in the fall of 2015. On May 29, 2015, Governor Greg Abbott requested a Major Disaster Declaration due to severe storms, tornadoes, straight-line winds, and flooding, which began on May 4, 2015 and continued through June 22, 2015. The Governor requested a declaration for 22 counties, including 16 Guadalupe River Basin

	counties. On May 29, 2015, the President declared a Presidential Disaster Declaration in the State of Texas.
DR-4332-TX, August 2017 (Hurricane Harvey)	On August 23, 2017, Hurricane Harvey was upgraded to a tropical depression. During the next 48 hours, Harvey would undergo a period of rapid intensification from a tropical depression to a Category 4 hurricane. Harvey made landfall along the Texas coast near Port Aransas on August 25 as a Category 4 hurricane and brought devastating impacts. As Harvey moved inland, its forward motion slowed and then meandered back offshore. The southern region of the Guadalupe River Basin was once again severely impacted by flooding during Hurricane Harvey. From late August through early September approximately 2.8 million acre-feet of water was released to the bay from Harvey rainfall. On August 25, 2017, Governor Greg Abbott requested an expedited Major Disaster Declaration due to Hurricane Harvey. The declaration request spanned the period of August 23 to September 15, 2017. The Governor also requested a declaration for Individual Assistance and direct federal assistance under the Public Assistance program for 41 counties, including 10 Guadalupe River Basin counties and Hazard Mitigation statewide. On August 25, 2017, the President declared a major disaster for the State of Texas.

Figure 1-24 provides a visual of the total flood events from 1996 to 2021. The area with the greatest number of events reported is Travis County with a total of 241 reported events.

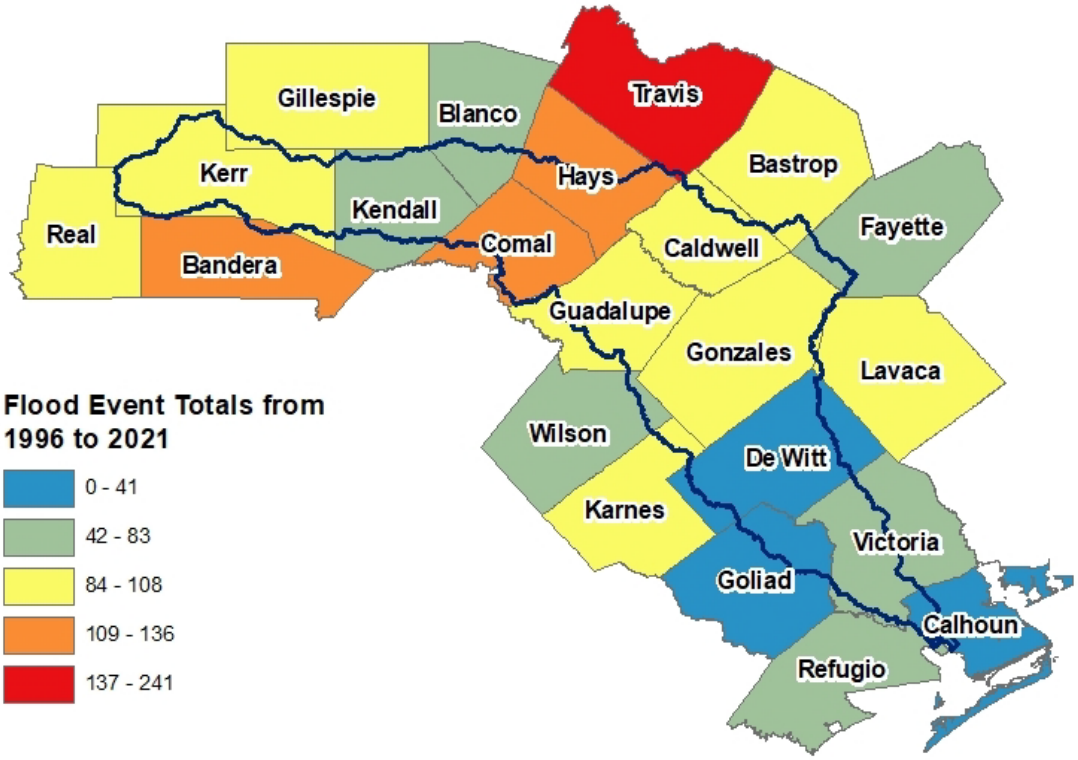


Figure 1-24: Total Flood Events from 1996 to 2021

Source: NOAA (National Oceanic and Atmospheric Administration) National Centers for Environmental Information storm database

According to the NOAA National Center for Environmental Information storm events database, which contains data recorded from 1996 to the present, the Guadalupe River Basin has incurred $1,412,160,426 in property losses and $20,893,020 in reported crop losses (**Table 1-9**). Along with these losses to property and crops, were losses to life and injuries. Of the 2,125 flood events, 96 deaths occurred with 5,636 injuries reported from the Guadalupe FPR.

Table 1-9: Property, Crop Losses, Losses to Life, and Injuries from 1996 to 2021

Counties	Event Totals	Total Deaths	Total Injuries	2022 Property Damage	2022 Crop Damage
Bandera	115	5	26	$11,331,981	$1,771,093
Bastrop	102	2	115	$25,846,604	$344,842
Blanco	77	5	10	$26,380,610	$327,861
Caldwell	100	11	620	$187,835,543	$1,278,101
Calhoun	41	-	-	$1,157,389	$122,716
Comal	136	6	920	$271,788,000	$1,250,885
DeWitt	118	-	1120	$67,452,953	$4,958,309
Fayette	83	1	15	$50,775,000	$600,011
Gillespie	94	4	9	$1,962,732	$315,880
Goliad	38	1	-	$35,381	-
Gonzales	96	-	730	$29,688,962	$2,548,852
Guadalupe	99	8	829	$83,900,496	$832,421
Hays	130	15	177	$271,848,874	$560,662
Karnes	88	0	170	$6,855,667	$869,364
Kendall	81	6	20	$9,888,007	$1,937,690
Kerr	95	3	22	$1,676,697	$327,605
Lavaca	108	1	355	$11,687,537	$1,790,905
Real	91	4	69	$4,362,667	$209,801
Refugio	54	-	-	-	-
Travis	241	23	171	$169,150,085	$362,602
Victoria	66	1	1	$26,558,870	-
Wilson	72	-	257	$151,976,370	$483,420
Totals	**2,125**	**96**	**5,636**	**$1,412,160,426**	**$20,893,020**

Figure 1-25 relates to the total cost in terms of property losses throughout the Guadalupe FPR. While Refugio County reported no losses, significant property losses were reported in Hays County and Comal County.

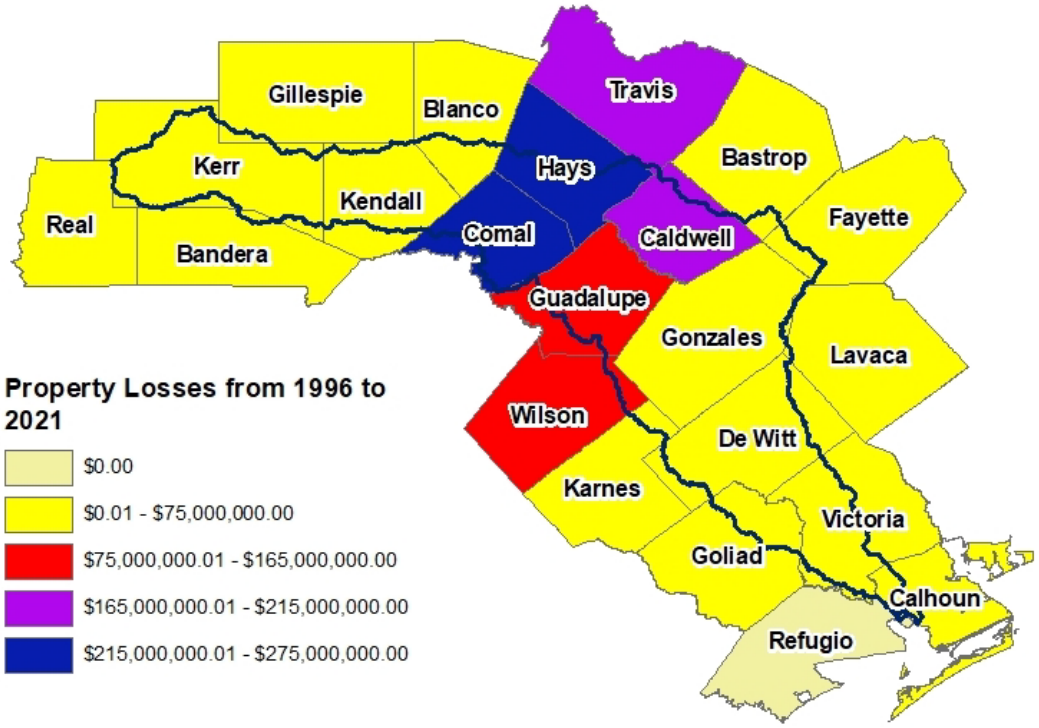


Figure 1-25: Property Losses from 1996 to 2021

Source: NOAA National Centers for Environmental Information storm database

1.2.3 Political Subdivisions with Flood-Related Authority and Local Regulations

Various political subdivisions with flood control authority exist within the Guadalupe FPR. There are some overlapping regulatory responsibilities among the various groups, including potential competing interests and priorities. The administrative rules governing the regional flood planning process, found in Title 31 Chapters 361 and 362 of the Texas Administrative Code, define a political subdivision as, "County, city, or other body politic or corporate of the state, including any district or authority created under Art. 3 § 52 or Art. 16 § 59 of the constitution and including any interstate compact commission to which the state is a party and any nonprofit Water Supply Corporation created and operating under Ch. 67."

Of the political subdivisions referred to above, the majority are municipal or county governments, both of which enjoy broad authority to set policies to mitigate flood risk. TWDB provided a list of 135 political subdivisions, or entities, that were thought to have some degree of flood-related authority in the Guadalupe FPR. Through additional data collection and

outreach, the RFPG gathered information on an additional five entities. A summary of the types of political subdivisions with potential to have flood-related authority within Region 11 are presented below in **Table 1-10**. It is important to note that, in the literal sense, "authority" could be any entity or agency that constructs, maintains, or otherwise touches a drainage system. In its purest sense, "authority" would only indicate entities with the authority to enact and enforce NFIP floodplain regulations, such as municipalities and counties. Throughout this report, distinctions are made to indicate whether the data is referencing all political entities or those with the regulatory authority. Representatives from each political subdivision were solicited to ensure receipt of the highest quality of information for each entity. Of those solicited, 30% responded with data via our data collection tool during the first round of data collection in late 2021. **Chapter 3** presents an evaluation of floodplain management practices throughout the Guadalupe FPR and offers floodplain management recommendations for entities with flood-related authority.

Table 1-10: Political Subdivisions with Potential Flood Related Authority

	Number of Jurisdictions
Municipalities	37
Counties	22
COGs	4
Special Districts (Water, Water Supply, Flood, & Utility Districts (MUDs, FWSDs, MWDs, SUDs, etc.))	72
River Authorities	5

In the Guadalupe FPR, 96.8% of eligible municipalities and 100% of eligible counties participate in the National Flood Insurance Program (NFIP). The Texas Water Code § 16.315 requires NFIP participants to adopt a floodplain management ordinance and to designate a floodplain administrator who is responsible for understanding and interpreting local floodplain management regulations and reviewing them for compliance with NFIP standards. Some of the rights and responsibilities granted under this authority include:

- Applying for grants and financing to support mitigation activities.
- Guiding the development of future construction away from locations threatened by flood hazards.
- Setting land use standards to constrict the development of land that is exposed to flood damage and minimize damage caused by flood losses.

- Collecting reasonable fees to cover the cost of administering floodplain management activities.
- Using regional or watershed approaches to improve floodplain management.
- Cooperating with the state to assess the adequacy of local structural and non-structural mitigation activities.

Common types of development standards are local regulations and development codes, floodplain ordinances, building and design standards, zoning and land use policies, and drainage criteria, each of which are described in the following paragraphs.

Local Regulations and Development Codes

Local regulations and development Codes are the framework that regulates where and what type of development can occur. Codes guide everything from permissible land uses and building densities, locations, and setbacks to street widths and parking requirements. When done well, codes make it easier for a community to implement its vision.

Floodplain Ordinances

FEMA provides a community with flood hazard information upon which floodplain management regulations are based. The community is required to adopt a floodplain management ordinance that meets or exceeds the minimum NFIP requirements. The overriding purpose of the floodplain management regulations is to ensure that participating communities address flood hazards, to the extent that they are known, in all official actions relating to land management and use.

Building and Design Standards

Building and design standards cover everything from the foundation and structural skeleton to indoor environment considerations and service-life calculations. With an eye toward efficiency in energy expenditure for climate control, building and design standards help reduce expenses while raising quality. Such standards can play an important role in protecting buildings from flood events by incorporating hazard mitigation measures into all stages and at all levels of planning and design, both for new and existing structures.

Zoning and Land Use Policies

The purpose of zoning is to promote public health, safety, morals, or general welfare and to protect and preserve places and areas of historical, cultural, or architectural importance and significance. Zoning regulations and restrictions are used by municipalities to control and direct the development of property within their borders. Land use involves the management and modification of natural environment or wilderness into a built environment, such as settlements and semi-natural habitats, such as arable fields, pastures, and managed woods.

Drainage Criteria

The purpose of drainage criteria is to establish standard principles and practices for the design and construction of drainage systems within a designated area. Drainage criteria are created to set the minimum standards for design engineers to follow when preparing plans for construction within the jurisdictions in which they serve. These could be for municipalities or counties within the basin. The document covers standards about submissions, right of way/easements, hydrology, and hydraulics. A storm drain system is defined as a network of open channels and underground pipes designed to capture and convey concentrated stormwater flows to a point beyond the limits of the property being developed. Developers may sometimes oversee creating drainage infrastructure that will be continuous and synergistic with the existing storm drain system and will not prevent surrounding property owners from extracting economic benefits from their properties. As identified by the survey results, only two jurisdictions have indicated that they currently have drainage criteria manuals/design manuals.

Figure 1-26 represents data from the region-wide survey. The data collected indicates the survey respondent's understanding of their jurisdiction's development standards and may not represent actual jurisdictional data.

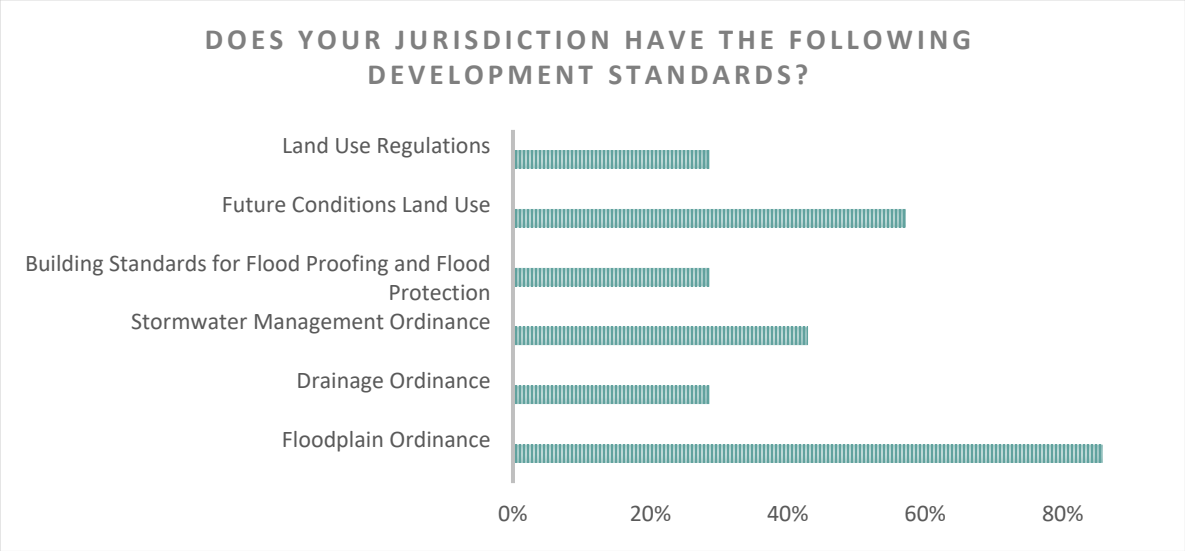


Figure 1-26: Types of Development Standards Identified in Region-Wide Survey

These regulations and ordinances cumulatively:

- Restrict and prohibit land uses that are dangerous
- Control alteration of floodplains, channels, and natural protective barriers
- Describe permitting and variance procedures for land use regulation about flood prevention
- Define the duties of the floodplain administrator

- Specify subdivision and construction standards
- Prescribe penalties for non-compliance to standards
- Define overall rules and regulations for flood control and flood hazard reduction

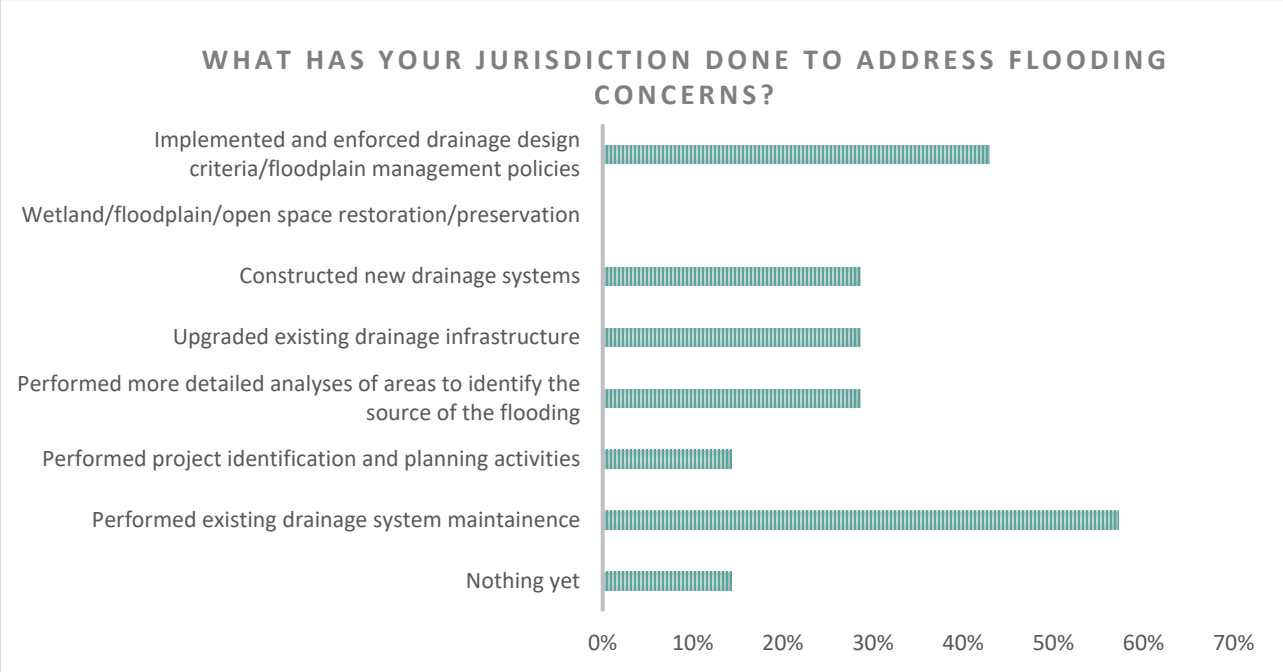


Figure 1-27: Types of Measures to Promote Resilience in Flood-Prone Areas Identified in Region-Wide Survey

1.2.4 Summary of Existing Flood Planning Documents

Several types of previous flood studies were identified and consulted in the development of this Guadalupe Regional Flood Plan (RFP). These include Flood Insurance Studies (FIS) prepared by FEMA, Hazard Mitigation Action Plans (HMAP) for various cities and counties, and U.S. Army Corps of Engineers (USACE) studies. In addition, local flood plans were identified using open-source research, a basin wide survey and call for data, and stakeholder outreach via email, public meetings, and phone calls. The identified types of local planning documents and studies include project- or watershed-specific studies, city-wide drainage masterplans, and capital improvement plans. Relevant content from existing plans have been incorporated into the recommendations of this report. **Appendix 1-A** contains a list of previous flood studies considered in the development of the Guadalupe RFP.

1.3 Assessment – Existing Flood Infrastructure

Understanding the current context of the existing natural and structural flood infrastructure in the Guadalupe FPR is an important step in helping to identify the appropriate strategies and recommendations to reduce flood risk throughout the Guadalupe FPR. Many communities within the Guadalupe River Basin, such as Kerrville, Victoria, San Marcos, and New Braunfels, benefit from flood infrastructure not only where it is located, but in the communities downstream as well. Existing flood infrastructure in the Guadalupe FPR is summarized in **Map 1, Map 3, and Table 1** in **Appendix 1-A**. Examples are provided in **Table 1-11**.

Table 1-11: Examples of Flood Infrastructure

Features	Region Counts	Features	Region Counts
Rivers, tributaries	6,851	Levees	10
Major lakes, reservoirs	7	Dams	220
Parks, preserves, natural areas	90	Pond structures ≥ 1 acre	3,870
Wetlands and marshes	5,217	Local stormwater systems, including tunnels, canals	5
Caves, sinkholes, springs	1,956	Low-water crossings	815
Barriers, gates	1		

Flood infrastructure in the Guadalupe FPR consists of an intricate network of natural areas and built features that are owned and managed by stakeholders ranging from public sector entities to individual property owners. Flood infrastructure may include non-structural measures, such as natural area preservation, buyout of repetitive flood loss properties, flood warning systems, and education/public awareness programs. It may also include all major public infrastructure, such as stormwater systems, detention facilities, and levee systems. TWDB provided numerous data sources to assist with the identification of flood management infrastructure in the Flood Data Hub. The Guadalupe FPR's database was populated with available information from TWDB and many other state and federal datasets, as outlined in the following sections. The multiple data sources were reviewed and amended to only include a single inventory per location.

1.3.1 Natural Features

As pastures and fields are replaced by urban development, the permeability of soil decreases. This makes land less efficient at slowing down rainwater and letting it percolate into the soil and recharge the aquifer. Instead, urban drainage infrastructure often collects rainwater and speeds it directly into a drainage channel and networks. This increases the speed and intensity of runoff, making flood water peak quicker and potentially higher.

From 1997 to 2017, the Texas Land Trends project, by Texas A&M's Natural Resources Institute (NRI), found that the Guadalupe FPR lost over 97,000 acres of working land (crops, grazing lands, timber, and wildlife management) to urban and suburban development. Simultaneously, the population increased by 75% in the Guadalupe FPR during that time as compared to the 48% increase for the state. These developments contain types of hard, oftentimes impervious, surfaces, increase the potential for runoff to burden waterbodies downstream, and increase fragmentation in the area. (Texas A&M Natural Resources Institute, 2021).

As the trend toward urbanization and fragmentation continues, the entities within the Guadalupe FPR will need to take a more thoughtful approach to manage natural infrastructure to continue to receive the benefits of open spaces, something which the USACE addresses in its Engineering with Nature initiatives. These initiatives align natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaborative projects. Currently, state and federal-level governments are managing local, state, and regional parks and wildlife management areas that form part of the Guadalupe FPR's natural infrastructure.

When left in their natural state, landscapes can be very efficient at handling rainfall. As raindrops fall from the sky, they are captured by trees, shrubs, or grasses, which slow their passage to the area's waterways and allow the rain time to soak into the soil. Wetlands and woodlands are most efficient at recycling rainfall, as the branches and undergrowth intercept water before it even reaches the ground, thus minimizing overland flow to tributaries and the river. Pastureland performs this function effectively as well, whereas cropland may shed a greater degree of water so as not to inundate the fields. Similarly, parklands in urban areas that are designed for dual functions can achieve nearly the same rate of capture of stormwater as lands in undeveloped areas. For natural features to achieve maximum effectiveness at flood mitigation, they should form part of an interconnected network of open space consisting of natural areas and other green features that also protect ecosystem functions and contribute to clean air. This is sometimes known as green infrastructure, the practice of replicating natural processes to capture stormwater runoff (Low Impact Development Center, 2021). Even small changes in developed areas can have a significant impact on downstream flooding.

Natural areas can be managed to be even more efficient at these functions in a variety of settings, including:

- **Watershed or Landscape Scale**: Where natural areas are interconnected to provide opportunities for water to slow down and soak in, and to overtop the banks of creeks and channels when needed. These solutions often include multiple jurisdictions and restoration of natural habitats to achieve maximum effectiveness. These areas may be embodied within the river corridors and tributaries which exist in many cities and towns

across Texas. When combined with regional greenway trail and recreation systems, these areas provide multiple benefits beyond just the conveyance of rainwater.

- **Neighborhood Scale**: Solutions built into corridors or neighborhoods that better manage rain where it falls. Communities establish regulatory standards for development that guide the use of neighborhood-scale strategies. These also provide great opportunities for neighborhood recreational connections to the regional greenway system. Some of those solutions could include neighborhood communities requesting annexation from a local municipality to achieve zoning status of "residential'" to provide some land use protections. Alternatively, the neighborhood community could request "park" or "greenway" zoning designations for protection, if those areas exist within the community or subdivision.

- **Coastal Solutions:** To protect against erosion and mitigate storm surges and tidally influenced flooding, nature-based solutions can be used to stabilize shorelines and restore wetlands. (Nature-Based Solutions, 2021)

Rivers, Tributaries, and Functioning Floodplains

The natural flood storage capacity of all streams and rivers and the adjacent floodplains contribute greatly to overall flood control and management. Surface water, floodplains, and other features of the landscape function as a single integrated natural system. Disrupting one of these elements can lead to effects throughout the watershed, which increases the risk of flooding to adjacent communities and working lands.

Maintaining the floodplain in an undeveloped state provides rivers and streams with room to spread out and store floodwaters to reduce flood peaks and velocities. Even in urban areas, preservation of this integrated system of waterways and floodplains serves a valuable function, as even small floods resulting from a 20% ACE (5-year) and 10% ACE (10-year) event can cause severe flood damage.

The Guadalupe River Basin is the fourth largest river basin (6,030 square miles) entirely within Texas and contains the 409-mile Guadalupe River. From the confluence of its North and South Forks in Kerr County, the Guadalupe River flows to San Antonio Bay, which drains to the Gulf of Mexico. The average flow is 1,422,000 acre-ft/year. Other significant streams within the basin include the Blanco, Comal, and San Marcos Rivers and Plum, Peach, Sandies, Johnson, and Coleto Creeks.

To gather the data required for this planning process, the Guadalupe FPR's streams were populated with available information from FEMA, USGS, TWDB, and stakeholders. It should be noted that the streams are compiled from the best available datasets; however, they generally do not always align with the current topography. Along with statewide mapping, TWDB is

developing updated stream layers that can be integrated into the next planning cycle. As displayed in **Table 1-12,** there are more than 4,800 stream miles in the Guadalupe FPR.

Table 1-12: Streams by HUC 8 Watershed

HUC 8 Name	Detailed Studies (miles)	Approximate Studies (miles)	Base Level Engineering (miles)	HUC 8 Totals (miles)	Percentage of HUC 8 (% of total miles)
Upper Guadalupe	91	930	163	1,185	25%
Middle Guadalupe	199	865	248	1,312	27%
Lower Guadalupe	94	819	286	1,198	25%
San Marcos	315	689	109	1,113	23%
East San Antonio Bay*	9	0	3	12	0%
Lower San Antonio*	9	0	0	9	0%
Region Totals	**716**	**3,304**	**809**	**4,828**	**100%**

**Only portions of the HUC 8 are included in the total mileage.*

Source: FEMA Coordinated Management Needs System (CNMS), USGS National Hydrography Dataset, and TWDB provided Major Streams and TNRIS rivers

Lakes, reservoirs, parks, and preserves serve as essential components of the ecosystem, as they house a wide variety of local flora and fauna and physical features that are necessary for the continued ecological health of the Guadalupe FPR. Additionally, these areas can also be essential components of water retention during flooding and severe rainfall events. These types of natural flood infrastructure are generally located in or close to floodplain areas throughout the basin, with higher concentrations of them being located along or close to the major rivers and tributaries. Indeed, in many of the Guadalupe FPR's original core areas of urbanization, such as the communities of New Braunfels, San Marcos, Victoria, and Kerrville, were oftentimes set aside for public parks and green spaces.

Karst Features

With major portions of the Upper Guadalupe and Blanco watersheds overlying the Edwards and Trinity Aquifers, karst features can have a significant impact on flooding, as well as water quality. A search of the Texas Speleological Society (TSS) database resulted in the karst feature counts presented in **Table 1-13** within the Guadalupe River Basin boundary for each of the listed counties. Caves listed as significant for biological, archeological, or paleontological reasons only were not included as major or significant. Springs that were described as being marked on the USGS topographic maps were included in the major or significant count, and some significant springs are connected with significant caves. Note also that some significant caves have more than one entrance and that all entrances have been included in the total caves count, but not necessarily in the major or significant count.

Table 1-13: Karst Features

	Caves	Sinkholes and Cavities	Springs	Major or Significant Caves	Major or Significant Springs
Blanco	3	1	15	0	0
Comal	178	98	38	11	5
Gillespie	1	0	3	0	0
Hays	210	467	54	9	5
Kendall	290	374	67	10	41
Kerr	40	12	105	4	3
Total	**722**	**952**	**282**	**34**	**54**

Significant portions of streams over the Edwards Aquifer show a trend of channel flow losses to groundwater sources as the Edwards Recharge Zone has the capacity to channel large volumes of floodwater underground. The nature of the interaction between surface and groundwater has not been widely studied but can have a noticeable impact on hydrology within the Upper Guadalupe River Basin (TWDB, 2016). Facilitation of groundwater infiltration into underlying aquifers could be a source of flood reduction. Due to the interaction of surface and groundwater within this Guadalupe FPR, stormwater quality from urban and suburban areas is highly regulated by regional and local authorities. Therefore, solutions to flooding problems in karst areas should also be coordinated with water quality control efforts to prevent groundwater contamination (TCEQ, 2007). However, the TCEQ requirement to seal karst features to prevent contamination of groundwater could exacerbate flooding. For this reason, karst features should continue to be protected due to their significant impact on flood reduction and water quality.

Lakes, Reservoirs, Parks, and Preserves

Table 1-14 details the acreage of each of these natural features and the total land area for each HUC 8 within the Guadalupe Basin. The Upper Guadalupe in the northern tip of the basin contains the greatest percentages of lakes, reservoirs, parks, and preserves followed by the Lower Guadalupe and East San Antonio Bay. Middle Guadalupe and San Marcos make up the remaining 9% of the natural features. The portion of the Lower San Antonio HUC 8 studied in this plan is a significantly smaller acreage; therefore, there were no natural features of note. Any waterbody greater than 1,000 acre-ft was included in the major lakes and reservoirs category. Included in the acreage and count for parks are all features classified as municipal, state, or regional parks. For preserves, all features classified as a preserve, wildlife management area, or state natural area were combined.

Table 1-14: Lakes, Reservoirs, Parks, and Preserves by HUC 8 Watershed

HUC 8 Name	Major Lakes, Reservoirs (acres)	Parks (acres)	Preserves (acres)	HUC 8 Totals (acres)	Percentage of HUC 8 Area (% of land)
Upper Guadalupe	8,235	3,788	8,901	20,924	61%
Middle Guadalupe	865	1,037	105	2,008	6%
Lower Guadalupe	4,245	1,009	323	5,577	16%
San Marcos	0	1,018	46	1,065	3%
East San Antonio Bay	0	0	5,001	5,001	14%
Lower San Antonio	0	0	0	0	0%
Region Totals	**13,345**	**6,853**	**14,377**	**34,575**	**100%**

Source: USGS National Hydrography Dataset and TWDB provided Waterbodies and Major Reservoirs, Municipal, County, State, and National Parks

Wetlands and Marshes

Table 1-15: Wetlands by HUC 8 Watershed

HUC 8 Name	Wetlands (acres)	Percentage of HUC 8 (% of land)
Upper Guadalupe	1,547	3%
Middle Guadalupe	211	0%
Lower Guadalupe	22,467	48%
San Marcos	929	2%
East San Antonio Bay	21,046	45%
Lower San Antonio	657	1%
Region Totals	**46,857**	**100%**

Wetlands and marshes are some of the most effective features for recycling water, by minimizing the overland flow and reducing the need for other types of flooding infrastructure. As the Guadalupe River heads southward toward the coast, the concentration of wetlands increases surrounding it. This not only mitigates flooding coming from upstream areas but also flooding coming from the coast in the form of hurricanes and other tropical storms. According to the USGS National Wetlands Inventory, wetlands comprise approximately 47,000 acres in the region. This means that wetlands are one of the largest types of natural infrastructure in the basin.

1.3.1 Structural Flood Infrastructure

Although there are a wide variety of measures Texas communities use to protect themselves from future flooding, such as flood control reservoirs, dams, levees, and local storm drainage infrastructure, dams may provide the most common structural mitigation to regionally reduce future flood risk. Dams in Texas serve many purposes, including flood risk mitigation, irrigation,

water supply, fire protection, and creating water bodies for recreation. About one third of the state's dams are for flood risk mitigation; one in seven dams are for irrigation or water supply.

Dams

USACE maintains a database of dams nationwide, including a total of 7,324 in Texas. The Texas Commission on Environmental Quality (TCEQ) maintains a database of similar state-regulated Texas dams, which include those above the size thresholds of Texas Administrative Code Title 30, Part 1, Chapter 299. Dams of unregulated size are deemed not to provide a safety risk to lives in the event of a breach. Finally, the Texas State Soil and Water Conservation Board (TSSCWCB) maintains a list of 2,041 earthen dams that were designed and constructed by the U.S. Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). These data sources were reviewed and amended to only include a single dam for each location, identifying a total of 220 dams in the Guadalupe FPR. The largest dam is Canyon Lake Dam, which is used primarily for flood control, but also has recreational and water supply uses. The run-of-river dams in Guadalupe County and Gonzales County are primarily for recreation. Coleto Creek Reservoir is used for power plant cooling, as well as recreation. Many of the remaining dams in the Guadalupe River Basin are NRCS regional flood control structures and water and sediment control basins constructed by UGRA based on the NRCS model for regional flood control structures.

Dams can be owned and operated by a wide range of organizations and people, including state and local governments, public and private agencies, and private citizens. Because of the diverse nature of ownership, the capacity of dams and the frequency of inspection may vary widely. Although reasons for building dams may include water storage for human consumption, agricultural use, power generation, industrial use, and recreation, for this report the analyses will focus on how dams are used for flood control purposes.

Levees

Levees are man-made structures that provide flood protection. More than 1 million Texans and $127 billion of property value are protected by levees. The Texas 2018 Levee Inventory Report lists 51 USACE levee systems in the state (Texas Infrastructure Report Card, 2021). These USACE levees are frequently maintained and inspected to federal standards and provide a high standard of flood protection. Although not all are used for flood control purposes, failure of a single levee could have multiple consequences for property and human safety downstream. There are 10 levees in the Guadalupe River Basin, five of which are USACE levee systems.

The Texas Water Code §16.236 requires that the design be based on the 1% ACE (100-year) and provide three to four feet of freeboard in urbanized areas. The Water Code also outlines a review-and-approval process for the construction and improvement of levees after an application filing and a set of preliminary plans for the levee that includes sufficient engineering

detail for evaluation. Applications must include the location and extent of the structure; the location of surrounding levees, reservoirs, dams, or other flood control structures that may be affected; and the location and ownership of all properties lying within any proposed protected area or others who may be affected by the project's alteration of the flood flow. The preliminary plans must demonstrate the effects that the proposed project will impose on existing flood conditions (TCEQ, 2005). **Table 1-16** and **Figure 1-28** provide the number of dams and levees by HUC 8 watersheds throughout the Guadalupe FPR.

Table 1-16: Dams and Levees by HUC 8 Watershed

HUC 8 Name	Dams (count)	Percentage of Region (% of total dams)	Levees (miles)	Percentage of Region (% of total levees)
Upper Guadalupe	49	22%	0	0%
Middle Guadalupe	66	30%	0	0%
Lower Guadalupe	5	2%	5.2	19%
San Marcos	95	43%	0	0%
East San Antonio Bay	3	1%	22.7	81%
Lower San Antonio	2	1%	0.1	0%
Region Totals	**220**	**100%**	**27.9**	**100%**

Source: USACE National Inventory of Dams, USACE National Levee Database, TNRIS

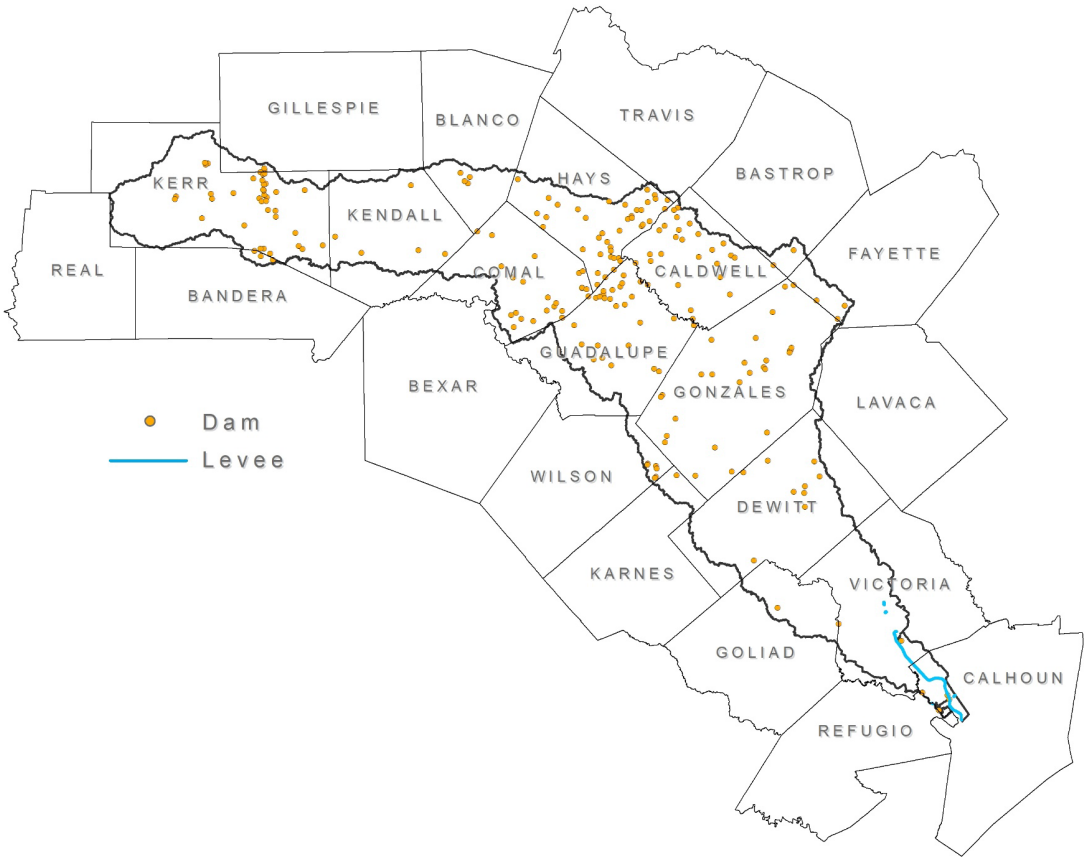


Figure 1-28: Dams and Levees

Stormwater Management Systems

Stormwater management systems serve to manage both the quantity and quality of the water that drains into the Guadalupe FPR's rivers and tributaries. Although survey respondents provided limited information as to their stormwater management systems, participants in the Texas Pollutant Discharge Elimination System (TPDES) which is managed by the TCEQ, are likely to have storm drainage infrastructure.

Five cities in the Guadalupe FPR have a drainage system classified as Phase II Municipal Separate Storm Sewer Systems (MS4s): San Marcos, New Braunfels, Victoria, Kyle, and Schertz.

Table 1-17: Storm Drainage and Roadways

HUC 8 Name	Storm Drain Systems (count)	Low Water Crossings (count)
Upper Guadalupe	0	213
Middle Guadalupe	2	244
Lower Guadalupe	1	21
San Marcos	2	337
East San Antonio Bay	0	0
Lower San Antonio	0	0
Region Totals	**5**	**815**

Source: Submitted community data and TWDB low water crossings

Roadways

Low-water crossings and at-risk roadway segments are utilized to assess existing condition risk, future condition risk, and potential mitigation benefits. TWDB defines a low-water crossing as a roadway crossing that is overtopped by the 1% ACE (100-year) or more frequent events. At-risk roadway segments are portions of the roadway that are inundated or impassable during flooding events that may impact emergency response or evacuation. The primary source for these low-water crossings was Texas Natural Resources Information System (TNRIS) data from 2013, supplemented by stakeholder data. **Section 2.2.5 of Chapter 2** includes additional discussion of the 661 low-water crossings, of the total 815 crossings, that lie within the existing condition flood hazard areas.

1.3.2 Condition and Functionality of Existing Flood Infrastructure

TWDB provided information and research on locations and types of existing flood infrastructure in the region. However, the data did not include information about the condition or functionality of the existing flood infrastructure, and no direct input was provided by survey respondents regarding infrastructure conditions and functionality. As a result, the state of existing infrastructure in the Guadalupe FPR is unknown at this time. In this section, a general discussion of the expected condition and functionality of key types of infrastructure are provided. To provide some level of assessment, the age of dams and levees was utilized where available to provide insight into the state of the Guadalupe FPR's existing flood infrastructure.

TWDB defines functional infrastructure as infrastructure that is serving the current design level of service, whereas a non-functional classification would indicate the infrastructure needs upgrades to meet a higher level of service. Similarly, TWDB defines deficient infrastructure as

being in a poor physical condition indicating the infrastructure needs replacement, restoration, or rehabilitation.

Throughout Texas, flood infrastructure is rapidly aging and in need of repair. In 2019, the Association of State Dam Safety Officials (ASDSO) estimated the cost to rehabilitate all non-federal dams in Texas at about $5 billion. The TSSWCB estimates around $2.1 billion is required to repair or rehabilitate dams included in the Small Watershed Programs. Even though the minority of the dams in the region were constructed for flood control, the consequences of failure can still be severe, with a potential loss of life, agricultural resources, and property. Of the approximately 7,200 non-federal dams in Texas, about 25% could result in loss of life if they should fail, and more than 3,200 Texas dams are exempt from dam safety requirements by state legislation (Texas Infrastructure Report Card, 2021).

Construction completion dates are available for the majority of the 220 dams in the Guadalupe FPR with 75% of dams having been constructed between 1950 and 1979 as shown in **Figure 1-29**. The 1960s were the most prolific period of dam construction in the Guadalupe FPR when more than 42% were constructed. The percentage of dams constructed between 1950-1959 and 1970-1979 was slightly less, at about 32%. According to the American Society of Civil Engineers (ASCE), the typical life span of a dam is 50-years, suggesting that more than 50% of the dams in the region are reaching the end of their life span.

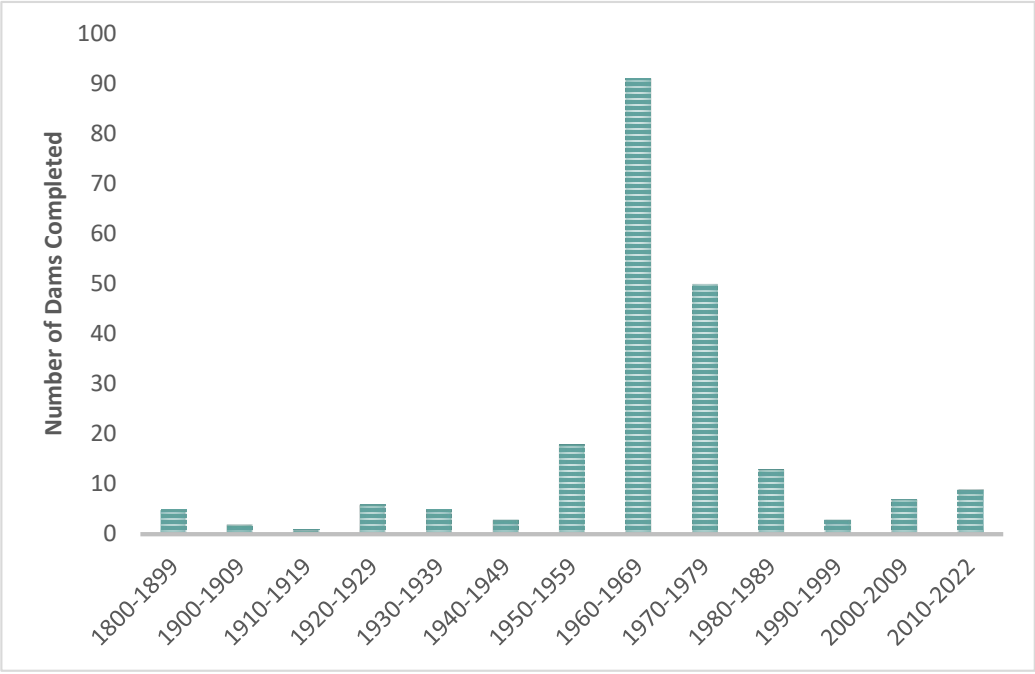


Figure 1-29: Year of Dam Completion for Region 11

Source: USACE National Inventory of Dams, TNRIS

The most common reasons for dam failure include overtopping by floods, foundation defects, piping, and seepage (TCEQ, 2006). Although stakeholders provided information about the nature of their dam infrastructure, the age of these structures alone indicates that many may be due for modernization, upgrades, maintenance, rehabilitation, or even retirement.

In addition, condition-related data for the Guadalupe FPR's levees are mostly unknown, since most of the levees in the state are built, inspected, and/or maintained by local governing agencies that may not have the resources for routine assessment and performance tracking. The Texas 2018 Levee Inventory Report lists 51 USACE levee systems with 291 miles protecting a population of 291,200 and 276 known non-USACE levee systems with 1,562 miles protecting a population of 707,700 statewide. Recent increases in the frequency and intensity of storms and hurricanes continue to test the capacity of the state's levees. Without a clearer picture of the state's levee infrastructure and concentrated funding to assist private owners, the vast majority of the state's levees will remain in the presumed deficient status (Texas Infrastructure Report Card, 2021). Additionally, the ASCE continues to give the state's levees a grade of D and emphasizes that the lack of a state Levee Safety program means that few levees may be conducting regular safety inspections and preparing public evacuation plans for affected communities.

Of the 28 miles of levee in the Guadalupe FPR, approximately 5 miles (16%) of them are identified as being accredited by the USACE. This indicates that several miles of levees within the Guadalupe FPR may be due for modernization, upgrades, maintenance, or rehabilitation.

1.4 Proposed and Ongoing Flood Mitigation Projects

Through outreach and data collection, information was obtained regarding several proposed or ongoing flood mitigation projects in the Guadalupe FPR. This section presents those known flood mitigation projects in the region that have dedicated funding and are therefore expected to be constructed in the near future. These projects are summarized in TWDB-required **Table 2** and on **Map 2** in **Appendix 1-B**. A total of seven ongoing flood mitigation projects were identified:

- City of New Braunfels Goodwin Lane Improvements
- City of New Braunfels Landa Park Aquatics Complex - Green Stormwater Infrastructure Retrofit
- City of San Marcos Sessom Creek Improvements
- City of San Marcos Briarwood and River Ridge Improvements
- Green DeWitt Drainage District Flood Warning System & Stream Gage Network
- Guadalupe-Blanco River Authority Lake McQueeney Spillgate Replacement and Dam Armoring
- Guadalupe-Blanco River Authority Lake Placid Spillgate Replacement and Dam Armoring

It is important to note that there are gaps and limitations provided by this data set. Overall, these projects only represent a small number of the communities within the basin and little data was provided on individual projects. It is anticipated that the inventory of ongoing flood mitigation projects will continue to grow in future planning cycles. In addition to these flood mitigation projects, various flood studies are ongoing in the basin, including Flood Infrastructure Fund Category 1 flood planning studies within Travis, Caldwell, Hays, and Bastrop Counties and the City of New Braunfels, as well as the Texas General Land Office's Combined River Basin Flood Study in the lower reach of the basin. These and other planning studies throughout the Guadalupe FPR are anticipated to produce data and information that can inform the second cycle of regional flood planning.

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Chapter 2: Flood Risk Analyses

Compiling a comprehensive understanding of flood risk as it exists throughout the Guadalupe Flood Planning Region was a critical first step in the creation of this regional flood plan. The current flood risk data, discussed herein, served as a keystone in the regional flood planning process upon which many of the subsequent regional flood planning tasks and decisions were based. Proactive planning for flood risk also requires an assessment of how flood risk could be expected to increase in the future. This chapter presents the findings of a future condition flood risk analysis, based on a no-action scenario of continued development trends, regulations, and population growth during the next 30 years. Flood risks were evaluated for both the 1% annual chance event (ACE) and 0.2% ACE, and incorporated various types and sources of flooding, including riverine, urban, and coastal.

The analyses were performed in three parts:

1. Flood hazard analyses to determine the location, magnitude, and frequency of flooding
2. Flood exposure analyses to identify who and what might be harmed within the region
3. Vulnerability analyses to identify the degree to which communities and critical facilities may be affected by flooding.

Figure 2-1: Flood Risk Analysis Components

The following sections describe the process that was undertaken to determine and quantify flood hazards in the region and present the results of the hazard, exposure, and vulnerability analyses. TWDB-required **Tables 3** and **5** summarize the quantitative results of this analysis by county and are included as **Appendix 2-A**. The maps, charts, figures, and other visuals presented in this chapter are drawn from the data in these tables.

It is important to note that the flood risk data gathered and generated in this task is intended to be used for planning purposes and is not intended for regulatory purposes, such as local floodplain management or by the National Flood Insurance Program (NFIP).

2.1 Flood Hazard

The first and largest step taken toward understanding current and future flood risk was the analysis of the location of flood hazard areas. The purpose was to compile a comprehensive dataset depicting the areas at risk of flooding in the region based on best available information.

2.1.1 Existing Flood Hazard

The effort to compile current flood hazard information in Region 11 relied on best available floodplain modeling and mapping information in the Flood Hazard Quilt dataset provided by TWDB in the Flood Planning Data Hub. The effort did not entail the development of new flood hazard mapping or modeling. The quilt feature was "stitched" together by TWDB from various sources to provide a comprehensive map of statewide flood hazard information. The data came from sources including, but not limited to, FEMA National Flood Hazard Layers (NFHL), Base Level Engineering (BLE), the First American Foundation Data Service (FAFDS), and cursory floodplain data from Fathom.

In locations where mapping information overlapped, the included information followed a hierarchy developed by TWDB based on the relative quality and data coverage. The Guadalupe RFPG adjusted the hierarchy based on the region's data availability and needs. The final, approved hierarchy is provided below in order of descending data source priority.

1. Local Studies[1]
2. FEMA NFHL (https://msc.fema.gov/portal/home)
    a. Pending flood hazard data
        i. This data has flood hazard information comprised of the most recent detailed and approximate studies that are pending release as an effective Flood Insurance Rate Map (FIRM). This data is (in a very broad sense) considered the best available data of the compiled data sets.
    b. Preliminary flood hazard data
        i. This data has maps of flood hazard areas issued for public review and awareness of proposed change. Next steps to effective map include addressing public comments and finalization. This data includes both detailed and approximate study data.
    c. Effective flood hazard data (detailed study areas only)
        i. This data has flood hazard information that includes detailed studies (Flood Zones AE, AO, AH, and VE) and is the current effective FIRM.
3. FEMA/USGS/TWDB Estimated Base Flood Elevation Viewer BLE data (https://webapps.usgs.gov/infrm/estbfe/)

[1] No Local Studies were identified for use in this analysis.

   a. This data contains flood hazard information created by approximate BLE that can be used as best available information where approximate Zone As on the effective FIRM exist. This data is not intended to replace FIRM flood hazard data found in a detailed study area.
4. NFHL Effective Data (approximate study areas only)
   a. This data has flood hazard information that includes approximate studies (Flood Zone A) on the effective FIRM map. Where approximate Zone As exist on the effective FIRM, there is no effective detailed study information.
5. First American Flood Data Services (FAFDS)
   a. This data contains digitized flood hazard information from previously published FIRMs and is not available on the NFHL. Even if certain areas in this data set include detailed study (such as AE zones), it is likely very old, so it is anticipated that BLE data is more accurate.
6. Cursory Floodplain (Fathom 3m) (Provided October 2021) (https://firststreet.org/flood-factor/)
   a. The Cursory Floodplain dataset is considered approximate due to the coarse level of detail and is intended only to be used in areas where no other data is available.

Because of the high availability of detailed floodplain mapping and data in the region, the coarser data included in the quilt, such as the paper FIRMs digitized by the First American Flood Data Service and the Fathom cursory floodplain datasets, were not used. As depicted in **Figure 2-2**, FEMA's effective and preliminary NFHL and BLE data were utilized.

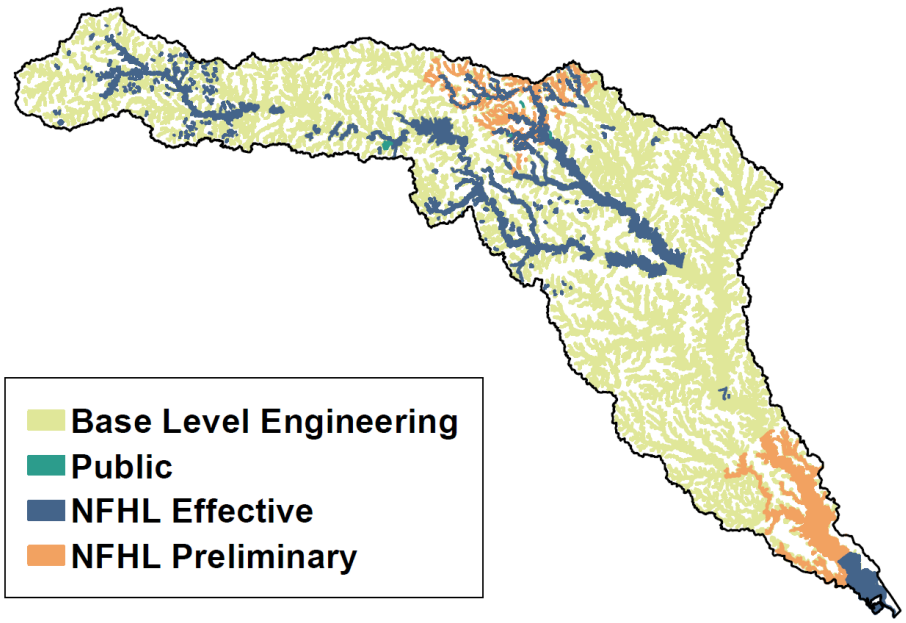


Figure 2-2: Flood Hazard Data Sources

The models supporting the FEMA NFHL and BLE data used in this task are listed in the List of Existing Hydrologic and Hydraulic Models (**Appendix 2-C**). A handful of other models exist from local communities' past flood risk and feasibility studies. These models are listed in the table but were not used to develop existing flood hazard information in this task.

In addition to the Flood Hazard Quilt data provided by TWDB, members of the public and regional stakeholders were provided the opportunity to identify additional flood-prone areas not included in the existing data using an online interactive map. Users were asked to provide input as points and polygons on flood hazard areas based on their understanding of local flooding problems, for example, based on historic flooding events. Sixty responses were recorded, identifying points of flood risk on the map. A large majority of the points were found to be within existing flood hazard areas. Those that were outside known floodplains were digitized into polygons to represent areas of likely inundation based on topography and the content of the survey responses, resulting in a total of 1.27 square miles of additional flood prone areas identified.

Results of the current condition flood hazard analysis indicate that more than 1,169 square miles and 19% of the land area in Region 11 are at risk of flooding. Of the mapped flood hazard area, 986 square miles are at risk during the 1% ACE, and an additional 183 square miles are at risk during the 0.2% ACE flood. Potential flood prone areas of unknown flood frequency identified by the public account for less than 1.3 square miles of total area across the region. **Appendix 2-A** contains a series of flood hazard area maps under existing conditions. Combined, these maps serve as TWDB-required **Map 4**: Existing Condition Flood Hazard. **Figure 2-3** depicts an overview of the coverage of these floodplain and flood prone areas within Region 11. In the following section, **Figure 2-5** presents the total area of existing and future condition floodplains and **Figure 2-6** displays the results by county.

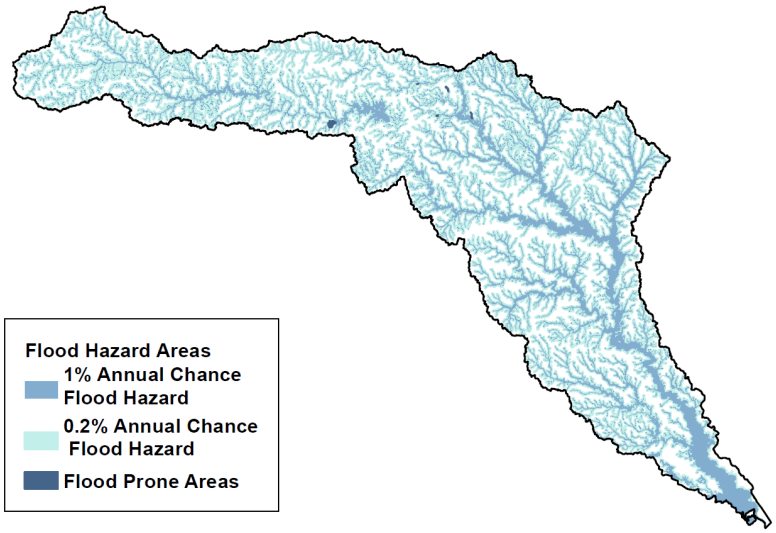


Figure 2-3: Flood Hazard Areas Overview

The areas of flood risk identified through this planning process are primarily associated with riverine systems, with coastal flooding only accounting for less than one square mile of the 1,169 square miles of land area at flood risk during existing conditions and the 1,384 square miles of land area subject to future condition flood risk. A limited amount of coastal flood risk is identified by the National Flood Hazard Layer along the shore of Mission Lake, Haynes Bay, and the San Antonio Bay. Therefore, the main types of risk reported in the flood hazard analysis are riverine and coastal. In future cycles of regional flood planning, there may be opportunity to

Riverine Flooding:

Caused by bank overtopping when the flow capacity of rivers is exceeded. Rising water generally originates from high intensity rainfall creating soil saturation and large volumes of runoff.

Urban (Pluvial) Flooding:

Caused by the inflow of stormwater in urban areas exceeds the capacity of drainage systems, causing flooding out into streets and nearby structures.

Coastal Flooding:

Occurs when normally dry, low lying land is flooded by seawater.

Figure 2-4: Types of Flooding

include other types of risk, such as urban and pluvial flood risk. **Figure 2-4** describes these three types of flooding in greater detail.

As mentioned previously, the Guadalupe FPR benefits by being data-rich, with numerous FEMA and BLE detailed floodplain mapping efforts previously performed. The coverage of these flood hazard maps in the region allowed this task to be completed using relatively high-quality data. This level of data quality and availability is not the reality for many of the other flood planning regions in the state.

2.1.2 Future Flood Hazard

History has demonstrated that flood hazards tend to increase over time in populated areas due to projected increases in impervious cover, change in sea level and land subsidence, sedimentation in flood control structures, and other factors, such as floodplain encroachment, that result in increased or altered flood hazards.

Future condition flood risk analyses were performed to determine the potential extent of both the 1% and 0.2% ACE flood hazard areas based on a 30-year future forecast period. This analysis was used solely for the purpose of roughly estimating the general magnitude of potential future increases in flood risk under the equivalent of a "do-nothing" or "no-action" alternative within the regional flood planning context and should not, in any way, be used for developing new flood hazard maps for any regulatory purposes.

The first step of the task was to identify areas within the region where future condition hydrologic and hydraulic model results and maps were available for use. No available future condition models were identified in Region 11. In areas where future condition flood hazard data is not available, TWDB outlined the following four methods for performing future condition flood identification, which are summarized in **Table 2-1** below.

Table 2-1: Future Condition Hazard Analysis Methodologies

Method	Description	Explanation
1	Increase water surface elevation based on projected percentage population increase (as proxy for development of land areas)	Method 1 involves making certain assumptions about development and then estimating correlations between impervious cover changes and changes to flood elevations. These results would vary based on a watershed's land use, soil type, and topography. TWDB acknowledges that population increases do not always lead to impervious cover increases, but this simplified approach can be utilized if desired.
2	Utilize the existing condition 0.2% ACE floodplain as a proxy for the future 1% ACE level	Method 2 utilizes existing modeling and mapping to create the future condition 1% annual exceedance flood hazard. However, it does not yield a future 0.2% flood hazard area, so a methodology will need to be used by the RFPG to determine the future 0.2% flood hazard area. TWDB notes that this method may be more appropriate in areas with high-growth rates that are categorized as urban or suburban.

Method	Description	Explanation
3	Combination of methods 1 and 2 or an RFPG-proposed method	Method 3 is a combination of the first two methods. As with the other methods, the rational/determination should be well-documented.
4	Request TWDB perform a Desktop Analysis	Method 4 has TWDB perform a desktop analysis to determine the future condition flood hazard boundaries. This would be primarily utilized in areas where the locations do not have future condition flood hazard data already available.

The RFPG elected to use Method 2 to develop the future condition flood hazard data, using the existing 0.2% ACE floodplain as a proxy for the future 1% ACE floodplain. To develop the future 0.2% floodplain, the RFPG elected to use BLE data as a starting point for the analysis, due to the full coverage of this dataset throughout the basin. The difference in water surface elevations between the existing 1% and existing 0.2% ACE floodplains from the BLE dataset were calculated. That calculated elevation difference was added to the existing 0.2% BLE water surface elevation as a vertical buffer and was mapped against the existing terrain to create the future 0.2% floodplain. When compared to the existing 0.2% floodplain, there were a few instances in the upper reaches of small tributaries where the future 0.2% floodplain was smaller than the existing 0.2% floodplain. This was due to the fact that BLE in that area (used for this future flood hazard analysis) represented smaller flood hazard area boundaries than the effective NFHL layers used in the area for the current flood hazard analysis. In these locations, a horizontal buffer was established by measuring the horizontal difference between the existing 1% and 0.2% floodplains, and the buffer was added to the existing 0.2% floodplain to create the boundary for the future 0.2% floodplain. The results in these areas were merged with the vertical buffer results to create a complete future 0.2% flood hazard area dataset.

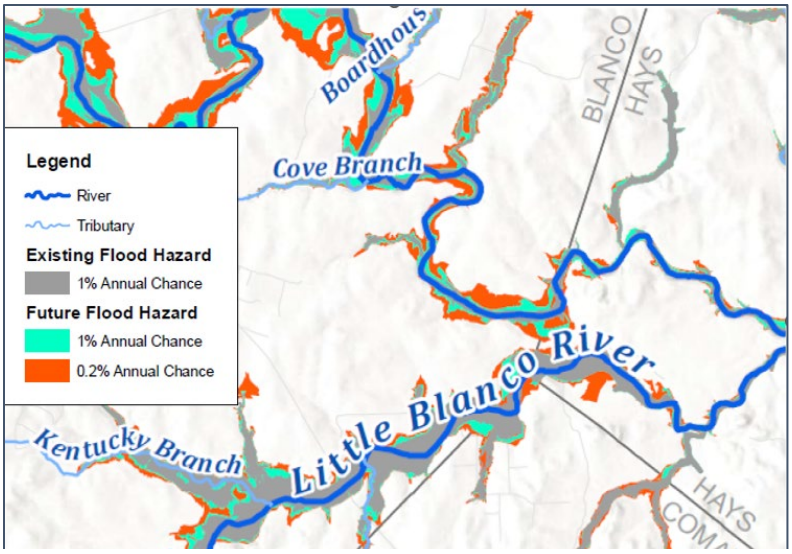
TWDB requires that the future condition flood risk analysis includes consideration of impacts from flood mitigation projects that are currently in progress, have dedicated construction funding, and are scheduled for completion prior to the adoption of the next state flood plan. During this expedited first planning cycle, models and data supporting the ongoing flood mitigation projects in the region were unobtainable, so the data did not exist to modify the existing flood hazard layer for these projects. To include these ongoing projects' floodplain delineations in the future condition flood hazard analysis, individual project models would need to be compiled, reviewed, and incorporated into the analysis. In addition, models would require calibration to ensure that inputs and assumptions were the same throughout the region. These requirements were deemed infeasible for the first cycle of regional flood planning; however,

this information may be included in the next cycle. Additional detail regarding the types of ongoing mitigation projects in the region can be found in **Chapter 1**.

The future condition flood hazard analyses indicate significant projected increases in flood hazard under a 30-year, no-action scenario. Overall results for the current and future condition analyses are presented in **Table 2-2**. **Appendix 2-B** contains a series of flood hazard area maps under projected future conditions. Combined, these maps serve as TWDB-required **Map 5**: Future Condition Flood Hazard. **Figure 2-5** depicts a snapsot of one of these maps, showing the current 1% ACE floodplain in gray, the future 1% ACE floodplain in teal, and the future 0.2% ACE floodplain in orange.

Table 2-2: Existing vs. Future Condition Flood Hazard Area Comparison

Figure 2-6 presents the total flood hazard area by county. Counties with total flood hazard area in Region 11 less than 2 square miles are excluded for clarity. This includes Lavaca, Travis, Bandera, Refugio, and Gillespie Counties, which lie mostly in bordering flood planning regions.



Overall, Gonzales, DeWitt, and Victoria Counties have the highest total flood hazard area, with more than 220 square miles of existing condition flood hazard area in Gonzales County and more than 130 square miles of existing condition flood hazard area in DeWitt and Victoria Counties.

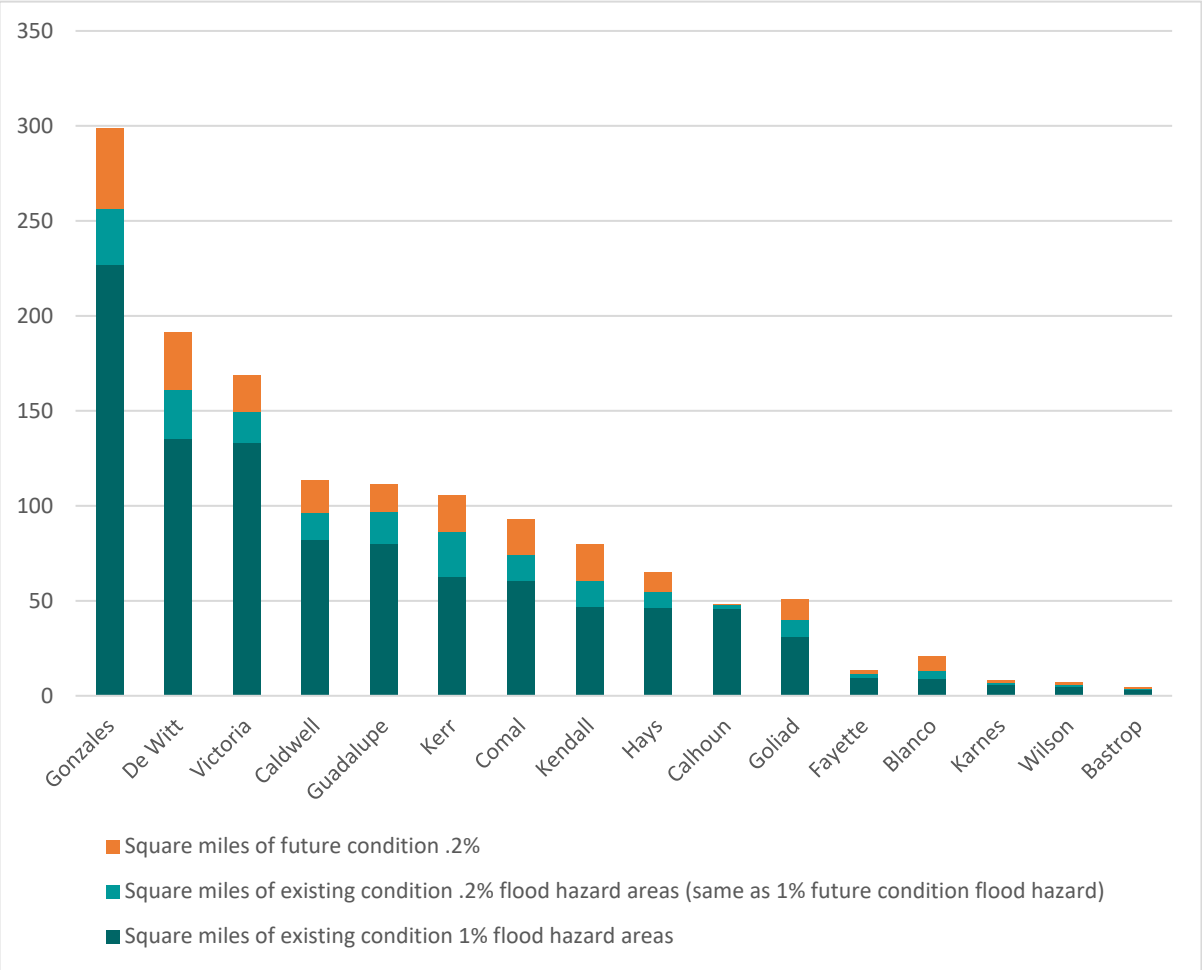


Figure 2-6: Flood Hazard Area by County

2.1.3 Flood Hazard Data Gaps

Although the Guadalupe FPR is relatively data-rich in comparison to other flood planning regions across the state, there are gaps and limitations in the data used to produce the existing and future condition flood hazard analyses. This section discusses those gaps and limitations and describes some of the key sources of data used.

A gap analysis was performed to identify areas needing updated flood hazard modeling and mapping. Through the analysis, the following five types of flood mapping gaps were identified:

1. Outdated FEMA NFHL data greater than 10 years old
2. Absence of detailed hydrologic and hydraulic models where BLE was used

3. Absence of modeling and mapping utilizing NOAA Atlas 14 rainfall data
4. Absence of future conditions modeling
5. Flood-prone areas where modeling is needed to determine frequencies

The coastal portion of Guadalupe FPR along Calhoun and Refugio Counties, has FEMA NFHL effective data that was published in 2018; however, the underlying study supporting the mapping in this area is more than 10 years old. By this gap analysis, this area is identified as needing updated modeling and mapping. BLE was used as a source for flood hazard data in much of the basin, as noted in **Figure 2-2**. The areas where BLE was used are identified as a gap area where more detailed mapping and modeling is needed.

In the western portion of DeWitt County within Region 11, the updated NOAA Atlas 14 rainfall data did not indicate increases in rainfall frequency. For the majority of the region, NOAA Atlas 14 data indicates that the 1% ACE may be greater than what was previously considered in many areas due to higher rainfall amounts. New modeling that incorporates this new rainfall data is needed to appropriately map increased flood risk.

No hydrologic or hydraulic models were identified for future conditions. As a result, the entire region is considered a gap under future conditions, and the creation of future conditions models and maps are needed region-wide. Lastly, the additional flood prone areas identified by the public and stakeholders through the outreach efforts described in **Section 2.1.1** are included as a gap area, where additional modeling and mapping are needed to further analyze the flood hazard and determine flood frequencies.

This information is presented visually in **Map 5**: Existing Condition Flood Hazard – Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas (**Appendix 2-A**) and **Map 9**: Future Condition Flood Hazard – Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas (**Appendix 2-B**). The unavailability of extensive future flood models and associated mapping data resulted in the future flood hazard mapping assumptions and approach discussed earlier. Therefore, the same data gaps exist for future flood hazard mapping as the existing conditions mapping, since the existing conditions were used to develop the future extents.

2.2 Flood Exposure

2.2.1 Overview

After locating areas of flood hazard throughout the region, the next major step in the analysis of risk was to perform an exposure analysis to identify who (people) and what (buildings, infrastructure) could be harmed in those identified areas of flood risk. The exposure analysis was completed using an automated GIS process that intersected various datasets with the flood hazard area boundaries to quantify the exposure of various feature types. The analysis considered exposure of different types of development within flood hazard areas, including:

1. **Buildings**: including residential and non-residential structures, those structures identified as critical facilities, and the associated population at risk. Both daytime and nighttime population estimates were generated by TWDB for each structure, with the higher of the two values being used to estimate the population for this analysis.
2. **Roadways**: including estimated number of roadway-stream crossings and total roadway length inundated by flooding.
3. **Agricultural Areas**: including the total area of farming and ranching lands within the flood hazard area.

TWDB requires the exposure analysis to be performed under both existing and future condition flood risk, using the existing and future condition flood hazard results discussed in **Section 2.1**. This exposure information will be used to not only identify areas within the region that have the greatest flood mitigation and study needs but to serve as a basis of comparison when assessing benefit of potential mitigation studies, projects, or strategies.

Table 2-3 below provides a summary of the Guadalupe FPR's existing condition flood exposure results. The information is further summarized in **Table 3** provided as **Appendix 2-A**. **Appendix 2-A** also contains a series of flood exposure maps under existing conditions. Combined, these maps serve as TWDB-required **Map 6**: Existing Condition Flood Exposure.

Table 2-3: Summary of the Guadalupe FPR's Existing Condition Flood Exposure Results

Exposure Feature Type	Flood Hazard Frequency			TOTAL
	Existing 1%	Existing .2%	Unknown*	
Total Structures	27,069	18,447	285	45,801
Structures: Residential	18,879	12,952	271	32,102
Structures: Non Residential	8,190	5,495	14	13,699
Critical Facilities	135	87	0	222
Roadway Stream Crossings (count)	2,872	330	4	3,206
Roadway Stream Crossings (miles)	935.2	438.4	5.9	1,379.5
Agricultural Land (sq miles)	562.9	126.7	0.5	689.6
Population	63,857	52,575	696	117,128

*Only includes the additional features that are exposed to flood risk in the .2% storm event and does not include the features that are accounted for within the existing 1% flood risk area.
**Additional flood prone areas identified by the public and stakeholders have an unknown

Table 2-4 shows the results of the future condition flood exposure analysis and summarizes the projected relative increase for each exposed feature type under future conditions. Because the future flood hazard layer resulted in larger mapping extents when compared to the existing conditions floodplain quilt, the number of people and structures at risk in the future conditions flood exposure analysis is larger than existing. **Appendix 2-B** also contains a series of flood exposure maps under future conditions. Combined, these maps serve as TWDB-required **Map 11**: Future Condition Flood Exposure.

Table 2-4: Results of the Future Condition Flood Exposure Analysis

Exposure Feature Type	Flood Hazard Frequency		TOTAL FUTURE	TOTAL EXISTING	% INCREASE
	Future 1%	Future .2%			
Total Structures	49,736	21,765	71,501	45,801	56.1%
Structures: Residential	36,035	16,981	53,016	32,102	65.1%
Structures: Non Residential	13,701	4,784	18,485	13,699	34.9%
Critical Facilities	222	88	310	222	39.6%
Roadway Stream Crossings (count)	3,206	340	3,546	3,206	10.6%
Roadway Stream Crossings (miles)	1,379.5	415.7	1,795.2	1,379.5	30.1%
Agricultural Land (sq miles)	657.1	150.9	808	689.6	17.2%
Population	126,607	64,569	191,176	117,128	63.2%

*Only includes the additional features that are exposed to flood risk in the .2% storm event and does not include the features that are accounted for within the future 1% flood risk area.

The following sections explore the results of the existing and future condition flood exposure analysis in greater detail. For each exposure type, a heat map shows the relative concentration of features exposed to existing condition flood hazard in each county. Additionally, a sensitivity bubble is included for each county to represent the relative increase in change in exposure under future conditions as compared to existing conditions. A larger bubble indicates that exposure increases more dramatically under future conditions for a given exposure type within that county.

A consideration of population and property located in areas where existing levees do not meet FEMA accreditation is also required by TWDB as a part of this exposure analysis. Levees not meeting FEMA standards are to be considered as inundated by flooding for this analysis. There is one levee within Region 11 that was determined to be de-accredited, and the flood hazard area in the levee location already reflected an overtopping of the levee during a 1% ACE. Therefore, no revisions were required, and it was assumed that the current floodplain limits properly reflect the lack of flood protection benefit of the levees.

A key limitation of this exposure analysis is that the automated GIS process used does not account for the height of exposed features or the depth of flooding due to the unavailability of necessary data to support that type of analysis. This means that, for example, some of the structures considered as exposed in this analysis may have a first floor that is higher in elevation than the depth of flooding, meaning that floodwaters would not enter and damage the building. The same goes for exposed roadways; it is possible that some roadways are elevated above the 1% ACE elevation. This exposure analysis may be refined and improved upon in the second cycle of regional flood planning, depending on data availability.

2.2.2 Residential Structures

Residential structures account for a large majority of the buildings currently exposed to flood hazard within Region 11, with 32,102 of the 45,801 total structures at risk being residential. **Figure 2-9** depicts the relative concentration of exposed buildings within Region 11 counties. The five counties with the highest number of residential properties in the existing condition flood hazard area are, in descending order, Comal, Guadalupe, Hays, Kerr, and DeWitt Counties. These counties contain the Cities of New Braunfels, Canyon Lake, Seguin, San Marcos, Kerrville, and Cuero. Outside of these areas, the next highest residential property counts under existing conditions are in Victoria, Gonzales, Caldwell, and Blanco Counties. The remaining 11 counties have drastically lower counts comparatively, with fewer than 100 residential structures in the existing condition flood hazard area in each. This is primarily due to the fact that many of the counties have only very small amounts of land area within Region 11, being located largely within other flood planning regions.

TWDB requires the identification of areas where development might occur within the next 30 years if the current land development practices in the region continue as a part of the future condition flood exposure analysis. It is inherently difficult to project exact locations of future

development, but an effort was made to estimate general areas that may see population growth within the next 30 years.

Starting with the TWDB 2022 State Water Plan population growth projections, the RFPG used the Water User Groups to distribute projected growth at a more granular scale than the HUC10 watersheds. This resulted in a variation of projected population growth density as show in **Figure 2-7**. The areas most likely for development to occur were identified by comparing factors that both favor and disfavor development.

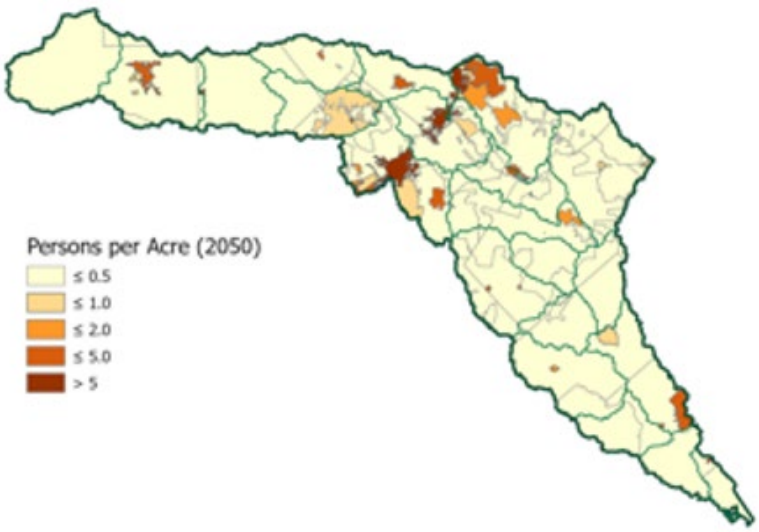


Figure 2-7: Projected Population Growth Density

Factors that favor development included proximity to highways and major roadways, areas experiencing recent development, and areas of existing development. Factors that restricted future development included existing floodplains and floodways, wetlands, parks, and nature reserves. The positive and negative growth attributes were overlaid in GIS software to identify areas that are more likely to develop by the years 2030, 2040, and 2050. An example of the projected growth areas is shown in **Figure 2-8**.

Once the likely to develop areas were identified, the refined population density growth data was used to estimate the number of new building footprints and population assigned to each building, and the footprints were distributed based on the highest likelihood of future development. For this analysis all buildings were assumed to be residential in nature. After estimating the likely number and distribution of future buildings, the new and existing building footprints were compared to the future flood hazard layer to determine the potential future flood risk exposure.

Figure 2-8: Projected Growth Areas

The future exposure analysis indicates that approximately 20,914 more residential buildings will be newly exposed to flood hazard under future conditions. This represents a 65.1% increase from existing conditions. These increases are the result of a combination of two factors: a projected increase in the extents of the flood hazard areas leading to existing buildings being newly exposed, as well as projected development of new structures in these areas, determined by the process described in the previous paragraphs. Bastrop, Caldwell, Hays, Blanco, and Gillespie Counties are projected to see the greatest relative increases in residential structures exposed to flooding, as depicted by the larger green sensitivity bubbles in **Figure 2-9**.

The general population of people can be put at risk by flood waters in a multitude of ways, such as at home, at work, commuting, or traveling to seek shelter. Population numbers for this flood exposure analysis are based on the TWDB-provided buildings layer with all populations being assigned to buildings. Thus, it is not indicative of people who are traveling in and out of the region or who might temporarily be in the area. Consequently, the distribution of population in this analysis aligns with the distribution of structures described in this section. **In total, there are an estimated 117,128 people currently exposed, and there are projected to be a total of 191,176 people (63.2% increase) exposed to flooding under future flood conditions.**

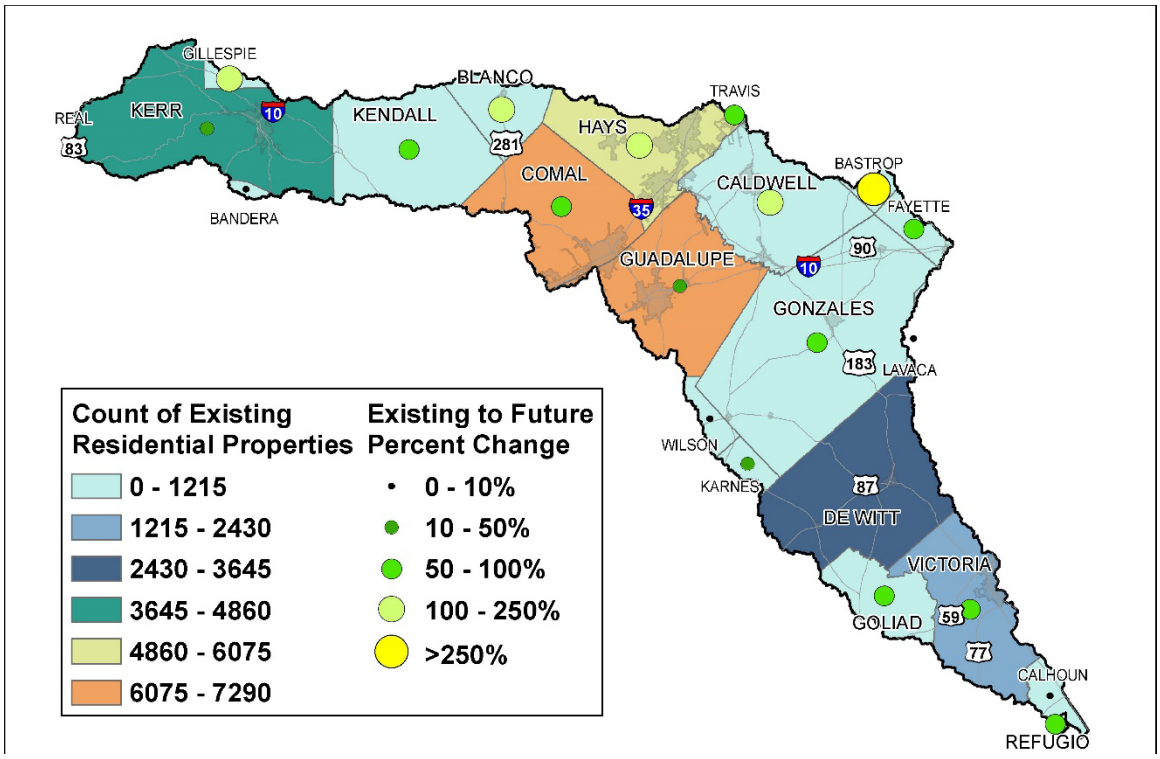


Figure 2-9: Residential Property Exposure

2.2.3 Non-Residential Structures

Non-residential structures within the flood hazard area follow a somewhat similar exposure pattern as residential structures with the same five counties containing the highest number of structures exposed under current flood conditions. Within the top five, however, the counties with the highest exposed residential versus non-residential structures vary. In descending order, the counties with the highest numbers of non-residential buildings at risk of flooding are Kerr, Comal, Hays, DeWitt, and Guadalupe Counties. The next highest non-residential building counts are in Gonzales, Kendall, Victoria, Caldwell, and Goliad Counties. The remaining 11 counties have drastically lower counts comparatively, with fewer than 100 non-residential structures in the flood hazard area in Region 11, with each, again, primarily due to many of these counties being predominantly within other flood planning regions. The number of non-residential structures in the existing flood hazard area is summarized in **Figure 2-10**. **Region-wide, there are approximately 13,699 non-residential structures exposed to flooding under current conditions.** The composition of non-residential structures within the region includes 5,058 commercial, 4,891 agricultural, 1,183 public, 140 industrial, and 2,427 vacant or unknown type.

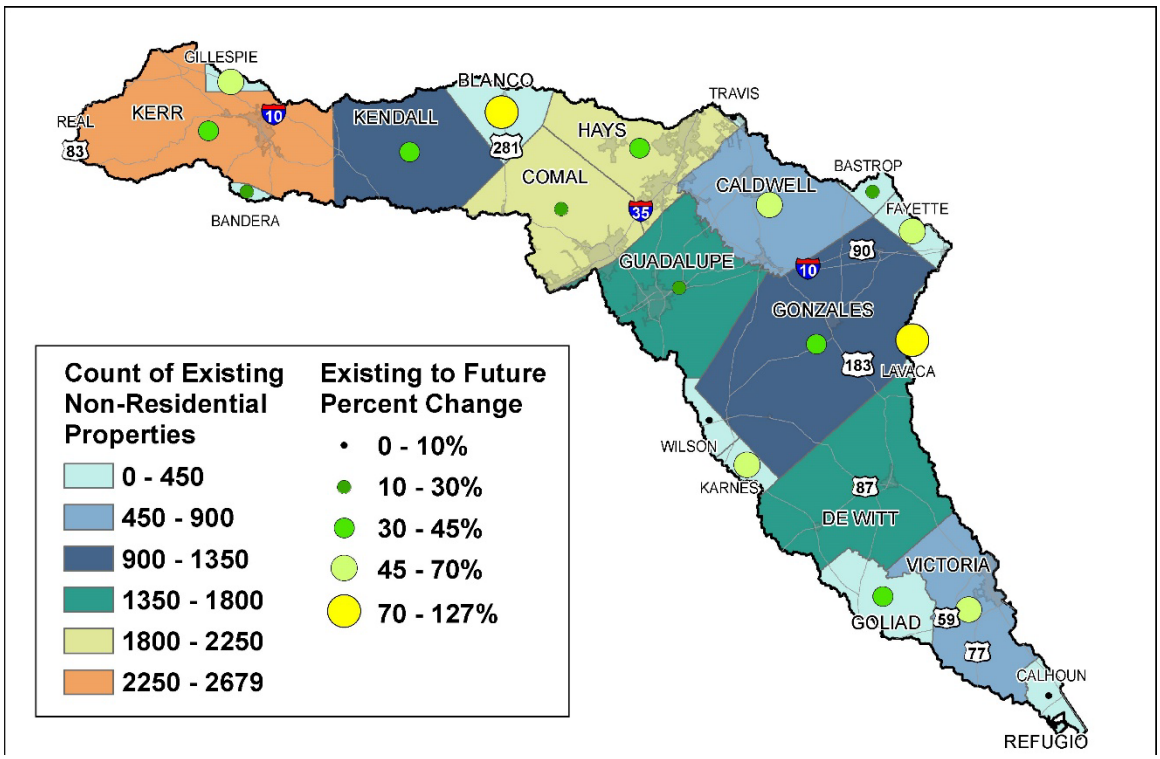


Figure 2-10: Non-Residential Property Exposure

Under future conditions, the number of non-residential structures are projected to increase 34.9%, with a new total of approximately 18,485. Blanco, Lavaca, Gillespie, Caldwell, Fayette, Karnes, and Goliad Counties are positioned to receive the bulk of those additional non-residential structures. These increases are due to existing non-residential structures being newly exposed in enlarged future flood hazard areas.

2.2.4 Public Infrastructure and Critical Facilities

Public infrastructure is a broad term that includes roads; public water collection, treatment, and distribution facilities; gas and electrical facilities; and other public utilities. These facilities often perform essential functions that require enhanced levels of flood protection, so that they may continue to function and provide services during and after a flood. As a result, a concentrated effort to identify "critical facilities" was performed in the flood exposure analyses. Examples of critical facilities include hospitals, fire stations, police stations, power generation facilities, water or wastewater treatment facilities, and schools. **A total of 222 critical facilities were identified as potentially exposed to flood risk within Region 11. Table 2-5** provides a count for each type of critical facility. The most common type of critical facilities within the existing flood hazard areas are schools and power generation facilities.

Table 2-5: Number of Critical Facilities

No. of Critical Facilities	
Medical	13
Fire	21
Other	24
Infrastructure	11
School	90
Power Generation	52
Wastewater Treatment	11
TOTAL	222

Figure 2-11 depicts the relative concentration of exposed critical facilities within Region 11 counties. The majority of critical facilities exposed to flooding currently lie within Victoria, DeWitt, and Comal Counties, but other major clusters include Hays, Guadalupe, and Caldwell Counties. **An additional 88 existing critical facilities (39.6% increase) are projected to be newly exposed under future conditions due to larger floodplain extents encroaching into areas with critical facilities, bringing the total number of exposed critical facilities to 310 in the future.** The additions, visualized below by the larger green sensitivity bubbles, are primarily in Kendall, Gonzales, Goliad, and Blanco Counties.

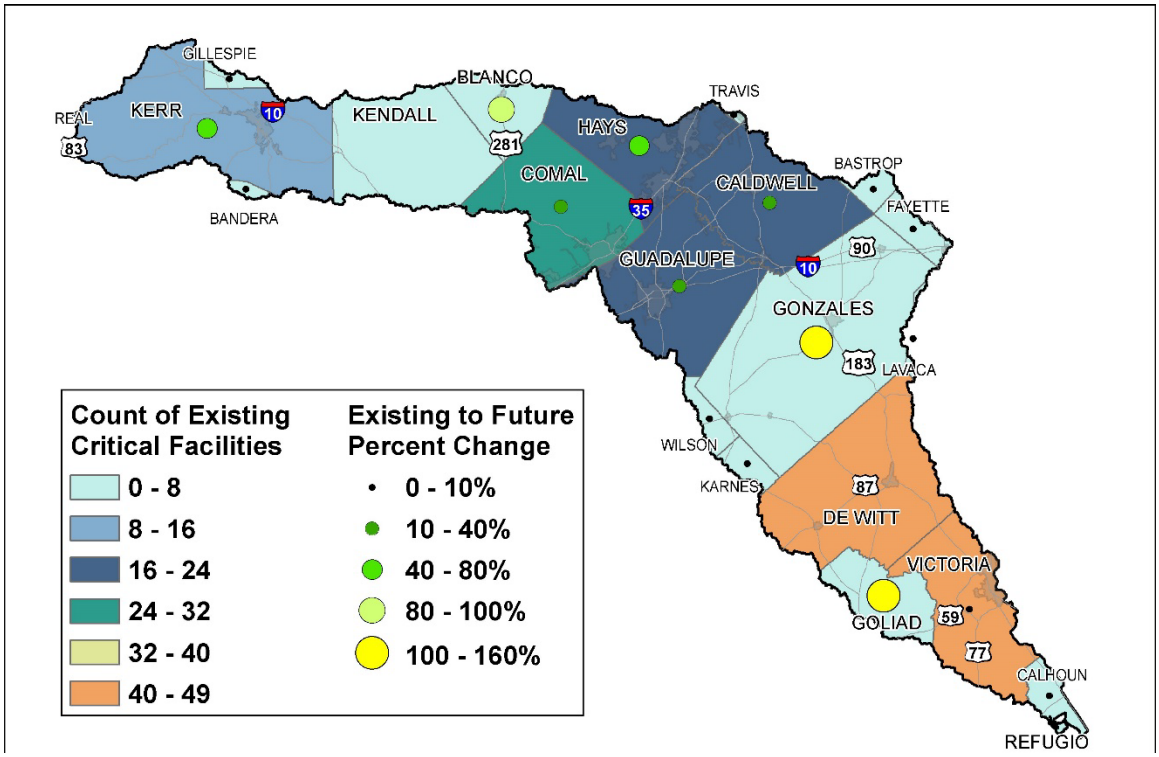


Figure 2-11: Critical Facilities Exposure

2.2.5 Roadway Crossings and Segments

Flooded roadways pose a substantial risk to motorists, as flood-related drownings often occur when vehicles are driven into hazardous flood waters. Functioning roadways serve a critical function during flood events, providing access to first responders and clear routes to safety in the case of an evacuation.

Exposed roadways were quantified in two ways: by the total number of roadway crossings and by the miles of roadway segments exposed. **First, approximately 3,206 roadway-stream crossings exist in the Guadalupe FPR, with the highest concentrations being in Kerr, Gonzales, Guadalupe, and DeWitt Counties. Figure 2-12** depicts the relative density of roadway stream crossings for each county. In contrast to the roadway stream crossings count analysis, Comal County emerges as one of the counties with highest number of total miles of roadway segments exposed. The other county with the most miles of roadway segments exposed is Kerr County, which is consistent with the roadway stream crossings count analysis. The next highest concentration of miles of roadway segments exposed to flood risk are in Hays, Guadalupe, Gonzales, and DeWitt Counties. **In total, there are approximately 1,379.5 miles of roadway segments potentially inundated during floods currently in Region 11, with a projected increase of 30.1% in the future to bring the total to 1,795.2 miles exposed under**

future flooding conditions. A 10.6% increase is expected for the count of roadway stream crossings, with a new total of 3,546 in the future.

A total of 815 low-water crossings were identified in the region as part of the data collection and outreach described in **Chapter 1**. The primary source for these low-water crossings was Texas Natural Resources Information System (TNRIS) data from 2013, supplemented by stakeholder data. Approximately 661 of the low-water crossings were determined to be within existing condition flood hazard areas though this analysis. Low-water crossing is a term that is not well defined, so, the use of the term has different meanings based on personal experience and even parts of the region. For this plan, time and resources did not allow for an in-depth evaluation of which roadway-stream crossings could be considered low-water crossings beyond comparison with the TNRIS data and intersection with the existing flood hazard areas; however, if time, scope, and resources allow, this data may be enhanced in the second cycle of regional flood planning. The number of exposed low-water crossings grows to 676 for future condition floods, a 2.3% increase. **Figure 2-14** depicts the locations of these low-water crossings in the existing and future condition flood hazard areas.

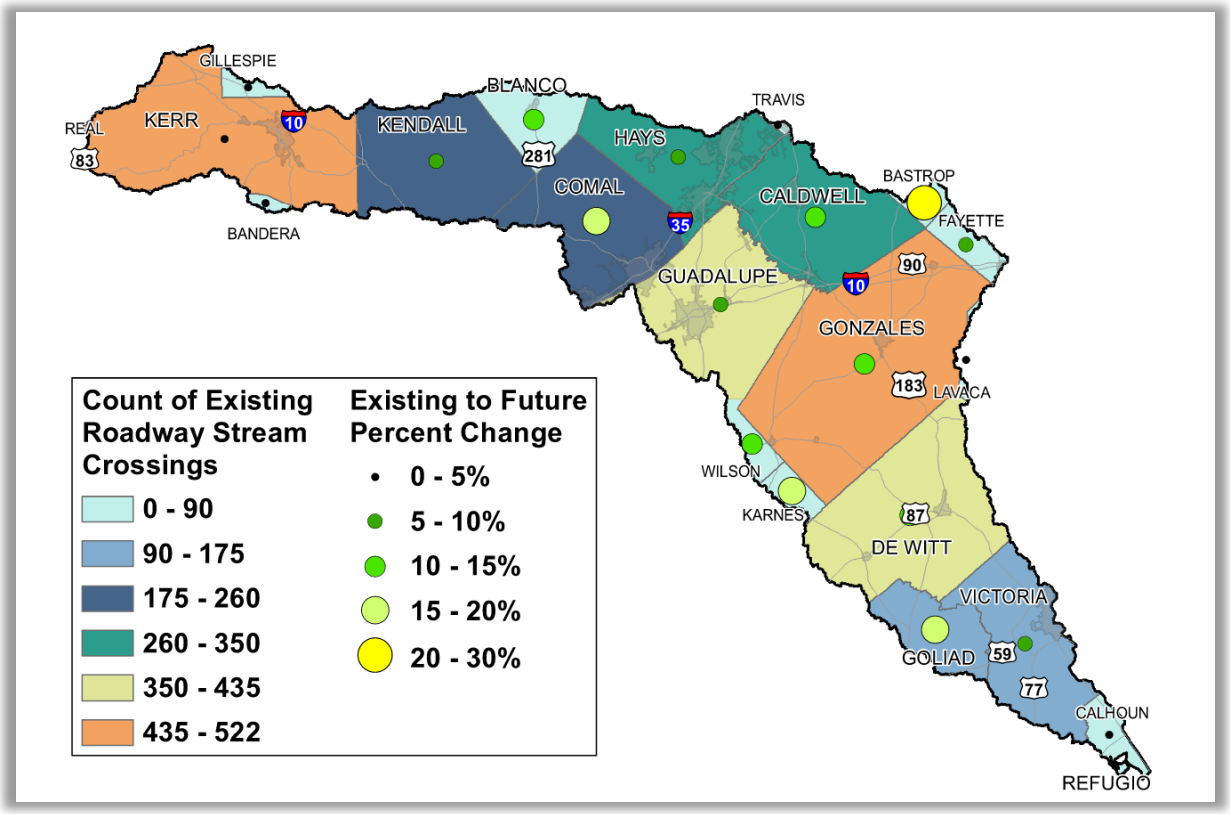


Figure 2-12: Roadway-Stream Crossings Exposure

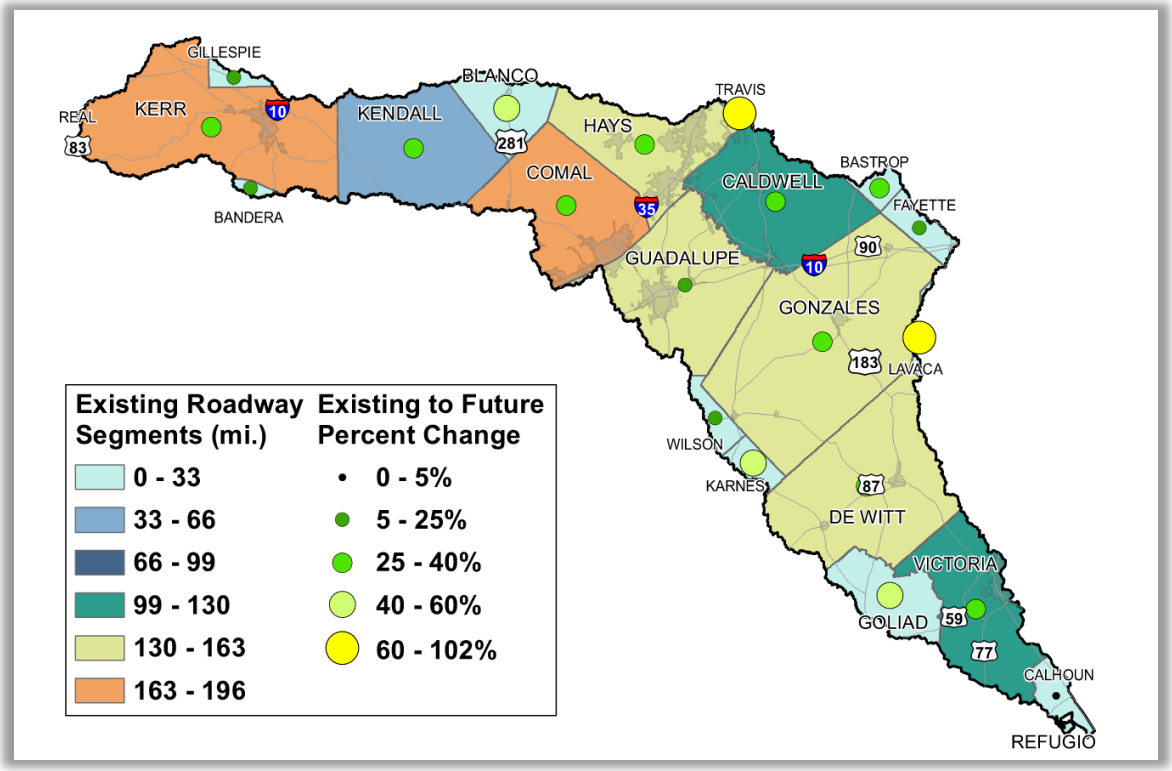


Figure 2-13: Roadway Segments Exposure

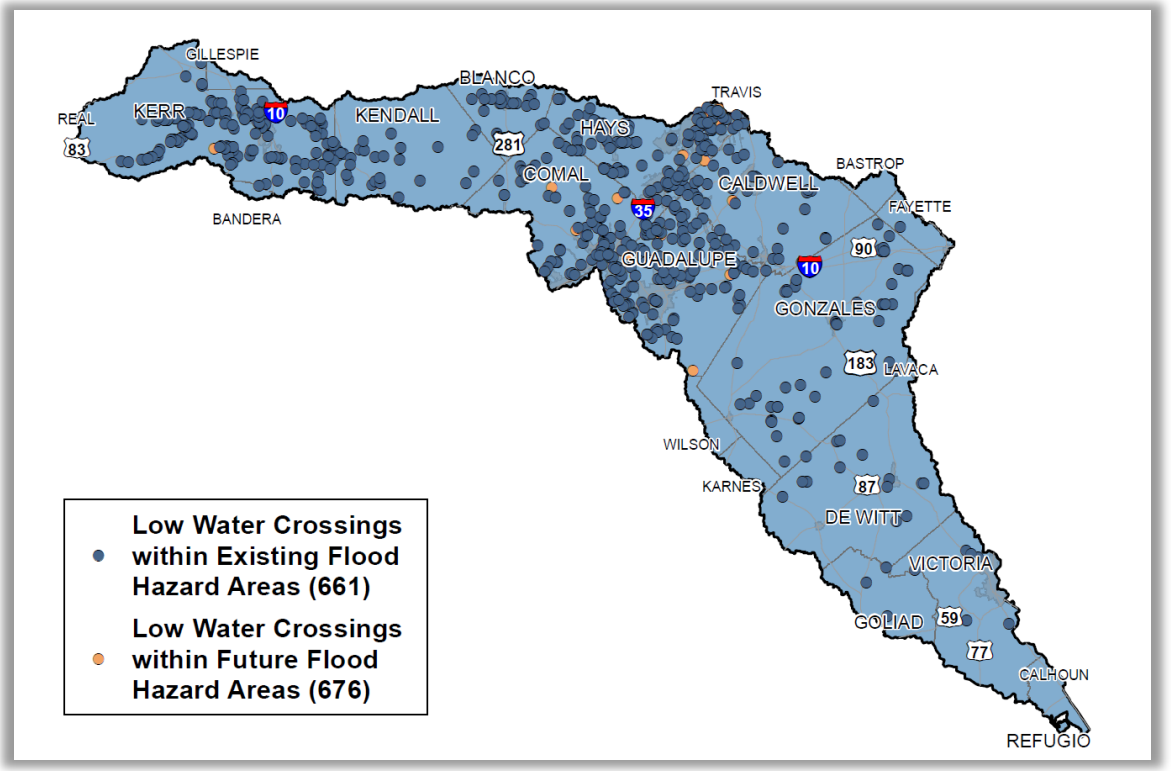


Figure 2-14: Low-Water Crossings Exposure

2.2.6 Agricultural Areas

Gonzales and DeWitt Counties have the most agricultural areas within the existing condition floodplain by far, with more than 184 and 119 square miles, respectively. Caldwell, Victoria, Kerr, Guadalupe, and Kendall Counties each have between 40 and 70 square miles of agricultural land exposed to flooding, and the remaining 14 counties each contain less than 30 square miles of exposed agricultural areas, with five of those having less than one square mile each. **Region-wide, there are approximately 689.6 square miles of agricultural land currently exposed to flood risk within the Guadalupe FPR.**

Hays and Victoria Counties are expected to see a decrease in the amount of agricultural land area exposed to flooding in the future, due to projected urbanization in those areas. Blanco and Gillespie Counties are projected to have significant increases in agricultural areas exposed to flooding, and the rest of the Region 11 counties are projected to see moderate increases. These projected increases are not likely due to a projected increase in land area newly becoming agricultural but instead due to expanding floodplains in existing agricultural areas. **In total, 808 square miles of agricultural land are projected to be exposed to flood risk in the future, representing a 17.2% increase.**

To evaluate the value of land exposed, average values for agricultural land in Texas were identified using data from the 2020 U.S. Department of Agriculture (USDA) Land Values Summary. This summary included an average value of $2,030 per acre for cropland and $1,680 per acre for pasture. Within the entire region, there are currently 19.05 square miles of cropland and 670.5 square miles of ranchland. From these values, a weighted average cost for agricultural land was identified as $1,689.67 per acre. **A total of $745 million of crops and pasture were determined to be exposed to flooding under current conditions. The amount and value of agricultural areas potentially impacted by flooding increases by 17.2% in the future flood hazard condition exposure analysis to 19.9 square miles of cropland and 788 square miles of ranchland for a total value of crops and pasture exposed of more than $873 million.**

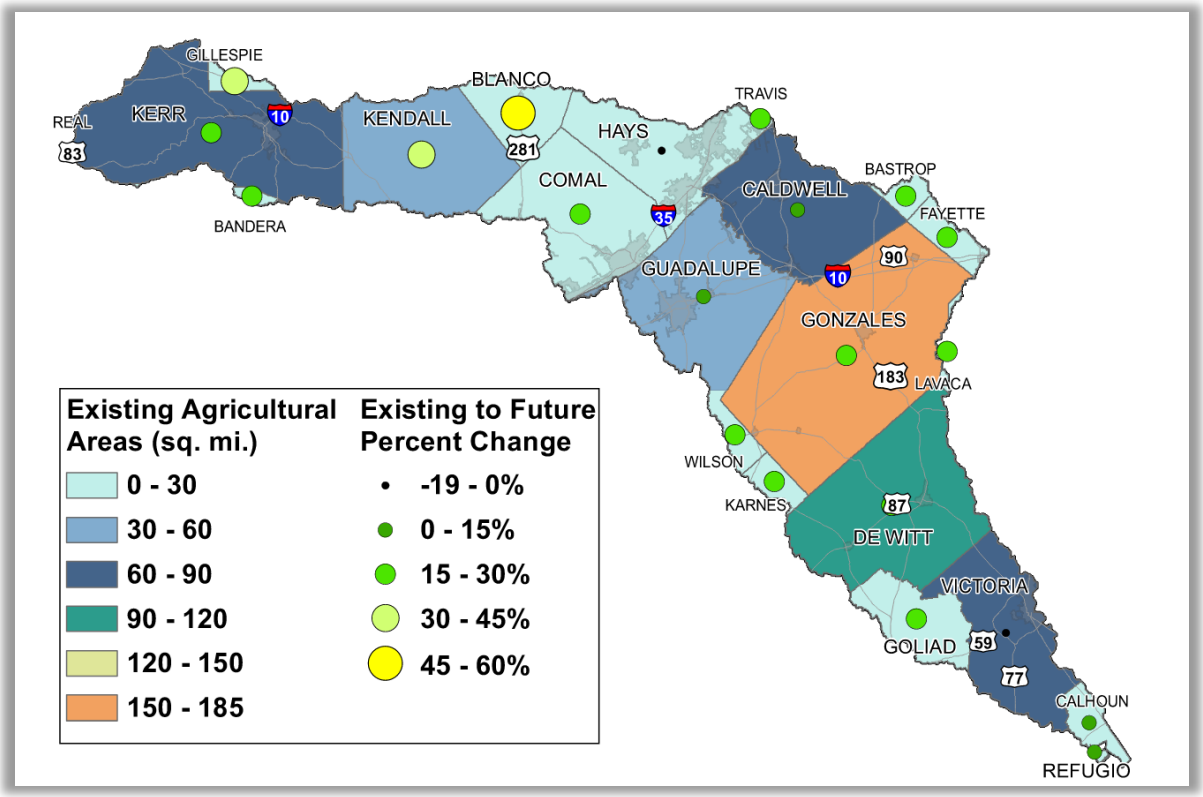


Figure 2-15: Agricultural Land Exposure

2.2.7 Expected Loss of Function

The impacts of flooding on lives and livelihoods are often felt not just during a flood event but long afterwards. As communities assess damages after a flood, several different types of impacts must be evaluated. Historical flood impacts, including dollar values of damages and known injuries and losses of life are quantified in **Chapter 1**. This section presents a qualitative assessment of the types of flood impacts and the expected losses of function for the various types of features exposed to flood hazard described in the previous sections.

Inundated Structures

Structural flooding can be devastating to property owners and communities as a whole. Structural flooding can cause water damage to the building, as well as the contents inside. Often this leads to additional costs due to families being displaced from their homes. Businesses may also lose inventory that is damaged during a flood and may not be able to operate while repairs are being made. In extreme cases, the flood damages can be so severe that the structure and contents constitute a total loss. Flooding impacts to structures are more significant at higher flood elevations, which is why it is important to consider depth when evaluating flood impacts on structures.

Health and Human Services

Health impacts from flooding can be both direct and indirect. Direct effects of flooding include heart attacks, drowning from travelling through flood waters, injuries from flood conditions, and disease. Indirect impacts include damage to health care infrastructure, water shortages and contamination, disruption of food supplies, and more. Health and human services include hospitals, nursing homes, and other services to enhance the health and well-being of the public. During a flood event, potential loss of function can occur for these services due to their location within the floodplain. Loss of function of health and human services can result in loss of available beds, displacement of patients, and a potential loss in the quality of care.

Water Supply and Wastewater Treatment

Floods can contaminate water supply sources, such as wells, springs, and lakes/ponds through polluted runoff laden with sediment, bacteria, animal waste, pesticides, and industrial waste and chemicals. Flooding has the potential to impact water and wastewater treatment facilities and reduce the effectiveness of the facilities. Water treatment plants can be particularly at-risk during flooding events, as many are located next to rivers or other water sources. Failure of water and wastewater treatment systems due to flooding may consist of direct losses such as equipment damage and contamination of pipes as well as indirect impacts, such as disruption of clean water supply. If systems are damaged in a flood, people can be left without adequate wastewater management systems until they can be repaired. Inundated wastewater treatment plans also have the potential to pollute wells used for potable supplies.

Utilities and Energy Generation

Potential failure of power generation plants due to flooding can cause direct losses such as equipment damage, as well as indirect impacts to surrounding homes and facilities due to loss of power.

Transportation and Emergency Services

Low-water crossings will likely become impassable and result in a loss of function during and after significant storm events. The impassable roadways can cause issues for emergency responders and motorists that could be travelling on the roadways. When roads are closed due to being unsafe for travel, this impacts the availability of transportation and evacuation routes. During significant storm events, debris buildup can cause loss of conveyance at bridges and exacerbate the risk of road crossings with higher flood waters overtopping the roadways and the potential for debris to overtop the roadway. Because of these impassable or closed roadways, flood events have potential to cause disruption to emergency services causing delays in response times and could hinder access to areas, such as shelters or locations of emergencies.

2.3 Flood Vulnerability

Once the flood exposure analysis was complete, the exposed features within the identified flood hazard area were analyzed to determine their vulnerability to flooding. Vulnerability was

assessed using the Center for Disease Control and Prevention (CDC) Social Vulnerability Index (SVI), as required by TWDB. The SVI is an indicator of a community's need for support before, during, or after a disaster. SVI is provided as a decimal value from 0.00 to 1.00; the higher the SVI, the more assistance a community is likely to need.

TWDB provided a building dataset that included SVI values for each building. SVI was also assigned to the other exposure features, such as low-water crossings or critical infrastructure, based on the average SVI of the surrounding census tract. Based on the exposure features in the existing condition flood hazard area, an average SVI of the exposed area was computed for each county. Using these results, vulnerable portions of the region were identified. **Within the Guadalupe FPR, only Calhoun County was identified as having an average SVI value higher than 0.75.**

The results of the analysis are summarized in **Figure 2-16** and **in Map 7**: Existing Condition Vulnerability and Critical Infrastructure (**Appendix 2-A**). The maps also include the location of critical facilities in the region color-coded by their SVI.

Of the 222 critical facilities within the existing flood hazard area, 78 facilities have an SVI value higher than 0.75, dispersed throughout the middle and lower parts of the region. A high SVI value indicates that if these critical facilities go offline as the result of a flood, they may lack the necessary resources to restore services or rebuild quickly, prolonging the disruption to the surrounding communities**. It is also noteworthy that of these 78 facilities, 51 are in the 1% ACE flood hazard area and 27 are in the 0.2% ACE flood hazard area.** Generally, a higher level of service is recommended for critical facilities to prevent damage or disruption of services during a flood. Improvements to these facilities, including flood proofing or relocation out of the floodplain, could mitigate damage and disruption during a flood event.

The vulnerability analysis for future conditions was performed in the same manner as the existing analysis but considered the future condition flood exposure features. The results of the analysis are summarized in **Figure 2-17** and also in **Map 12**: Future Condition Vulnerability and Critical Infrastructure (**Appendix 2-B**). The maps also include the location of critical facilities in the region color-coded by their SVI. **The overall results of the future conditions vulnerability analysis is largely the same as the current condition analysis, with the exception of the inclusion of 11 more critical facilities with SVI higher than .75 throughout the region.**

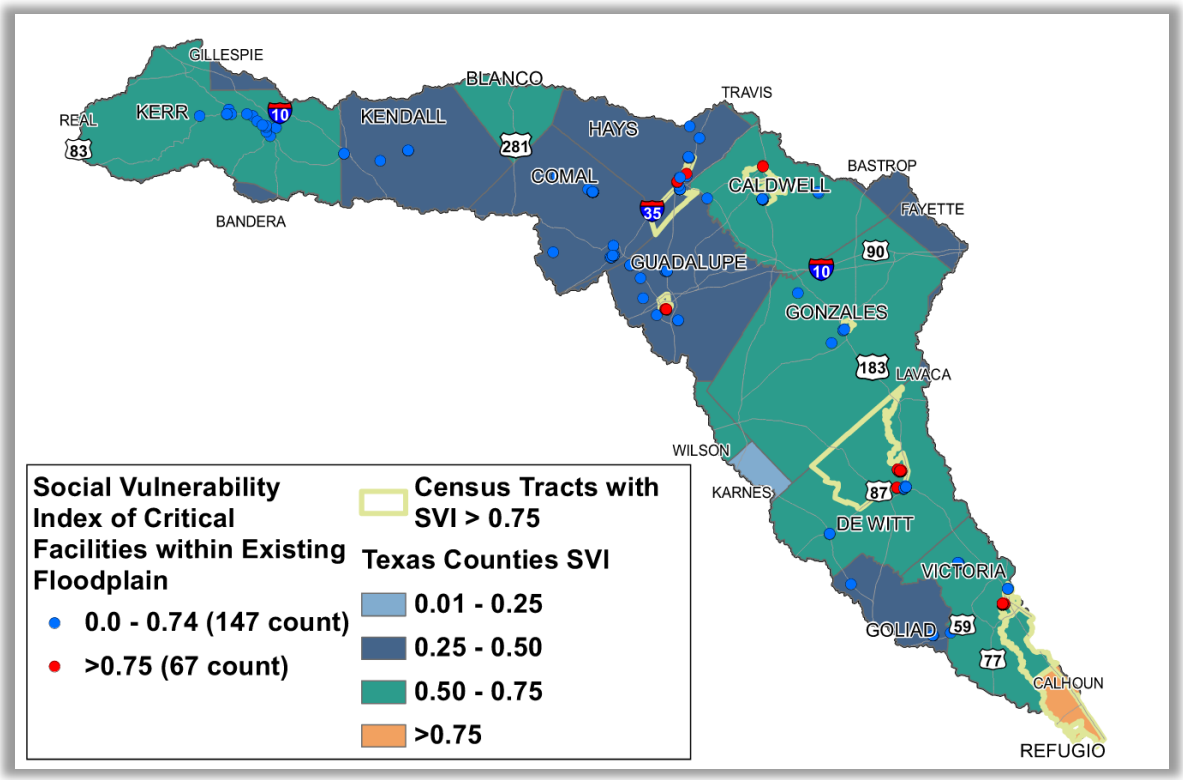


Figure 2-16: Existing Condition Vulnerability Analysis

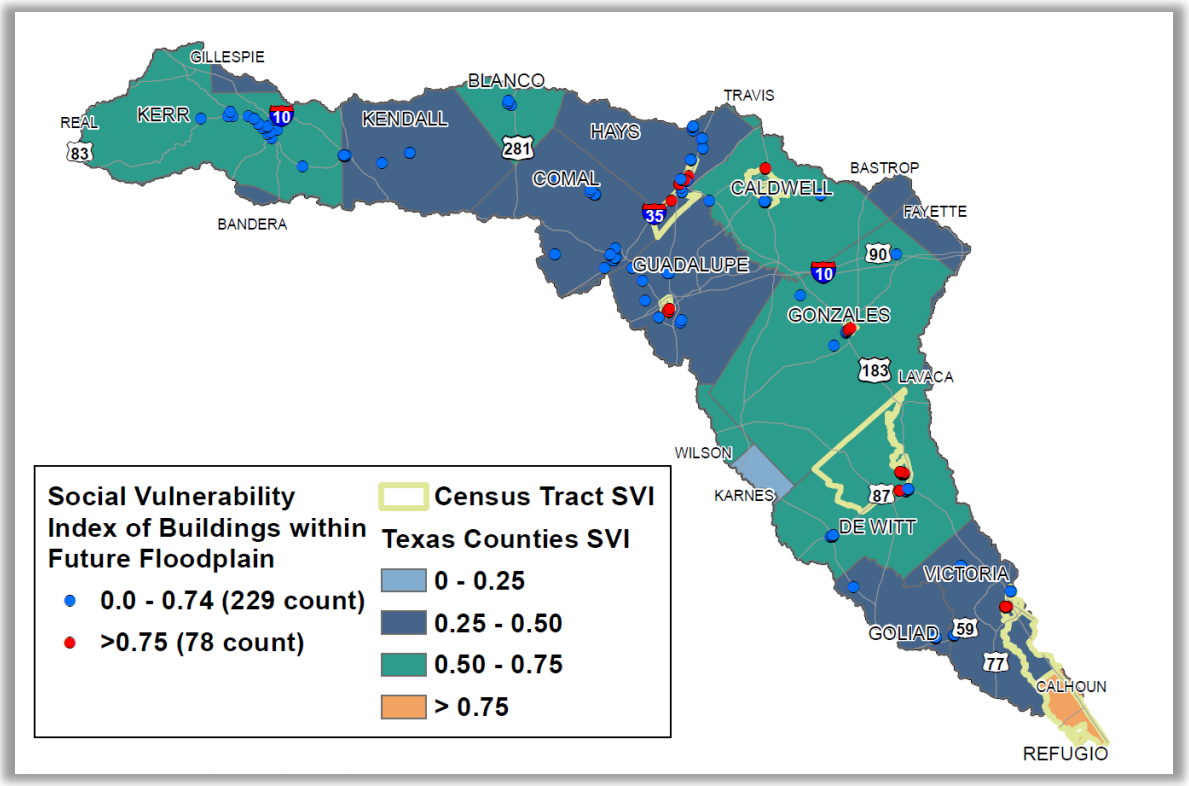


Figure 2-17: Future Condition Vulnerability Analysis

Chapter 3: Floodplain Management Practices and Flood Protection Goals

The Guadalupe RFPG is tasked with evaluating and recommending floodplain management practices (Task 3A) and adopting flood mitigation goals (Task 3B) within the Guadalupe Flood Planning Region (FPR). The intent of regional flood planning is twofold:

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

Floodplain management, land use, infrastructure design, and other practices play a key role in preventing additional future flood risk in the region. **Section 3.1** presents a qualitative assessment of current floodplain management practices in the region and recommendations for improvement. **Section 3.2** discusses the goal-setting process and describes the flood mitigation and floodplain management goals adopted by the RFPG for this plan.

3.1 Evaluation and Recommendations on Floodplain Management Practices

3.1.1 National Flood Insurance Program and Community Rating System Participation

The initial effort under Task 3A was to collect and perform a qualitative assessment of current floodplain management regulations within the Guadalupe FPR. Floodplain management regulations that were available on publicly available websites were first collected. Parallel to this effort, requests were made for applicable ordinances and court orders, and a survey was provided to each regulatory entity in the Guadalupe FPR to gather additional information. Based on the data collected:

- All 22 counties and 31 out of 32 cities and towns (96.8%) within the Guadalupe FPR are participants in the National Flood Insurance Program (NFIP).
- The Cities of New Braunfels and San Marcos along with Guadalupe and Bastrop Counties are participants in the Federal Emergency Management Agency (FEMA) Community Rating System (CRS) program.

Cities and counties have the authority to establish their own policies, standards, and practices to manage land use in and around areas of flood risk. As a basis of participation, NFIP-participating communities have the responsibility and authority to permit development to be reasonably safe from flooding. Communities can adopt and enforce higher standards than the FEMA NFIP minimum standards to enhance protection of life and property from flooding.

Cities and counties participating in the NFIP program provide their residents and businesses the opportunity to purchase flood insurance to reduce the socio-economic impacts of floods, as well as to make the community eligible for disaster assistance following a flood event.

Although the Guadalupe FPR has high NFIP participation, the RFPG considers that many of the communities only adopt minimum flood development standards and are not pro-active in their approach to floodplain development. In addition, many entities at the county level are not aware of their authority to implement floodplain development standards higher than NFIP minimums. The RFPG concludes that communities could enhance their policies to minimize the potential of additional flood risks in the future.

The CRS program recognizes and encourages local governments to take the opportunity to perform additional floodplain management practices and programs above NFIP minimum standards to enhance public safety and reduce flood insurance premiums within their jurisdiction. CRS program includes multiple alternatives, and the more practices employed by the local jurisdiction, the more points that are scored, further reducing flood insurance premiums.

Table 6 in **Appendix 3-A** summarizes existing floodplain management regulations for the cities and counties in Region 11, based on a combination of review of regulations that were available on publicly available websites, phone calls with local officials, and surveys. **Map 13,** also in **Appendix 3-A,** presents the information visually.

3.1.2 Future Population and Flood Protection Practices

The Guadalupe FPR's population is projected to increase from about 618,874 in 2020 to 999,837 in 2050, an increase of 62%. Some of the existing floodplain ordinances and standards may continue to protect future population and property if they are properly enforced. However, the diversity in key floodplain management practices across the region poses an increasing level of flood risk as the population continues to increase.

Future floodplain boundaries are uncertain, as exemplified by the recent Atlas 14 study that increased rainfall depths based on historical data, thus generating larger floodplain limits and depths. In addition, the hydrologic and hydraulic (H&H) models are regularly being updated with new topography, survey, precipitation, runoff, and other data as development occurs in and around floodplains. The future Base Flood Elevations (BFE) will likely increase, expanding floodplain areas in the region. Detailed models and maps are needed to depict the floodplain boundaries to guide future development decision making. **Chapter 2** includes a future flood risk analysis, aimed at projecting possible increases in future flood risk under a 30-year no-action scenario.

Some flood protection practices that local governments can implement to prevent the creation of additional flood risk involve:

- Producing and providing updated floodplain maps to the community to minimize the potential of new development within the floodplain. In absence of detailed maps, adopting base level engineering (BLE) as best available information and using it to regulate and/or steer development.
- When developing detailed floodplain models and maps, utilizing future land use conditions to establish floodplain limits to provide a factor of safety above floodplain maps based on existing conditions.
- Adopting higher standards (above NFIP minimum), such as increasing freeboard requirements for new structures in the event that future water surface elevation increases.
- Requiring stormwater detention basins (ponds) or inclusion of nature-based solutions.
- Adopting regulations for new development so that the post-development peak flow rate is less than or equal to the existing peak flow rate (undeveloped condition) to protect downstream landowners. This includes managing a full range of storm events from the 2- to 100-year storm events.
- Protecting natural habitats within riparian areas to help mitigate for erosion and downstream impacts, as well as providing water quality benefits and mitigating increases in future flood risks.
- Requiring that new roadway crossings are elevated above the 100-year flood level to minimize the potential loss of life that can result in low-water crossings. Enhanced safety features, such as barricades, flashers, or other flood warning systems, should be installed when this standard is not practical due to physical or fiscal constraints of the entity.
- Developing and adopting guidance materials to be made available to public and private developments. For example, adopting drainage criteria manuals, green infrastructure recommendations and increasing design criteria or constraint considerations within high flood risk areas.

3.1.3 Consideration of Recommendation or Adoption of Minimum Floodplain Management Practices

The Guadalupe RFPG may recommend or adopt consistent minimum floodplain management standards and land use practices for the region. Recommended practices encourage entities with flood control responsibilities to establish additional floodplain management standards over the next several years. If the RFPG were to adopt minimum standards, it will require entities to adopt the minimum standards before their Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) could be considered for potential inclusion in the Guadalupe RFP. To ensure this first planning cycle is as

inclusive as possible, **the RFPG chose not to adopt minimum standards for this planning cycle.** The RFPG may consider adopting minimum standards in future planning cycles.

The topic of recommending or adopting minimum floodplain management standards was introduced at the August 4, 2021, RFPG meeting. During the public meeting, an interactive web-based polling session was conducted to gather feedback from the RFPG and members of the public with regard to the following topics:

- Primary flooding concerns
- Issues that were considered to be the primary impediments to effective floodplain management
- Recommending or adopting minimum standards for all entities within the region
- Types of minimum standards to be considered
- Most important outcomes of the regional flood planning effort

In general, the RFPG and public attendees recommended the following potential management practices:

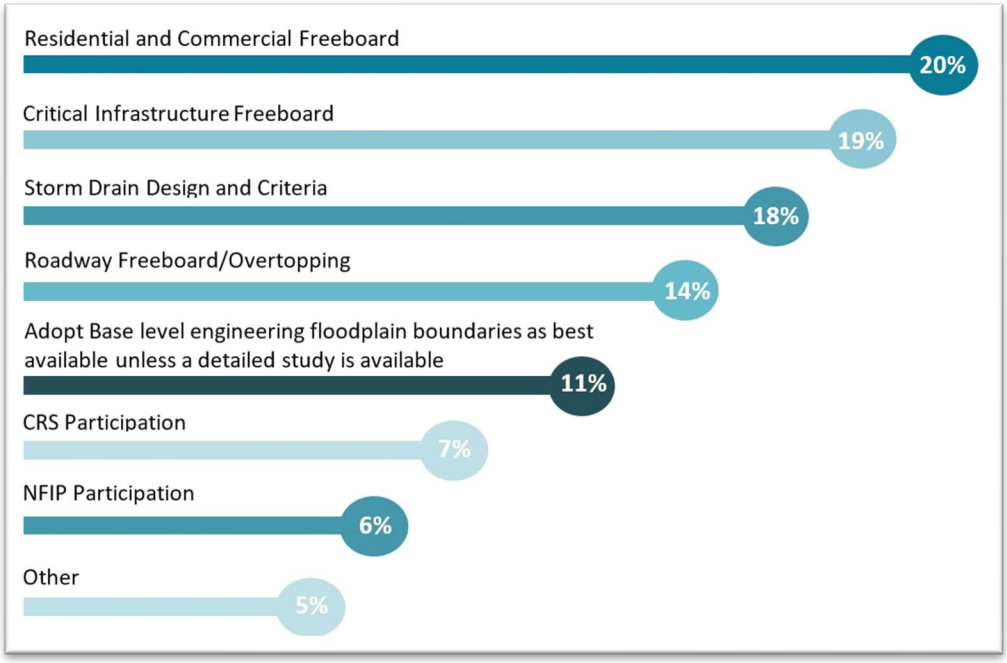


Figure 3-1: Recommended Potential Management Practices

The attendees also provided input on the desired outcomes for a successful regional flood plan and noted in **Figure 3-2**:

Figure 3-2: Desired Outcomes

In subsequent RFPG meetings on September 8, 2021, and October 5, 2021, the RFPG further discussed and evaluated floodplain management recommendations and goals. Through this process, the RFPG refined their flood mitigation practices, and they are noted in **Figure 3-3** in priority order:

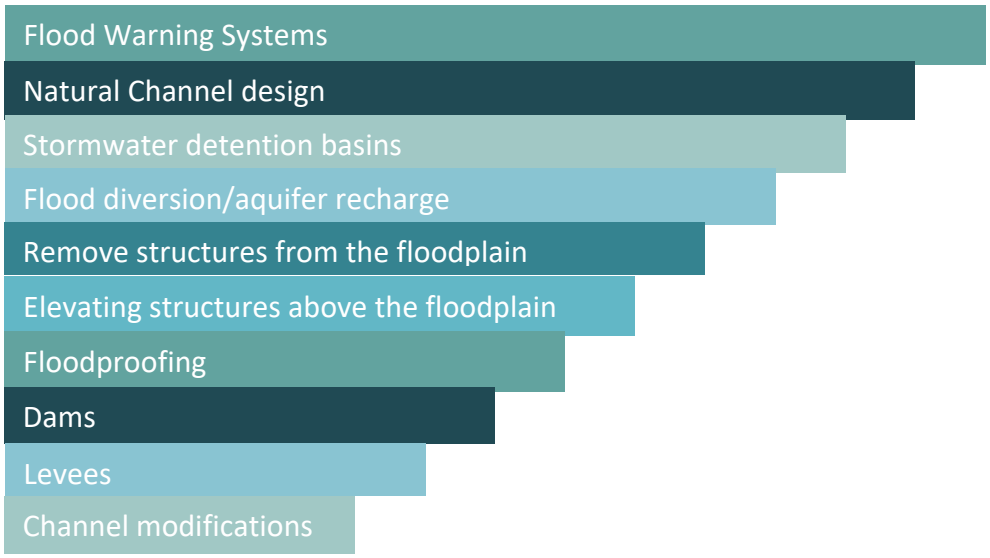


Figure 3-3: Flood Mitigation Practices

The RFPG recommended flood prevention practices, shown in priority order in **Figure 3-4**:

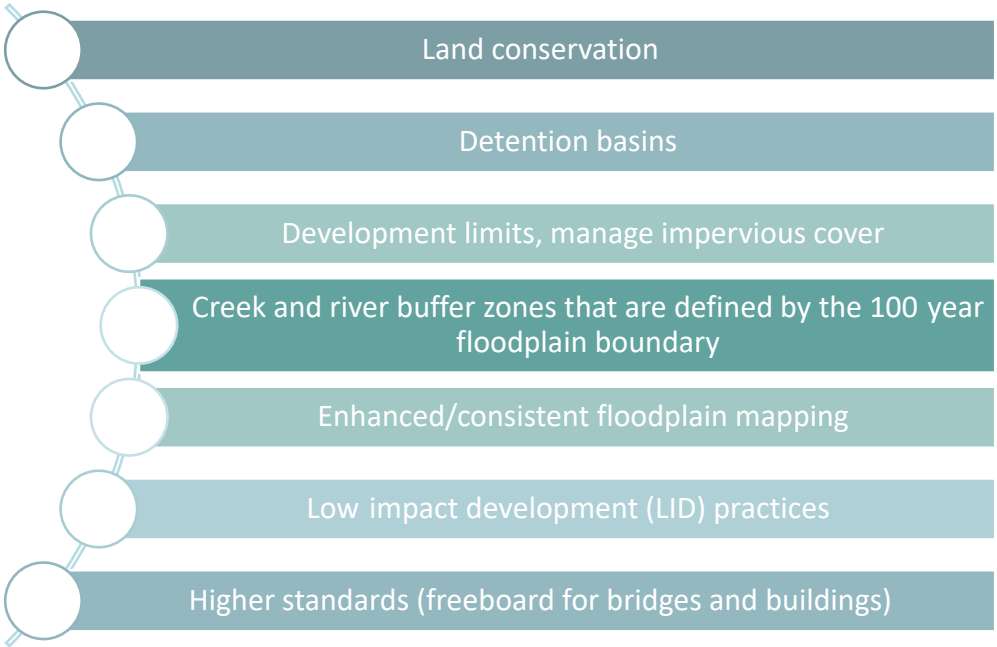


Figure 3-4: Flood Prevention Practices

Primary flooding concerns were evaluated with the highest levels of concern relating to potential loss of life and critical facility flooding, presented in **Figure 3-5**:

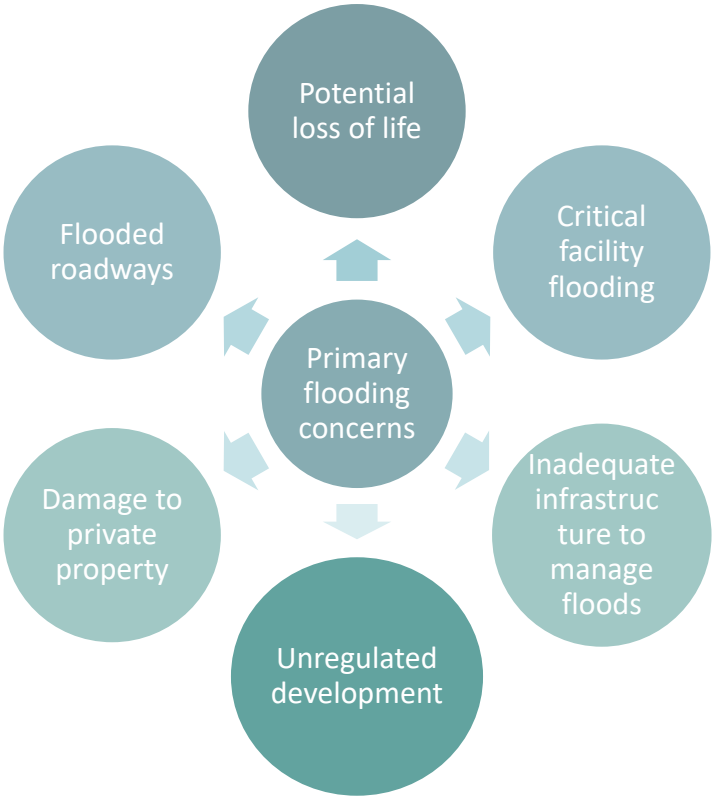


Figure 3-5: Primary Flooding Concerns

Primary impediments to effective floodplain management were described, summarized in **Figure 3-6**:

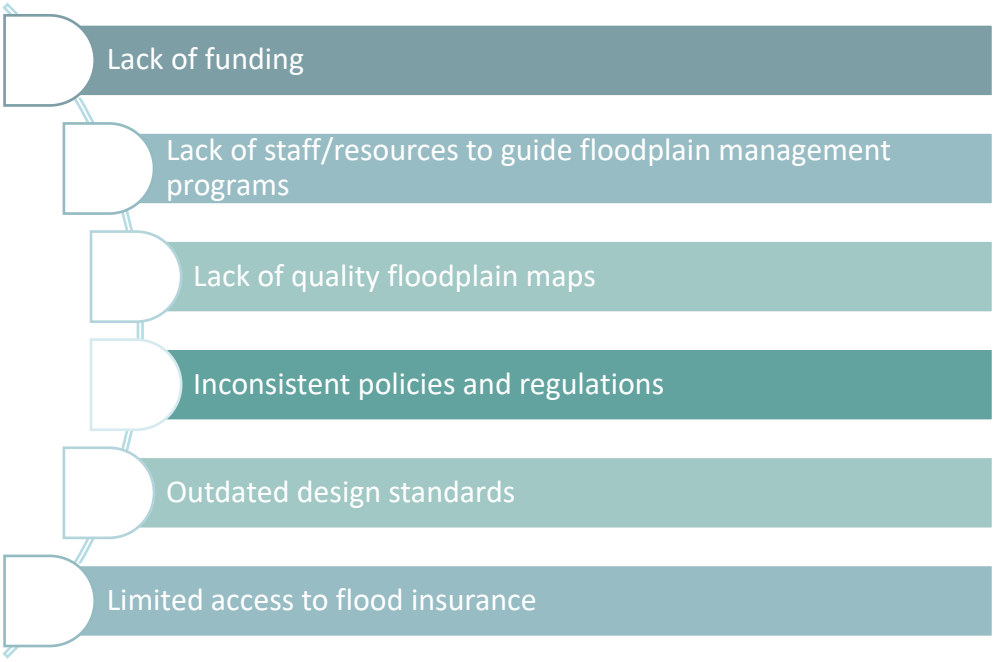


Figure 3-6: Primary Impediments to Effective Floodplain Management

Another aspect of the RFPG planning process included considering whether to recommend varying standards across the Guadalupe FPR due to significant differences in topography, soils, land use, and storm events. For example, it is understood that while flash flooding is more prevalent in the western portion (Hill Country) of the watershed the lower basin experiences longer duration flooding at a lower velocity. Currently, the RFPG does not recommend different floodplain management practices for the varying regions. **The RFPG encourages local governments throughout the region to adopt higher standards and consider CRS participation**, including measures that are appropriate for their jurisdiction, such as the Recommended Potential Management Practices in **Figure 3-1** and the Flood Prevention Practices in **Figure 3-4**.

It is understood that modifying floodplain management practices takes time through the local government political processes and floodplain management practices will be re-evaluated during the next planning cycle. The RFPG prepared a list of legislative, administrative, and regulatory recommendations that are found in **Chapter 8**, including recommendations related to floodplain management.

3.2 Flood Mitigation and Floodplain Management Goals

This task defines the overarching flood mitigation and floodplain management goals for this regional flood plan. The RFPG must identify goals that are specific, achievable, and, when implemented, will demonstrate progress toward the overarching goal set by the state of protecting against the loss of life and property. The RFPG's selected goals guided the development and recommendation of the FMSs, FMEs, and FMPs for the planning region, as discussed in **Chapters 4** and **5**. Progress toward adopted goals will be measured and reported in future planning cycles.

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 to be 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 to be used to measure goal attainment
- Association with overarching goal categories

3.2.1 Goal Development Process

The RFPG utilized the data and information from previous tasks, such as the existing and future condition flood risk analyses described in **Chapter 2** and the assessment of current floodplain management and land use practices described in **Section 3.1** as guides for developing and defining the goals for Guadalupe FPR. The proposed goals considered input from the RFPG provided at the regular RFPG meetings, as well as input from other regional stakeholders provided through the data collection survey. Public input opportunities were provided at each RFPG meeting. The input process is outlined below:

- **June 30, 2021** – Introduction to flood mitigation and floodplain management goals.
- **August 4, 2021** – Interactive goal discussion and public meeting input.
- **August/September 2021** – Continued public input on goals, strategies, concerns, potential projects via online survey, interactive map, and interaction with the project team.
- **September 8, 2021** – Presentation and discussion of draft flood mitigation and floodplain management goals based upon previous RFPG input and responses to the RFPG survey.
- **October 6, 2021** – Discussion of draft goals and input from the planning group.

After careful consideration, the RFPG adopted the flood mitigation and floodplain management goals listed in **Table 3-1**. Additional details regarding these goals can be found in **Table 11** in **Appendix 3-B**. These specific goals were approved by the Guadalupe RFPG on May 10, 2022. The adopted goals apply to the entire flood planning region; no sub-regional goals were identified.

Table 3-1: Adopted Flood Mitigation and Floodplain Management Goals

Short term goal (10 years)	Long term goal (30 years)
Improve safety beyond minimal signage at 35% of low water crossings through automatic flood warning gates and/or flood level passed.	Improve safety beyond minimal signage at 90% of low water crossings through automatic flood warning gates and/or flood level passed.
Consider incorporating nature-based practices when acreage exceeds one acre (LID, green infrastructure, natural channel design) in 30% of Flood Mitigation Projects and Flood Management Strategies recommended in the Regional Flood Plan.	Consider incorporating nature-based practices when acreage exceeds one acre (LID, green infrastructure, natural channel design) in 100% of Flood Mitigation Projects and Flood Management Strategies recommended in the Regional Flood Plan.
Increase adoption of higher standards to 30% of communities in high growth counties.	Increase adoption of higher standards to 70% of communities in high growth counties.
Increase high growth community CRS participation to 50% of all high growth communities.	Increase high growth community CRS participation to 75% of all high growth communities.
Reduce number of vulnerable buildings/structures/critical facilities within the 1% existing flood hazard layer by 20%.	Reduce number of vulnerable buildings/structures/critical facilities within the 1% existing flood hazard layer by 50%.
Increase percentage of communities with dedicated funding sources for operations & maintenance and implementation of storm drainage systems to 35% of communities.	Increase percentage of communities with dedicated funding sources for operations & maintenance and implementation of storm drainage system to 60% of communities

During RFPG meetings, there was considerable discussion of goals and their nuances based on RFPG member experiences and observations of changing conditions in the watershed. Examples of the conversation are presented for improving safety at low-water crossings and considering nature-based practices in flood mitigation and management.

Regarding the RFPG's goal to "Improve safety beyond minimal signage at 35% of low-water crossings through automatic flood warning gates and/or flood level passed," the RFPG noted that the low-water crossing definition and priorities should be established based on flood depth over road, highway traffic count, and type of roadway crossing. It was understood that not all low-water crossings may need structural improvements, as safety can be enhanced by flood warning systems and additional signage.

Goals related to considering nature-based practices in flood mitigation projects and flood management strategies generated significant discussion amongst RFPG members at several

meetings. The members agreed that information and education on nature-based solutions is necessary and should be available to planners, engineers, and local and state government staff. The nature-based practices cover a broad range from conservation and low impact development strategies to natural-channel design that can provide water and environmental benefits in addition to flood management and mitigation. General project data required, as noted in 3.9B of TWDB Exhibit C, *Technical Guidelines for Regional Flood Planning*, includes nature-based solutions as a data point by noting the percentage of the project cost using nature-based solutions techniques, such as using vegetation rather than concrete to stabilize creeks/riverbanks.

3.2.2 Benefits and Residual Risk after Goals are Met

The adopted goals were developed so that they can be quantified and measured in future regional and state flood planning cycles. Future data collection efforts or implementation of evaluations, strategies, and/or projects may be used to measure progress toward achieving the goals. These data may also be used to adjust the goals and/or generate new goals in upcoming planning cycles. Achieving the adopted goals will help reduce current and future levels of flood risk in the region.

It is recognized that it is not possible to protect against all potential flood risks. In selecting the goals, the RFPG defined the accepted residual risk for the region. Potential residual risks for the flood risk reduction goals could be characterized as follows:

1) While a new development may be constructed outside the 1% ACE, flood events of greater magnitude will inundate areas beyond those preserved as a floodplain.
2) Flood events may exceed the level of service for which infrastructure is designed.
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) Policies, regulations, and standards reduce adverse impacts associated with development activity but do not eliminate them.
5) Lack of local enforcement of floodplain regulations creates risk.
6) There are limits of understanding and precision associated with studies, models, and plans.
7) Human behavior is unpredictable; people may choose to ignore flood warning systems and/or cross flooded roadways.

Chapter 4: Assessment and Identification of Flood Mitigation Needs

4.1 Flood Mitigation Needs Analysis

This chapter describes the process adopted by the Guadalupe Regional Flood Planning Group (RFPG) to conduct the Flood Mitigation Needs Analysis resulting in identifying the areas with the greatest gaps in flood risk knowledge and the areas of greatest known flood risk and mitigation needs. The Task 4A process is a big-picture assessment that helps guide the subsequent Task 4B effort of identifying Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs). **Table 4-1** provides a summary of TWDB guidance (left column) and factors that were considered in the Flood Mitigation Needs Analysis (right column). A brief explanation about how the factors were considered to identify areas of high risk or areas that lack quality risk information are described after **Table 4-1**.

Table 4-1: TWDB Guidance and Factors to Consider

Guidance	Factors to Consider
1. Most prone to flooding that threatens life and property	• Buildings within 1% annual chance event (ACE) floodplain • Low-water crossings • Agricultural and ranching areas in 1% ACE floodplain • Critical facilities in 1% ACE floodplain
2. Locations, extent, and performance of current floodplain management and land use policies and infrastructure	• Communities not participating in the National Flood Insurance Program (NFIP) • Disadvantaged/underserved communities • City/county design manuals • Land use policies • Floodplain ordinance(s)
3. Inadequate inundation mapping	• No mapping • Presence of Fathom/BLE/FEMA Zone A flood risk data • Detailed FEMA models older than 10 years
4. Lack of hydrologic and hydraulic (H&H) models	• Communities with zero or limited models
5. Emergency need	• Damaged or failing infrastructure • Other emergency conditions

Guidance	Factors to Consider
6. Existing modeling analyses and flood risk mitigation plans	• Exclude flood mitigation plans already in implementation • Leverage existing models, analyses, and flood risk mitigation plans
7. Previously identified and evaluated flood mitigation projects	• Exclude flood mitigation projects already in implementation • Leverage existing flood mitigation projects
8. Historic flooding events	• Flood insurance claim information • Areas with a history of flooding according to survey responses • Other significant local events
9. Previously implemented flood mitigation projects	• Exclude areas where flood mitigation projects have already been implemented unless significant residual risk remains
10. Additional other factors deemed relevant by RFPG	• Social Vulnerability Index (SVI)

4.1.1 Process and Scoring Criteria

The main objectives of the Flood Mitigation Needs Analysis are to identify the areas of greatest known flood risk and areas where the greatest flood risk knowledge gaps exist. This analysis was based on a geospatial process that combines information from multiple datasets representing several of the factors listed in **Table 4-1** and provides a basis for achieving the analysis objectives. The geospatial process was developed in GIS and was based on the data collected in Tasks 1 through 3. A variety of data sources were used in this assessment, including GIS data collected directly from stakeholders during outreach efforts. During the data collection phase, stakeholders participated in an online survey through which they were able to respond geographically on a map. The stakeholder responses were applied to this assessment.

The geospatial assessment was prepared at a Hydrologic Unit Code Level 12 (HUC 12) watershed level, which provides a level of resolution that was considered suitable for performing the assessment at a regional scale. The Hydrologic Unit Code (HUC) is a unique number assigned to watersheds in the United States. As the watersheds get smaller, the number of digits in the code increases. The smallest unit of division that is completely delineated for the United States is the HUC 12 level. The Guadalupe Basin has a total of 152 HUC 12 watersheds, with an average size of 39.5 square miles.

A total of 11 data categories were used in the geospatial assessment and a scoring range was established for each category based on the statistical distribution of the data. A uniform scoring scale of zero to five, with 5 being the highest risk, was adopted, and each HUC 12 was assigned an appropriate score for each category. The scoring ranges vary for each category based on the HUC 12s with the smallest and largest quantity. The scores for each category were added to obtain a total score to quantify the level of known flood risk. The HUC 12s with the highest scores indicate areas of greatest

known flood risk. The Inadequate Inundation Mapping category was selected as the basis for determining the areas where the greatest flood risk knowledge gaps exist.

The following sections provide an overview of the data categories included in the analysis and how each HUC 12 watershed was scored. The objective of the Task 4A process is to determine the risk factors that are present within a given HUC 12 and to what degree they exist; not necessarily to determine the relative importance of each factor in determining flood risk. Therefore, no weight has been applied to emphasize one factor over another at this time.

4.1.2 Areas Most Prone to Flooding that Threatens Life and Property

Buildings in the 1% ACE Floodplain

The buildings within the 1% ACE floodplain were identified as part of the flood exposure analysis (see **Chapter 2**). Scores were assigned for this category based on the total number of buildings in the 1% ACE floodplain within each HUC 12. A total of 27,069 structures were identified within the 1% ACE floodplain. The points breakdown for this metric is shown in **Table 4-2**.

Table 4-2: Task 4A Category Scoring Ranges: Areas Most Prone to Flooding that Threatens Life and Property

Score (low to high risk))	0	1	2	3	4	5
Number of Buildings	0	1-150	151-250	251-350	351-500	500+
Number of Low Water Crossings	0	1	2	3	4	5+
Total Agricultural Area (sq. mi.)	0	0-1.5	1.51-3	3.1-4	4.1-6	6+
Number of Critical Facilities	0	1-2	3-4	5-9	10-20	20+
Total Mileage of Roads	0	0-4	5-10	11-15	16-30	30+

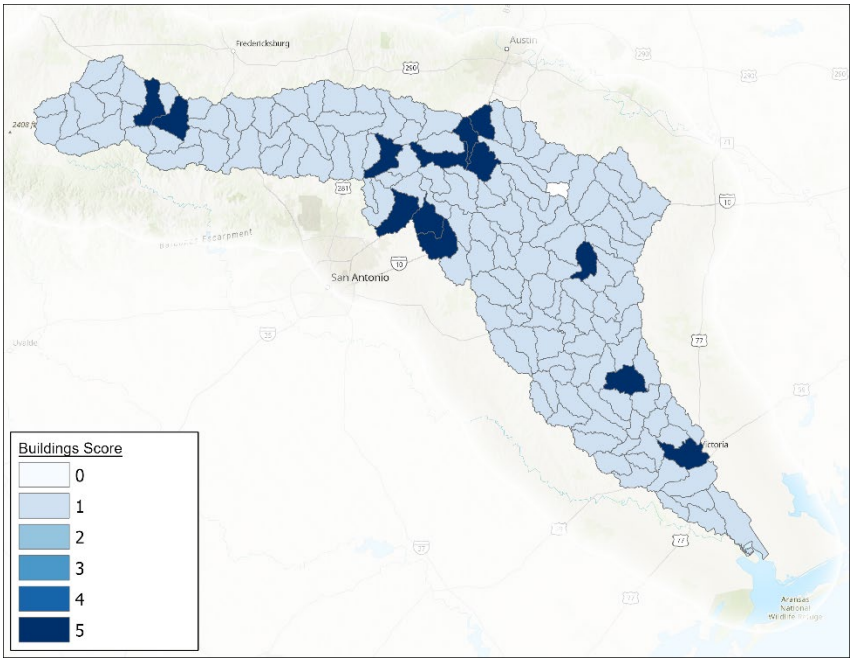


Figure 4-1: Buildings in the 1% ACE Floodplain

Low-Water Crossings

Low-water crossings were identified as part of the flood exposure analysis (see **Chapter 2**). This category is scored based on the number of low-water crossings occurring within a HUC 12. A total of 661 low-water crossings were identified (TNRIS 2013 data) in the 1% ACE floodplain. The points breakdown for this metric is shown in **Table 4-2**.

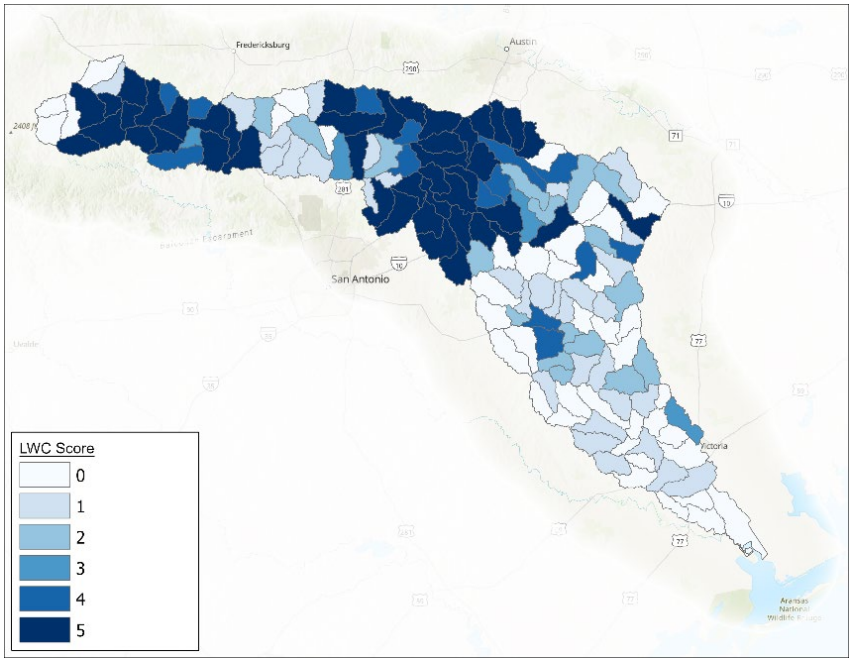


Figure 4-2: Low-Water Crossings at Risk

Agricultural Areas at Risk of Flooding

Agricultural areas have been defined for this task as a land use of either farming or ranching. Impacted agricultural areas are those intersecting the 1% ACE floodplain as determined in the flood exposure analysis (see **Chapter 2**). This layer will emphasize rural HUC 12s where agricultural impacts due to flooding are most prominent. The total impacted agricultural area in each HUC 12 was the criteria considered to assign points. The points breakdown for this metric is shown in **Table 4-2**.

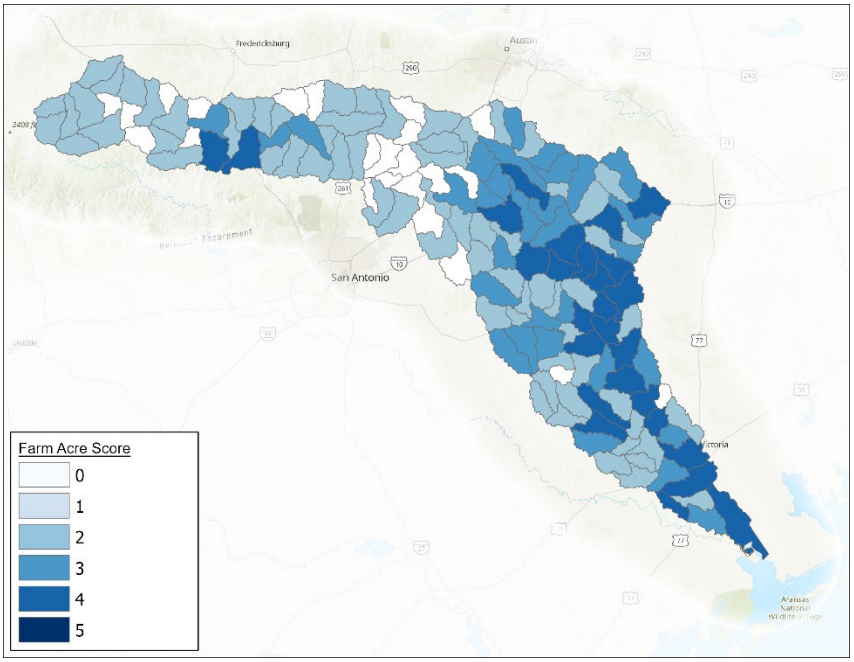


Figure 4-3: Agricultural Land at Risk

Existing Critical Facilities

Critical facilities within the 1% ACE floodplain were identified as part of the flood exposure analysis (see **Chapter 2**). Critical facilities for this assessment include hospitals, schools, fire stations, shelters, power plants, public works facilities, superfund sites, and water/wastewater treatment plants. A total of 127 critical facilities were identified within the 1% ACE floodplain. This category is scored based on the total number of critical facilities within each HUC 12 as shown in **Table 4-2**.

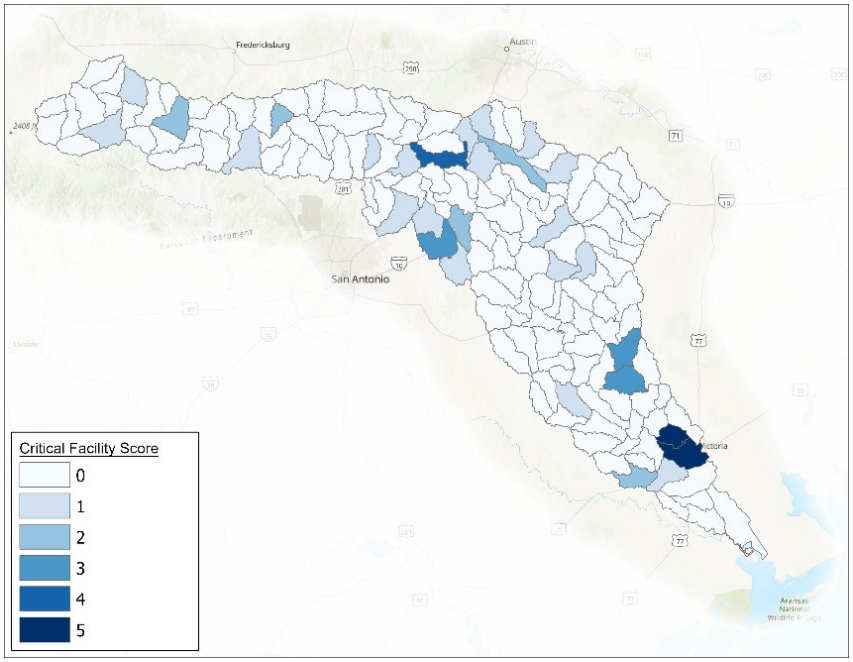


Figure 4-4: Critical Facilities at Risk

Locations where the Road Floods

Road-flooding locations within the 1% ACE floodplain were identified as part of the flood exposure analysis (see **Chapter 2**). Although this factor primarily addresses water over roadways, it also represents potential urban flooding scenarios. Each road flooding location was represented as a line feature. This category is scored based on the total mileage of roads within each HUC 12. The points breakdown for this metric is shown in **Table 4-2**.

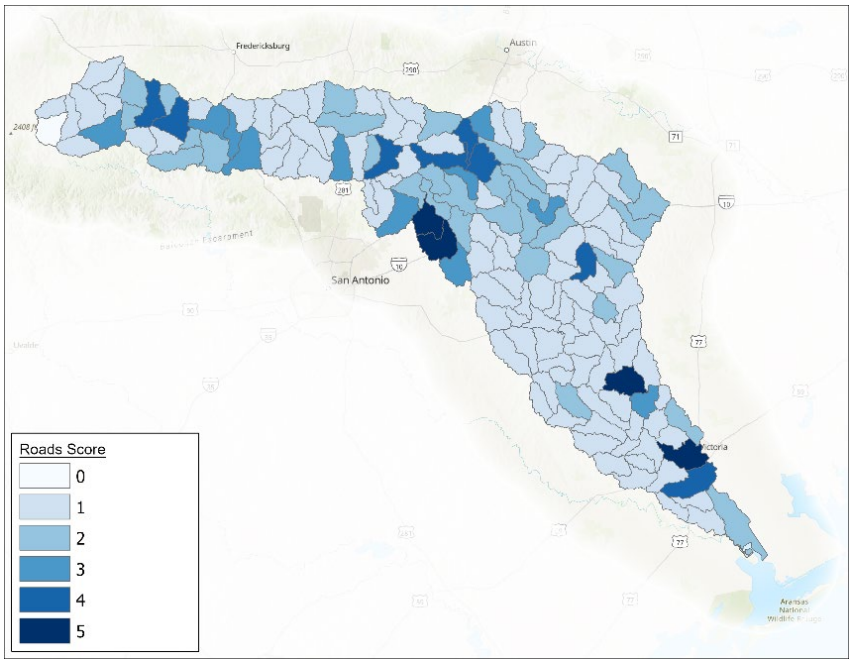


Figure 4-5: Roadways at Risk

4.1.3 Current Floodplain Management and Land Use Policies and Infrastructure

Communities Not Participating in the NFIP

Participation in the NFIP is considered as a proxy for having adequate floodplain management regulations in each community. The NFIP participation status for communities within the Guadalupe FPR is presented in **Chapter 3** (**Section 3.1**). Non-participating communities are not eligible for flood insurance under the NFIP. In addition, if a flood-related, presidentially declared disaster occurs, non-participating communities are not eligible for federal financial assistance to repair or reconstruct insurable buildings in floodplains. Therefore, this analysis considered non-NFIP communities as being more vulnerable to flooding risks. If most of the HUC 12 (>= 50%) intersected a non-NFIP community, it was assigned 5 points. Otherwise, no points were allocated (**Table 4-3**).

Table 4-3: Task 4A Category Scoring Ranges: Current Floodplain Management and Land Use Policies and Infrastructure

Score (low to high risk)	0	1	2	3	4	5
Community	NFIP Participant	-	-	-	-	Non-NFIP Participant

Areas Without Adequate Inundation Maps

As discussed in **Section 2.1.3** Flood Hazard Gaps, the RFPG identified five types of flood mapping gaps within the Guadalupe FPR:

1. Outdated FEMA National Flood Hazard Layer data greater than 10 years old.
2. Absence of detailed H&H models where base-level engineering was used.
3. Absence of modeling and mapping utilizing NOAA Atlas 14 rainfall data.
4. Absence of future conditions modeling – already exists in feature class.
5. Flood-prone areas where modeling is needed to determine frequencies.

This analysis was completed based on the "Flood Map Gaps" data, and the scoring was based on the "Reason for Gap" within each HUC 12 layer. None of the existing model data is based on Atlas 14 rainfall data or future land use conditions; therefore, these potential criteria were not included in the analysis as they offer no differentiation across the basin. The only area where old FEMA NFHL data was found is also covered by base-level engineering (portions of Calhoun and Refugio Counties). To prevent double counting, the older NFHL data was not included as a criterion for the analysis. Lastly, the additional flood-prone areas were reviewed. Because these areas represent about 0.1% of the known inundation area within the Guadalupe FPR, they were determined to be statically insignificant for this analysis.

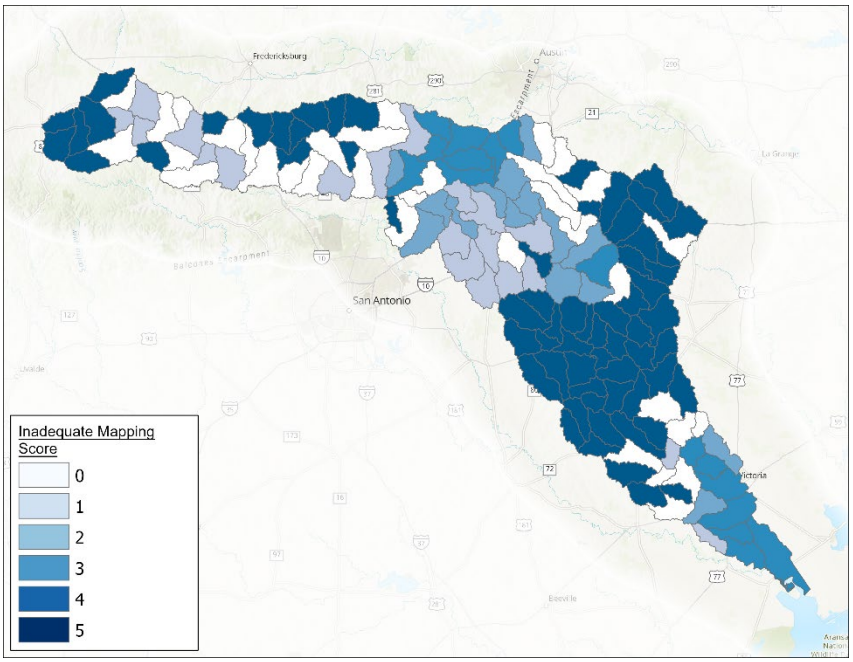


Figure 4-6: Flood Hazard Gaps

It should be noted that, although the base-level engineering boundaries are approximate, communities can use the data to support local flood management efforts if it is considered the "best available" information for their area and the local codes and ordinances are properly written.

The scoring matrix for this metric (**Table 4-4**) considers the prioritization of the Flood Quilt data established by TWDB and confirmed by the RFPG.

Table 4-4: Task 4A Category Scoring Ranges: Areas without Adequate Inundation Maps

Reason for Gap (least to most adequate)	Score
Fathom or no data available	5
NFHL Zone A (approximate)	4
Base-Level Engineering	3
Detailed Study (<50% of watershed)	2
Detailed Study (>50% of watershed)	1

4.1.4 Areas Without H&H Models

A separate scoring criterion was not developed for this category because the risk associated with lack of technical data is already being considered by the "Inadequate Inundation Mapping," as areas with detailed mapping are presumed to have H&H modeling. The existing H&H models identified for the Guadalupe Basin are presented in the Existing Hydrologic and Hydraulic Model List in **Appendix 2-C**.

4.1.5 Areas with Emergency Needs

For this plan, an emergency need has been defined as infrastructure in immediate need for repair or construction, particularly following a natural disaster or other destructive event. No emergency needs were identified by sponsors within the Guadalupe Basin; therefore, this category was not included as a scoring criterion for the first draft of the RFP.

4.1.6 Existing Modeling Analyses and Flood Risk Mitigation Plans

HMAPs were identified for all counties within the Guadalupe Basin. Because this criterion would not provide any differentiation, this category was not included as a scoring criterion for the first draft of the RFP.

4.1.7 Flood Mitigation Projects Previously Identified

Chapter 1 summarized the ongoing and previously identified projects identified through the stakeholder survey and outreach. Much of what is known at this time was taken from publicly available data such as HMAPs and drainage master plans. These often lack the level of detail needed to assess potential risk reduction as compared to more detailed preliminary engineering studies. Since insufficient risk reduction data is available to determine statistically significant changes at this time, this category was not included in the first planning cycle. The list is anticipated to grow as stakeholder outreach continues, and the relevant data will improve as FMEs are completed.

4.1.8 Historic Flooding Events

Reported Flood Concerns

In addition to the Flood Hazard Quilt data provided by TWDB, members of the public and regional stakeholders were provided the opportunity to identify additional flood-prone areas not included in the existing data using an online interactive map. Sixty responses were recorded, identifying points of flood risk on the map. A large majority of the points were found to be within existing flood hazard areas. Those that were outside known floodplains were digitized into polygons to represent areas of likely inundation based on topography and the content of the survey responses, resulting in a total of 1.27 square miles of additional flood prone areas identified.

Although the reported flooding outside of known hazard areas was limited, the "Flood History" input was used to reflect this additional risk. The scoring metric is shown in **Table 4-5**.

FEMA Claims

This dataset compiles all known FEMA flood claims within the Guadalupe Basin as of February 8, 2021. The claims were grouped by Census Track ID numbers included in the costs of FEMA claims for each HUC 12 based on an area-weighted average. The weighted average was based on the percentage of the census tract within a HUC 12 multiplied by the total number of the total cost of FEMA claims for the census tract. This procedure is followed for all census tracts intersecting a HUC 12 boundary, and the weighted costs were tallied for each HUC 12.

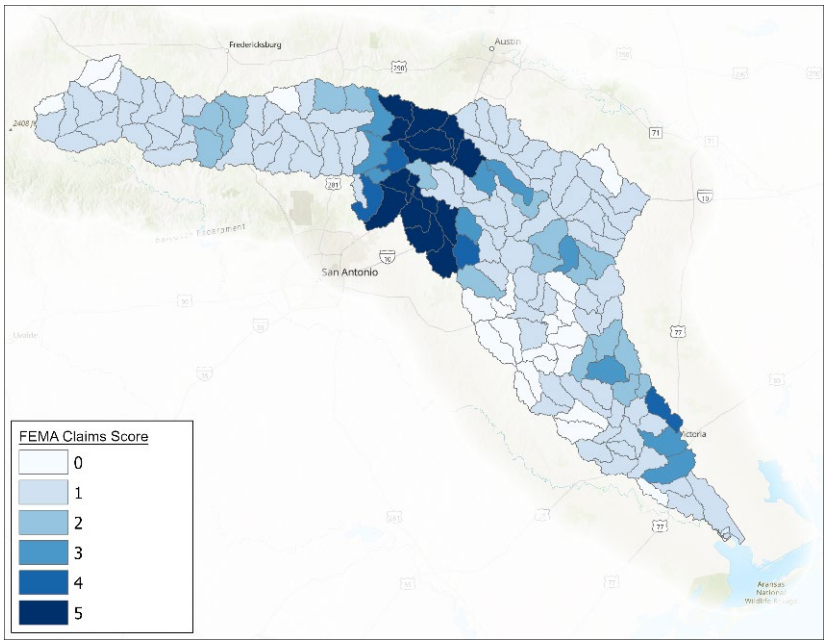


Figure 4-7: FEMA Flood Claims

4.1.9 Historic Storm Events

The occurrence of historic storm events (disaster declarations) was evaluated using the FEMA Disaster Information Database. That database compiles disaster declarations since 1950 and, among other

things, documents Major Disaster Declarations and Emergency Declarations due to floods, hurricanes, and severe storms. As shown in **Table 1-9** in **Chapter 1**, 36 disaster and 8 emergency declarations were reported for counties in the Guadalupe Basin between 1953 and 2020.

The number of declarations occurring within each HUC 12 was tabulated and scores were assigned according to the points breakdown shown in **Table 4-5**.

Table 4-5: Task 4A Category Scoring Ranges: Historic Flood Events

Score (low to high damages)	0	1	2	3	4	5
Disaster Declarations	0	0-3	3-6	6-10	10-15	15+
FEMA Claims (dollars)	0	0-1,000,000	1-3,000,000	3-6,000,000	6-20,000,000	20mil+
Additional Flood Concerns	0	1	2	2+		

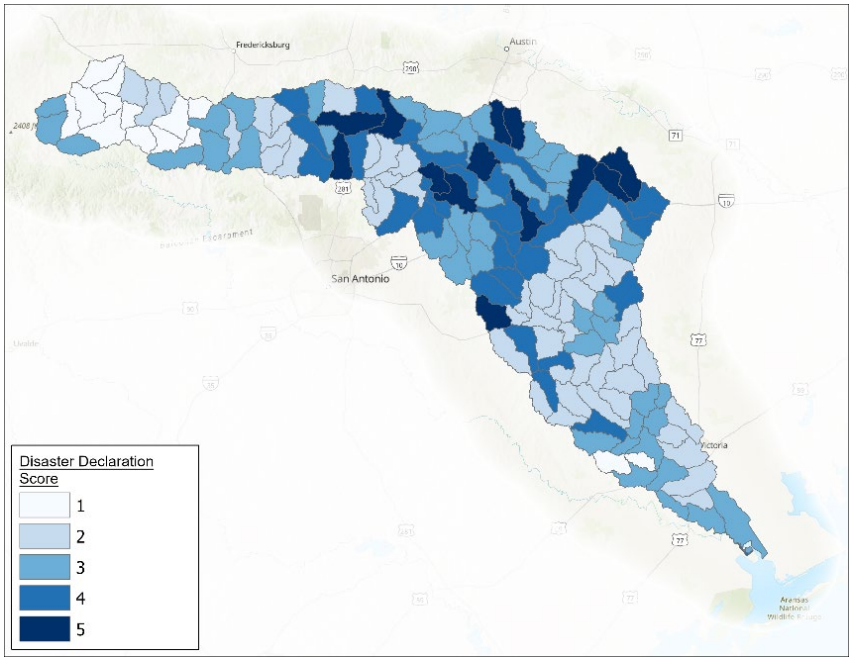


Figure 4-8: Disaster Declarations

4.1.10 Other Factors

Social Vulnerability Index (SVI)

SVI refers to the potential negative effects on communities caused by external stresses on human health, such as natural disasters. SVI can be an indicator on a community's ability to prevent and/or recover from those stresses. Factors that contribute to social vulnerability include poverty, lack of transportation access, and crowded housing. SVI values for the state of Texas are based on the 2018 Centers for Disease Control and Prevention Agency for Toxic Substances and Disease Registry (CDC/ATSDR) (www.atsdr.cdc.gov/placeandhealth/svi/index.html).

SVI values are assigned per census tract and were converted to reflect SVI for each HUC 12 based on an area-weighted average. The weighted average was based on the percentage of the census tract within a HUC 12 was multiplied by the SVI for the census tract. This procedure was followed for all census tracts intersecting a HUC 12 boundary, and the weighted SVI values were combined to produce a single SVI value for each HUC 12. The SVI ratings vary between 0-1 and were scored according to **Table 4-6**. Higher SVI values reflect a higher vulnerability, with lower values indicating higher resilience. Communities with an SVI greater than or equal to 0.75 are generally able to receive a large portion of state and federal funding in grants rather than loans. Overall, the HUC 12s located within Calhoun, Gonzales, and DeWitt Counties have the highest SVIs.

Table 4-6: Task 4A Category Scoring Ranges: Social Vulnerability Index (SVI)

Score (least to most vulnerable)	1	2	3	4	5
SVI Rating	0.01 - 0.25	0.26 - 0.35	0.36 - 0.50	0.50 - 0.65	0.66+

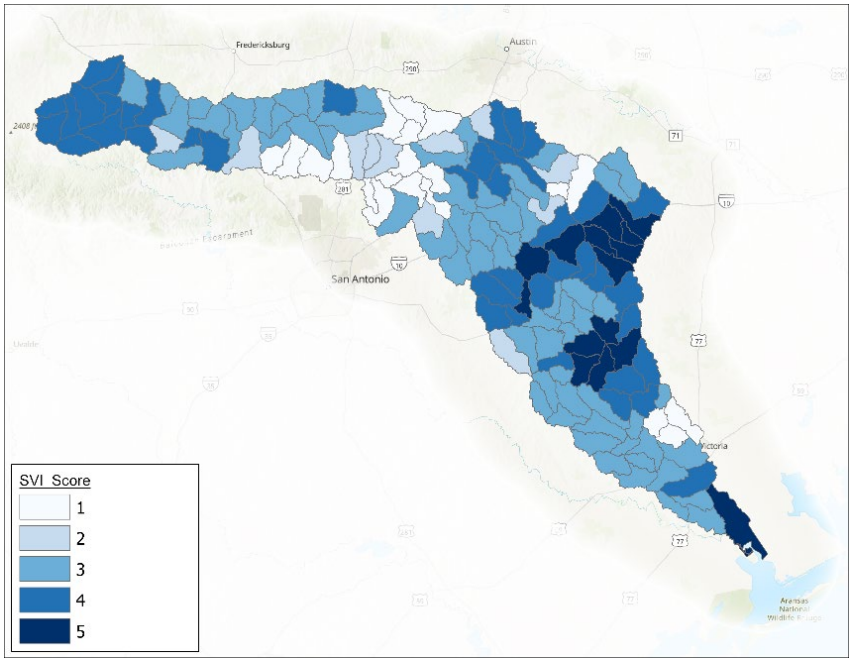


Figure 4-9: Social Vulnerability

4.1.11 Analysis and Results

The process and scoring methodology described above was implemented across the entire basin to address the two objectives of the Flood Mitigation Needs Analysis. The first objective is to identify the areas where the greatest flood risk knowledge gaps exist. The Inadequate Inundation Mapping category was selected as the basis for identifying these areas. Based on the data available, approximately 65% of the Guadalupe Basin is considered inadequately mapped as shown in **Figure 4-10** and **Map 14**: Greatest Gaps in Flood Risk Information (**Appendix 4-A**). Except for the portions of Calhoun and Refugio Counties that have FEMA NFHL maps based on a study that is more than 10 years old, most of these areas only have base-level engineering mapping available. Although base-level engineering maps are considered

inadequate because they lack detail, it is important to note these products are considered “best available” data in areas that have either outdated maps or none, and can be used by communities for floodplain management.

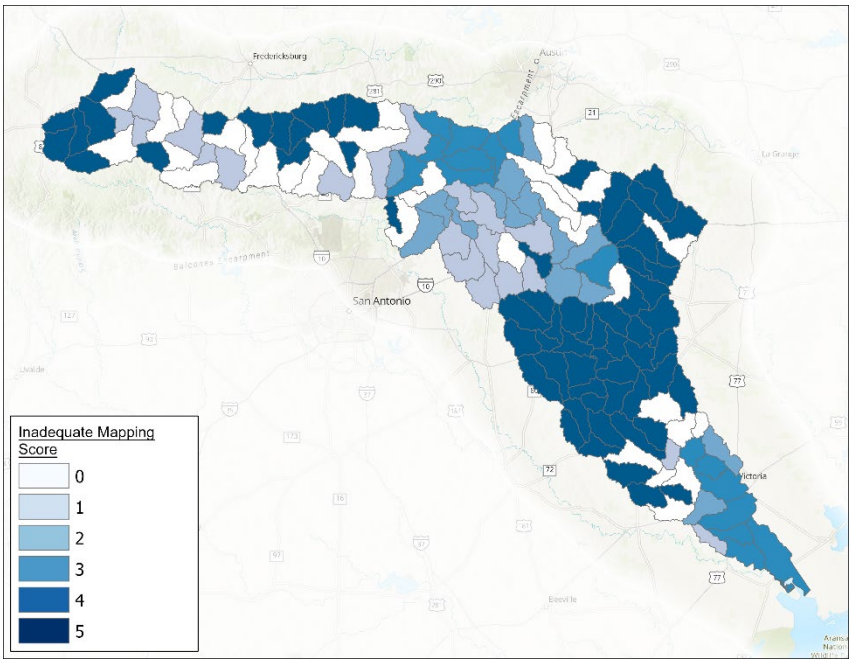


Figure 4-10: Greatest Gaps in Flood Risk Information

The second objective is to determine the areas of greatest known flood risk and flood mitigation needs. The scores developed in Task 4A were compiled at the HUC 12 watershed scale to establish relative flood risk across the Guadalupe FPR. **Figure 4-11** and **Map 15** in **Appendix 4-A** present the results of the analysis and indicate the areas with the highest known flood risk and flood mitigation needs. It is important to note that a low score for any HUC 12 watershed does not necessarily mean there is no flood risk. Rather, it simply reflects flood risk is lower as compared to other watersheds.

The Cities of New Braunfels, San Marcos, Cuero, Gonzales, and Victoria were identified as those with the greatest known flood risks. The areas with the second highest level of known flood risk include the Cities of Kerrville and Kyle; however, there is significant risk scattered across the Guadalupe FPR close to population centers.

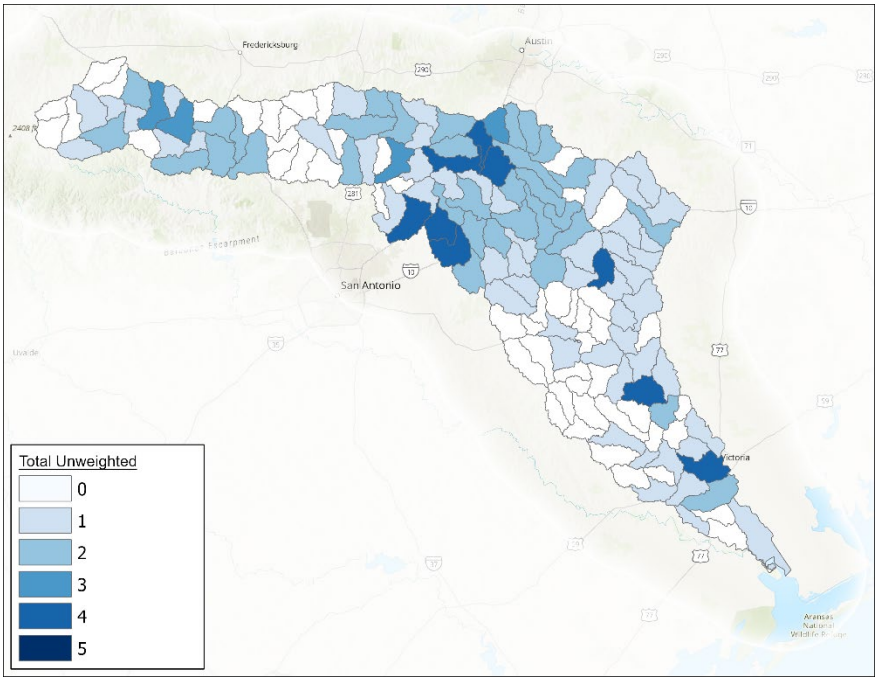


Figure 4-11: Areas with Greatest Flood Risk and Mitigation Needs

4.2 Identification and Evaluation of Potential FMEs, FMSs, and FMPs

The objective of Task 4B is to identify and evaluate a wide range of potential actions to define and mitigate flood risk across the basin. These actions have been broadly categorized into three distinct types:

- **Flood Management Evaluation (FME)**: 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.
- **Flood Mitigation Project (FMP)**: a proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring costs, and when implemented will reduce flood risk or mitigate flood hazards to life or property
- **Flood Management Strategy** (**FMS**): a proposed plan to reduce or mitigate flood hazards to life or property.

This first regional flood planning cycle relies primarily on readily available information and stakeholder input to determine appropriate flood mitigation actions to recommend for inclusion in the draft plan. Identification of potential FMEs and potentially feasible FMPs and FMSs began with reaching out to communities within the Guadalupe River Basin to get an understanding of their needs. It also involved reviewing Hazard Mitigation Action Plans, previous flood studies, drainage master plans, capital improvement studies, and other sources of publicly available data to begin identifying potential flood management and flood mitigation actions. These actions were initially categorized as potential FMPs, FMEs, or FMSs based on the information available. After preliminary categorization of actions through an initial screening and data collection performed under this task, the FMEs, FMSs, and FMPs were further evaluated, and additional stakeholder outreach efforts were made to compile the necessary technical data for the RFPG to decide whether to recommend these actions or a subset of these actions as part of Task 5.

A list of previous studies considered for development of the Regional Flood Plan can be found in **Appendix 1-A**.

4.2.1 Classification of Potential FMEs and Potentially Feasible FMSs and FMPs

The *Technical Guidance* included a summary of different general action types, listed below in **Table 4-7.** After potential flood risk reduction actions were identified, a high-level screening process was used to confirm that potential actions had been sorted into their appropriate category. The screening process is shown in **Figure 4-12.**

Table 4-7: General Flood Risk Reduction Action Types

Flood Risk Reduction Action Category	Action Types
Flood Management Evaluation (FME)	a. Watershed planning i. Hydraulic and hydrologic (H&H) modeling ii. Flood mapping updates iii. Regional watershed studies b. Engineering project planning i. Feasibility assessments c. Preliminary engineering (alternative analysis and up to 30% design) d. Studies on Flood Preparedness
Flood Mitigation Projects (FMP)	**Structural** a. Low-water crossings or bridge improvements b. Infrastructure (channels, ditches, ponds, stormwater pipes and more) c. Regional detention d. Regional channel improvements e. Storm drain improvements f. Reservoirs g. Dam improvements, maintenance, and repair h. Flood walls/levees i. Coastal protections j. Nature-based projects – living levees, increasing storage, increasing channel roughness, increasing losses, de-synchronizing peak flows, dune management, river restoration, riparian restoration, run-off pathway management, wetland restoration, low-impact development, green infrastructure k. Comprehensive regional project – includes a combination of projects intended to work together.
	Non-Structural a. Property or easement acquisition b. Elevation of individual structures c. Flood readiness and resilience d. Flood early warning systems, including stream gauges and monitoring stations e. Floodproofing f. Regulatory requirements for reduction of flood risk
Flood Management Strategies (FMS)	None specified; RFPGs were instructed to include at a minimum any proposed action that the group wanted to consider for inclusion in the plan that did not qualify as either an FME or FMP.

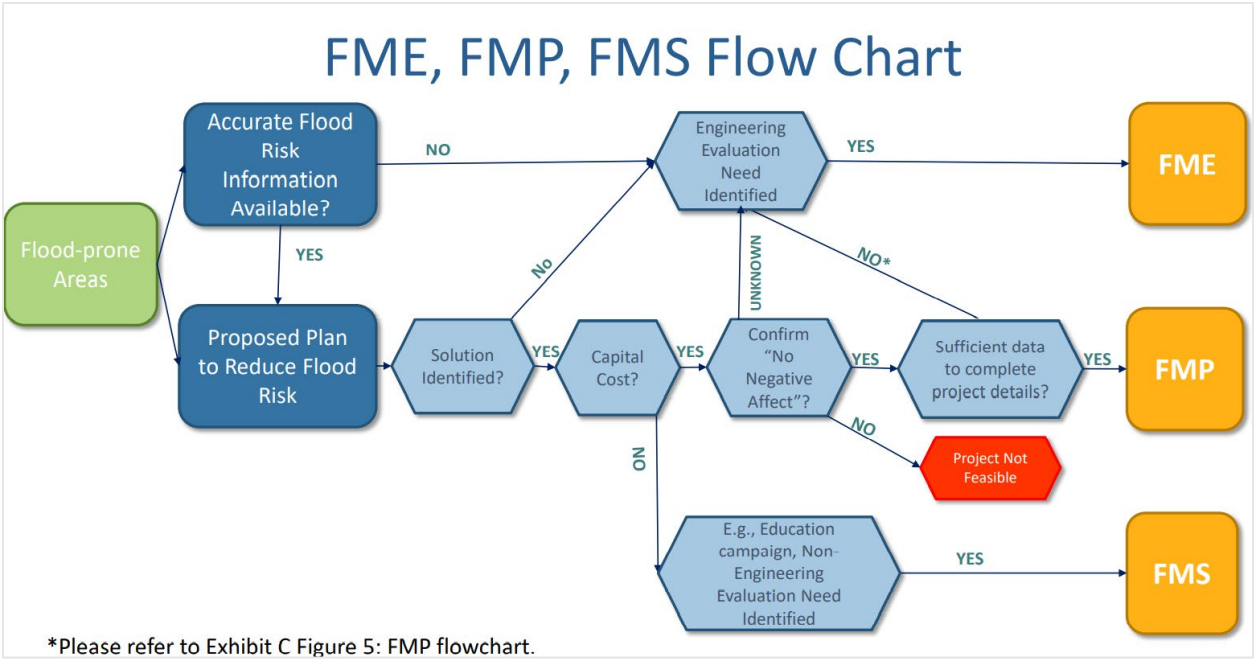


Figure 4-12: Potential Flood Risk Reduction Action Screening Process

Source: TWDB

Generally, an action is considered an FME if it describes a study to quantify flood risk (floodplain modeling and mapping) or to define and evaluate potential for flood risk reduction and negative impacts of FMPs (project feasibility or preliminary engineering). Potential actions that could be considered FMPs were screened to determine if they have been developed in enough detail and include sufficient data to meet the minimum technical requirements for these action types. Actions initially considered for inclusion as FMPs that did not meet the requirements were generally reclassified as FMEs; however, potential actions that did not clearly meet the criteria for FMEs or FMPs were included as FMSs. The specific requirements for each action type are described in subsequent sections.

FMSs were also identified for other non-construction-related strategies that communities and the RFPG believe will lead to flood risk reduction within the basin. One example of a potential FMS involves establishing a community-wide program to acquire and preserve open spaces in flood-prone areas to be implemented over time, as compared to targeted acquisitions identified through a feasibility or preliminary engineering study that could qualify as an FMP. Other examples of potential FMSs include developing/implementing program(s) to increase public education and awareness about flood risk and flood insurance or evaluating and updating codes and ordinances to reduce future flood risk and to protect open space.

4.2.2 Evaluation of Potential FMEs

Several actions were identified as potential FMEs to address gaps in available flood risk data associated with the first planning cycle. The following data sources were used to identify FMEs across the basin:

- Hazard Mitigation Action Plans (HMAP)
- Capital improvement plans (CIPs)
- Drainage master plans
- Previous community flood studies
- Flood Infrastructure Fund (FIF) applications not chosen for funding
- Stakeholder input

The evaluation of FMEs relied on the compilation of planning-level data to gauge alignment with regional goals and flood-planning guidance, the potential flood risk in the area, and the funding need and availability. This data included:

- Type of study and location
- Availability of existing modeling and mapping data
- Regional flood mitigation and floodplain management goals addressed by the FME, and whether the FME meets an emergency need
- Flood risk information, including flood risk type, number and location of structures, population, roadways, and agricultural areas at risk
- Sponsor entity and other entities with oversight
- Cost information, including study cost and potential funding sources

FME Types

The definition of an FME allows for a variety of study types to help assess flood risk and potentially define future FMPs and FMSs. A general list of study types was previously summarized in **Table 4-7**. The following section describes these project types in more detail and provides a summary of the different potential FMEs identified in Region 11.

Watershed Planning

Watershed planning studies typically involve H&H modeling and floodplain mapping to define flood risk or identify flood-prone areas at a regional scale. The goal of watershed planning is to identify the flood risks and to develop plans, programs, and projects that maintain watershed function and/or reduce flood risk without creating negative impacts. A wide variety of project types fit under the umbrella of watershed planning, and the subcategories defined in Region 11 include:

- Flood modeling and mapping updates
- Drainage master plans
- Watershed studies

Engineering Project Planning

FMEs classified under engineering project planning include studies to evaluate potential construction projects. These evaluations include feasibility assessments and preliminary engineering design studies. The flood planning process defines a 30% design level as the cut-off between the preliminary engineering associated with an FME and the final design and implementation associated with an FMP. The following engineering project planning subcategories were identified in Region 11:

- Culvert and low-water crossing improvements
- Road/bridge improvements
- Creek improvements for conveyance, erosion control, and stabilization
- Storm drain improvements
- Detention
- Buyouts/elevation
- Floodproofing and hardening critical facilities

Flood Preparedness Studies

Studies for flood preparedness include proactive evaluations of a community's readiness to respond to a flood event. These types of evaluations consider factors like early warning systems, public awareness about flooding, capabilities of emergency operations personnel, and the development of emergency operations and evacuation plans. The subcategories identified in Region 11 included:

- Dam evaluations, breach mapping, and evacuation planning
- Improving ingress/egress routes for emergency responders

FME Classification Summary

A summary of identified FMEs is provided in **Table 4-8,** and supporting technical information is presented in TWDB-required **Table 12 (Appendix 4-B)**. In total, 138 potential FMEs were identified and evaluated. The geographical distribution of the identified FMEs is shown in **Figure 4-13** and **Map 16** in **Appendix 4-B**.

Table 4-8: FME Types and General Description

FME Type		Description	Number
Watershed Planning	Drainage master plans, other community-scale plans	Supports the development and analysis of H&H models to evaluate flood risk within a given jurisdiction, evaluates potential alternatives to mitigate flood risk, and develops CIPs.	21
	H&H modeling, regional watershed studies	Supports the development and analysis of H&H models to define flood risk or identify flood-prone areas OR large-scale studies that are likely to benefit multiple jurisdictions.	12
	Flood mapping updates	Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Creates FEMA mapping in previously unmapped areas and updates existing FEMA maps as needed.	3
Project Planning	Engineering project planning	Evaluates a proposed project to determine whether implementation would be feasible; OR provides initial engineering assessment, including conceptual design, alternative analysis, and up to 30% engineering design.	95
Preparedness	Studies on Flood Preparedness	Encourages preemptive evaluations and strategies to better prepare an area in the event of flood.	7

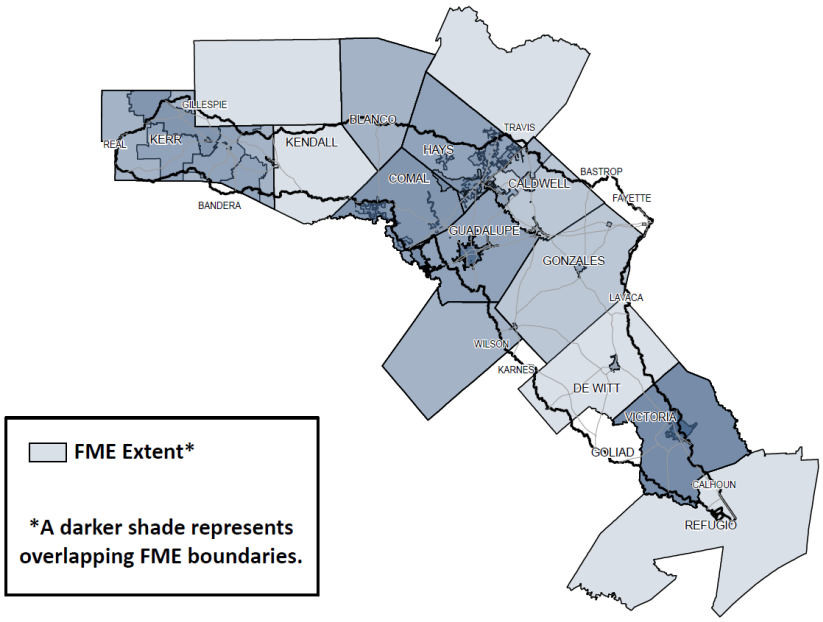


Figure 4-13: Geographical Distribution of Potential FMEs

Planning Level Cost Estimates

Planning level cost estimates were primarily sourced from the community's local studies used to identify the action as a potential FME, with high-level verification and validation of those costs performed. In cases where the sponsor had not previously identified a cost for the study, a cost estimate was produced using the processes outlined in the following sections. Cost estimates presented are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. Through the Flood Infrastructure Financing Survey discussed in **Chapter 9**, sponsors were given the opportunity to confirm or alter the cost estimates produced as a part of this planning effort. *Local sponsors will further refine and develop detailed scopes of work and associated cost estimates prior to submitting future funding applications through TWDB or other sources.*

Watershed Planning – Drainage Master Plans and Other Community-Scale Plans

All of the 21 FMEs to perform community-scale planning studies of risk and potential solutions were sourced from sponsors' existing local plans and reports, such as HMAPs. Six of the reports had detailed cost estimates for the FME. Those costs were elevated to 2020 values based on the date of the study, in accordance with TWDB guidance. A large majority of the source documents (accounting for 14 of the 26 FMEs in this category) contained only an estimated construction cost for the eventual improvements that the FME is intended to identify and evaluate. It was assumed that the evaluation effort would equate to 10% of the total construction cost listed in the report or a minimum of $100,000. Again, project costs were escalated based on the date of the initial study. The remaining studies with no sponsor-

identified study or construction costs were assigned estimated costs based on costs for similar FMEs identified and professional judgement of the local area and project type.

Watershed Planning – H&H Modeling, Regional Watershed Studies, Flood Mapping Updates

Sponsor-provided costs were utilized for all FMEs entailing flood mapping updates or large-scale H&H modeling, as described in **Table 4-8**. The costs provided by sponsors were reviewed for reasonableness based on the information available and validated before inclusion as cost-level estimates in this plan.

Project Planning – Engineering Project Planning

Engineering project planning considers two important components:

- Evaluation of a proposed project to determine whether implementation would be feasible (conceptual design)
- An initial engineering assessment, including alternative analysis, and up to 30% engineering design

Each evaluation area is project-specific and varies due to the wide range of potential improvements in channels, culverts and low-water crossings, roads and bridges, storm drain systems, and stream stabilization.

Costs for each evaluation were taken from sponsors' existing plans and reports, when available. Similar to drainage master plans and other community-scale plans, a few of the source reports had detailed cost estimates for the FME. Those costs were elevated to 2020 values based on the date of the study, in accordance with TWDB guidance. A large majority of the source documents contained only an estimated construction cost for the eventual improvements that the FME is intended to identify and evaluate. It was assumed that the total cost represented in the report was the overall estimated construction cost and that the evaluation effort would equate to 10% of the total construction cost or a minimum of $100,000. Project costs were escalated to 2020 values based on the date of the initial study. All costs provided by sponsors were reviewed for reasonableness based on the information available. In instances where a source document or report was not available for the FME or no cost estimate was provided, costs were estimated based on costs for similar FMEs identified and professional judgement of the local area and project type.

Studies on Flood Preparedness

Studies on flood preparedness encourage preemptive evaluations and strategies to better prepare an area in the event of a flood. The identified FMEs in this category include studies to perform vulnerability assessments, develop emergency action or evacuation plans, and to evaluate access roads to emergency vehicle ingress and egress. Costs for each evaluation were taken from sponsors' existing plans and reports when available. Approximately half of the source reports had detailed cost estimates for the FME, and the remaining were estimated

based on costs for similar FMEs identified and professional judgement of the local area and project type.

Process to Determine Flood Risk Indicators

Flood risk indicators were quantified to define the existing flood hazard, flood risk, and flood vulnerability within each FME project area. An automated tool was developed in a geographic information system (GIS) to combine and summarize this information by clipping the flood risk information generated for the basin as part of Task 2A to the individual project boundaries associated with each FME. The resulting flood risk indicator information was used to populate the associated fields in the FME feature class. These values are summarized in **Table 12 (Appendix 4-B)**.

Comparison and Assessment of FMEs

A majority of the FMEs collected were categorized as engineering project planning. These include specific flood-prone areas known to a community through observation and eyewitness flood reports or through limited studies that identified conceptual improvement alternatives. These FMEs include storm drainage and roadway crossing improvements, floodproofing, and possible voluntary buyouts or structural elevation. In the limited cases where existing analyses have been performed, the proposed projects did not meet the full requirements to be included as an FMP and were classified as an FME for further refinement. The engineering project planning projects collected generally reflect the areas with the greatest known flood risks and represent communities from the upper basin down to the coast.

Determination of Emergency Need

The term emergency need can be interpreted in multiple ways, and each region has been tasked with defining the term for each individual flood planning region. For the purposes of this evaluation, an action was considered to meet an emergency need if it addresses an issue related to infrastructure in immediate need for repair or construction, particularly following a natural disaster or other destructive event. While flooding can occur at any time of year with any magnitude, and often without warning, studies and evaluations on flooding generally do not meet these criteria because of the time it takes to complete a study and develop actionable alternatives. As a result, no FME was classified as demonstrating an emergency need.

4.2.3 Evaluation of Potentially Feasible FMPs and FMSs

Potentially feasible FMPs were identified based on responses to survey, reviews of previous studies, FIF applications not selected for funding, and direct outreach with stakeholders. FMSs and FMPs are required to be developed in a sufficient level of detail to be included in the Regional Flood Plan and recommended for state funding. In most cases, this includes having recent H&H modeling data to assess the impacts of the project and an associated project cost to develop the project's benefit-cost ratio (BCR). The development and use of the technical information to evaluate potentially feasible actions are described in the subsections that follow.

Potentially Feasible FMPs

The RFPG identified 28 potentially feasible FMPs. The geographical distribution of each identified FMP is shown in **Figure 4-14 (Map 17** in **Appendix 4-B)** with technical information for each FMP summarized in **Table 13 (Appendix 4-B).** Each project is unique, and the specific FMPs recommended by the RFPG will be described in detail in **Chapter 5**. A general description of the potentially feasible FMPs is presented in **Table 4-9**.

Table 4-9: Summary of FMP Types

FMP Type	General Description	Number of FMPs Identified
Stormwater Infrastructure Improvements	Improvements to stormwater infrastructure, including channels, ditches, ponds, and stormwater pipes	7
Roadway Drainage Improvements	Improvements to roadway drainage infrastructure, including side ditches, culvert crossings, and bridge crossings	5
Regional Detention Facilities	Runoff control and management via detention facilities	9
Property Acquisition	Voluntary acquisition of flood-prone structures.	1
Flood Warning Systems	Installation of gauges, sensors, or barricades to monitor streams and low-water crossings for potential flooding and support emergency response.	2
Emergency Generators	Purchasing and installing emergency generators at critical facilities	4

The identified potentially feasible FMPs for this first planning cycle are concentrated in the mid-to-lower reaches of the basin but do include projects in the upper portion of the basin. These were the only actions for which sufficient information was available to be considered as a potentially feasible FMP or that an existing unfunded FIF application was potentially available. The potential sponsors and their associated number of FMPs are listed in **Table 4-10**.

Table 4-10: Potentially Feasible FMPs

FMP ID Number	Name	Sponsor
113000001	Detention on the Blanco River	Blanco County
113000006	Plum Creek Tributary 3 Arbor Knot Dr. Improvement	City of Kyle

FMP ID Number	Name	Sponsor
113000007	Plum Creek Tributary 4 Sledge Rd. Improvement	City of Kyle
113000010	65 ft Channel Modification and Additional Culvert	City of Kyle
113000011	Plum Creek Detention Pond Upstream of IH 35	City of Kyle
113000015	Improve Flood Warning Systems	City of San Marcos
113000026	Purgatory Creek Channel Improvement	City of San Marcos
113000027	Sherwood/Kingwood Drainage Improvements	City of San Marcos
113000035	Guadalupe Street Automatic Flood Gates	City of Seguin
113000036	Baldridge Creek Regional Detention Pond	City of Waelder
113000037	Baldridge Creek Channel and Culvert Improvement	City of Waelder
113000039	Wilson Creek – Green Acres Dr. Improvement	City of Wimberley
113000040	Regional Detention South of Mountain Crest Drive	City of Woodcreek
113000041	Brookside Drive Culvert Crossing Improvements	City of Woodcreek
113000042	Brookmeadow Drive Drainage Improvements	City of Woodcreek
113000044	Regional Detention on Bear Creek	Comal County
113000047	Regional Detention on Peach Creek	Gonzales County
113000052	Kerr County Back-up Power Generators	Kerr County
113000060	City of Victoria Back-up Power Generators	City of Victoria
113000061	City of Buda-Lifschutz Headwaters Voluntary Buyout	City of Buda
113000062	City of Nixon-Wastewater System Flood Improvements	City of Nixon
113000063	City of San Marcos-Emergency Generators	City of San Marcos
113000064	Victoria County-Emergency Generators	Victoria County
113000065	City of Seguin Regional Detention Southwest of Seguin City Limits	City of Seguin
113000066	City of Seguin – Culvert Improvements at Guadalupe River Drive	City of Seguin
113000067	City of Victoria Channel and Bridge Modifications on Highway 87	City of Victoria
113000068	City of Victoria Detention Upstream of State Highway 87	City of Victoria

FMP ID Number	Name	Sponsor
113000069	Guadalupe County Detention on York Creek Project	Guadalupe County

Additional potentially feasible FMPs may be identified through continued outreach with regional stakeholders or through the execution of identified FMEs. TWDB has provided additional funding for the execution of FMEs recommended in the Regional Flood Plan, with the goal of additional FMPs being included in the Amended Regional Flood Plan, due to TWDB July 2023.

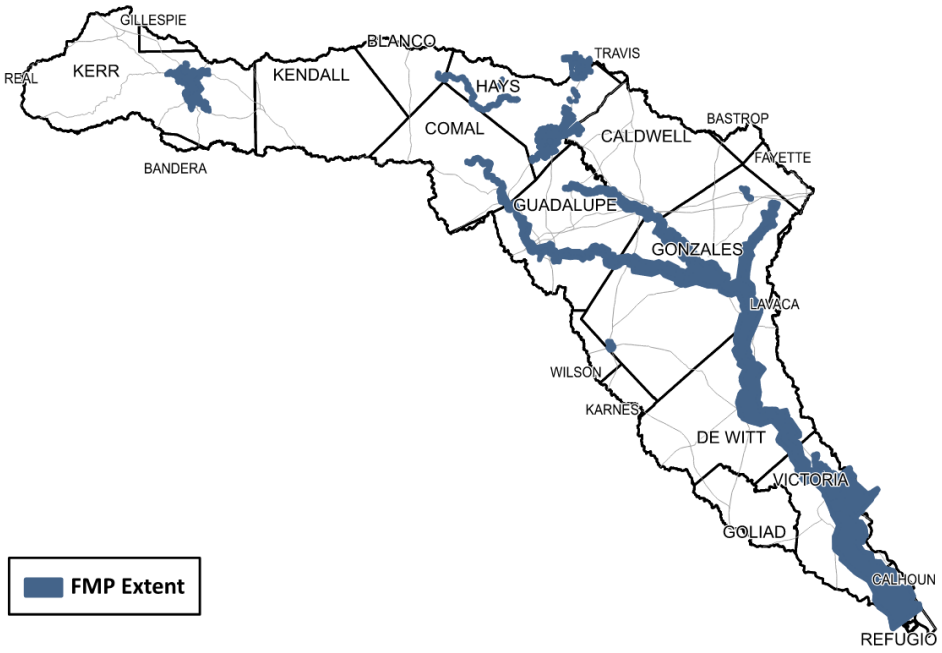


Figure 4-14: Geographical Distribution of Potential FMPs

Potentially Feasible FMSs

The RFPG identified approximately 185 potentially feasible FMSs, and the geographical distribution of each identified FMS is shown in **Figure 4-15 (Map 18** in **Appendix 4-B)**. Technical information for each FMS is summarized in TWDB-required **Table 14 (Appendix 4-B).**

A variety of FMS types were identified. Some establish and implement public awareness and educational programs to better inform communities of the risks associated with flood waters. Other FMSs improve preventative maintenance programs to maximize operational efficiency of existing stormwater management infrastructure, develop stormwater management manuals to encourage best management practices, or set up programs to establish community-wide flood warning systems. A few property acquisition programs were also identified. These programs include a variety of purposes, such as acquiring floodplain and environmentally sensitive areas

to convert them into open space land and acquisition of repetitive loss structures. A summary listing of FMS types is provided in **Table 4-11**.

Table 4-11: Summary of FMS Types

FMS Type	General Description	Number of FMSs Identified
Education and Outreach	Develops a coordinated education, outreach, and training program to inform and educate the public about the dangers of flooding, flood insurance, how to prevent flood damages to property, and training.	61
Flood Measurement and Warning	Develops early warning systems; installs gauges, barricades, signage and improvements to increase low-water crossing safety; creates or enhances evacuation plans; improves community preparedness.	45
Infrastructure Projects	Supports general city- and countywide programs to develop and implement flood-reduction projects.	16
Property Acquisition and Structural Elevation	Acquires, relocates, and/or elevates flood-prone structures. Acquires floodplain and protect environmentally sensitive areas by converting floodplain encroachments into open space land	31
Regulatory and Guidance	Reviews, updates, and enhances flood-damage prevention ordinances and development practices. Considers incorporating higher standards.	31
	Develops and adopts “green infrastructure” programs and incorporates regulatory standards to protect open space in flood-prone areas	
	Joins the FEMA Cooperating Technical Partners (CTP) program to lower flood insurance rates for residents	

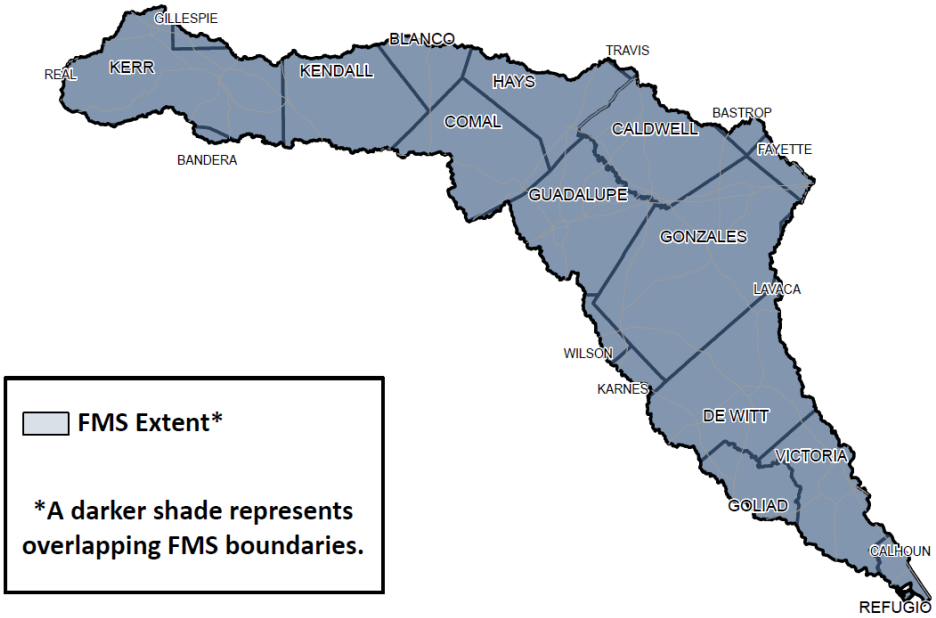


Figure 4-15: Geographical Distribution of Potential FMSs

Potentially Feasible FMS Comparison and Assessment

More than 70% of the identified FMSs are categorized as Education and Outreach or Flood Measurement and Warning, and almost 20% are related to Regulatory and Guidance. Developing education and flood-warning programs are relatively cost-effective means for reducing flood risk through avoidance; however, human nature is unpredictable, so these measures alone do not guarantee long-term flood risk reduction. Maintaining minimum NFIP or adopting higher floodplain regulatory standards for new development or redevelopment are proven to save more money than they cost. In fact, a Natural Hazard Mitigation study prepared by FEMA should result in a 7:1 reduction in flood mitigation costs as compared to above-code design. Minimum FEMA NFIP floodplain regulations can be found in Chapter 44 of the *Code of Federal Regulations* (44 CRF). The Texas Floodplain Management Association (TFMA) has developed a *Guide for Higher Standards for Floodplain Management (2018),* which can serve as an example for higher floodplain development standards for the referenced FMSs.

Thirty-six sponsors requested flood awareness and safety education support. These FMSs range from implementing the National Weather Service's "StormReady" campaign to general education with regard to the NFIP, flood insurance campaigns, and training.

Twenty-three sponsors expressed interest in flood measuring, monitoring, and warning systems. These systems include local warning notifications, monitoring/measuring gages, signage, and barricades. Proposed FMSs also included evacuation planning/training and improving communications to the public and among the emergency service departments.

Another FMS identified relates to property and land acquisition programs. The individual strategies included riparian corridor protection and floodplain preservation, but could be expanded to include voluntary buyout programs. Not only do these programs have the capacity to reduce existing flood risk and avoid future flood risk, but they also provide opportunities for recreation, environmental uplift, and groundwater recharge.

Effects on Neighboring Areas of FMSs or FMPs

Each potentially feasible FMP and FMS must demonstrate that there would be no negative impacts on a neighboring area or community due to its implementation. For flood mitigation projects, no negative impacts typically means that a project will not increase flood risk to surrounding properties (upstream or downstream). In effect, the goal is to reduce flood risk in a particular area without increasing flood risk in another. The analysis must be based on best available data and be sufficiently detailed to demonstrate that the post-project flood hazard is no greater than the existing (pre-project) flood hazard.

Several communities in the Guadalupe region have established “no negative flood impact” policies for proposed development. However, communities have different thresholds for defining what level of impact is considered adverse and require the analysis to be performed for different flood event scenarios. The *Technical Guidelines and Rules* governing state flood planning require the impacts analysis to be performed for the 1% ACE. Additionally, the *Technical Guidelines* require the following criteria to be met, as applicable, to establish no negative flood impact:

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 1-D water surface elevation must round to 0.0 feet (< 0.05 feet) measured along the hydraulic cross-section.
4. Maximum increase of 2-D water surface elevations must round to 0.3 feet (< 0.35 feet) measured at each computational cell.
5. Maximum increase in hydrologic peak discharge must be < 0.5 percent measured at computational nodes (sub-basins, junctions, reaches, and reservoirs). This discharge restriction does not apply to a 2-D overland analysis.

If negative impacts are identified, mitigation measures may be utilized to alleviate such impacts. Projects with design-level mitigation measures already identified may be included in the Regional Flood Plan and could be finalized at a later stage to conform to the “no negative impact” requirements prior to funding or execution of a project. Furthermore, the RFPG has flexibility to consider and accept additional “negative impact” for requirements 1 through 5 based on the engineer’s professional judgment and analysis, provided all affected stakeholders are informed and accept the impacts. This should be well-documented and consistent across

the entire region; however, flexibility regarding negative impact remains subject to TWDB review.

A comparative assessment of pre- and post-project conditions for the 1% ACE (100-year flood) was documented for each applicable potentially feasible FMP based on their associated study results. FMPs, such as installation of flood warning systems only (no associated channel or roadway improvements) and emergency generators, will not alter the existing flood risk, and therefore the analysis is not applicable.

The comparative assessment to determine "no negative flood impact" on upstream or downstream areas or neighboring regions was performed based on currently available regional planning level data. The local sponsor will be ultimately responsible for proving the final project design has no negative flood impact prior to initiating construction.

No negative impact assessments were not required for any of the FMSs identified because they do not involve construction projects that will alter the existing flood hazard extents. While the Infrastructure Projects type could include such actions, the currently identified actions focus on establishing programs and are not currently linked to a specific project(s). The RFPG anticipates these programs will result in addition of FMEs and FMPs for consideration in future plans.

Estimated Benefits of FMP or FMS

To be recommended, each FMP or FMS must align with a regional floodplain management goal established under Task 3 and demonstrate a flood risk reduction benefit. To quantify the flood risk reduction benefit of each FMP or FMS, the anticipated impact after project implementation was evaluated according to the following criteria:

- Reduction in habitable, equivalent living units flood risk
- Reduction in residential population flood risk
- Reduction in critical facilities flood risk
- Reduction in road closure occurrences
- Reduction in acres of active farmland and ranchland flood risk
- Estimated reduction in fatalities, when available
- Estimated reduction in injuries, when available
- Reduction in expected annual damages from residential, commercial, and public property
- Other benefits as deemed relevant by the RFPG, including environmental benefits and other public benefits

These estimated benefits were produced from geospatial data (where available) by analyzing the existing 1% and 0.2% ACE floodplain boundaries with the proposed post-project floodplain boundaries. These proposed flood risk conditions were compared to the existing conditions flood risk indicators for a given area to quantify the reduction of flood risk achieved by implementation of an FMP or FMS. Where geospatial data was not available, data was

extracted from the available studies and reports. The results of the analysis are shown for each FMP or FMS in **Table 13 (Appendix 4-B)** and **Table 14 (Appendix 4-B)**, respectively.

Potential Impacts and Benefits from the FMS or FMP to Other Resources

Potential impacts and benefits from FMS or FMP were explored from the standpoint of environment, agriculture, recreation, navigation, water quality, erosion and sedimentation. Factors unique to the Guadalupe basin were reviewed and an assessment of how these factors might interact with a potential FMS or FMP are discussed as follows.

Environmental

Senate Bill 3 (SB3) (80th Texas Legislature, 2007) was designed to establish environmental flow standards for all major river basins and bay systems in Texas through a scientific, stakeholder-driven and consensus-based process. The key questions addressed by the SB3 process, as defined by TWDB, are:

1. What is the quantity of water required by the state's rivers/estuaries to sustain a sound ecological environment?
2. How can this water be protected?
3. What is the appropriate balance between water needed to sustain a sound ecological environment and water needed for human or other uses?

FMSs or FMPs in the region should consider potential impacts as it relates to the ecological flows established under the directive of Senate Bill 3. Because none of the proposed FMSs or FMPs involved permanent detention or retention, there are no anticipated impacts to base or environmental flows. In fact, short-term detention for peak flood attenuation may improve base flow slightly.

Several of the proposed actions involve protecting or improving riparian corridors through regulation, acquisition, and erosion prevention/repair. These types of actions would have direct and indirect environmental benefits by minimizing erosion and restoring natural stream function.

Agricultural

According to the Texas A&M AgriLife Extension Service economists, Hurricane Harvey caused more than $200 million in crop and livestock losses in Texas. Flood waters have the potential to destroy standing crops; create water-logged conditions that delay planting or harvesting; wash away productive topsoil; and damage farm equipment and infrastructure. FMSs or FMPs potentially reduce extremely high flows in rivers and streams, thereby preventing flood waters from inundating areas outside of the floodway, including agricultural areas. Structural FMSs or FMPs, such as small flood control ponds, also have the potential to assist in agricultural production by serving dual purpose of flood mitigation and water supply. Non-structural FMSs or FMPs have similar impacts on flood peak-flow reduction and flooding, including agricultural conservation practices like conservation tillage, residue management, cover crops and furrow

dikes. These practices not only reduce downstream flooding by minimizing surface runoff and increasing infiltration on agricultural lands but also lessen sediment and nutrient losses, thereby improving downstream water quality.

Many of the mitigation actions focus on urban areas and will have only incidental benefits to agriculture. The Regulatory and Guidance FMSs and Watershed Planning FMEs have the potential to benefit agricultural operations by improving their understanding of flood risks, making insurance available for structures and preventing construction of regulated structures within the floodplain.

Recreational Resources

There are five major lakes and reservoirs in Region 11 (Canyon Lake, Coleto Creek, Lake Dunlap, Lake McQueeney, and Lake Gonzales). While many of these may help regulate floods, only one of these reservoirs, Canyon Lake Dam, was designed with specific flood-control function. Flood control reservoirs hold water in flood pools during peak runoff periods until the impounded water can be safely released downstream. During these periods, recreation use potential of adjacent parks and playgrounds may be vastly reduced. This is also true for many of the smaller and/or regional detention ponds commonly associated with development in urbanized centers where the basin often doubles as parks or recreational space. Although there are FMPs and FMSs that contemplate regional detention, no new major flood control reservoirs are currently proposed in the Regional Flood Plan and the none of the proposed actions are anticipated to impact the current reservoir operations.

Navigation

The Guadalupe River is not used for commercial navigation; however, the Victoria Barge Canal parallels the river for approximately 35 miles north, from San Antonio Bay. Navigation on the Guadalupe River is generally limited to recreational canoeing and kayaking in the rivers and creeks, and boating in the lakes and reservoirs. These activities are currently impacted when flows in the Guadalupe River and water levels in the reservoirs are elevated due to large rainfall events or are being actively managed for flood control. These impacts include limited or restricted access to recreational navigation when the rivers and reservoirs are at or above flood stage. None of the proposed actions in the plan are anticipated to impact navigation in the Guadalupe River Basin.

Water Quality, Erosion, and Sedimentation

Water quality, erosion, and sedimentation are complex and interrelated issues. Water quality impairments in Texas are often related to nutrient and bacterial indicator loading but can also include sediment and turbidity. The Environmental Protection Agency lists sediment as a pollutant that can cause negative impacts to rivers, streams, and lakes. Small particles that remain suspended can result in turbidity that obstructs sunlight and limits photosynthesis of aquatic plants, reduces biologically available oxygen, and increases water temperature. Larger sediment particles can reduce aquatic habitat when they settle to the bottom of streams or

lakes and can carry other pollutants, such as heavy metals or bacteria. Most water quality issues are influenced by sedimentation and erosion in the upland, riparian, and stream channel areas. While some sources are natural, sedimentation and erosion (thus water quality) can be impacted by changes to upstream variables, particularly increased impervious cover that increases runoff from the watershed and changes channel dynamics. These issues have been of significant concern to the region in part due to the topography and geology of the basin, which transitions from generally steep and rocky in the mid- to upper basin to flatter alluvial soils in the lower basin.

Many of the actions considered in this plan will improve understanding of the floodplains and allow for better understanding of any future projects impacts weather at a project scale or regional scale. None of the proposed actions are expected to have adverse impacts to water quality, erosion, or sedimentation, but these will need to be considered as future FMPs are developed. If these elements are considered early in the planning process, many flood reduction actions can provide additional benefits of improving water quality and reducing erosion and sedimentation, including:

- Reducing stormwater runoff has the potential to reduce nutrient loading to waterways through capture, as well as potentially increasing or extending base flows in intermittent streams.
- Protecting or restoring riparian corridors can reduce bed and bank erosion, while improving terrestrial and aquatic habit. Land conservation practices can result in reduced source loads, thus improving water quality while reducing sedimentation
- Constructing local and regional flood control ponds to temporality store excess runoff and can allow for a significant amount of suspended sediment to settle out of the water.

Inclusion of green infrastructure and other nature-based approaches in the design of flood risk reduction projects can improve water quality further by treating pollutant loads. In addition to nutrients, bacteria, and sediment, these approaches can reduce metals, organics, and other pollutants if designed with water quality treatment in mind from the outset.

Estimated Capital Cost of FMPs and FMSs

Cost estimates for each FMP were taken from associated engineering reports and were adjusted as needed. These costs were escalated using construction cost indices to account for inflation and other changes to the construction market. The cost estimates listed in **Table 13 (Appendix 4-B)** and **Table 14 (Appendix 4-B)** are expressed in September 2020 dollars.

Similarly, cost estimates for each FMS were taken from their associated HMAP. If a cost range was provided, the high end of that estimate was used. The costs were then compared to similar FMSs to establish relative consistency and adjusted based on judgement.

Cost estimates presented in this section are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. The RFPG anticipates that the local sponsor

will develop detailed scopes of work and associated cost estimates prior to submitting any future funding application through TWDB or other sources.

Benefit-Cost Ratio for FMPs

Benefit-Cost Analysis (BCA) is the method by which the future benefits of a proposed flood mitigation project are estimated and compared to its implementation costs. The result is a Benefit-Cost Ratio (BCR), which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. Total benefits are calculated by estimating future costs or future losses that can be avoided by completing a mitigation project. The future cost/loss avoidance over the life of the project are converted to present day value for comparison with the project cost (including future maintenance). Benefits may include physical damages, loss of function, displacement costs, social benefits, and environmental benefits.

The BCR is a numerical expression of the relative "cost-effectiveness" of a project. A project is generally considered to be cost effective when the BCR is 1.0 or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (FEMA, 2009). However, a BCR greater than 1.0 is not a requirement for inclusion in the Regional Flood Plan. The RFPG can recommend a project with a lower BCR with appropriate justification.

When a BCR had been previously calculated in an engineering report or study, that previously calculated BCR value was utilized for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was utilized in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values.

Residual, Post-Project, and Future Risks of FMPs

It is expected that the implementation of recommended FMPs will reduce current and future levels of flood risk in the region. While it is not possible to protect against all potential flood risks, the evaluation of FMPs should consider their associated residual, post-project and future risks, including the risk of potential catastrophic failure and the potential for future increases to these risks due to lack of maintenance.

During project development, communities need to balance existing risk and risk reduction, physical and financial constraints, permitting and constructability, and adverse impacts (environmental, flood, community) to identify mitigation measures that make sense.

Figure 4-16: Project Development Considerations

When trying to find the right balance, it is common for flood control projects to be designed to a storm smaller than 1% ACE. This does not mean projects should avoid evaluating the 100-year storm. Nor does it mean that the projects don't provide some level of risk reduction for larger storms. Rather, it means that the community needs to understand what the residual risk will be. Common examples include flooding in developed areas, where limited right-of-way and utility conflicts can limit the size or impart a significant financial burden; or creek crossings, where construction of a bridge is not practicable due to topography, right-of-way, and costs.

In general, residual and future risks for 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. Lack of routine maintenance to maintain, repair, or replace design capacity (storage and conveyance).
4. Policy changes that adversely impact budgets, prior plans, assets, and design or floodplain management standards.
5. Human behavior is unpredictable, and people may choose to ignore flood warning systems or cross flooded roadways for a variety of reasons.

Implementation Issues of FMPs

Potential project implementation issues include conflicts pertaining to right-of-way or easements; permitting, utility or transportation relocations; and other issues that may need to be resolved before an FMP is able to be fully implemented. Such issues are an inherent part of flood mitigation projects and do not exclude actions from being considered for the plan.

Because a right-of-way is a public use on private land, it can create issues when securing access to projects for construction and maintenance. The acquisition of right-of-way or other property

and utility relocation located near or on property that is impacted by a project requires close coordination between government agencies, private entities, and landowners. Coordination and early engagement with the appropriate entities is key to facilitating projects.

Most FMPs will require a variety of permits from local to state and federal depending on the scale. Because permitting can be a lengthy process, the goal is to identify permitting needs during the project development phase to avoid surprises and to build permitting into the implementation schedule. Understanding the permitting needs early allows the permitting process to start as early as practicable in final design. This will minimize significant design changes and delays in project implementation.

The terms "buyout**"** and "acquisition" are often utilized interchangeably, but in the context of flood protection, both refer generally to the purchase of private property by the government for public use. In the case of flood acquisitions, the process usually involves purchasing land to preserve floodplains and riparian corridors and/or purchasing property to remove structures and reduce repetitive flood damage. Voluntary buyout programs are a specific subset of property acquisitions in which private land is purchased, existing structures demolished, and the land is returned to an undeveloped state in perpetuity. Voluntary property acquisition is not a simple process and requires agreement by the property owner and local jurisdiction. If state or federal funding is involved, the process will include other governmental agencies and program requirements. The process can also be financially burdensome and lengthy.

Utility relocations include water and wastewater lines, existing storm drain systems, telecommunication, power lines, and similar infrastructure. The local government and franchise utility owners are usually responsible for utility relocations; however, developers may also assume responsibility for utility relocations depending on the project. Utility relocation includes removing and reinstalling the utility, installing temporary utilities if needed; and may include acquiring right-of-way or easements. Utility relocations can take significant lead time to accomplish and can be a significant portion of the total project implementation cost, particularly in more densely populated areas.

4.2.4 Potential Funding Sources

A wide variety of funding opportunities could be utilized to fund the identified actions. **Chapter 9** describes some common avenues of generating local funds, various state and federal financial assistance programs available to communities, and common barriers to accessing funding. **Chapter 9** also presents the results of a survey effort intended to gauge how sponsors propose to finance recommended FMEs, FMSs, and FMPs and provides recommendations for the role the state should have in financing these recommended actions.

Chapter 5: Recommendation of Flood Management Evaluations, Flood Management Strategies and Associated Flood Mitigation Projects

The objective of Task 5 is for RFPGs to use the information developed under Task 4 to recommend flood mitigation actions for inclusion in the Regional Flood Plan. While there was a lot of overlap in the performance of Tasks 4B and 5 (Task 5 is a continuation of 4B), **Chapter 4.2** focused on the technical evaluations and screening of the potential FMEs and potentially feasible FMSs and FMPs, while **Chapter 5** focuses on how the RFPG used this data to determine whether to recommend flood mitigation actions. This chapter summarizes and documents:

1. The process undertaken to make final recommendations on flood mitigation actions
2. The potential FMEs and potentially feasible FMSs and FMPs identified and evaluated under Task 4B and whether these actions are recommended by the RFPG
3. The entities that will benefit from the recommended flood mitigation actions

While there is a significant need across the region to improve flood risk awareness and to develop and implement actions for reducing existing and future flood risk, not every flood mitigation action can be recommended in the Regional Flood Plan or included in the State Flood Plan.

The Guadalupe RFPG opted to take an inclusive approach to the evaluation and recommendation process. If an evaluation, strategy, or project met TWDB requirements, was aligned with the regions' flood mitigation and floodplain management goals, and seemed reasonable, the planning group chose to show deference to the local communities/sponsors and leaned toward including in the regional plan.

5.1 RFPG Evaluation and Recommendation Process

The RFPG considered recommendations of flood mitigation actions through a multistep process. The methodology included screening all potential flood mitigation actions considering TWDB requirements for inclusion in the Regional Flood Plan. The reasons for not recommending a particular flood mitigation action are clearly documented as part of the screening, evaluation, and recommendation process.

The screening process for evaluating and recommending flood mitigation actions is summarized in **Figure 5-1** for FMPs and FMSs, and **Figure 5-2** for FMEs. These processes were developed following TWDB rules and requirements that left some evaluation criteria at the discretion of the RFPG.

As stated above, the RFPG approach to recommendations was to be inclusive; therefore, the group decided they would not establish additional criteria for the minimum level of service or BCR. Similarly, because many of the known flood mitigation projects were identified by local jurisdictions, the drainage areas are often under 1 square mile, and the RFPG did not want to exclude those from the plan. The RFPG did express a desire to identify and group small individual projects to create larger FMPs within single jurisdictions, as well as to encourage communities to work together on regional projects. Those efforts are somewhat limited in this first cycle but will be an important aspect of the amended plan, to be submitted in July 2023.

Due to the overlap of Tasks 4B and 5, the recommendation process was in many ways an extension of the initial screening process with a more detailed evaluation of each action, geospatial location, determination of flood risk indicators and risk reduction potential, and reassignment of actions as needed (for example, FMP to FME).

5.2 Sponsor Support

Initial efforts to contact potential sponsors consisted of sending surveys to communities. These surveys included actions identified for each community, giving the community an opportunity to identify any that are no longer relevant or that they are actively pursuing. These surveys were followed up with calls to inform communities of the survey and its purpose. To supplement this outreach effort, the planning group leveraged existing relationships to contact communities in an effort to increase community participation and gather additional input.

While these efforts furthered the goal of receiving community input on which actions to pursue, not all communities could be reached. Accordingly, the RFPG decided that an affirmative willingness to sponsor a given action would not be a prerequisite for inclusion in the plan. Therefore, all potential actions were considered for inclusion in the plan, unless an entity had specifically declined to be listed as a sponsor and no other appropriate potential sponsor was identified. This approach was adopted because:

1. It provides a conservative estimate of the flood mitigation need in the region.
2. Inclusion in the plan does not obligate an entity to sponsorship an action; it simply allows an entity to be eligible for funding if they have the interest and capacity to pursue an action.

It is important to note that all sponsors associated with recommended actions were subsequently sent a survey to identify potential funding sources for the actions listed in the plan. This effort is detailed in **Chapter 9**.

Figure 5-1: FMP and FMS Screening Process

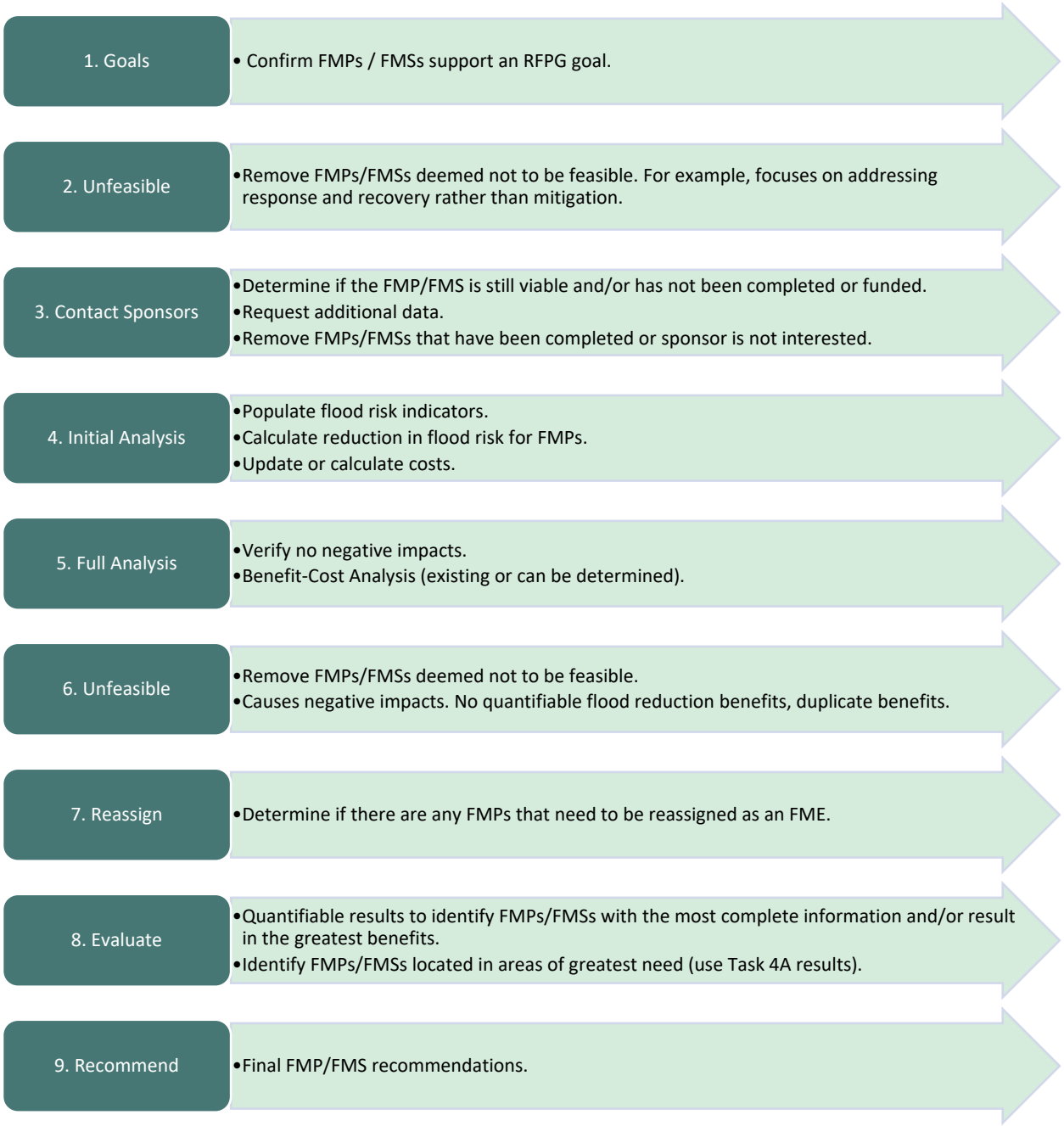


Figure 5-2: FME Screening Process

5.3 Flood Management Evaluations

5.3.1 Description and Summary of Recommended FMEs

A total of 138 potential FMEs were identified and evaluated by the RFPG. Of these, all 138 were recommended, representing a combined total of $69,696,167 of flood management evaluation need covering more than 33,000 square miles across the region. Some of the FMEs also included an estimated construction cost totaling an additional $543,794,784. The number and types of studies recommended by the RFPG are summarized in **Table 5-1**.

Table 5-1: Summary of Recommended FMEs

FME ID	Name	Type	Study Cost
111000001	Blanco County Low Water Crossing Improvements Study	Watershed Planning	$250,000
111000002	Blanco County Soil Conservation Plan	Watershed Planning	$100,000
111000003	Caldwell County Bridge Improvements Project Planning	Project Planning	$256,000
111000004	Caldwell County Emergency Service District #1 Drainage and Utility Plan	Watershed Planning	$100,000
111000005	Caldwell County Emergency Service District #3 River Crossing Improvements Study	Watershed Planning	$1,000,000
111000006	Caldwell County Emergency Service District #3 Repetitive Loss Property Mitigation Study	Project Planning	$1,000,000
111000007	Caldwell County Emergency Service District #4 Fire Station 2 Project Planning	Project Planning	$100,000
111000008	Canyon Regional WA Hays Caldwell Water Treatment Plant Floodwall Project Planning	Project Planning	$159,355
111000009	Center Point ISD Drainage Improvements Study	Watershed Planning	$100,000
111000010	City of Cibolo and Seguin Road Access and Conditions Study	Preparedness	$500,000
111000011	City of Cibolo and Seguin USACE Study	Watershed Planning	$1,000,000
111000012	City of Buda Dam Study	Preparedness	$500,000
111000013	City of Bulverde Drainage Improvements Study	Watershed Planning	$150,000
111000014	City of Bulverde Local Flooding Study	Watershed Planning	$100,000
111000015	City of Flatonia Drainage Project Planning	Project Planning	$2,739,000

FME ID	Name	Type	Study Cost
111000016	City of Flatonia WWTP Floodproofing Project Planning	Project Planning	$100,000
111000017	City of Garden Ridge Drainage Improvements Project Planning	Project Planning	$100,000
111000018	City of Gonzales Tinsley Creek Improvement Project Planning	Project Planning	$600,000
111000019	City of Gonzales Tinsley Creek Flood Mitigation Project Planning	Project Planning	$430,000
111000020	City of Ingram Drainage Improvements Study	Watershed Planning	$100,000
111000022	City of Kerrville Pinto Trail Project Planning	Project Planning	$100,000
111000023	City of Kerrville Park Street Low Water Crossing Project Planning	Project Planning	$340,000
111000024	City of Kerrville First Street Low Water Crossing Project Planning	Project Planning	$510,000
111000025	City of Kerrville Fourth Street Low Water Crossing Project Planning	Project Planning	$180,000
111000026	City of Kerrville Hill Country Drive at SH 16 Project Planning	Project Planning	$245,000
111000028	City of Kerrville Harper Street between Culberson Avenue and Lewis Avenue Project Planning	Project Planning	$180,000
111000029	City of Kerrville Circle Avenue Drainage Channel Project Planning	Project Planning	$100,000
111000030	City of Kerrville Jack Drive - Undersized Inlet Project Planning	Project Planning	$240,000
111000031	City of Kerrville Harper Road to Town Creek (Fay Drive) Drainage Improvements Study	Project Planning	$150,000
111000033	City of Kyle Prairie and Woodland Restoration Plan	Watershed Planning	$250,000
111000034	City of Kyle - N. Burleson Street Drainage Improvements Project Planning	Project Planning	$983,000
111000035	City of Lockhart Drainage Improvements Study	Watershed Planning	$2,400,000
111000036	City of Lockhart USACE Study	Watershed Planning	$360,000
111000037	City of Luling Drainage Improvements Study	Watershed Planning	$150,000
111000038	City of Martindale Drainage Improvements Study	Watershed Planning	$100,000

FME ID	Name	Type	Study Cost
111000039	City of Mountain City Repetitive Loss Structure Mitigation Study	Project Planning	$150,000
111000043	City of New Braunfels - Box Culvert Installation to Reduce Flood Risk on Blieders Creek, Comal River and Landa Park Project Planning	Project Planning	$878,000
111000044	City of New Braunfels Faust St / Nacogdoches Ave Improvements Project Planning	Watershed Planning	$1,102,000
111000045	City of New Braunfels Dry Comal Creek Tributary East Watershed Project Planning	Watershed Planning	$344,000
111000047	City of New Braunfels Hunters Creek Regional Project Planning	Watershed Planning	$211,000
111000048	City of New Braunfels South Guadalupe Tributary Watershed Project Planning	Watershed Planning	$168,000
111000049	City of New Braunfels Dry Comal Creek West Watershed Project Planning	Watershed Planning	$126,000
111000051	City of Niederwald Engineering Review of City Hall	Project Planning	$10,000
111000052	City of Nixon Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000054	City of San Marcos Regional Detention Study	Watershed Planning	$200,000
111000055	City of San Marcos Modeling of Purgatory Creek and Willow Springs Creek Overflow Area	Watershed Planning	$271,000
111000056	City of San Marcos Low Water Crossing at Jackman Project Planning	Project Planning	$150,000
111000057	City of San Marcos Low Water Crossing at Mitchell and Purgatory Creek Project Planning	Project Planning	$200,000
111000058	City of San Marcos LWC at River Road and Railroad Trestle/Blanco River Project Planning	Project Planning	$150,000
111000059	City of San Marcos LWC at S LBJ and Purgatory Creek Project Planning	Project Planning	$150,000
111000060	City of San Marcos - Extension of River Ridge Parkway West Project Planning	Project Planning	$298,000
111000061	City of Seguin Drainage Improvements Study	Watershed Planning	$1,100,000
111000062	City of Seguin Low Water Crossing Improvements Study	Watershed Planning	$1,500,000

FME ID	Name	Type	Study Cost
111000063	City of Seguin Ingress Egress Improvements Project Planning	Preparedness	$250,000
111000064	City of Seguin City-wide Drainage Improvements Project Planning	Project Planning	$200,000
111000065	City of Seguin Voluntary Buyout Program Project Planning	Project Planning	$300,000
111000066	City of Seguin Citywide Drainage Project Planning	Project Planning	$4,304,000
111000067	City of Seguin Sewage Treatment Plant Floodproofing Project Planning	Project Planning	$100,000
111000068	City of Uhland Drainage Improvement Project Planning	Project Planning	$1,334,000
111000069	City of Victoria Drainage Improvement Study	Watershed Planning	$1,000,000
111000070	City of Victoria Harden Critical Infrastructure Project Planning	Project Planning	$100,000
111000071	City of Victoria Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000072	City of Victoria Flood Gate Project Planning	Project Planning	$45,000
111000073	City of Victoria Regional Drainage Solutions Project Planning	Project Planning	$1,327,962
111000074	City of Victoria - Storm Sewer Improvements Project Planning	Project Planning	$3,946,100
111000075	City of Victoria Clean and Televise Storm Sewers Project Planning	Project Planning	$1,662,106
111000076	City of Victoria Regrade Priority Ditches and Driveway Culverts Project Planning	Project Planning	$1,165,853
111000077	City of Victoria Repair Channel Failures & Sediment Removal Project Planning	Project Planning	$276,201
111000078	City of Victoria Stream Restoration Study	Watershed Planning	$500,000
111000079	City of Waelder Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000080	City of Wimberley Drainage Master Plan	Watershed Planning	$150,000
111000081	City of Wimberley FM 1492 at Blanco River Low Water Crossing Project Planning	Project Planning	$100,000
111000082	City of Wimberley Hidden Valley at Blanco River Low Water Crossing Project Planning	Project Planning	$100,000
111000083	City of Wimberley Little Arkansas at Blanco River Low Water Crossing Project Planning	Project Planning	$100,000

FME ID	Name	Type	Study Cost
111000084	City of Wimberley Valley Drive at Pierce Creek Low Water Crossing Project Planning	Project Planning	$100,000
111000085	City of Wimberley Flite Acres Road Low Water Crossing Project Planning	Project Planning	$100,000
111000086	City of Wimberley FM 1492 at Pierce Creek Low Water Crossing Project Planning	Project Planning	$100,000
111000087	City of Wimberley Wilson Creek at River Road Low Water Crossing Project Planning	Project Planning	$100,000
111000088	City of Wimberley Green Acres Dr. at Fire Station Low Water Crossing Project Planning	Project Planning	$100,000
111000089	City of Wimberley Leveritt's Loop Low Water Crossing Project Planning	Project Planning	$100,000
111000090	City of Wimberley Spoke Hollow Dr. at Spoke Pile Creek Low Water Crossing Project Planning	Project Planning	$100,000
111000091	City of Wimberley River Road at Western City Limit Low Water Crossing Project Planning	Project Planning	$100,000
111000092	City of Wimberley Paradise Hills Low Water Crossing Project Planning	Project Planning	$100,000
111000093	City of Wimberley River Road Reconstruction Project Planning	Project Planning	$100,000
111000094	City of Wimberley Little Ranches at Panther Creek Low Water Crossing Project Planning	Project Planning	$100,000
111000095	City of Wimberley Hoots Holler Low Water Crossing Project Planning	Project Planning	$100,000
111000096	Comal County Evacuation and Dam Safety Plan	Preparedness	$50,000
111000097	Comal County Low Water Crossing Improvements Project Planning	Project Planning	$150,000
111000098	Comal County Voluntary Buyout Program Project Planning	Project Planning	$357,000
111000099	Comal County Retention Dam Project Planning	Project Planning	$8,000,000
111000100	Comal County Master WID River Road Low Water Crossing Improvement Project Planning	Project Planning	$700,000
111000101	City of Cuero Drainage Improvements Study	Watershed Planning	$150,000

FME ID	Name	Type	Study Cost
111000102	City of Cuero City Public Service Station Project Planning	Project Planning	$100,000
111000103	City of Cuero WWTP Floodproofing Project Planning	Project Planning	$100,000
111000104	Green DeWitt Drainage District Channel Improvements Project Planning	Project Planning	$250,000
111000105	DeWitt County (City of Nordheim) Flash Flood Mitigation Project Planning	Project Planning	$150,000
111000106	Gillespie County Low Water Crossing Improvements Project Planning	Project Planning	$50,000
111000107	Gonzales County Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000108	GBRA FEMA Cooperating Technical Partners (CTP) Modeling and Mapping	Watershed Planning	$250,000
111000109	Guadalupe County Drainage Improvements Study	Watershed Planning	$3,000,000
111000110	Guadalupe County Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000111	Guadalupe County LWC Project Planning	Project Planning	$2,000,000
111000112	Hays County Dam Inundation Maps	Preparedness	$500,000
111000113	Hays County Harden Critical Infrastructure Project Planning	Project Planning	$100,000
111000114	Hays County Drainage Project Planning (Willow Springs Creek between McCarty Lane and Hunter Road)	Project Planning	$800,000
111000115	Hays County Drainage Project Planning (Willow Springs Creek between Hunter Rd and the Railroad)	Project Planning	$1,200,000
111000116	Hays County Southeastern Property Acquisition Project Planning	Project Planning	$800,000
111000118	Hays County Community Flood Mitigation Project Planning	Project Planning	$238,035
111000119	Hunts ISD Storm Drainage Infrastructure Project Planning	Project Planning	$100,000
111000120	Ingram ISD Construct New Storm Drainage Infrastructure	Project Planning	$100,000
111000121	Ingram ISD Improve Existing Storm Drainage Infrastructure	Project Planning	$100,000
111000122	Kerr County Center Point Storm Drainage Infrastructure Project Planning	Project Planning	$125,000
111000123	Kerr County Dam Integrity Study	Preparedness	$500,000

FME ID	Name	Type	Study Cost
111000124	Kerr ISD Storm Drainage Infrastructure Project Planning	Project Planning	$100,000
111000126	Travis County Voluntary Buyout Program Project Planning	Project Planning	$300,000
111000127	Upper Guadalupe River Authority Evaluation of Water and Sediment Control Facilities	Watershed Planning	$250,000
111000128	Victoria County Planning and Development Standards Study	Watershed Planning	$100,000
111000129	Victoria County Drainage Improvements Study	Watershed Planning	$150,000
111000130	Victoria County FIRMs	Watershed Planning	$500,000
111000131	Victoria County Drainage Improvements around County EOC Project Planning	Project Planning	$100,000
111000132	Victoria County Bridge Improvements Project Planning	Project Planning	$500,000
111000133	Victoria County Voluntary Buyout Program Project Planning	Project Planning	$300,000
111000134	Wilson County Stormwater Management Plan	Watershed Planning	$500,000
111000135	Wilson County Low Water Crossing Improvements Project Planning	Project Planning	$150,000
111000136	Wilson County Voluntary Buyout Program Project Planning	Project Planning	$150,000
111000137	City of Blanco Emergency power generators at critical infrastructure/key resource locations project planning	Project Planning	$100,000
111000138	Kendall County Cypress Creek Regional detention	Project Planning	$113,855
111000139	Edwards Aquifer Authority Technical Study to Enhance Great Springs Project Regional Flood Mitigation	Watershed Planning	$250,000
111000140	City of Victoria WWTP Protection Project	Project Planning	$300,000
111000141	City of San Marcos McKie Street at Willow Springs Creek Project Planning	Project Planning	$50,000
111000142	City of San Marcos South LBJ Drive at Willow Springs Creek Project Planning	Project Planning	$50,000
111000143	Green DeWitt Drainage District Cuero Levee Study	Project Planning	$250,000
111000144	City of New Braunfels Wood Road/Landa Street Drainage Improvement	Project Planning	$3,575,700

FME ID	Name	Type	Study Cost
111000145	Kendall County Guadalupe River Model Study	Watershed Planning	$250,000
111000146	Kendall County Stream Gauges and Flood Hazard Beacons	Preparedness	$150,000
111000147	City of Kerrville Spring Street Project	Project Planning	$15,000
111000148	City of Kerrville Clay Street Drainage and Kroc Center Detention Pond Spillway Improvements	Project Planning	$15,000
111000149	City of Kerrville Coronado Drive and Junction Highway Drainage Improvements	Project Planning	$15,000
		TOTAL	**$69,696,167**

Map 19 and **Table 15** for recommended FMEs is presented in **Appendix 5-A**. One-page summaries of the FMEs are included in **Appendix 5-B.**

Flood Infrastructure Fund Category 1 Studies

Based on information provided by TWDB, there are five Flood Infrastructure Fund (FIF) Category 1 planning projects within the Guadalupe flood planning region. Information regarding each of these studies can be found below. After performing a high-level review and comparison between these FIF studies and the FMEs recommended in this regional flood plan, there appears to be no overlapping effort; however, this analysis was based on the limited information available regarding the specific scopes of work, tasks, and deliverables involved in each. In areas where the FIF project will generate a master drainage plan or watershed-wide study, it is assumed that any modeling or other data that is generated by the FIF study would be available and leveraged in the performance of a future FME. It will be the ultimate responsibility of Sponsors of FMEs to ensure that any program or funding requirements of the TWDB are met, including ensuring no duplication of effort, when seeking future state funding for FMEs. The FIF Category 1 planning projects within the Guadalupe region are:

- FIF Project No. 40012 Caldwell County Flood Protection Planning Study
- FIF Project No. 40043 Bastrop County Flood Protection Studies Phase 6
- FIF Project No. 40077 Hays County Onion Creek Watershed Floodplain Study and Mapping
- FIF Project No. 40085 New Braunfels Drainage Area Master Plan Future Phases
- FIF Project No. 40133 Travis County Master Flood Plan Phase 1

County-Wide Evaluations

The Guadalupe RFPG recognizes that several county-wide evaluations cross into adjacent flood planning regions. Because these actions are sponsored by an entity that overlaps multiple planning regions the efforts will not be duplicated, and coordination efforts will continue to adjudicate potential funding or costs. For example, Comal County is sponsoring an FME related to study of low water crossing improvements throughout the entire county. This regional action

will include the portions of Regions 11 and 12 so there is no duplicative effort; however, it is not clear if the funding has been proportioned or needs to be split to reflect the effort within the respective regions. If it is determined that the costs need to be adjusted the RFPG will adjust in the amended plan.

5.4 Flood Mitigation Projects

5.4.1 Summary of Approach in Recommending FMPs

For consideration as an FMP, a project must be defined in a sufficient level of detail to meet the technical requirements of the flood planning project *Scope of Work* and the associated *Technical Guidelines* developed by TWDB. In summary, the RFPG must be able to demonstrate that each recommended FMP meets the following TWDB requirements:

1. The primary purpose is mitigation (response and recovery projects are not eligible for inclusion in the Regional Flood Plan).
2. Supports at least one regional floodplain management and flood mitigation goal.
3. The FMP is a discrete project (not an entire capital program or drainage master plan).
4. Implementation of the FMP results in:
    a. Quantifiable flood risk reduction benefits
    b. No negative impacts to adjacent or downstream properties
    c. No negative impacts to an entity's water supply
    d. No overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan

In addition, TWDB recommends that, minimally, FMPs should mitigate flood events associated with the 1% ACE flood. However, if a 1% ACE flood is not feasible, the RFGP can document the reasons for its infeasibility and still recommend an FMP with a lower level of service (LOS).

Updated construction cost estimates and estimates of project benefits must also be available to define a BCR for each recommended FMP. TWDB recommends that proposed projects have a BCR greater than 1.0, but the RFPG may recommend FMPs with a BCR lower than 1.0 with proper justification.

All potentially feasible FMPs that had the necessary data and detailed modeling results available to populate these technical requirements were considered for recommendation by the RFPG. Pertinent details about the FMP evaluation are provided in the following section.

5.4.2 FMP Evaluation

Initial Evaluation

The scope of work for each FMP was evaluated to ensure that it would support at least one of the regional floodplain management and flood mitigation goals established in **Chapter 3**. The goals associated with each FMP are included in **Appendix 3**. Based on a review of supporting information, it was determined that the primary purpose for each FMP is mitigation (rather

than a response or recovery project); they are discrete projects; and they do not have any anticipated impacts to water supply or water availability allocations as established in the most recent adopted State Water Plan. A list of associated models and engineering studies that support the evaluation of no negative impacts is presented in **Appendix 2-C.**

LOS Evaluation and BCR

All the recommended FMPs provide some level of flood reduction benefits that are included based on the available information. When a BCR had been previously calculated in an engineering report or study that was used to create an FMP, the previously calculated BCR value was utilized for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was utilized in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values.

Description and Summary of Recommended FMPs

Due to the high level of detail required for consideration as an FMP, 28 projects were determined to have enough details available for evaluation and potential recommendation as FMPs. All FMPs were recommended by the RFPG, representing a combined total project cost of $155,543,000. A summary of the recommended FMPs for inclusion in the Regional Flood Plan is presented in **Table 5-2 (Table 16** in **Appendix 5-A)**. A map of project areas for the recommended FMPs is provided as **Map 20 (Appendix 5-A)**. One page summaries of the FMPs are included in **Appendix 5-B.**

Table 5-2: Summary of Recommended FMPs

FMP ID	Name	Description	Cost
113000001	Blanco County Detention on the Blanco River	The proposed dam height of 102 feet and dam length of 1,840 feet will provide a maximum storage capacity of approximately 1128 acre-feet.	$9,338,000
113000006	City of Kyle Plum Creek Tributary 3 Arbor Knot Dr. Improvement	A proposed culvert improvement has been developed to convey a 1% ACE event. The proposed culvert improvement is to add one additional 8ft x 4ft culvert totaling three culverts at this location, and raising the finished deck elevation by 0.5ft.	$557,000
113000007	City of Kyle Plum Creek Tributary 4 Sledge Rd. Improvement	The proposed culvert improvement resulted in eight 7-foot-by-4-foot box culverts needed to clear the roadway and to alleviate additional backwater flooding.	$1,149,000
113000010	City of Kyle 65-foot Channel Modification	The channel modifications consist of 65-foot bottom width channel modifications with 4:1 side slopes spanning from the	$589,000

FMP ID	Name	Description	Cost
	and Additional Culvert	North IH 35 frontage road past Goforth Road to Kym Way.	
113000011	City of Kyle Plum Creek Detention Pond Upstream of IH 35	This project consists of a detention pond between the railroad track and the South bound IH 35 frontage road. Under this proposed alternative a 13-foot high dam wall would be placed on Plum Creek near Kyle Center Drive.	$864,000
113000015	City of San Marcos Improve Flood Warning Systems	Enhancing stream flow gage network by increasing number of gages throughout community by at least six.	$339,000
113000026	City of San Marcos Purgatory Creek Channel Improvement	Purgatory Creek Channel Improvement Project Preliminary Engineering Report	$22,391,000
113000027	City of San Marcos Sherwood/Kingwood Drainage Improvements	Sherwood Drive and Kingwood Street Improvements Preliminary Engineering Report	$5,644,000
113000035	City of Seguin Guadalupe Street Automatic Flood Gates	Place automatic flood gates with vehicle detection on inside of flooded area to allow for egress.	$115,000
113000036	City of Waelder Baldridge Creek Regional Detention Pond	The scope of work includes constructing a regional detention pond on Baldridge Creek upstream of the City. The proposed pond would be located northwest of the City and would release runoff at a substantially lower flowrate, resulting in lower flood elevation.	$2,573,000
113000037	City of Waelder Baldridge Creek Channel and Culvert Improvement	A combination of a 50-foot bottom width channel modification with 3:1 side slopes downstream of SH 97 and the addition of two 10-foot-by-10-foot concrete box culverts was determined to be the most effective flood mitigation solution for the area.	$3,928,000

FMP ID	Name	Description	Cost
113000039	City of Wimberley Wilson Creek – Green Acres Dr. Improvement	A proposed updated culvert geometry consists of 11 10-foot-by-12-foot box culverts and a raised finished deck elevation (3-foot rise).	$1,246,000
113000040	City of Woodcreek Regional Detention South of Mountain Crest Drive	The alternative consists of a 20-foot tall detention structure with a 175 acre-foot detention capacity. The outflow control would consist of culverts for low flow and an overflow weir for high flow.	$946,000
113000041	City of Woodcreek Improvements to Brookside Drive Culvert Crossing	The culvert opening will be increased to three 36-inch concrete pipes to match the culvert capacity downstream at Brook Meadow Dr. and also involve some minimal regrading of the stream flowline.	$38,000
113000042	City of Woodcreek Brook-meadow Drive Drainage Improvements	The proposed alternative consists of a rip rap ditch along the south side of Brookmeadow Drive, under Overbrook Court and down to Hog Creek. The capacity of the ditch would be enough to hold the most frequent flows	$65,000
113000044	Comal County Regional Detention on Bear Creek	The proposed dam height of 85 feet and dam length of 620 feet will provide a maximum storage capacity of approximately 3,375 acre-feet.	$6,973,000
113000047	Gonzales County Regional Detention on Peach Creek	A 29-foot high dam with a length of 5,780 feet would provide approximately 41,774 acre-feet of storage. This site would accommodate a large volume of water and greatly reduce the peak from the Peach Creek watershed.	$7,821,000
113000052	Kerr County Back-up Power Generators	Installing generators at critical facilities will help ensure physical safety for facility occupants and maintain electronic systems' functionality during power outages. Portable generators will maintain additional systems functionality.	$806,000
113000060	City of Victoria Back-up Power Generators	Install emergency generators and quick connects on all buildings, critical infrastructure, and government buildings.	$551,000

FMP ID	Name	Description	Cost
113000061	City of Buda-Lifschutz Headwaters Voluntary Buyout	Voluntary, targeted buyouts for one or more affected properties. (November 11, 2016 Preliminary Engineering Report)	$565,000
113000062	City of Nixon-Wastewater System Flood Improvements	The WWTP lift station and 8th Avenue lift station have experienced inundation and caused overflows due to stormwater inflow into the wastewater system. Also need a new generator and SCADA System Improvements at the City's WWTP, Water Well 6/Water Pl.	$3,949,000
113000063	City of San Marcos-Emergency Generators	Purchase and installation of generators for temporary sheltering efforts in all public facilities capable of housing citizens.	$58,000
113000064	Victoria County-Emergency Generators	Install emergency generators at critical facilities.	$551,000
113000065	City of Seguin Regional Detention Southwest of Seguin City Limits Project	Proposed regional detention project on Mays Creek.	$2,015,000
113000066	City of Seguin - Culvert Improve-ments at Guadalupe River Drive Project	Proposed project to add two additional 10-foot-by-10 foot reinforced concrete box culverts on either side of the existing two-10-foot-by-10 foot box culverts at Guadalupe River Dr.	$594,000
113000067	City of Victoria Channel and Bridge Modifications on State Highway 87 Project	Proposed channel and bridge modification project. The design modification consists of adding two additional piers to the right and left overbanks of the bridge.	$8,350,000
113000068	City of Victoria Detention Structure Located Upstream of SH 87 Project	Proposed detention structure located upstream of SH 87. The detention basin has a proposed height of 11 feet from crest to inlet structure. The dam has a proposed capacity of 3700 acre-feet.	$58,395,000

FMP ID	Name	Description	Cost
113000069	Guadalupe County Detention on York Creek Project	Project for detention on York Creek. The currently proposed dam height of 48 feet and dam length of 4,800 feet will provide a maximum storage capacity of approximately 48,130 acre-feet.	$15,133,000
		TOTAL	**$155,543,000**

5.5 Flood Management Strategies

5.5.1 Summary of Approach in Recommending FMSs

The approach for recommending FMSs adheres to similar requirements as the FMP process except some requirements may not be applicable to certain FMS types due to the flexibility and varying nature of RFPG's potential utilization of FMSs. In general, the RFPG must be able to demonstrate that each recommended FMS meets the following TWDB requirements as applicable:

1. The primary purpose is mitigation (response and recovery projects are not eligible for inclusion in the Regional Flood Plan).
2. Supports at least one regional floodplain management and flood mitigation goal.
3. Implementation of the FMS results in:
    a. Quantifiable flood risk reduction benefits
    b. No negative impacts to adjacent or downstream properties (no negative impact certification is required)
    c. No negative impacts to an entities water supply
    d. No overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan.

In addition, TWDB recommends that, at a minimum, FMSs should mitigate flood events associated with the 1% ACE (100-year LOS). If a 100-year LOS is not feasible, the RFGP can document the reasons for its infeasibility and still recommend an FMS with a lower LOS.

Although each potentially feasible FMS must demonstrate that there would be no negative flood impacts on a neighboring area due to its implementation, there were no structural FMSs identified for this region. Therefore, no adverse impacts from flooding or to the water supply are anticipated.

Description and Summary of Recommended FMSs

The RFPG identified and reviewed more than 150 individual strategies from stakeholders within the region. Many of the identified strategies were found in existing HMAPs and, it was noted, that there is a lot of similarity in the strategies. All the strategies can be categorized as one of the five strategy types identified in the TWDB Guidance Documents. For these reasons, the planning group decided to bundle the individual strategies under five regional strategies. The

main reasons for this decision were to make each strategy inclusive of all communities within the region that choose to pursue them and to encourage collaboration between sponsors, particularly neighboring communities.

For example, many communities identified media campaigns for public education and outreach. Rather than developing individual programs or material, the RFPG encourages communities within media markets to develop joint programs to provide consistency and efficient use of resources. A one-page summary for each strategy in included in **Appendix 5-B**, along with a table of individual actions identified to date under each strategy.

Education and Outreach

This strategy covers all potential sponsors within the region to undertake activities not limited to implementing/improving flood education and awareness programs for residents, elected officials, and real estate agents/developers; and flood insurance campaigns. Communications tools and programs may include brochures, websites, social media, workshops, mail inserts, and newspaper/radio. The desired outcomes include reducing flood risk through education and avoidance of flood risk, as well as increasing NFIP participation.

Property Acquisitions and Structural Elevation

This strategy covers all potential sponsors within the region that choose to develop and implement a voluntary buyout or structural elevation assistance programs. Desired outcomes include eliminating repetitive-loss structures and implementing programs to purchase and preserve open space to protecting existing riparian corridors and protecting or restoring floodplain functionality and conveyance.

Regulatory and Guidance

This strategy covers all potential sponsors within the region to regularly review and update floodplain ordinances, land use/zoning, development criteria, and enforcement. Actions are not limited to developing and implementing higher standards, such as increased freeboard and detention requirements; developing and implementing green infrastructure programs or riparian preservation; or updating codes and ordinances to allow a community to use of “best available data” if needed. The ability to use best available data is a particularly important point for communities that have either outdated or no effective floodplains defined because it allows for the use of BLE products to manage floodplains.

Flood Measurement and Warning

This strategy covers all potential sponsors within the region to develop or implement programs to increase flood warning. Actions are not limited to installing reverse 911 systems; preparing, maintaining, and exercising evacuation/emergency management plans (including personnel training); purchasing NOAA all-hazards radios for critical facilities and for discounted distribution to residents; installing stream gauges to provide advanced flood warning; and

developing a program to increase flood safety systems at low-water crossings, such as barricades, signs and flashers.

Infrastructure Projects

This strategy covers all potential sponsors within the region to develop or implement maintenance programs to preserve system functionality of existing infrastructure, such as storm drains, culverts, and bridges; stream restoration/channelization programs to enhance riparian corridors and preserve floodplain capacity; and infrastructure improvements programs that identify and prioritize flood risk reduction projects.

The total estimated cost for the recommended FMSs is approximately $33,473,000. While the recommended strategies are combined for the region, the number and types of individual strategies identified are summarized in **Table 5-3**. The full list of FMSs is included as **Table 17** in **Appendix 5-A,** and a map of recommended FMSs is presented as **Map 21** in **Appendix 5-A**.

Table 5-3: Summary of Recommended FMSs

FMS Type	# of FMSs Identified	# of FMSs Recommended	Total Cost of Recommended FMSs
Education and Outreach	61	1	$978,000
Flood Measurement and Warning	46	1	$9,541,000
Property Acquisition and Structural Elevation	31	1	$1,250,000
Regulatory and Guidance	31	1	$93,000
Infrastructure Projects	16	1	$21,611,000
Total	**185**	**5**	**$33,473,000**

Chapter 6: Impact and Contribution of the Regional Flood Plan

6.1 Impacts of Regional Flood Plan

The goal of Task 6A is to summarize 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 (details provided in **Section 6.2**), and overall impact on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation. This chapter describes the processes undertaken by the Regional Flood Planning Group (RFPG) to achieve these tasks and summarizes the outcomes of this effort.

The impacts will generally be determined based on before-and-after (regional flood plan implementation) comparisons of the same types of information provided in **Chapter 2** existing flood risk and future flood risk analyses. These two comparisons may, for example, indicate a percent change in flood risk faced by various elements, including critical infrastructure. These two comparisons (one comparison each for a 1% ACE and another for a 0.2% ACE) should illustrate both how much the region's existing flood risk will be reduced through implementation of the plan as well as how much additional, future flood risk (such as risk that might otherwise arise if no changes were made to floodplain policies) will be avoided through implementation of the regional flood plan, including recommended changes/improvements to the region's floodplain management policies.

This effort included a:

1. Region-wide summary of the relative reduction in flood risk that implementation of the Regional Flood Plan would achieve within the region including with regard to life, injuries, and property.
2. Statement that the FMPs in the plan, when implemented, will not negatively impact neighboring areas located within or outside of the Flood Planning Region (FPR).
3. General description of the types of potential positive and negative socioeconomic or recreational impacts of the recommended FMSs and FMPs within the FPR.
4. General description of the overall impacts of the recommended FMPs and FMSs in the Regional Flood Plan on the environment, agriculture, recreational resources, water quality, erosion, sedimentation, and navigation.

6.1.1 FMP Impacts

Twenty-eight FMPs were identified and recommended, as discussed in detail in **Chapters 4** and **5**. As proposed, the recommended FMPs within this plan will not negatively impact neighboring areas located within or outside of the FPR. The local sponsor will ultimately be responsible for proving that the final project design and implementation has no negative flood impacts prior to construction.

Of these FMPs, approximately half are conveyance improvement projects that have the potential to increase flows downstream by expanding channels, culverts, and/or bridges. To increase the likelihood that there will be no negative impacts to neighboring areas, conveyance mitigation measures, such as detention or valley storage have been included in the projects and will have to be analyzed and designed once the projects are funded. The remaining FMPs consist of new or improved detention facilities without conveyance improvements, acquisition or elevation of repetitive loss properties, installation of emergency generators, or infrastructure hardening. The RFPG reviewed previous assessments of impact to upstream or downstream areas or neighboring regions and deferred to the professional engineering judgement expressed in those assessments to determine whether no negative impact exists (see list of related studies and models in **Appendix 1**). The local sponsor will be ultimately responsible for proving the final conveyance project design has no negative flood impact prior to initiating construction. As proposed, the recommended FMPs, when implemented, will not negatively impact neighboring areas located within or outside of the FPR.

Additionally, based on the planning level data available, none of the FMPs recommended in the plan will negatively or measurably reduce water availability or water supply volumes and will not impact the State Water Plan.

As detailed in **Table 13 (Appendix 4-B)**, the 28 FMPs would remove 633 structures from the 1% ACE floodplain and remove an additional 411 structures from the 0.2% ACE floodplain. This would help protect approximately 1,566 people from living within the 1% ACE floodplain. In addition to these structures that would be completely removed from the floodplain, there is a significant number of structures, 9,924, that would see reduced risk (reduced water surface elevation) to their structures during a 1% ACE event through implementation of the recommended FMPs. The FMPs also include actions that would reduce or eliminate flood risk at 17 low water crossings. Some of these projects are expected to benefit agricultural lands. Additional benefits will include reduction in flooding in park lands, which will benefit recreational users. The streams impacted by the FMPs will not affect navigability.

If fully implemented, the Regional Flood Plan (RFP) will have profound and lasting impacts on flooding in Region 11.

6.1.2 FMS Impacts

The RFPG identified and reviewed more than 150 individual strategies from stakeholders within the Guadalupe FPR. Many of the identified strategies were found in existing Hazard Mitigation Action Plans, and it was noted there is a lot of similarity in the strategies. It was therefore determined to group the FMSs into the five strategy types identified in the TWDB Guidance Documents, and to consolidate the individual FMSs into five regional FMSs. The main reasons for this decision were to make each strategy inclusive of all communities within the Guadalupe FPR that choose to pursue them and to encourage collaboration between sponsors, particularly neighboring communities.

There are 31 individual actions that are bundled into the Regulatory and Guidance regional FMS. Actions listed within this category will improve regulation of development to decrease current and future flood risks. Some sample FMSs are NFIP participation, stormwater management criteria development including higher standards, floodplain management staff acquisition and training, ordinances, land use/zoning, and developing and implementing Green Infrastructure programs. Positive impacts include reducing the number of structures and roadways built in the floodplain, minimizing expansion of future floodplains, protecting riparian areas from development, which protects the environment, water quality, erosion, and sedimentation, and providing more regulatory certainty and consistency across the Guadalupe FPR. Potential negative impacts include the increased regulatory and financial burden on citizens and the increase in staff workload for communities.

Property Acquisition and Structural Elevation actions involve voluntary buyout programs and/or structural elevation assistance programs. There are 31 individual actions that are bundled into the Property Acquisition and Structural Elevation regional FMS. Although the individual actions focus on open space preservation, the regional FMS includes land acquisition to protect open space, acquiring or buying out flood prone structures, and elevation assistance programs. Anticipated positive impacts include reducing the number of structures in the floodplain and increased protection of citizens, allowing people to remove themselves from the floodplain without losing their investments, restoring/preserving floodplain functionality and conveyance, and ultimately protecting riparian areas from development – which protects natural environments, water quality, erosion, sedimentation. Potential negative impacts include increasing the regulatory and financial burden on citizens, increasing staff workloads for each community, causing “blight” in certain neighborhoods if not handled appropriately, and could be politically objectionable in some circumstances.

Some strategies considered Education and Outreach to increase awareness of flooding issues, risks, and regulation to citizens and other stakeholders. There are 61 individual actions that are bundled into the Education and Outreach regional FMS. These include public awareness

campaigns; flood safety education for residents, elected officials and real estate agents/developers; and flood insurance campaigns. Anticipated positive impacts include reduced violations of floodplain regulations which can decrease flood risks, increased public awareness of flood hazard areas, increased NFIP participation, and increased awareness of imminent flood events - which can help with early evacuations and mitigation measures to prevent further damages, save lives, and minimize risky behavior during floods which can reduce deaths, especially while driving. One negative impact of this strategy category is that it could increase staff workloads for communities. Establishing these types of programs would also introduce a small financial burden on citizens.

There are 46 individual actions that are bundled into the Flood Measurement and Warning regional FMS. This type involves the installation and operation of rainfall and flow measurement devices. These devices may have predictive systems in place to better forecast flooding, barricades, and warnings. Example FMSs include flood gauges, early alert systems, flood warning systems, evacuation/emergency management plans, and flood safety systems at Low Water Crossings. The anticipated benefits of implementing this FMS would be allowing people at risk of flooding to better prepare for flood events, mitigate damages, evaluate their respective area(s), and prevent vehicles from driving on flooded roads. All of these measures can help save lives by allowing local officials and community staff members to take proper precautions such as: closing hazardous roads and evacuating the predicted flooded areas before the actual flood begins. Potential negative impacts include increasing the financial burden on citizens, increasing staff workloads for communities, and the potential for false alarms or failed warnings if the system is not properly maintained and calibrated.

The Infrastructure Projects category is specific to Region 11 and is comprised of any other type of FMS that does not fall within the five categories outlined above. There are 16 individual actions that are bundled into the Infrastructure Projects regional FMS. While these may lead to future FMEs and FMPs, the specific actions represent the creation of programs. These include nature-based solutions (for example green infrastructure), site-specific maintenance programs, and county-wide maintenance programs. Some positive impacts include an established, routine-level maintenance plan/program to clear debris from flood-prone areas such as bridges, box culverts, and drainage systems to prevent overtopping and backup during flood events; developing plans to increase channel and bank stabilization by reducing erosion impacts; preserving system functionality (man-made and natural); avoiding large capital expenses resulting from deferred maintenance; prolonging facilities performing at their desired level of service; and financial transparency to customers about major capital expenses. Potential negative impacts include increasing the financial burden on citizens and increasing local staff workloads to properly maintain these areas on a routine basis.

While not readily quantifiable, these strategies and measures will generally protect the health, safety, and well-being of individuals within the region while simultaneously improving the region's economic well-being by reducing the flood frequency and severity, providing advanced warning of flood risks, minimizing the number of drivers on flooded roads, giving community officials the resources they need to prevent construction in flood prone areas, and alleviating known flooding issues. Development, especially in the floodplain, leads to increases in flood flows that can cause downcutting and erosion of streams – both of which ultimately lead to environmental issues. The FMSs in Region 11's RFP will help minimize and prevent future damage, which will help preserve developable land, protect agricultural land, reduce erosion, and prevent downstream sedimentation. Most flood mitigation measures have the potential to negatively impact neighboring areas, especially when conveyance is increased. These impacts will be mitigated during design and construction to increase the likelihood that no negative impacts occur. Many of the FMSs will require more active floodplain management by communities in the region which will burden community officials who must enforce regulations and will likely meet some resistance from citizens and developers wishing to engage in floodplain construction. Most of these strategies would add costs that would be incurred by the citizens of the community. These issues can be overcome and lead to stronger communities, and this fully funded RFP would aid in providing the tools needed to accomplish these goals.

If all of these FMSs are implemented and enforced, Region 11 will prevent a significant increase in flood exposures. Without these FMSs in place, Region 11 could see the 1% ACE floodplain area increase by 183 square miles and the 0.2% ACE floodplain increase by 32 square miles. This would expose an additional 22,667 structures and 92,715 people to the 1% ACE floodplain, and 3,318 structures and 9,569 people to the 0.2% ACE floodplain.

Based on the planning level data available, none of the FMSs recommended in the plan will negatively or measurably reduce water availability or water supply volumes and will not impact the State Water Plan.

6.1.3 FME Impacts

A total of 138 FMEs were recommended by the RFPG in three broad categories. These categories, examples, and their positive and negative impacts are described below.

The Preparedness category includes evaluations pertaining to communities being prepared for flood events. Example FMEs in this category are inundation studies, dam compliance assessments, hazard/vulnerability assessments, dam integrity studies, evacuation and dam safety plans, road access studies. These actions can provide a positive impact by having preemptive evaluations and strategies to better prepare an area or community in the event of flood. There are seven FMEs in this category.

Evaluations marked as Project Planning conduct up to 30 percent design for specific projects and flood mitigation measures that were previously identified by sponsors. There are 95 FMEs in Region 11 in this category. Typical projects include storm drain upgrades, culvert upsizing, and channel modifications. Expected positive impacts include reducing flooding and exposure to flooding, reducing impact of flooding on existing facilities, and reducing roadway overtopping. One negative impact is that all conveyance improvement projects have the potential to increase flooding downstream. Mitigation measures will need to be considered during the development of these actions.

Actions such as conducting watershed studies to establish accurate floodplain modeling and mapping and evaluation of potential flood mitigation measures are marked as Watershed Planning. There are 36 FMEs in this category. These include Flood Insurance Studies (FIS), watershed studies, and city-wide and county-wide drainage master plans (DMPs). Typical positive impacts include:

- More accurate flood maps, which allow for risk avoidance, better regulations, and better planning
- Understanding the needs for flood reduction in a watershed, which allow for better allocation of resources, providing design details needed for eventually converting an FME into an FMP that can be funded and implemented
- Projects that come from these FMEs can reduce flooding and exposure to flooding

Potential negative impacts are that all conveyance improvement projects have the potential to increase flooding downstream; therefore, mitigation measures will need to be considered if any such projects are identified during the FME, and more projects are usually identified than there is available funding.

The watershed studies and project specific FMEs will provide the information needed to increase the likelihood that cost-effective flood mitigation measures are implemented in Region 11 that do not negatively impact other areas. These projects will reduce flood risks, saves lives, and protect valuable infrastructure.

Detailed modeling and mapping will also help protect recreational resources and agriculture by identifying flood risk to these areas and allowing for the evaluation of future development impacts.

Until all of these FMEs are completed, their specific benefits cannot be quantified. However, there is FME coverage across almost the entire region, which, as Chapter 2 notes, contains 45,801 structures, 117,128 people, and 3,206 roadway-stream crossings at risk of flooding. These FMEs will make strides towards developing projects aimed at reducing flood risks to these people and help prevent additional people from becoming exposed to the 1% ACE

floodplain due to expansion of the floodplain and uncontrolled development. By providing more accurate information on the flood risks, communities will be empowered to control development within the floodplain.

6.1.4 Impacts of RFP Implementation

Avoidance of Negative Impacts

During the evaluation of alternatives for a flood mitigation project, potential negative impacts of alternatives are analyzed, and those alternatives are removed from consideration if the negative impacts cannot be reasonably mitigated for. Therefore, for each FMP considered, the preliminary engineering or alternative analysis reports that were obtained for each FMP were reviewed to determine any potentially unmitigated negative impacts. No unmitigated negative impacts were discovered for any of the FMPs. Some FMPs related to installation of stream gauges or emergency generators did not include modeling but were assumed to inherently have no negative impacts.

Potential negative impacts were also considered for the FMEs and FMSs. The planning-level assessment for these actions included a much simpler review of the potential impacts, based on the limited data available to determine potential impacts. The FMEs are set forth to identify if there are any potential negative impacts of the proposed action. There are no negative impacts for completing a study or evaluation to gain a better understanding of the proposed flood mitigation action. Like the FMEs, the FMSs will also identify negative impacts if the proposed action is executed. However, there are no negative impacts to implement new flood management strategies. The sponsors for all actions will need to demonstrate a commitment to no negative impacts before they can receive funding. Ultimately, it will be the responsibility of the local sponsor to demonstrate the final project design has no negative impacts prior to construction.

As stated above, based on the planning level data available, none of the actions recommended in the plan will negatively or measurably reduce water availability or water supply volumes and will not impact the State Water Plan.

6.1.5 Potential Future Benefits

Many of the proposed actions included in this plan will reap benefits now and long into the future. Evaluations and strategies are the best candidates for actions that include current benefits, future benefits, and no negative impacts. Examples of these actions include flood warning systems, buyouts, higher design standards, education and outreach programs, and flood preparedness. These types of actions will increase the community's resiliency by providing knowledge in advance of a storm, removing development in the floodplain, and preventing future development in the floodplain. With higher design standards, population

growth and economic development would occur in areas outside of the floodplain and further away from the flooding source. Together, these actions will remove people and structures from the existing floodplain and reduce the future flood risk.

Regional Detention, when sized for future development conditions, is an example of an FMP with current benefits, future benefits, and no negative impacts. This allows for future development to occur upstream while the increased flows have already been mitigated with a detention pond that has been sized to accommodate the increased flows and increased volume of runoff. There are not any anticipated negative impacts for this type of project, as the downstream discharge and volume can be controlled by the outlet structure of the impoundment.

The policies discussed and recommended in **Chapter 3** are another example of how this plan can provide long lasting benefits. The implementation of these standards will reduce the future flood risk throughout the Guadalupe FPR. Collectively, the standards listed above will protect the riparian areas of the floodplain from encroaching development, providing a buffer between development and the floodplain now and in the future.

6.1.6 Socioeconomic & Recreational Impacts of the RFP

Flooding can result in significant damage to the economy, the environment, infrastructure, and property, and a hazard to people. Various types of flooding can be caused by flash flooding, coastal flooding, urban flooding, riverine flooding, and pluvial flooding. Several types of flood strategies and projects have been developed to protect against flooding. However, the managing of flood risk and the development and implementation of flood defenses has both advantages and disadvantages in recreation and socioeconomically.

Ultimately, flood evaluations and projects protect homes and people, and decrease the rate of erosion, preventing foundation and structural damage in the long run. They also save money in terms of roadway infrastructure repairs due to the impacts of flooding.

Socioeconomic Impacts

According to the American Psychological Association, “socioeconomic advantage and disadvantage can be defined as people's access to material and social resources, and their ability to participate in society”. Studies of socioeconomic status can reveal inequities in access to resources which could prevent accessing the services to plan, respond and recover from flood events.

Flooding does not only result in destroyed infrastructure and damaged property, but also has a negative social impact on the citizens impacted. The impacts, both short-term and long-term, on physical and mental health result in changes to the livelihoods of impacted citizens creating greater socioeconomic disparity.

The FMSs and FMPs listed are intended to provide watershed wide benefits to the disproportionally disadvantaged or socially vulnerable population by reducing risk and promoting 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 unimpacted by flood.

Ensuring equity in the development and implementation of strategies and projects reduces any perceived disadvantages. Any disadvantages would occur if the socioeconomically disadvantaged population was not served directly or indirectly by the FMSs or FMPs.

Recreational Impacts

Using natural or man-made water bodies for recreation is highly valued in the Guadalupe FPR and throughout Texas. Many waterfront parks are spaces are designed to be flooded with minimal damage during storm or flood events. Additionally, urban river restorations focus on restoring aquatic and riparian habitats, increasing flood protection, and enhancing recreational potential. Wetlands also play an important role in water resources as these areas store and filter water pollutants. In agricultural areas, when floodplains are not full of water, they can grow grass and be used as grazing areas. These floodplains and wetlands can support tourism, recreation, and freshwater fisheries.

While flood defense or protection projects do protect homes, infrastructure, and people, they also provide protection to natural habitats. Many shorelines are conservation areas, and flood defenses help preserve these areas. Maintaining floodplains in their natural states can create positive impacts through potential recreational, environmental, and biological benefits. Several types of flood projects, mainly those that are classified as natural systems, promote biodiversity. Wetlands that function as flood plains support a wide range of bird species while ponds support newts, leeches, and wading birds. Riparian systems can sustain several types of animal life.

There are potential disadvantages to using the floodplain and waterfront parks for recreation. Were damages to occur to recreational waterbodies, they can become dangerous to use. While flood strategies and projects can be effective at protecting people, property, and resources, the initial and ongoing costs of installation and maintenance can be prohibitive. These costs can be prohibitive and can overwhelm communities struggling to find funding for long-term flooding solutions.

6.1.7 Summary of the Impacts of the RFP

If fully implemented, the RFP will have profound and lasting impacts on flood risk reduction in Region 11. While not readily quantifiable, these measures will also protect the health and safety of the Guadalupe FPR, as well as its economic wellbeing. This is done by reducing the

flooding frequency and severity, providing advanced warning of flood risks, reducing driving on flooded roads, and giving community officials the tools they need to prevent construction in flood prone areas and alleviating known flooding issues. Development in general, and especially in the floodplain, leads to increases in flood flows that can cause downcutting and erosion of streams that can lead to environmental issues and sedimentation downstream.

Most flood mitigation measures have the potential to negatively impact neighboring areas, especially when conveyance is increased. These impacts will be mitigated during design and construction to increase the likelihood that no negative impacts occur. Many of the FMSs will require more active floodplain management by communities in the Guadalupe FPR. This will burden community officials who must enforce regulations and will meet some resistance from citizens wishing to engage in risky floodplain construction. These issues can be overcome and lead to stronger communities and this RFP, fully funded and implemented, would provide the tools needed to make this happen.

None of the FMSs, FMEs, or FMPs specifically address water supply issues and are not expected to have a significant impact on water supply. However, some flood risk reduction actions could contribute to water supply and are discussed further in **Section 6.2.5**.

6.2 Contributions to and Impacts on Water Supply Development and the State Water Plan

The Guadalupe Regional Flood Planning Group (RFPG) is tasked with evaluating potential impacts of the regional flood plan on water supply development and the state water plan. This chapter describes the processes undertaken by the RFPG to achieve these tasks and summarizes the outcomes of this effort.

This effort included a region-wide summary of:

- The contribution that the regional flood plan would have on water supply development;
- The specific flood management strategies (FMS) and/or flood mitigation projects (FMP) that would contribute to water supply, and
- Anticipated impacts that regional flood plan FMSs and FMPs may have on water supply or water availability projects in the state water plan.

The Guadalupe River Basin is almost completely contained in the Region L Water Plan (https://www.twdb.texas.gov/waterplanning/rwp/regions/l/index.asp). However, Kerr County is within the Region J Water Plan (https://www.twdb.texas.gov/waterplanning/rwp/regions/j/index.asp). The information in **Section 6.2.1** and **Section 6.2.2** below summarize the Region L Water Plan and potential FMSs and FMPs that could measurably contribute to water supply. **Section 6.2.3** and **Section 6.2.4** summarize the Region J Water Plan.

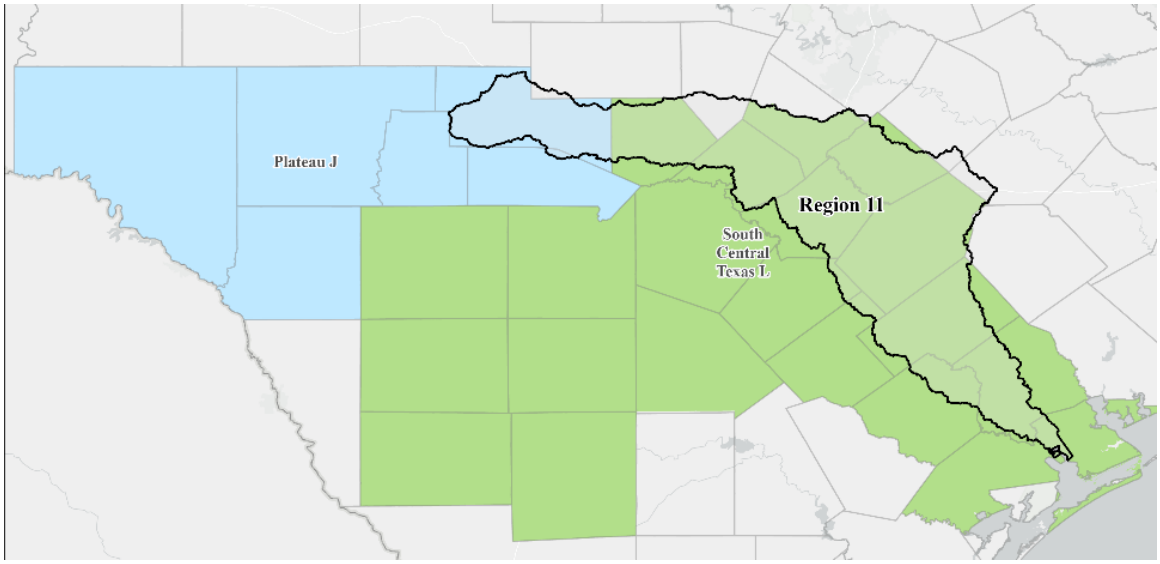


Figure 6-1: Boundaries of Plateau Water Planning Region (Region J), South Central Texas Water Planning Region (Region L), and Guadalupe Flood Planning Region (Region 11)

6.2.1 Region L Water Plan Overview

Since 1957, the Texas Water Development Board (TWDB) has been charged with preparing a comprehensive and flexible long-term plan for the development, conservation, and management of the state's water resources. The current state water plan (SWP), 2022 State Water Plan – Water for Texas, was produced by TWDB and based on approved regional water plans (RWPs) pursuant to requirements of Senate Bill (SB) 1, enacted in 1997 by the 75th Texas Legislature. As stated in SB1 Section 16.053.a, the purpose of the regional water planning effort is to: "…provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions in order that sufficient water will be available at a reasonable cost to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of that particular region." SB 1 also provides that future regulatory and financing decisions of the Texas Commission on Environmental Quality (TCEQ) and TWDB, respectively, be consistent with approved regional plans.

TWDB divided the state into 16 regional water planning regions and appointed members to the regional planning groups. As shown on **Figure 6-2**, the South-Central Texas Region (Region L) includes all or portions of 21 counties. The South-Central Texas Regional Water Planning Group (SCTRWPG) has a total of 31 voting members with one vacancy at the time of this report. These members represent 12 stakeholder groups (public, counties, municipalities, industry, agriculture, environmental, small business, electric generating utilities, river authorities, water districts, water utilities, and groundwater management areas), serve without pay, and are responsible for the development of the South-Central Texas Regional Water Plan (SCTRWP).

The 2021 SCTRWP represents the fifth update of an RWP as presently required to occur on a 5-year cycle. TWDB integrated this 2021 SCTRWP into the 2022 State Water Plan (SWP).

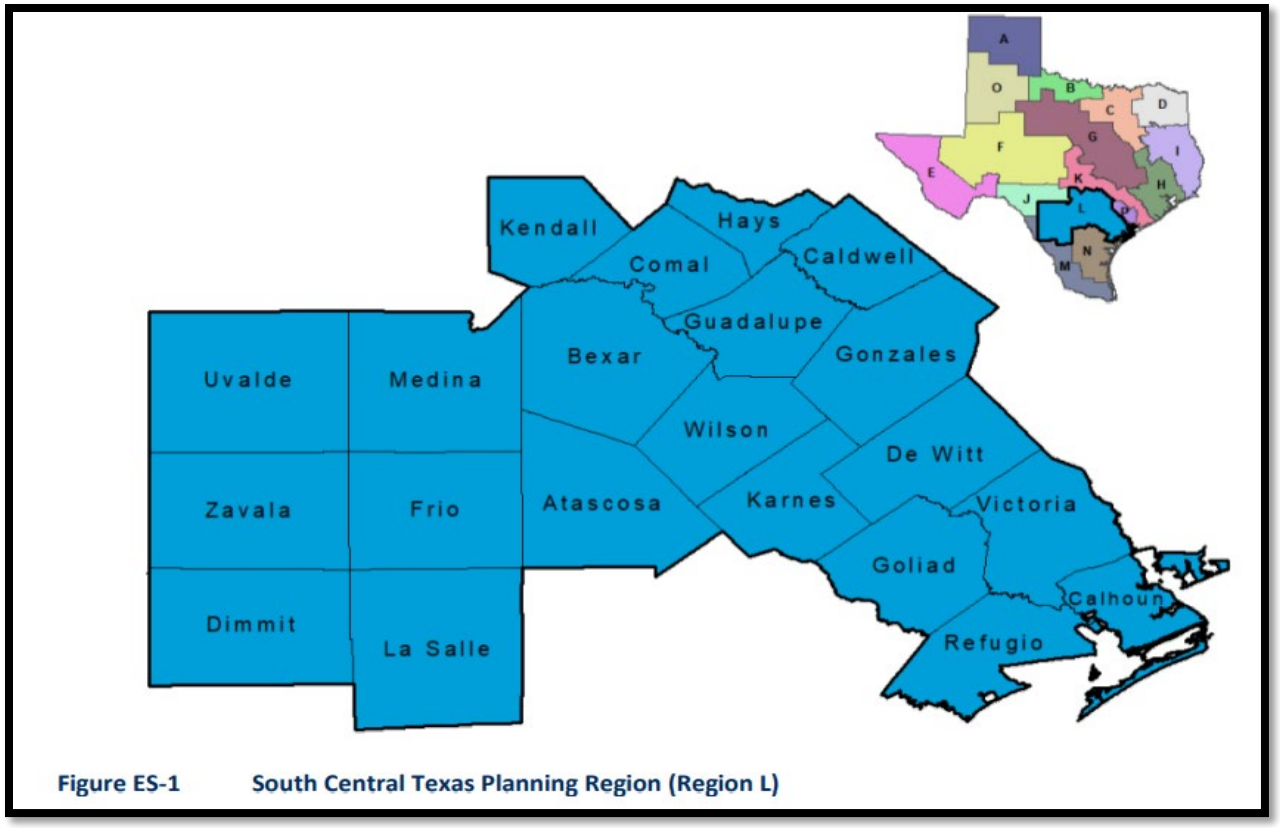


Figure 6-2: South Central Texas Planning Region (Region L)

Source: Region L

By 2070, approximately 59 percent of the South-Central Texas Region's total population is projected to reside in Bexar County. The counties with the largest anticipated population growth between 2020 and 2070 are Bexar, Comal, Guadalupe, and Hays Counties. The population is anticipated to grow from about 3 million people in 2020 to about 5.2 million in 2070, a 73 percent increase.

Five major and five minor aquifers supply groundwater to the South-Central Texas Region. The five major aquifers are the Edwards-Balcones Fault Zone (including the Barton Springs Segment), Carrizo Wilcox, Trinity, Gulf Coast, and Edwards-Trinity (Plateau) Aquifers. The primary water supply reservoir in the river basin is the Canyon Reservoir upstream of New Braunfels.

6.2.2 Region L Recommended Water Strategies for Entities within Region 11

Table 6-1 below identifies the water management strategies recommended by Region L for entities within Region 11. **The 2021 Region L Water Plan notes in its Appendix 11-A that no water project or strategy involves the reallocation of flood control and does not provide any measurable flood risk reduction.**

Table 6-1: Water Management Strategies Recommended in 2021 Region L Plan for Entities within Region 11

County	Water User Group (WUG)	Strategy Name
Caldwell	Aqua WSC	Advanced Water Conservation
Caldwell	City of Lockhart	Advanced Water Conservation
Caldwell	City of Lockhart	ARWA/GBRA Project (Phase 1)
Caldwell	City of Luling	Advanced Water Conservation
		Local Groundwater
Caldwell	Martindale WSC	Drought Management
		Facilities Expansion: CRWA Hays Caldwell WTP Expansion
		Martindale WSC Alluvial Well Project
		Purchase from WWP (CRWA)
Caldwell	Maxwell WSC	Maxwell WSC Trinity Well
Caldwell	Polonia WSC*	Advanced Water Conservation
Caldwell	Tri Community WSC	Advanced Water Conservation
Comal	Canyon Lake Water Service*	Advanced Water Conservation
		Purchase from WWP (GBRA)
Comal	Clear Water Estates Water System	Advanced Water Conservation
		Drought Management
		Local Groundwater
Comal	City of Garden Ridge*	Advanced Water Conservation
		Drought Management
		Local Groundwater
Comal	Green Valley SUD*	ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)
Comal	KT Water Development	Advanced Water Conservation
		Drought Management
		Local Groundwater
Comal	New Braunfels Utilities (NBU)	Advanced Water Conservation
		Facilities Expansion: NBU South WTP Expansion
		Facilities Expansion: NBU-Seguin Interconnect
		ARWA/GBRA Project (Phase 1)
		NBU ASR
		NBU Trinity Well Field Expansion
DeWitt	City of Cuero	Advanced Water Conservation
DeWitt	City of Yorktown	Advanced Water Conservation
Gonzales	City of Gonzales	Advanced Water Conservation
Gonzales	Gonzales County WSC	Advanced Water Conservation

County	Water User Group (WUG)	Strategy Name
Gonzales	City of Nixon	Advanced Water Conservation
Gonzales	City of Smiley	Advanced Water Conservation
Gonzales	City of Waelder	Advanced Water Conservation
Guadalupe	City of Schertz	Advanced Water Conservation
		CVLGC Carrizo Project
		SSLGC Expanded Carrizo Project
		SSLGC Expanded Brackish Wilcox Project
Guadalupe	City of Seguin*	Advanced Water Conservation
		Drought Management
		SSLGC Expanded Carrizo Project
		SSLGC Expanded Brackish Wilcox Project
Guadalupe	Springs Hill WSC*	Facilities Expansion: Lake Placid WTP Expansion
		Facilities Expansion: Bored Pipeline
Hays	City of Buda	Advanced Water Conservation
		ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)
Hays	County Line SUD	ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)
		Recycled Water Strategies
		County Line SUD Trinity Well Field
		County Line SUD Brackish Edwards Project
Hays	Crystal Clear WSC	Advanced Water Conservation
		ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)
		Drought Management
Hays	Goforth SUD	Advanced Water Conservation
		Drought Management
		ARWA/GBRA Project (Phase 1)
Hays	City of Kyle	Advanced Water Conservation
		ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)
Hays	City of San Marcos	Advanced Water Conservation
		ARWA/GBRA Project (Phase 1)
		ARWA Project (Phase 2)
		ARWA Project (Phase 3)

County	Water User Group (WUG)	Strategy Name
		Facilities Expansion: CRWA Hays Caldwell WTP Expansion
		Recycled Water Strategies: San Marcos Non-Potable Reuse
		Recycled Water Strategies: San Marcos Potable Reuse
Hays	South Buda WCID 1	Advanced Water Conservation
Hays	Texas State University	Advanced Water Conservation
Hays	Wimberly WSC	Purchase from WWP (GBRA)
Victoria	City of Victoria	Advanced Water Conservation
		Drought Management
		City of Victoria ASR
		City of Victoria Groundwater-Surface Water Exchange

*Partially within another Flood Planning Region

6.2.3 Region J Water Plan Overview

As shown on **Figure 6-3**, the Plateau Water Planning Region (Region J) includes all or portions of six counties (Bandera, Edwards, Kerr, Kinney, Real and Val Verde). Only one of those counties (Kerr) lies within the Region 11 Guadalupe Flood Planning Region (FPR). The Plateau Water Planning Region currently has a total of 22 voting members. These members represent 13 stakeholder groups (public, counties, municipalities, industry, tourism, agriculture, environmental, small business, river authorities, water districts, water utilities, groundwater management areas, and other) including at least one representative from each of the six counties, serve without pay, and are responsible for the development of the Region J Regional Water Plan (RWP).

The 2021 Region J Regional Water Plan represents the fifth update of the RWP as presently required to occur on a 5-year cycle. TWDB will integrate this 2021 Region J RWP into the 2022 State Water Plan (SWP).

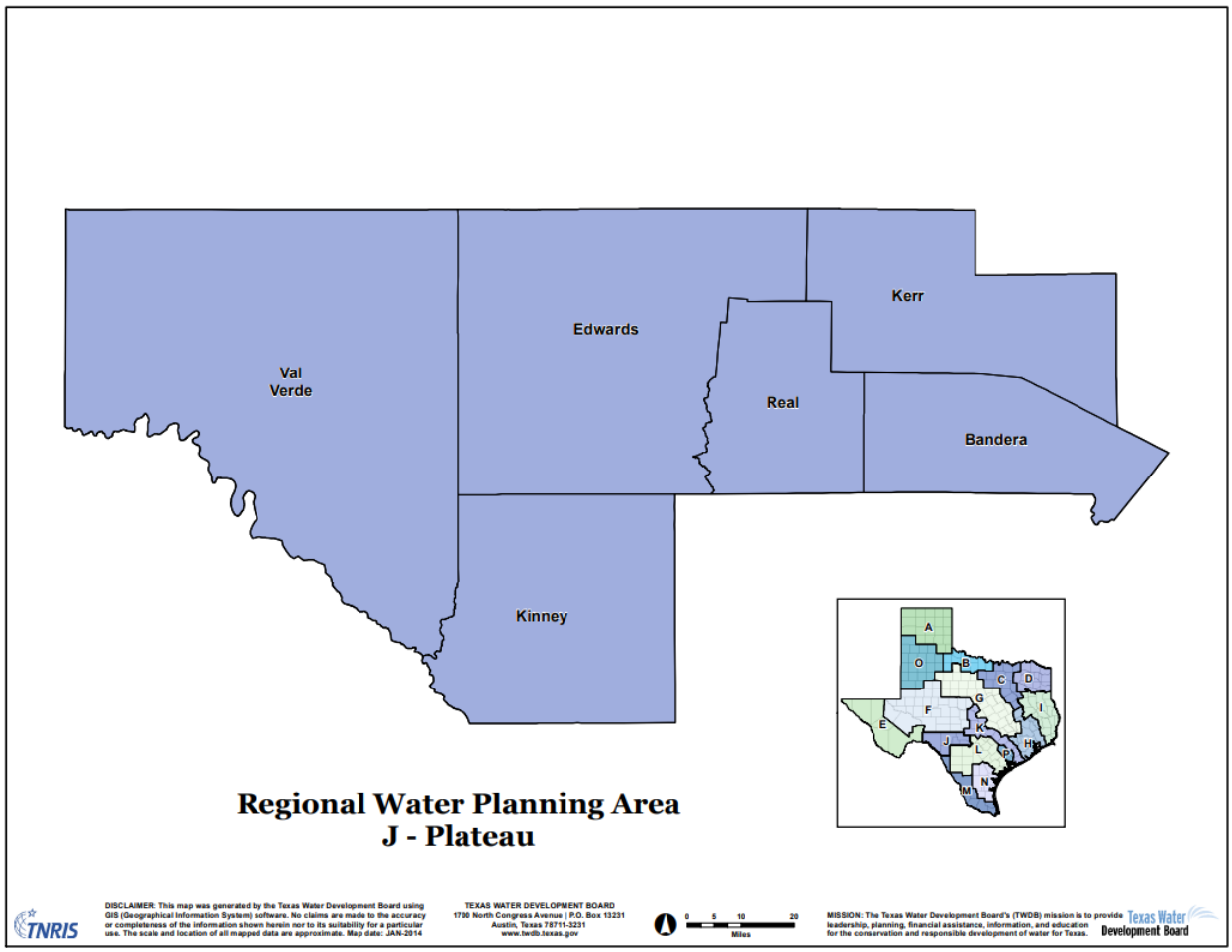


Figure 6-3: Region J Planning Region

Source: Texas Water Development Board

Approximately 46 percent of the Plateau Water Planning Region's total population is located in the two largest cities: Del Rio and Kerrville. Total population of the six counties is anticipated to increase by approximately 52 percent between 2020 and 2070. These population estimates do not include a significant transient (tourism, hunting, recreation, etc.) population that has a resulting significant impact on overall water supply demand in the region. The Region J RWP emphasizes that there is likely a need for more water than is accounted for from the population-derived water demand estimates.

Land use is primarily shrub/scrub and grassland, with urban and agricultural comprising less than one percent of the region's total land area. The climate of the Plateau Water Planning Region is semi-arid to arid, with precipitation decreasing as one moves further west. Average annual precipitation for the Plateau Water Planning Region is 25 inches.

6.2.4 Region J Recommended Water Strategies for Entities within Region 11

Table 6-2 below identifies the water management strategies recommended by Region J for entities within Region 11.

Table 6- 2: Water Management Strategies Recommended in 2021 Region J Plan for Entities within Region 11

County	Water User Group (WUG)	Strategy Name
Kerr	City of Kerrville	Increase wastewater reuse
		Water loss audit and main-line repair
		Explore and develop new Ellenburger Aquifer well supply
		Increased water treatment and ASR capacity
Kerr	Kerr County Other – Eastern Kerr County Regional Water Supply Project	Project 1. Construction of an Ellenburger Aquifer water supply well
		Project 2. Construction of off-channel surface water storage
		Project 2. Construction of surface water treatment facilities and transmission lines
		Project 3. Construction of ASR facility
		Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas
		Project 4. Construction of desalination plant
Kerr	Kerr County Other – Center Point	Public conservation education
		Purchase water from EKCRWSP
Kerr	Kerr County Other – Center Point Taylor System	Public conservation education
		Purchase water from EKCRWSP
Kerr	Kerr County Other – Verde Park Estates	Water loss audit and main-line repair

The water supply connections between Region 11 and Region J derive primarily from the fact that the Guadalupe River serves as an important water supply source for the City of Kerrville and other communities in Kerr County. There is no mention in the plan of a water management strategy or project providing any measurable flood reduction risk. The 2021 Region J Water Plan does not directly comment on the connections between water planning and flood planning; however, there are some indirect ties that cannot be measured but are worth noting:

- Upper Guadalupe River Authority's (UGRA) existing water and sediment control facilities are operating at nine different locations in the upper Guadalupe River basin. The basins temporarily retain waters along the Guadalupe River and its tributaries. During flood

events, the basins allow the flows to be released in a controlled manner to protect water quality and control erosion.

- Potential for surface water contamination resulting from urban runoff in rapidly growing population centers
- Vegetative management and land stewardship programs are not qualified as water management strategies under regional water planning guidelines as they are not considered to reduce water demand. However, the Region J RWP devotes portions of the plan to educate the public on both the potential water supply benefits (recharge of alluvial aquifers and improvement of water quality), as well as potential flood benefits (riparian areas buffer and slow floodwaters).
- Upper Guadalupe River Authority's (UGRA) existing rainwater catchment system rebate and incentive programs are a water conservation program that can retain some rainfall and potentially generate a slight decrease in peak runoff rates. The plan also recommends rainwater harvesting programs for the City of Bandera, although there is no mention of their benefit towards flood flows.

6.2.5 Region 11 Flood Management Actions with Water Supply Component

Detention Structures

FMSs, FMEs and FMPs that could measurably contribute to water supply are proposed large detention structures. This plan does not include any FMSs, FMEs or FMPs for large detention structures that have a quantified water supply component, although there are a handful of flood management actions that could potentially be modified in the design phase to include a water supply component for irrigation or other nearby needs (see **Table 6-3** below). However, those basins should be evaluated for evaporation and seepage loss to confirm that water rights and water availability are not adversely affected. There are also several existing reservoirs in the basin that are permitted for water supply but indirectly have a flood mitigation impact. Finally, small detention basins such as the nine existing basins managed by UGRA may be used as a domestic water supply for one household, as well as watering livestock.

Table 6-3: Detention Structures Recommended in 2022 Region 11 Flood Plan

ID	Name	Sponsor	Size (if known)	Water Supply Benefits
113000069	Detention York Creek	Guadalupe County	48,310 acre-feet	Indirect
113000068	Detention Victoria	City of Victoria	3,700 acre-feet	Indirect
113000065	Regional Detention – Seguin	City of Seguin	392 acre-feet	Indirect
111000054	Regional Detention Study	City of San Marcos	TBD	Indirect
113000047	Detention Peach Creek	Gonzales County	41,774 acre-feet	Indirect
113000044	Detention Bear Creek	Comal County	3,375 acre-feet	Indirect
113000001	Detention Blanco River	Blanco County	1,128 acre-feet	Indirect
111000127	Evaluation of Water and Sediment Control Facilities	UGRA	TBD	Indirect

Ordinances and Criteria

To promote water supply enhancement with flood management, stormwater criteria such as the LCRA Highland Lakes Watershed Ordinance rainwater harvesting measure could be adopted to meet stormwater goals and at the same time offset water needs. This stormwater management alternative could be included in drainage codes and criteria to encourage flood management with water supply benefits.

Another regulatory option is the adoption and implementation of stormwater management ordinances that manage flooding but could also include a water supply aspect of beneficial reuse for irrigation purposes. This approach could use an automated batch detention system combined with an irrigation system to help meet local outdoor watering needs. The TCEQ Edwards Aquifer Protection Program allows new development projects to use this stormwater management measure to obtain compliance with the technical criteria to protect water quality and minimize stream degradation. The Edwards Aquifer and its Contributing Zone are found in Travis, Hays, and Comal counties in the Guadalupe River Basin.

Currently, these types of actions generally target onsite reuse opportunities and the overall potential impacts to water supply are not quantified.

Recharge Enhancement

There are several initiatives within the basin to enhance aquifer recharge for environmental and water supply benefits, as well as reduce flood risk. These initiatives are captured as flood

management actions, as well as legislative recommendations in this plan. The Great Springs Project is leading an initiative to conserve an additional 50,000 acres of sensitive land in the Austin-San Antonio corridor. Much of the 50,000 acres will be aquifer recharge and contributing zone land in Hays and Comal Counties in the most densely populated area of the Region 11 flood planning area. Great Springs Project intends to acquire aquifer recharge and contributing zone land which is strategically valuable for flood mitigation purposes, since this could simultaneously reduce flood risk while enhancing the recharge of the Edwards Aquifer. The Camp Bullis Sentinel Landscape Project can provide funding opportunities for flood mitigation projects on the Edwards Aquifer Recharge and Contributing zones that could enhance recharge, including acquisition and permanent protection of land.

Currently the potential contribution to water supply is unknown. In fact, one of the goals for some of the studies such and the Great Springs Project is to develop methods to quantify additional potential benefits.

Nature Based Solutions

Finally, while not generating a measurable water supply, green infrastructure, natural channel design, stormwater detention, low impact development, and other measures can help mitigate flood flows and at the same time protect water quality. This can help manage downstream water treatment costs and benefit rate payers.

Potential Model for Floodplain Management and Water Supply Enhancement

New Braunfels Utilities (NBU), in coordination with the City of New Braunfels and the Guadalupe-Blanco River Authority (GBRA), developed a One Water plan to guide coordination and cooperation to maximize water supply availability while doing so in a manner that protects the streams and rivers. The plan recognizes the value of all water including stormwater runoff that can be harvested for beneficial use and managed through green infrastructure practices to avoid negatively impacting water supply (surface and groundwater) amount and quality and providing flood management. These practices take a conservation and nature-based approach to limit water supply and floodplain management costs while creating habitat and attractive projects to bring the residents and visitors to the community in support of their economic goals.

The One Water Plan was completed in 2021 and includes a road map for success that established a vision, targets, indicators, and an action plan to define roles and responsibilities to move from the plan to implementation of multiple measures. NBU hired a One Water Coordinator to lead the effort and there are ongoing meetings with the City Commissions and Boards, GBRA, and other stakeholders to further share the plan and obtain support across the community.

Chapter 7: Flood Response Information and Activities

This chapter summarizes the flood response preparations using demographic, historical, projected, and statistical data from the previous chapters, and by implementing data from the survey responses. The Texas Water Development Board (TWDB) specifically stated that RFPG "shall not perform analyses or other activities related to planning for disaster response or recovery activities." The focus of this chapter is summarizing the information obtained and providing general recommendations regarding flood response activities. As discussed in **Chapters 1** and **2**, a variety of types of flood risks exist in the Guadalupe Flood Planning Region (FPR), including riverine, flash, urban, and coastal flooding. When such flood events occur, it is imperative that plans are in place to address flood response and recovery needs.

7.1 The Nature and Types of Flood Activities

There are four phases to emergency management:

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

Examples of preparedness actions include creating disaster preparedness plans, performing drills and exercises, installing disaster warning systems, creating essential supply lists, and assessing potential vulnerabilities. During the response phase, disaster plans are implemented, search and rescues may occur, and low water crossing signs may be erected. In the recovery phase, evaluation of flood damage, rebuilding damaged structures, and removing debris occurs. The most important step of the four phases of emergency management is mitigation. The Federal Emergency Management Agency (FEMA) defines hazard mitigation as, "any sustainable action that reduces or eliminates long-term risk to people and property from future disasters."

Flood mitigation is the primary focus of the regional flood planning process and plan development efforts regarding identifying and recommending FMEs, FMSs and FMPs by the RFPG. The plan may also include flood preparedness FMEs, FMSs and FMPs.

Examples of mitigation actions include structural and non-structural flood risk reduction projects such as property acquisition and relocation, drainage or channel improvements, dams,

or levees but also includes actions such as planning, zoning, floodplain regulation and protection, and public outreach projects.

7.2 Guadalupe Basin Flood Response – Stakeholder Input

7.2.1 Actions and Preparations

Hazard Mitigation Action Plans served as the primary data source for identifying flood mitigation (and preparation) actions. Mitigation actions from Hazard Mitigation Action Plans include:

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

This initial list was refined and expanded upon through two different avenues of public input: a survey conducted through the Region 11 online Data Collection Tool that filtered questions based on whether the respondent indicated general public or practitioner, and direct questionnaires with sponsors of potential FMEs, FMSs, and FMPs. The survey indicated that several of the types of actions listed were in place or being implemented in the next 5 years including flood warning signs, reverse 911 systems, crews to set up barricades or close gates, social media, portable and/or temporary traffic message boards, stream or rain gauges with alerts, and flood gauges.

Figure 7-1, Figure 7-2, Figure 7-3, Figure 7-4, and Figure 7-5 present the results of survey and questionnaire relevant to Region 11 communities' current preparedness, response, recovery, and mitigation efforts.

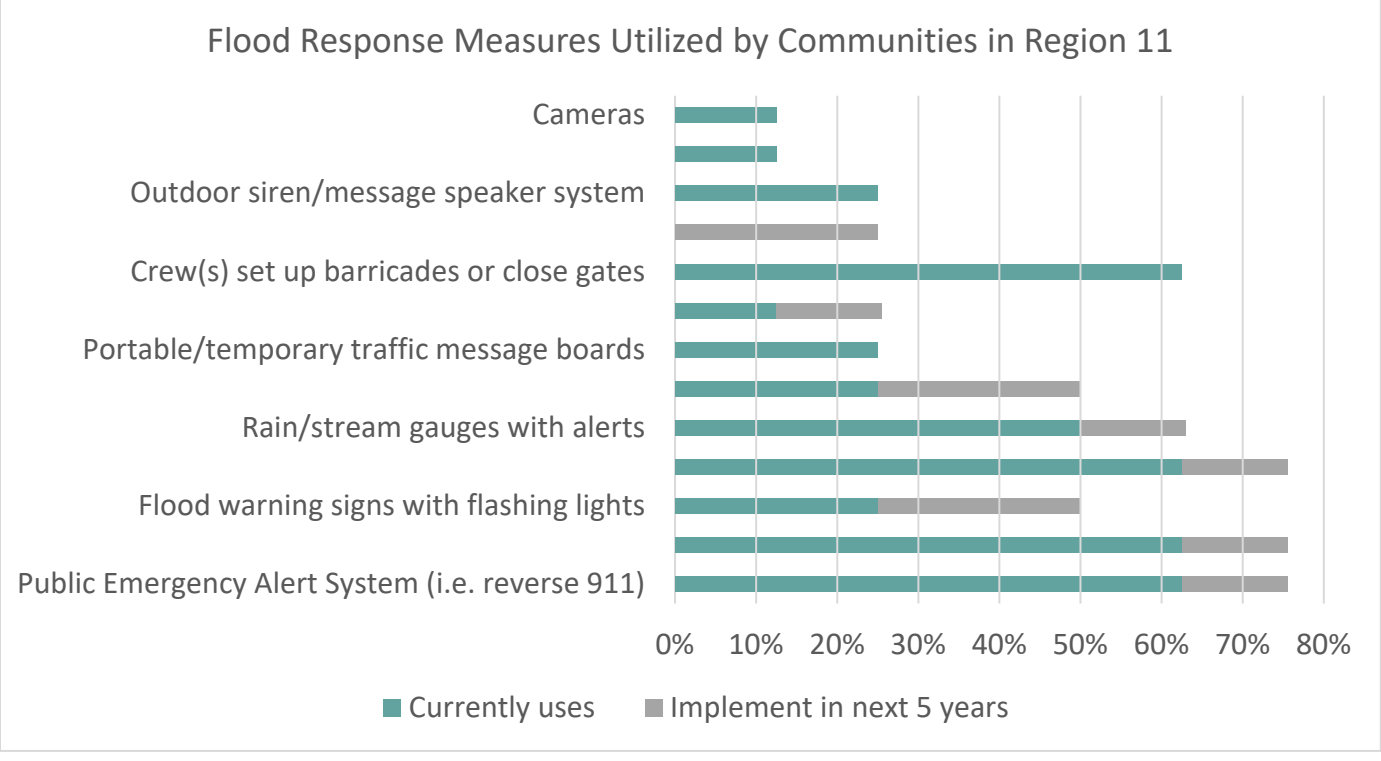


Figure 7-1: Flood Response Measures

Source: Region 11 Data Collection Tool as of May 27, 2022

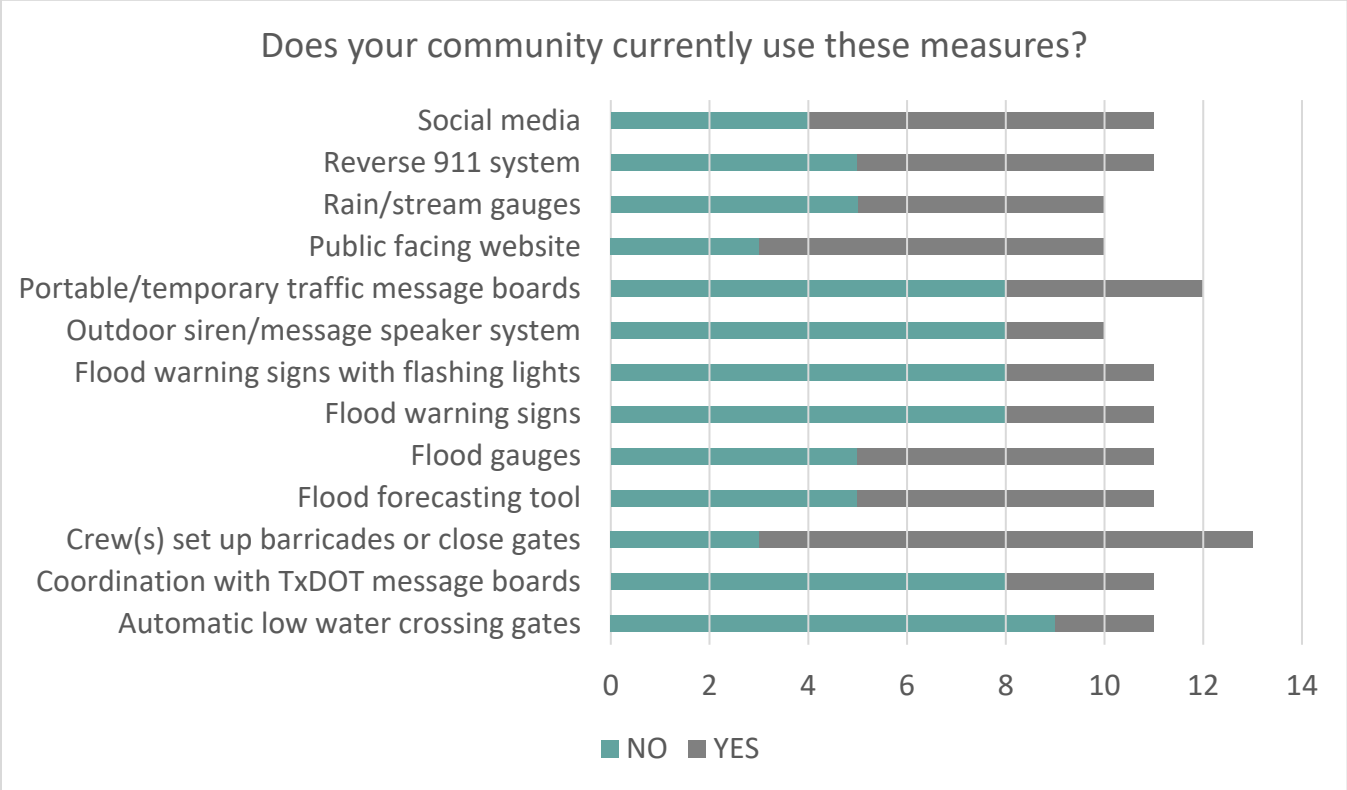


Figure 7-2: Flood Response Measures Communities are Currently Using

Source: Region 11 Sponsor Questionnaire

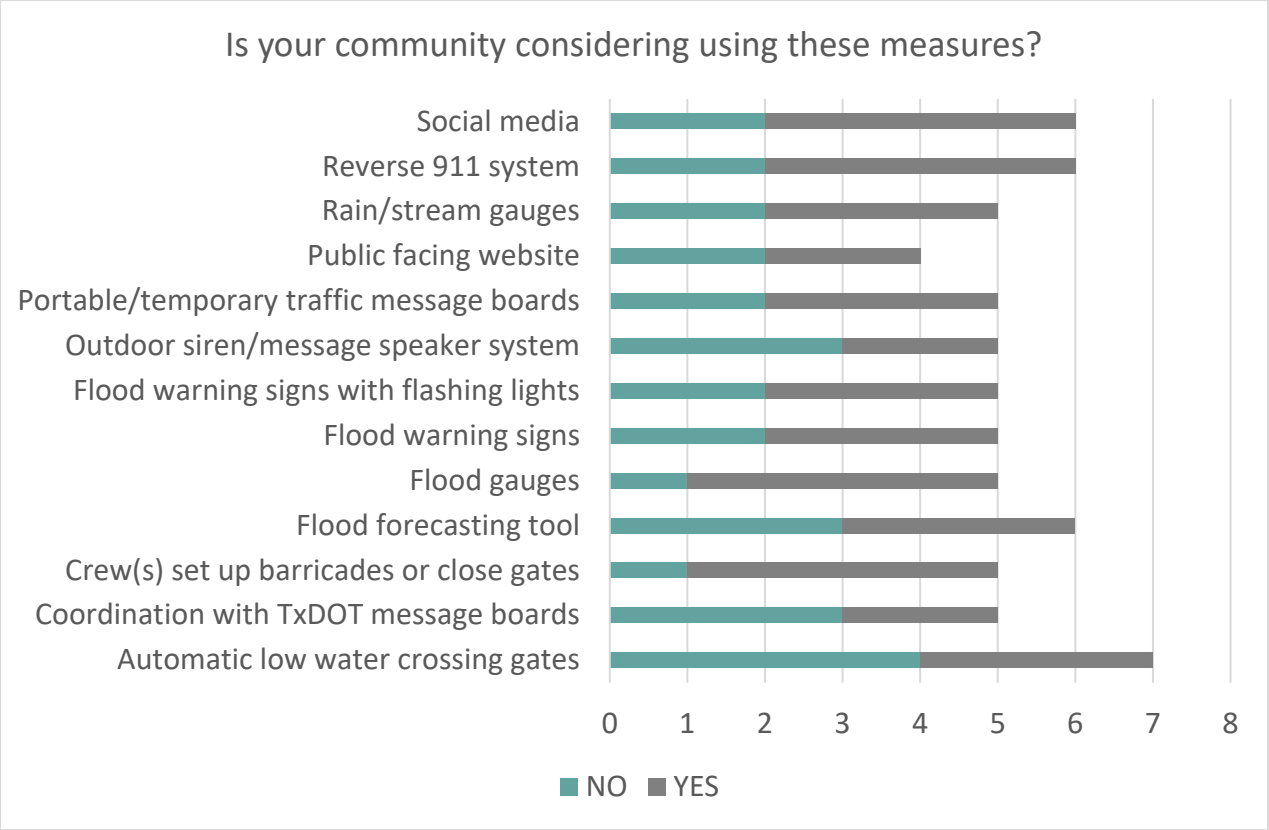


Figure 7-3: Flood Response Measures Communities are Considering

Source: Region 11 Sponsor Questionnaire

Figure 7-4: Community Participation in Flood Management Activities

Source: Region 11 Data Collection Tool as of May 27, 2022

Survey respondents indicated that specific activities have already been in place to address flooding concerns in their jurisdiction, including performing existing drainage system maintenance and implementation and enforcement of drainage design criteria/floodplain management policies.

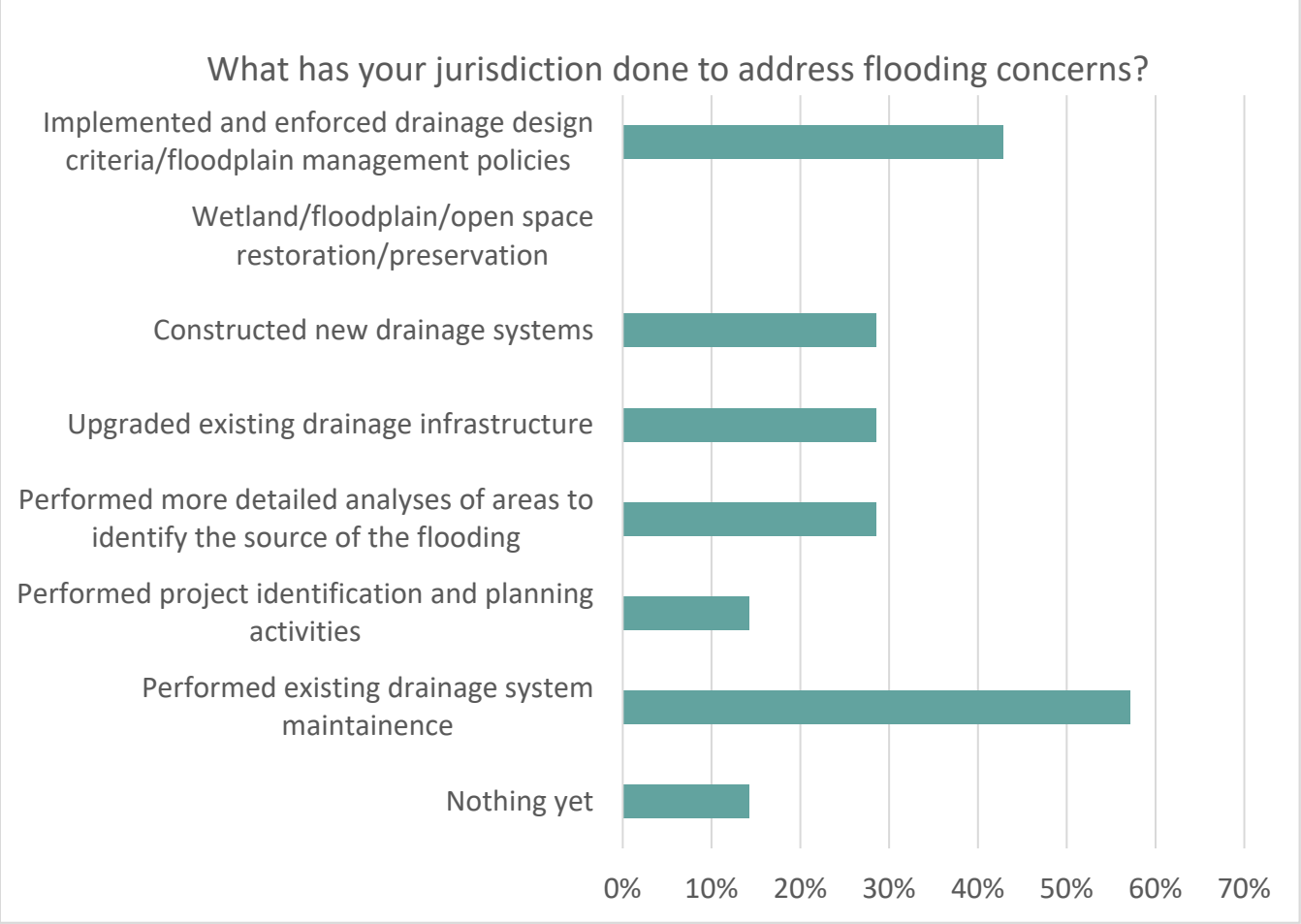


Figure 7-5: Flooding Concerns

Source: Region 11 Data Collection Tool as of May 27, 2022

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

7.3 Relevant Entities in the Region

The purpose of flood risk management is to help prevent or reduce flood risk. Responsibility for flood risk management is shared between federal, state, and local government agencies; private-sector stakeholders; and the public. Listed below are the various contributing entities and partners who play significant roles in flood risk management.

The Texas A&M AgriLife Extension employs agricultural agents in each county throughout Texas, who serve as an expert or teacher on the topic of agriculture. Agents can provide valuable information on preparation and recovery from flood events specific to agricultural entities. The Guadalupe FPR has a significant agricultural footprint making working closely with agricultural extension agents crucial to prevent losses.

Municipalities and counties are generally responsible for local response, recovery, and preparedness for flood disasters within their jurisdictions. Emergency management operations will need the support of many of the departments within the jurisdictions including, but not limited to emergency responders, public works officials, road and maintenance crews, and city officials. Typical response activities for cities include the work of emergency responders to perform rescues during events. Public Works departments manage utilities including operating back-up generators for water and sewer plants. Road and maintenance crews monitor road conditions and close roadways to prevent vehicles from entering high water. City officials also update their citizens through social media posts and public alerts before, during and after events. During flood events, counties will provide the public with critical information, close flooded roadways, perform high water rescues, and coordinate emergency operations. In the aftermath of a flood event, cities and counties coordinate to provide recovery services for residents including but not limited to debris clean up, providing vital resources such as fresh water, medical care, and shelter, issuing permits for the repair of flooded properties, and local infrastructure repair or improvements to mitigate future risk. Cities and counties can provide long-term resiliency through the successful implementation of mitigation projects to reduce the impact of future floods.

Council of Governments, regional councils or commissions are voluntary associations that represent member local governments codified pursuant to the Texas Local Government Code, Chapter 391. There are 24 regional councils in Texas that represent all 254 counties. The following COGs represent the Guadalupe FPG area: Alamo Area, Capital Area, Coastal Bend, Golden Crescent and the Middle Rio Grande. The COGs are focused on providing community services, cooperative planning, coordination, and technical assistance on a regional scale. COGs can serve as a resource for flood data, flood planning, and flood management. In addition, COGs are an eligible entity to apply as the designated grantee regarding federal and state funds. When recovering from a flood event, COGs can serve as a valuable resource by providing information, services, and toolkits for residents. COGs facilitate recovery through public engagement and community outreach, the planning of and implementation of regional infrastructure projects, and the development of plans to aid in recovery and resilience.

TWDB provides water and flood planning, data collection, flood mapping and dissemination, financial assistance, technical assistance services and training to the citizens and communities of Texas. TWDB financial assistance offers a variety of options to meet a community's needs. The financial assistance is in the form of grant programs, including administering FEMA's Flood Mitigation Assistance program, and cost- effective loan programs to aid in preparedness, response, recovery, and mitigation efforts.

FEMA has many functions in the support of planning and disaster recovery efforts at the Federal level. The agency works closely with States to provide state and local governments with resources, experts, funding and policies to help mitigate and rebuild before and after a disaster to reduce the loss of life and infrastructure. FEMA's Mitigation division has several grant

programs that are categorized by what type of project a community is applying for funds. These funds are used for:

- rebuilding after a disaster
- reducing risk prior to a disaster
- reducing risk of flood damage
- building resiliency after a wildfire

Additionally, FEMA manages the National Flood Insurance Program (NFIP) which enables homeowners, business owners and renters to purchase federally backed flood insurance in communities who participate in the NFIP.

The United States Department of Agriculture (USDA)'s Natural Resources Conservation Service (NRCS) program provides financial assistance, technical assistance and incentives for easements to farmers and ranchers, local and state governments, and other federal agencies to maintain and improve their land.

The NCRS administers the Watershed Protection and Flood Prevention Operations Program was established to assist federal, state, local and tribal governments to protect and restore watersheds up to 250,000 acres. This program provides financial and technical assistance for planning and implementing watershed projects.

Flood Control Districts were created by the Texas Legislature to reduce the effects of flooding and is governed by County Commissioners Court. This is done by developing and implementing flood reduction plans and maintaining the districts infrastructure. There are 14 Flood Control Districts in the region that provide flood control.

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.

Daily river forecasts are issued by the West Gulf River Forecast Center through the National Weather Service using hydrologic models based on rainfall, soil characteristics, precipitation forecasts, and several other variables. Forecasts are used by a wide range of entities, including but not limited to those in agriculture, hydroelectric dam operation, and water supply resources. The forecasts can provide essential information on the river levels and conditions.

Wireless Emergency Alerts (WEAs) can be sent out by the National Weather Service via cell phone towers to provide short emergency messages to alert locals of emergency situations in their area.

The National Oceanic and Atmospheric Administration (NOAA) is a scientific and regulatory agency that is staffed with expertise to provide resources and information to local communities including planners, emergency managers, and citizens. These resources include weather

forecasts, severe storm warnings and climate monitoring. In addition, NOAA's National Center for Environmental Information (NCEI) is a major resource for communities in regard to historical weather data. This data is beneficial to communities in determining their future probability of flood events and is key in the planning and mitigation process. NOAA's Office of Coastal Management plays a key role in providing information, technology, and flood management strategies.

The General Land Office (GLO) administers Community Development Block Grant Disaster Recovery (CDBG-DR) and Mitigation (CDBG-MIT) funds from the U.S. Department of Housing and Urban Development (HUD) through its Community Development and Revitalization division. These funds are used in rebuilding or restoring critical infrastructure and mitigating future damages. These funds are key elements in recovery and mitigation in the Guadalupe FPR.

River Authorities or Districts are public agencies established by the state legislature to conserve and manage the distribution of water. Guadalupe has five River Authorities within its region that each have the power to protect, maintain, control, conserve, employ, and allocate the waters of a specific geographical area for the public.

The Texas Division of Emergency Management (TDEM), is responsible for the emergency management at the State level and to assist local jurisdictions in the recovery, rebuilding and future mitigation efforts to reduce the loss of life and property. This is done through training exercise, planning, and funding programs at both the recovery and mitigation stages of a disaster.

There are six TDEM regions throughout Texas to carry out the agency mission by providing technical assistance, planning, deployments of staff and resources. Additionally, TDEM manages the Hazard Mitigation Grant Program (HMGP) and Building Resilient Infrastructure and Communities (BRIC) FEMA grant programs. The Guadalupe FPR is completely within TDEM's Region 6.

The Texas Department of Transportation's (TxDOT) primary responsibility is the construction and maintenance of the state's highway system. TxDOT can provide real time road closure and low water crossing information during and after a flood event. Users can access this data through TxDOT's Drive Texas website: https://drivetexas.org.

Texas Public Works Emergency Response Council was established to promote and provide support for Public Works Agencies. The Council provides mutual aid assistance and trainings has created a statewide database of response.

The U.S. Army Corps of Engineers (USACE) offers many services through their programs. One is to reduce disaster risk by oversite of infrastructure programs such as construction and maintenance of dams, reservoirs and flood control projects. The Guadalupe FPR is within

several Districts of the USACE's Southwestern Division: the Galveston District and the Fort Worth District.

The USACE Flood Risk Management Program (FRMP) works across the agency regarding policies, programs, and expertise concerning the reduction of flood risk. The program was established to set the national flood risk management vision and to communicate the vision to federal, state and local levels of government.

In the planning process it is important to consider flood planning in preparation, during, and following a flood event to access the entities that provide the respondents with the most assistance and support. Of the entities we received survey data from, the top entities in which coordination was indicated as key were the County and the City with all other entities accounting for much smaller responses.

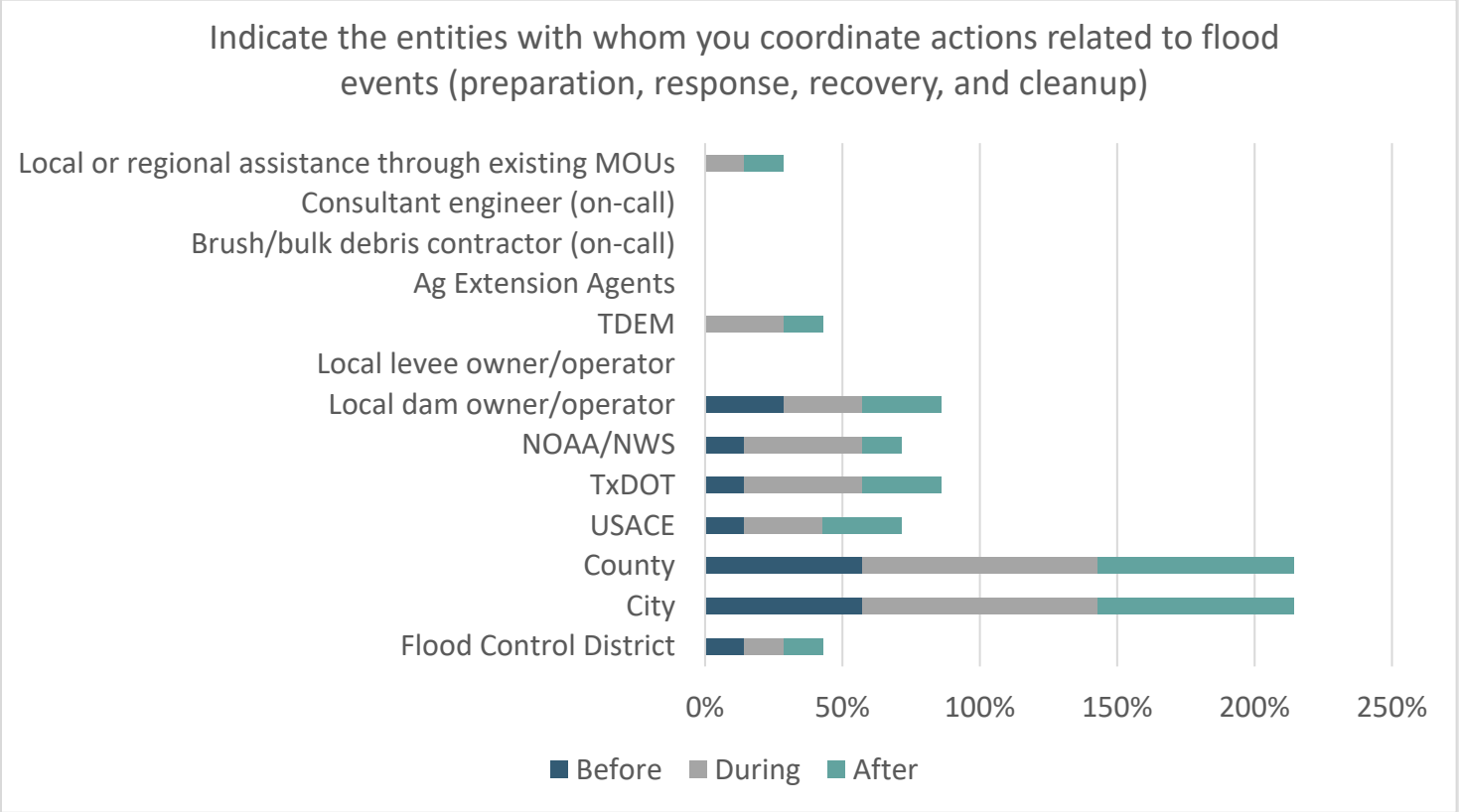


Figure 7-6: Coordination with Entities

Source: Region 11 Data Collection Tool as of May 27, 2022

7.4 Emergency Information

There are various means by which data can be collected and disseminated during a flooding event. These can range from physical collection devices (gauges), public announcements, and alert systems.

Two types of collection devices that are communally used are rain and stream gauges. A rain gauge is an instrument to measure rain fall depth over time, while a stream gauging station is used to measure the discharge, or the volume of water moving through a stream at a given period.

Stream gauging station data for the Guadalupe River basin can be accessed through the United States Geological survey website: www.waterdata.usgs/TX/nwis/current. This site has real-time stream flow data to use in determining possible flood conditions.

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 issue flood watches, warnings, and emergency notifications.

An Emergency Alert System (EAS) is type of software that provides alert messages during an emergency, interrupting radio and television programming to broadcast emergency alert information by the President within 10 minutes.

A reverse 911 system allows an agency to pull up a map on a computer, define an area and send off a recorded phone message to each business or residence in that area. It can provide data to residents of flood dangers in their area.

School emergency alert systems are tools that allow schools to communicate quickly to staff, students, first responders and others so that they can take appropriate action in the event of an emergency. Various versions of this tool are used in schools throughout the region from daycares to K-12 grade, as well as universities. Messages may include important announcements about school events or emergency situations, such as inclement weather and local flooding.

7.5 Plans to be Considered

7.5.1 State and Regional Plans

The State Hazard Mitigation Plan is an effective instrument to reduce 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 affecting Texas as determined by frequency of event, economic impact, deaths and injuries. The plan:

- Assesses hazard risk.
- Reviews current state and local hazard mitigation

- Develops strategies and identifies state agency (and other entities) potential actions to address needs.

7.5.2 Local Plans

In the Guadalupe FPR's data collection effort and survey tool 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 consumption.

As indicated in **Chapter 1**, The Guadalupe FPR has several plans and regulations in place region wide that provide the framework that dictates a community's capabilities in implementing mitigation and preparedness actions. The plans include Hazard Mitigation Plans, Emergency Action Plans, as well as Watershed Master Plans.

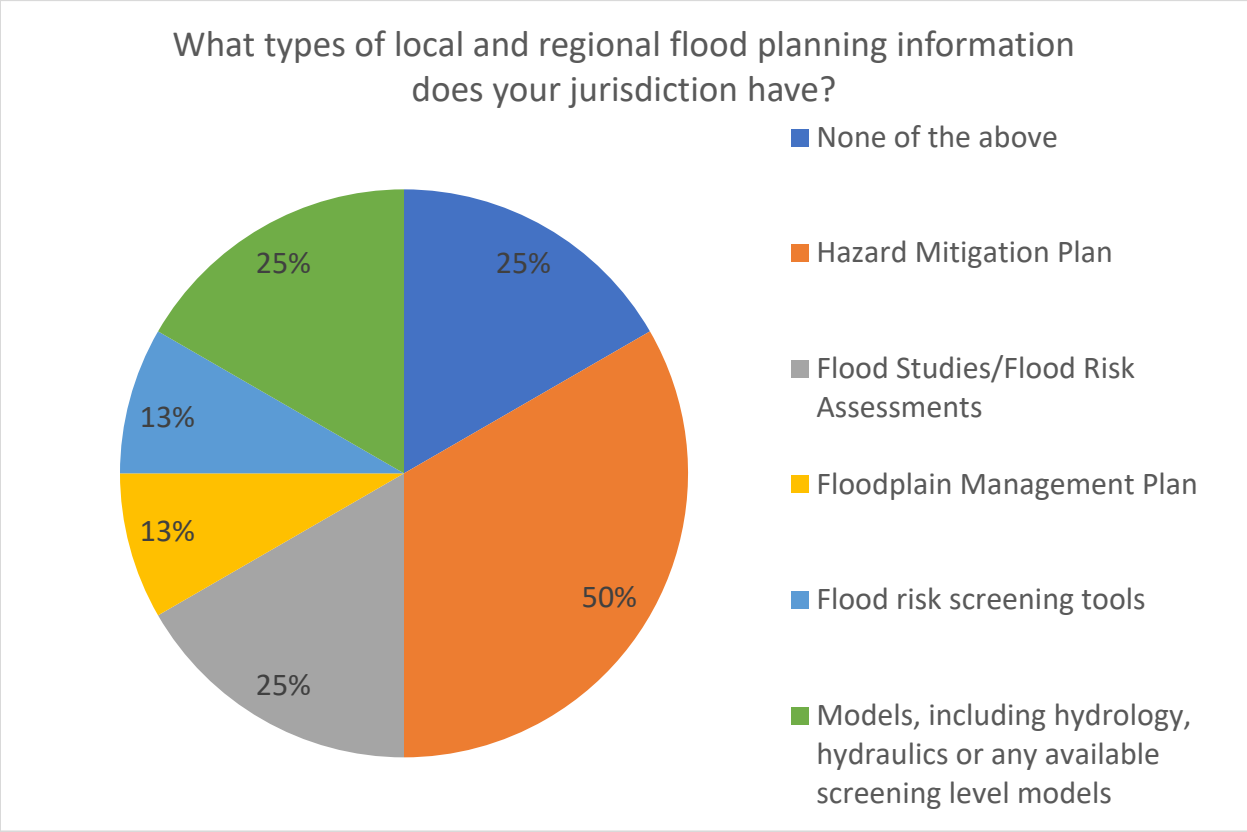


Figure 7-7: Flood Planning Resources

Source: Region 11 Data Collection Tool as of May 27, 2022

Table 7-1: Current Flood Plans and Regulations

Plan or Regulation	Total
Floodplain Ordinance	86
Drainage Ordinance	29
Stormwater Management Ordinance	43
Building Standards for Flood Proofing and Flood Protection	29
Future Conditions Land Use	57
Land Use Regulations	29

Source: Region 11 Data Collection Tool as of May 27, 2022

Hazard mitigation planning reduces loss of life and property by minimizing the impact of disasters. It begins with state, tribal, and local governments identifying natural disaster risks and vulnerabilities that are common in their area and developing long-term strategies to reduce those risks. Mitigation plans are key to breaking the cycle of disaster damage and reconstruction. Of the counties that have had a Hazard Mitigation Plan, only 14 out of 22 county plans are currently approved by FEMA, as they are to be updated on a five-year cycle. Three counties (Bastrop, Kendall, and Travis) are in the process of having their plans updated. Having an up to date HMP is key in assessing risk and in developing mitigation actions.

Emergency action plans (EAP) are developed to document processes and actions to be taken in response to potential events such as major floods to minimize damage to property or life as well as impacts to critical service. EAPs identify actions and responsible parties that can be taken in the lead up to an event (preparedness), emergency response during the event, and recovery actions after an event.

A watershed master plan is essentially a decision-making tool for communities. These plans typically evaluate the existing and expected (often based on future land use maps) flood, erosion, and water quality issues within a watershed and develop conceptual or preliminary mitigation actions to address those problems. The results of watershed plans are used to develop capital improvement to reduce existing flood risk. Watershed plans can also be used to educate and inform the public and community leaders regarding the impacts of land use changes and/or potential modifications to development regulations to reduce future flood risk.

The Guadalupe FPR's ability to prepare, respond, recover, and mitigate disaster events is determined by several factors. With a clear understanding of the plans that determine a community's capabilities, a recognition of the entities with whom coordination is key, and knowledge of the actions sustained to promote resiliency, the Guadalupe FPR can be better equipped to implement sound measures for flood mitigation and preparedness.

Chapter 8: Legislative, Administrative, and Regulatory Recommendations

As guided by TWDB rules for regional flood planning, the Regional Flood Planning Groups may adopt recommendations on policy issues related to floodplain management and flood mitigation planning and implementation. Specifically, the RFPGs may adopt:

1. Legislative recommendations considered necessary to facilitate floodplain management and flood mitigation planning and implementation.
2. Other regulatory or administrative recommendations considered necessary to facilitate floodplain management and flood mitigation planning and implementation.
3. Any other recommendations that the RFPG believes are needed and desirable to achieve its regional flood mitigation and floodplain management goals.
4. 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 levels and may include suggested changes to the flood planning process for TWDB to consider in the next regional and state flood planning cycle.

Legislative, regulatory, and administrative recommendations adopted by the Guadalupe Regional Flood Planning Group (RFPG) follow. The associated TWDB guidance principles found in TWDB Exhibit C, Part 3.1, are linked with the recommendations to underscore alliance with the over-arching flood planning goals.

8.1 Legislative Recommendations

Table 8-1 below presents recommendations related to flood planning, flood risk mitigation, and funding adopted by the Guadalupe RFPG that will require legislative action.

Table 8-1: Legislative Recommendations

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.1.1	**Continue recurring biennial appropriations to Flood Infrastructure Fund (FIF)** for Study,	The FIF allocations provide local governments with funding to develop and implement flood management projects. Continuing this effort will further enhance public safety and help	3, 13, 14, 16

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
	Strategy, and Project implementation.	achieve the Regional Flood Plan and State Flood Plan goals of reducing the risk and impact to life and property.	
8.1.2	**State adoption of higher flood standards,** for example, establish a minimum floor elevation two feet above the base flood elevation to account for potential changes in future rainfall depths and flood elevations. Enact legislation updating the state building code to a more recent edition (e.g., the 2018 edition of the International Building Code and International Residential Code).	Establishing higher standards such as freeboard, development outside the floodplain, etc. helps prevent an increase in flood problems and provides public safety benefits. Without a current mandatory state building code, local entities in Texas do not qualify for some, or are at a disadvantage for, federal funding programs such as FEMA's Building Resilient Infrastructure and Communities (BRIC) Grant. Statewide standards will lead to consistent development standards so that new development/commercial/industrial projects cannot seek communities with fewer restrictions to implement their projects.	2, 5, 8, 13, 14
8.1.3	**Promote, develop and allocate State funding to assist dam owners** (public and private) with the costs associated with repair and maintenance of dams	There are thousands of dams in Texas, many are not regulated by the dam safety program. With Atlas 14 signaling larger rainfall events since dam completion, developing a prioritization system and providing funding for dam repairs is important in protecting downstream life and property.	14, 16, 22
8.1.4	**Expand the ongoing program and funding to enhance flood early warning system implementation** on a regional basis (especially in rural areas)	Flood early warning systems can play an important role in notifying residents and business owners of impending flooding and the need for evacuation and/or implementing floodproofing measures. Expanding funding for flood early warning systems serves an important public safety function and can be coordinated across a watershed with multiple local governments	14, 16, 22

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.1.5	**Provide guidance and funding for "buy out" programs to remove repetitive loss structures and potentially convert flood prone neighborhoods into green space/parkland** as an alternative to large-scale construction projects. Importantly, funding should consider factors other than benefit-to-cost ratio (BCR). Funding should continue and be expanded for both pre- and post-disaster buyout programs.	Repetitive loss neighborhoods are often located in low lying areas that are difficult to remove from the floodplain (high water areas). Providing funding to buy-out neighborhoods can eliminate the flood risk to residents and result in the creation of green space and parkland for the larger community to enjoy. By avoiding project implementation within the waterway, habitat and ecological systems can be preserved. At the same time, there is not the need for long-term project operations and maintenance requirements. Property values in potential buy out areas often make it difficult to achieve a BCR of 1.0; therefore, equitable funding selection and approval should consider factors – especially future risk reduction.	14, 16, 17, 23, 39
8.1.6	**Continue and expand funding to improve safety at low water crossings through structural improvements and/or flood warning systems or other enhanced safety measures.**	There are an estimated 661 low-water roadway crossings (LWC) within Region 11. Low water crossings are defined as crossings experiencing swift water flow conditions, not standing water from poorly functioning storm drain systems. Many of the LWCs experience frequent flooding but may have minor flood risk, in terms of public safety due to low traffic levels. Enhanced funding should prioritize low water crossing improvements based on traffic counts, type of roadway, existing level of risk (storm event) and the potential to use signage, reverse 911 notifications, and/or gates to minimize structural improvements to stretch financial resources. This program could be implemented by TXDOT, TXDEM, and/or TWDB singly or in collaboration with one	14, 16, 22

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
		another and local governmental agencies. This recommendation aligns with the goal recommendation in **Chapter 3**.	
8.1.7	**Provide counties with the authority to require commercial outfitters, landowners, and parks to safely park recreational vehicles and recreational equipment outside of the floodplain.** Develop and promote educational materials such as flood warning or evacuation planning to help guide businesses and parks.	Recreational vehicles (single chassis, >400 square feet, designed as temporary living quarters) and equipment, canoes, tables, chairs, tents, trailers, concession stands, and other similar equipment in the floodplain can impede flows and increase floodplain elevations. During flooding, these items can be swept downstream and pose safety and floodplain issues to downstream landowners.	14, 16, 28
8.1.8	**Provide funding to increase the number of conservation easements for riparian areas** and land in the 100-year floodplains.	Acquiring known flood prone areas can preserve natural storage to maintain existing floodplain conditions and can prevent development in the floodplain.	7, 10, 24, 27, 36, 39
8.1.9	**Modify the enabling legislation for Green DeWitt Drainage District** to allow them expand to watershed boundaries rather than political (Municipal or County) boundaries.	The Green DeWitt Drainage District's jurisdictional boundary does not include properties upstream of the City of Cuero. Approximately 67% of the local watershed is located upstream of the district and, although the district must deal with the resulting runoff, they do not have any ability to regulate development. Other states and jurisdictions recognize these challenges/limits and use watershed boundaries when establishing drainage districts.	1, 6, 7, 10, 14, 16, 23, 26, 32

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.1.10	Modify CDBG-MIT funding rules to eliminate the need for an eligible recipient to sign a waiver to allow funding to pass down to sub-recipients if those sub-recipients are also eligible for funding.	The full suite of funding opportunities should be as accessible as possible to those entities eligible for the funding.	1, 14, 16, 26, 38
8.1.11	**Clarify existing legislation** (perhaps through issuing guidance or administrative rule) that provides counties the authority to regulate floodplains to regulate floodplains including development of land use plans and regulatory authorities such as permitting.	State legislation was amended in 1999 to require all cities and counties to adopt ordinances or orders to become eligible to participate in the NFIP. **The existing legislation gave Counties the ability to regulate floodplains but interpretation varies widely.** The legislative bill lacks implementation guidance in the form of administrative rules.	20, 32

8.2 Administrative Recommendations

Other flood-related policy recommendations will not require legislative action but could be addressed through administrative actions, existing authority, and implemented with existing and/or increased state agency resources. **Table 8-2** presents administrative recommendations adopted by the Guadalupe RFPG.

Table 8-2: Administrative Recommendations

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.2.1	**Develop model ordinances for general law cities** (building codes, Low Impact Design/Development,	TWDB, FEMA, state agencies, and other organizations (TFMA) support professional education, training, and technical assistance programs. Programs can be crafted to include model	6, 7, 8, 20

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
	Green Infrastructure, other)	ordinances that illustrate the value of enhanced standards, criteria, and regulations (stormwater detention, buffer zones, etc.) to minimize development in the floodplain and protect existing downstream property owners from unmanaged development.	
8.2.2	**Continue and expand funding to support ongoing education/ training regarding floodplain management**	TWDB, FEMA, TFMA, and other organizations provide professional education, training, and technical assistance programs. The audience for these programs is typically local officials, elected and professional, that may not be experienced in floodplain managed practices. This training and support can assist local governments in implementing higher standards for existing and new development. Education and outreach information can also be shared with the community to underscore the importance of avoiding/not driving through low water crossings during flood events.	6, 7, 10, 17, 27, 36, 39
8.2.3	**Modify the selection process for flood projects** so that project selection is not scored or awarded only on a traditional benefit-cost ratio	Applied benefit-cost analysis methods incentivize the protection of high-value public and private assets usually found in urbanized areas. The project funding/scoring systems should be modified to consider factors beyond benefit-cost analysis including social vulnerability, environmental, public health, and habitat benefits.	16, 17, 24, 27
8.2.4	**Continue and increase funding and/or technical assistance to develop updated floodplain maps**	There are many local governments in Region 11 that lack floodplain maps or are using outdated maps. Accurate floodplain models and maps are necessary to manage existing and new development to minimize flood risk. The State should continue the BLE program	4, 7

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
		and continue funding/support to local governments to allow them to update their maps to FEMA standards. At the same time, the State should encourage the delineation of anticipated future development floodplain maps.	
8.2.5	**Develop a statewide database and tracking system to document flood-related fatalities** and provide a public website/dashboard that conveys map-based statistical information regarding these fatalities	The development of a database/website/dashboard will identify dangerous areas and low water crossings that can be prioritized for future projects. This can be incorporated into project scoring systems in pursuit of FIF and other funds.	1, 13
8.2.6	**Continue and increase funding for stream monitoring at high-risk flood prone areas.**	Flood early warning systems are effective tools to warn residents of approaching high water using social media, radio, and reverse 911 notifications. TWDB and other entities could implement programs in at-risk regions and/or enhance/expand current systems to provide a broader range of coverage.	14, 16, 22
8.2.7	**Provide incentives to local governments to participate in the FEMA Community Rating System (CRS) program.**	The CRS can be an effective program to implement flood management and mitigation measures in a community while reducing flood insurance premiums. However, there is a cost to local government to implement and operate a CRS system, often, requiring staff. The State could provide funding or other incentives (higher priority FIF project ranking, etc.) to help local governments establish programs.	6, 7, 17, 23, 24
8.2.8	**TWDB, TFMA, river authorities, and local governments should provide Green**	TWDB, TFMA, and others can fund/host workshops to inform local governments, engineers, and elected officials of the potential value of flood mitigation	17, 18, 24, 36, 37, 39

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
	Infrastructure training to agencies, local governments, engineers, planners and encourage this practice in flood mitigation efforts.	through green infrastructure including social, economic, and environmental benefits. There could be different training levels and toolboxes to move from informational to design and operations and maintenance guidance for engineers. By implementing green infrastructure, ecological and habitat benefits are accrued while mitigating flooding on downstream landowners that can occur from typical conventional projects (culverts, concrete channels, storm drain systems, etc.)	
8.2.9	**TWDB Flood Infrastructure Fund (FIF) project selection process should place additional emphasis on social vulnerability, sustainability, environmental resilience, etc**. in addition to benefit cost analysis to guide the funding and implementation of multi-dimensional projects that can provide water supply and other benefits beyond flood mitigation.	In the first round of funding from the Flood Infrastructure Fund, TWDB requested information about social vulnerability, socioeconomic attributes of the populations of areas for which funding is being sought, and green/natured based approaches in addition to benefit cost analysis There is an opportunity to emphasize these projects aspects so that communities can receive multiple benefits from a project, not just a one-dimensional flood mitigation improvement that is primarily based on avoidance of flood losses to property and the value of constructed/acquired improvements.	12, 17, 27, 28
8.2.10	**TWDB/TFMA or others should develop a riparian management guidance document that addresses vegetation management purpose, timing, and location**	Management of vegetation is balancing act for many communities. Mechanical removal of vegetation and trees can create a riparian zone susceptible to erosion. Native vegetation can reduce the need for maintenance while slowing floodwaters and increasing floodplain	15, 16, 20

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
	within the floodplain and floodway	storage thus helping to manage downstream flood levels. Similarly, lack of vegetative management, especially in engineered channels and where non-native vegetation is present can result in a loss of function/conveyance that may result in upstream flooding. Development of a vegetation management guidance document is essential to assist landowners and local governments find a balance in vegetation management.	
8.2.11	**Encourage cities and counties to exercise their existing authority to manage new and existing development, and fund projects to mitigate existing flooding.**	Cities and Counties have floodplain management responsibilities and existing authority that can be used to enhance their role in floodplain management and mitigation. This effort could be coupled with education of officials and floodplain administrators to make them aware of existing authority (TFMA/TWDB)	20, 32
8.2.12	**Encourage communities to work together to enhance program/project efforts to improve funding and implementation opportunities**	Flooding occurs within watersheds that may span multiple jurisdictions. Encourage cooperation and coordination with other local governments, regional entities, and state agencies to enhance flood mitigation and floodplain management (preventing the creation of additional flood risk in the future). 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 for regional projects TWDB, GLO, and other agency project evaluation processes. Another is the creation of regional drainage districts.	29, 33

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.2.13	**TWDB should work with FEMA and other regulatory agencies to develop a more effective way to measure/calculate flood damages including the number of structures, and financial cost of damages.**	FEMA is one agency that provides data on flooding to include, among many other things, the number of homes and businesses flooded and the total cost of the flood damage. FEMA uses the number of Flood Insurance Claims filed as an indicator of the number of homes and businesses flooded. Other agencies use those numbers to evaluate the severity of an event to a particular location. These data are used in evaluating applicants for grants to be used to mitigate flood damages. However, as reasonable as this might seem, it is not accurate and penalizes the most needy. For example, during one flood event in Cuero, Texas there was one reported insurance claim although there were over 250 flooded homes. Because FEMA only reported one home flooded, funds to assist were denied. The truth was the families in the other homes were not wealthy enough to afford flood insurance, or the damage was not enough to sufficiently exceed the insurance deductible to go through the effort of filing a claim. These homes and businesses were left out of the data, both as to being flooded and as to the total cost of the event, as a result.	3, 6, 13, 26, 29, 32, 35

8.3 Regulatory Recommendations

Other flood-related policy issues may need to be addressed through regulatory actions adopted by the State. **Table 8-3** presents regulatory recommendations adopted by the Guadalupe RFPG.

Table 8-3: Regulatory Recommendations

ID Number	Recommendation	Rationale	Associated TWDB Guiding Principles
8.3.1	**TxDOT design criteria should include stormwater detention requirements to not increase downstream flooding from new highway projects**	TXDOT should take a leadership role in flood management/stormwater detention to strive to meet this standard for public safety and risk reduction. It is recognized it may not be feasible in all cases, however, TXDOT can initiate a policy with this goal that could trickle down to counties and local governments to encourage them to do the same as many local governments use TxDOT design guidelines	10, 14, 16, 26
8.3.2	**Statewide detention and/or verification of no downstream impact** from new development for design storms ranging from the 2-year to the 100-year storm	Prevent downstream landowners from experiencing more frequent and severe flooding from upstream development to protect their property from excessive erosion and property loss. This also protects downstream infrastructure from being adversely impacted (washed away utilities, bridge/culvert failures, increased low water crossing risk). This recommendation directly complies with the Regional Flood Plan goal of eliminating the increase of additional flooding.	10, 16, 20, 28, 29, 39
8.3.3	**State should provide guidance and/or authority to local governments to manage proposed RV parks in the floodplain**	RV parks are a unique development practice that can avoid most local government regulations. By providing standards, local governments will have the authority to prevent the practice of placing structures and other features in the floodplain that can be swept away in flooding events, posing flood and safety risks to adjacent and downstream residents.	14, 16, 28

8.4 Flood Planning Process Recommendations

Regional Water Planning (RWP) and Regional Flood Planning (RFP) serve separate and distinct purposes; however, there is value and potential mutual benefits, to coordination and information sharing between planning groups, sponsors, and consultants. Through coordination and integrated water resources management planning, future projects included in RFPs may benefit water supplies and vice versa. Combining functions in future projects could also increase opportunities for additional funding. For example, nature-based practices are not currently eligible for SWIFT funding, but they can enhance aquifer/ground water recharge and stream flow, making water available for potable use through water conservation and flood mitigation strategies.

To avoid the processes from becoming too encumbering they should remain separate, but TWDB should require RWPs to include a strategy aimed at identifying opportunities to combine projects or functions (where they make sense) with the RFPs to mitigate flood risk. This would align with RFPs considering potential contributions and impacts to water supply as discussed in Chapter 6.

Chapter 9: Flood Infrastructure Financing Analysis

The Texas Water Development Board (TWDB) requires that each regional flood planning group (RFPG) assess and report on how Sponsors propose to finance recommended FMEs, FMSs, and FMPs. A primary aim of this survey effort is to understand the funding needs of local Sponsors and propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs.

Section 9.1 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 9.2**.

9.1 Sources of Funding for Flood Management Activities

Communities across the state utilize a variety of funding sources for their flood management efforts, including local, state, and federal sources. This section discusses some of the most common avenues of generating local funding and various state and federal financial assistance programs available to communities. **Table 9-1** on the following page summarizes the local, state, and federal sources discussed in this chapter, and characterizes each by the following three key parameters: first, which state and federal agencies are involved, if applicable; second, whether they offer grants, loans, or both; and third, whether they are classified as regularly occurring opportunities or are only available after a disaster.

9.1.1 Local Funding

Through the RFPG's initial stakeholder outreach efforts, the Guadalupe RFPG sought to understand the landscape of local funding for flood efforts in the basin. Response rates were low for these efforts but of those that did respond, 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 and 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 this Chapter.

A community's general fund revenue (for cities or counties) 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 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 (HHPD)**	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		TWDB	**Flood Infrastructure Fund (FIF)**	G	L	
		TWDB	**Texas Water Development Fund (Dfund)**		L	
		TSSWCB	**Structural Dam Repair Grant Program**	G		
		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. To provide these services, municipalities assess fees from users of the stormwater utility system. Impact fees, which are collected from development to cover a portion of the expense to expand storm water systems necessitated by the new development, 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, 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), 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 raising 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 raising 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.

9.1.2 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: 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 nonstructural projects, planning studies, and preparedness efforts such as flood early warning systems. 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 in this regional flood plan will be included in the overall state flood plan and will thus be eligible for this funding source.

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 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 (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 percent of the cost of an eligible operation and maintenance activity as defined by the program rules; the remaining 10 percent 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 percent 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.

9.1.3 Federal Funding

Federal funding currently accounts for a large share of total available funding for flood projects throughout the state, with federal funding programs having greater access and availability to large funding amounts from the federal government appropriated by Congress. Commonly utilized funding programs administered by seven different federal agencies are discussed in this section. The funding for these programs originates from the federal government but for many of the programs, a state agency partner plays a key role in the management of the program. Each funding program has its own unique eligible applicants, eligible project types, requirements, and application and award timelines. A few examples of eligibility requirements for some of the federal grant programs are requiring recipients of funding to participate in the

National Flood Insurance Program (NFIP), requiring recipients to have an approved Hazard Mitigation Plan, or requiring a project to have a benefit cost ratio of 1.0 or greater. More information regarding each program and their unique eligibility requirements and award processes can be found at the links in this section.

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 (FMA) is a nationally competitive annual grant program that provides funding to states, local communities, federally recognized tribes, and territories. FMA is administered in Texas by 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 percent federal grant with a 25 percent local match. Projects mitigating repetitive loss and severe repetitive loss properties may be funded through a 90 percent federal grant and 100 percent 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.

The Building Resilient Infrastructure and Communities (BRIC) is a new nationally competitive non-disaster annual 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 percent federal grant with a 25 percent local match. Small, impoverished communities may be funded through a 90 percent federal grant and 100 percent 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 percent 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 percent federal grant with a 25 percent 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 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 percent federal grant (25 percent local match) and typically not more than 90 percent federal grant (10 percent 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 partnership agreement. Working with the FEMA regions, a program participant can develop business plans and apply for grants to perform eligible activities.

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 percent

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 with typically 100% grants. 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 to small, rural cities and counties to help communities grow by providing housing and expanding economic opportunities. 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).

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, including Floodplain Management Services and the Planning Assistance to States program, available to local communities.

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 TWDB.

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; to prevent erosion, floodwater, and sediment damage; to further the conservation development, use and disposal of water; and to further 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 to 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.

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. Communities have significant flexibility to meet local needs within the eligible use categories, one of which includes improving stormwater facilities and infrastructure as an authorized use. Eligible entities may request their allocation of Coronavirus State and Local Fiscal Recovery Funds directly from the U.S. Department of Treasury.

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, including several of the flood funding programs discussed herein, as well as creating new programs.

9.1.4 Barriers to Funding

Local communities encounter 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. 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.

9.2 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 mailed survey or other means of collecting 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. For the Guadalupe FPR, a first round of targeted outreach via phone calls and emails to Sponsors gathered preliminary information on funding needs for recommended FMEs, FMSs, and FMPs. To garner additional responses, a follow-up survey via email was also sent to Sponsors.

A total of 54 Sponsors of recommended FMEs, FMSs, and FMPs with capital costs identified were contacted via email and, in some cases, follow up phone calls, and 12 responded. This represents a response rate of 22% percent. **Appendix 9-A** presents the results of the survey for each FME, FMS, and FMP in **Table 19**. The response rate for the survey was relatively low and therefore does not accurately represent the total need for state and federal funding in the Guadalupe FPR. To assess the remaining need, it was estimated that 90% of total project costs are required from state and federal sources for those actions where the Sponsor did not respond to the survey. This represents an average of 10% projected local investment in projects. A high percentage of outside need is supported by the initial stakeholder outreach discussed in **Section 9.1.1**, which confirmed that many communities, particularly smaller and more rural communities, do not have any local funding available for flood management activities. Those communities that did report having local funding indicated relatively little local funding available in relation to overall need.

Overall, there is an estimated $802,506,951 required to implement the recommended FMEs, FMSs, and FMPs in this regional flood plan. Of that amount, approximately $717,406,571 in state and federal funding is projected to be needed (89.4%) based on the survey results and estimates of remaining needs. Since most federal funding programs are dependent on availability or on project selection in a nationally competitive grant program, it is difficult to estimate how much federal funding may be available to implement these studies, strategies, and projects. It is conservatively estimated that as much as the full amount may be needed from state sources. 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 Guadalupe FPR. **Chapter 8** presents legislative, administrative, and regulatory recommendations that the Guadalupe RFPG considers necessary to facilitate floodplain management and flood mitigation planning and implementation, including recommendations regarding the need for additional funding for flood projects and studies. Overall, a combination of increased local capabilities to self-fund flood-related activities and projects and increased funding from state and federal sources are needed to address the flood risk reduction needs identified through this regional planning process and documented in this plan.

Chapter 10: Public Outreach and Involvement

10.1 Overview

The Guadalupe Regional Flood Planning Group (RFPG) made a commitment to develop the 2023 Guadalupe Regional Flood Plan (RFP) through a transparent process in which public input and participation is welcomed and encouraged. As part of this process, the Texas Water Code (TWC) Section 16.062 and Title 31 Texas Administrative Code (TAC) Chapter 361, require public notice and input opportunities. The technical consultant team prepared a Public Involvement Plan (PIP) for the RFPG to supplement those legally required efforts with opportunities to encourage and obtain meaningful public and stakeholder input throughout the planning process. As the project sponsor, the Guadalupe-Blanco River Authority (GBRA) was responsible for ensuring all public notice and participation activities were carried out as required by the TWC and 31 TAC.

The flood planning process is guided by the Texas Water Development Board (TWDB), led by the voting members of the Guadalupe RFPG and the Executive Committee, governed by by-laws, administered by GBRA, and supported by a team of technical consultants. The Guadalupe RFPG is composed of 15 voting members, with one member representing each of the following interests: *general public, agriculture, small business, industries, environmental, electric generating utility, water utility, flood districts, and water districts*; and two members representing each of the following interests: *municipalities, counties, and river authorities*. The members represent the interests of entities and organizations throughout the Guadalupe River Basin. A list of the voting members is found in **Table 10-1**. The Guadalupe RFPG also consists of non-voting members comprised of representatives from state agencies, river authorities, counties, and environmental organizations. Non-voting members are listed in **Table 10-2**.

Table 10-1: Guadalupe RFPG Voting Membership

Interest Group	Member Name	Organization/Entity
Agricultural	Doug Miller	Highlife Ranch/Miller & Miller Insurance
Counties	John Johnston, PE, CFM	Victoria County
Counties	Lon Shell	Hays County Commissioner, Pct 3
Electric Generating Utilities	Bobby Christmas	Guadalupe Valley Electric Cooperative
Environmental	Annalisa Peace	Greater Edwards Aquifer Alliance
Flood Districts	Doug Sethness	Green DeWitt Drainage District, President

Interest Group	Member Name	Organization/Entity
Industries	Kevin Stone	Martin Marietta
Municipalities	Joe Pantalion, PE	City of San Marcos
Municipalities	Ken Gill, PE	City of Victoria
Public	Kimberly Meitzen, PhD	Texas State University, Department of Geography
River Authorities	Brian Perkins, PE	Guadalupe-Blanco River Authority
River Authorities	Ray Buck*	Upper Guadalupe River Authority
Small Business	Gian Villarreal, PE, CFM	WEAT/Seagull PME
Water Districts	Ronald (Ron) Fieseler	Blanco Pedernales Groundwater Conservation District
Water Utilities	Steven Fonville	Martindale Water Supply Corporation

***New member will be placed in 2023.**

Table 10-2: Guadalupe RFPG Non-Voting Membership

Name	Organization Entity
Sue Reilly	Texas Parks and Wildlife Department
Jim Guin	Texas Division of Emergency Management
Jami McCool	Texas Department of Agriculture
Allen Nash	Texas State Soil and Water Conservation Board
Kris Robles	General Land Office
Ryke Moore	Texas Water Development Board
Joel Klumpp	Texas Commission on Environmental Quality
Don Durden	Kendall County Commissioner, Pct 4
Patrick Brzozowski	Lavaca-Navidad River Authority (Liaison from neighboring Region 10)
Doris Cooksey	City Public Service (Liaison from neighboring Region 12)

10.2 Guadalupe RFPG Public Outreach and Involvement Summary

The Guadalupe RFPG began meeting in fall 2020 with its initial kick-off meeting taking place on November 4, 2020. Initial public involvement efforts included the dissemination of information and event details via the planning group website and electronic mail announcements. The Guadalupe RFPG continued to meet monthly, and in the spring of 2021, they selected a technical consultant team to support the development of the Guadalupe RFP. During early discussions between the Guadalupe RFPG and the technical consultant team, the Guadalupe RFPG identified public outreach and participation as critical elements for the success of the regional flood planning process.

The *Regional Flood Planning Public Notification Quick Reference* is a resource that was prepared by TWDB and identifies the TWC and 31 TAC requirements for public notice and public comment. This tool was regularly utilized by the Guadalupe RFPG and GBRA to satisfy all legal notice requirements. In addition, the Guadalupe RFPG encouraged public input and comment in a manner that exceeded the requirements in the TWC and 31 TAC. Highlights of the public involvement and outreach strategies employed are listed below and described further within this chapter.

- Development of a Public Involvement Plan (PIP), see Appendix 10-F.
- Development of an extensive public and stakeholder contact list.
- Development and implementation of an interactive mapping tool to place on the Guadalupe RFPG website to gather information about flood-prone areas and existing flood management efforts using forms and surveys.
- Identification and evaluation of opportunities to enhance available information on the Guadalupe RFPG website.
- Use of social media accounts to post messages about upcoming Guadalupe RFPG meetings and activities.
- Development and implementation of a Virtual Public Meeting (VPM) tool to supplement the second in-person Guadalupe RFPG pre-planning meeting.
- Routine review and reporting of all public comments received through either the Guadalupe RFPG website or the Guadalupe RFPG email account.

Each of these strategies are discussed in detail below in **Section 10.3**.

10.3 Guadalupe RFPG Public Outreach and Involvement Tools and Strategies

The public and stakeholder involvement efforts emphasized two-way communication between the public and stakeholders and the Guadalupe RFPG. The Guadalupe RFPG maintained proactive communication and information dissemination during the planning process so that the public and stakeholders were informed and provided a process for how they could provide input, share data, or have their comments, questions, or concerns addressed.

The approved PIP provided an outline of public and stakeholder outreach and involvement activities to occur throughout the planning process and was implemented through the strategies and activities described as follows. These strategies provided a broad range of opportunities to reinforce public and stakeholder engagement and participation.

10.3.1 Public and Stakeholder Contact List

So as not to duplicate efforts with the Texas General Land Office (GLO) regional flood study that included the Guadalupe River Basin, the technical consultant team developed a public and stakeholder contact list by starting with the list compiled by the GLO. Consistent contacts (for example, county judges and mayors) with those included in the GLO study area counties were added to the list for those counties outside of the GLO study area, such as Bandera, Blanco, Gillespie, Hays, Kendall, Kerr, Real, and Wilson Counties. The technical consultant team performed an extensive review of the flood planning basin to identify entities with jurisdictions that were primarily located in the Guadalupe Flood Planning Region (FPR). This review allowed the technical consultant team to better facilitate conversations and outreach without duplicating efforts of neighboring RFPGs.

To date, **the list includes approximately 480 contacts** and reflects the following public and stakeholder contact categories:

- Legislators
- County Judges and County Commissioners
- Mayors, City Councilmembers, and City Administrators/Managers
- County Floodplain Administrators
- Emergency Management staff
- County Engineers
- County Public Works Directors
- City Public Works Directors
- Fire Chiefs
- River Authorities
- Groundwater Conservation Districts
- Regional Water Planning Group members
- Environmental organizations
- General public

This list continues to be updated as the plan development proceeds and more of the public and stakeholders become aware of the Guadalupe RFPG's efforts and request to be added to the list. This extensive list is regularly updated and utilized to carry out the public outreach activities described below for RFPG meetings.

10.3.2 Website

As the Guadalupe RFPG sponsor, GBRA developed and continues to maintain a website (www.guadaluperfpg.org) for the Guadalupe RFPG (see images provided in **Figure 10-1**). This

website is a hub for resources, notices, and information regarding the activities and planning process of the Guadalupe RFPG. The website contains information and announcements that help to inform the public and stakeholders. These include announcements of upcoming Guadalupe RFPG meetings, agendas, and materials, notices of membership vacancies, draft technical memoranda, and draft iterations of regional flood plan. On the website, there is also a portal to sign up for notices and to submit public comments.

10.3.3 eBlasts

The technical consultant team developed electronic mail notices, referred to as '*eBlasts*' to disseminate important information to stakeholders regarding the flood planning process. eBlast notices were posted in advance of pre-planning meetings, regular public meetings, and public hearings on the draft plan. Additionally, eBlasts were used to inform stakeholders on how best to provide input, comments, and data throughout the process.

10.3.4 Social Media

The technical consultant team worked in coordination with GBRA staff to create social media posts for various social media platforms (see images provided in **Figure 10-2**). These social media accounts were established and administered by GBRA. Social media messaging was posted in advance of the second pre-planning meeting, regular public meetings, and public hearings on the draft plan.

10.3.5 Public Comment Tracking, Response, and Reporting

The technical consultant team developed a system for receiving and reviewing all public and stakeholder comments received through either the Guadalupe RFPG website or through the Guadalupe RFPG email account. As stakeholders and the public submitted information through these two avenues, the team would respond to each comment and provide monthly reports to the Guadalupe RFPG of comments and responses.

10.3.6 Pre-Planning Meeting: Virtual Public Meeting

One of the strategies that the technical consultant team utilized was the use of a Virtual Public Meeting (VPM) room to supplement the second in-person Guadalupe RFPG pre-planning public meeting held on August 4, 2021 (see images provided in **Figure 10-3**). This VPM format enabled participation across the entire flood planning basin by allowing stakeholders and the public to view information, maps, and figures in a "virtual meeting room" environment. The virtual meeting room contained information stations located throughout the room. At the start of the meeting, meeting attendees (such as elected officials, agency representatives, members of the public, etc.) entered the meeting on-line at the "sign-in" station, where they were asked to sign in to record their attendance. They were welcomed by Doug Miller, Guadalupe RFPG Chair, and

greeted by narrators who guided them through the virtual meeting room and provided information regarding the meeting content (such as presentations, display boards, videos) presented at each station. The meeting attendees moved through the meeting content at their own pace, including re-visiting stations as needed. The final station provided an opportunity for meeting attendees to post questions or comments. The virtual public meeting went live on August 4, 2021 and remained publicly accessible for the public for two weeks via the main Guadalupe RFPG website and vi a direct URL link (https://www.blantonassociates.com/GBRA_Pre-Planning_vpm/).

10.3.7 Interactive Comment Mapping Tool

The technical consultant team also created an interactive comment mapping tool with a functionality that allowed users to geolocate points on a map where there are known flood impacts, flood concerns or flood mitigation strategies being implemented (https://blanton.maps.arcgis.com/apps/CrowdsourceReporter/index.html?appid=9109c845c61a4719bd83370be46cdfc8). The tool allowed users to provide descriptive comments and to upload images or key data sets if they had information to share (see images provided in **Figure 10-4**). The map was accompanied by a form for the public to complete to add their comments and information regarding flood prone areas and flood strategies or projects in their communities. The interactive tool was accessible via the Guadalupe RFPG website and the VPM and remained available for the duration of the planning process. Information uploaded through the interactive comment mapping tool after September 2021 was not considered for the 2023 Guadalupe RFP because of TWDB deadlines for completion of certain milestones. However, any information received after this date will be stored and considered for use in the next regional flood planning cycle.

10.3.8 Stakeholder Survey

To facilitate data collection and to further characterize flooding needs and risks in the flood region, the Guadalupe RFPG developed a stakeholder survey (see images provided in **Figure 10-5**). The survey was designed to gather background information, current flood risk, flood related resources, and existing flood infrastructure within a community. A copy of the stakeholder survey can be found in **Appendix 10-B**. The categories of questions and topics addressed in the survey included: floodplain management practices and regulations, data inventory of natural features and major flood infrastructure, strategies and projects, and current funding mechanisms. Some questions included opportunities for stakeholders to upload relevant data including information about current floodplain management practices and ordinances, studies backing ongoing flood mitigation efforts, or documentation regarding flooding and flood infrastructure conditions in their communities.

The survey was accessible through the website, the VPM room, and distributed to the identified stakeholders and public on August 4, 2021, via email announcements. The initial notification was provided through an email blast, and several email reminders were sent in the following weeks. The survey remained open with a due date of September 30, 2021, for information to be considered in this planning round. Follow-up communication was utilized to boost response rates and ensure all stakeholders had the opportunity to provide their feedback. In addition, the technical consultant team made several direct phone calls to key stakeholders to ensure that stakeholders received the email containing the survey, understood the importance and purpose of the survey, and was provided with any help needed to navigate or respond to the survey. Although there was a cutoff date for submitting responses and information, the survey remained accessible to stakeholders throughout the planning process. Information was continually collected, but only submittals provided by the due date were considered for incorporation into this first flood plan.

10.3.9 Sponsor Questionnaires

To further validate information that was previously collected from agency representatives and key stakeholders, the technical consultant team conducted two rounds of region-wide outreach to entities that were directly planning to sponsor flood management evaluations (FMEs), flood management projects (FMPs) or flood management strategies (FMSs). These two rounds of sponsor outreach were performed prior to the publication of the draft flood plan. In February-March 2022, sponsors were contacted directly, to provide them with a table showing which flood planning actions had been identified for them, determine if any actions were missing, and requested a response if there were any assumptions that were inaccurate. A second round of questionnaires was sent to sponsors in June 2022, primarily to engage the sponsors to review the cost assumptions of the revised list of actions based on feedback received during the first round.

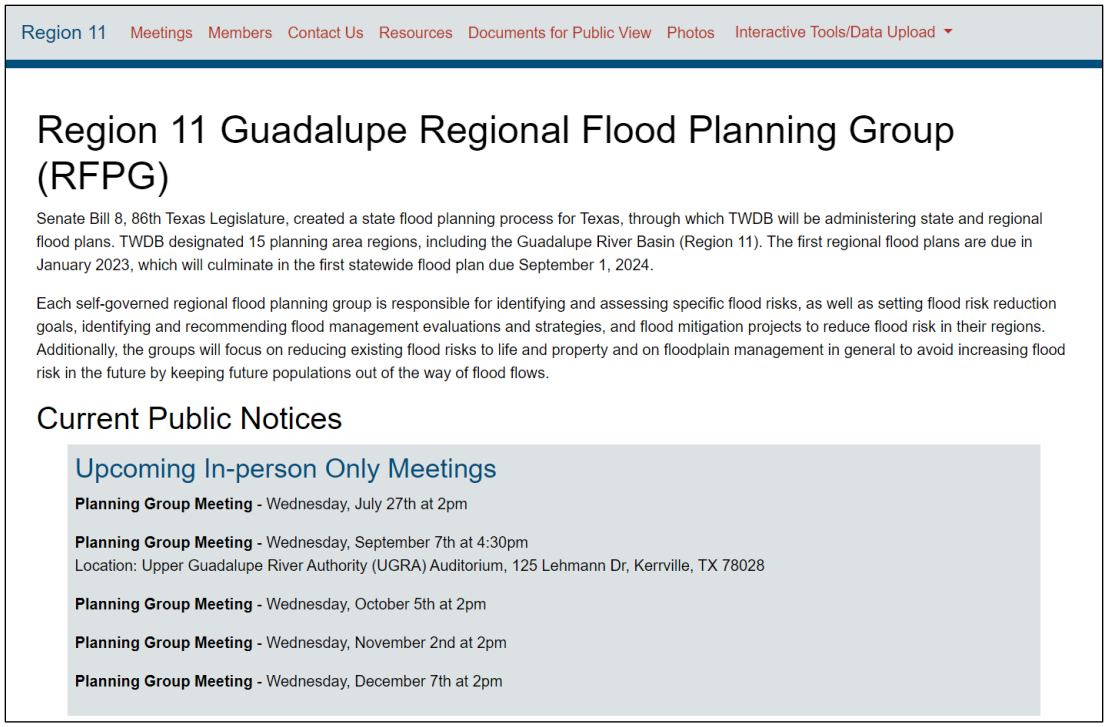
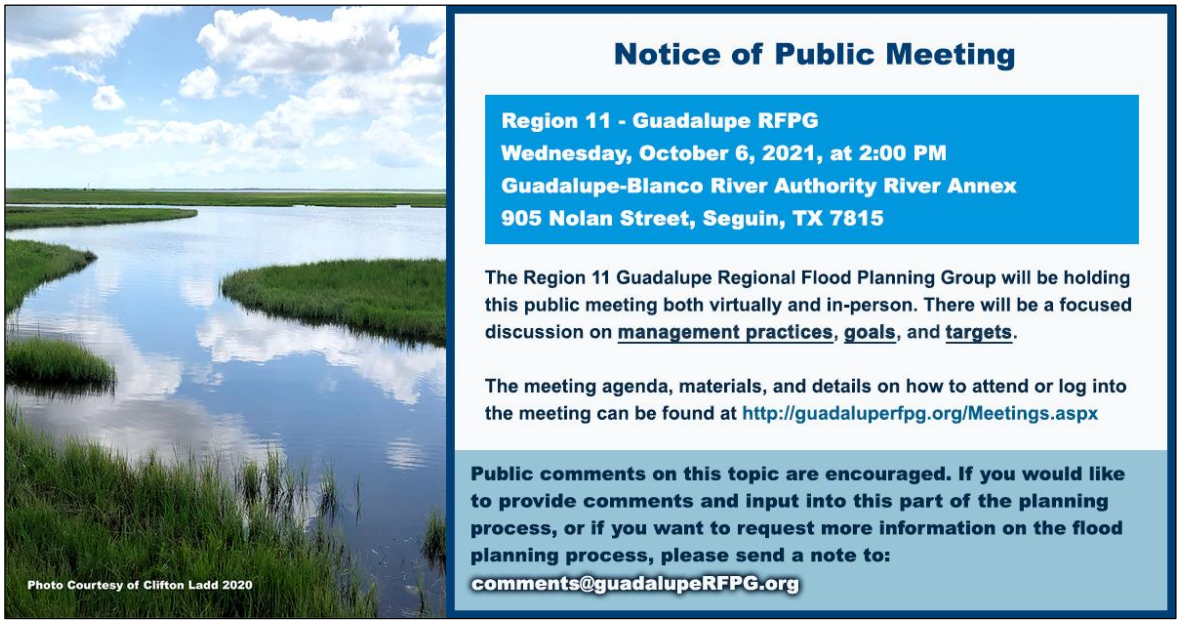


Figure 10-1: Guadalupe RFPG Website Images



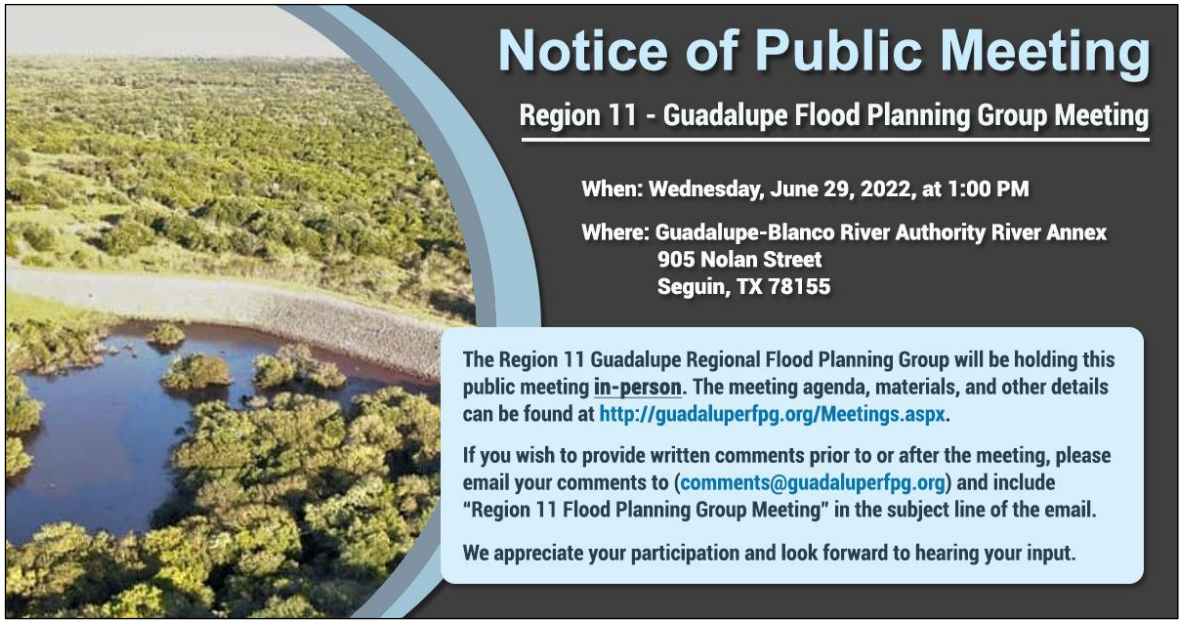
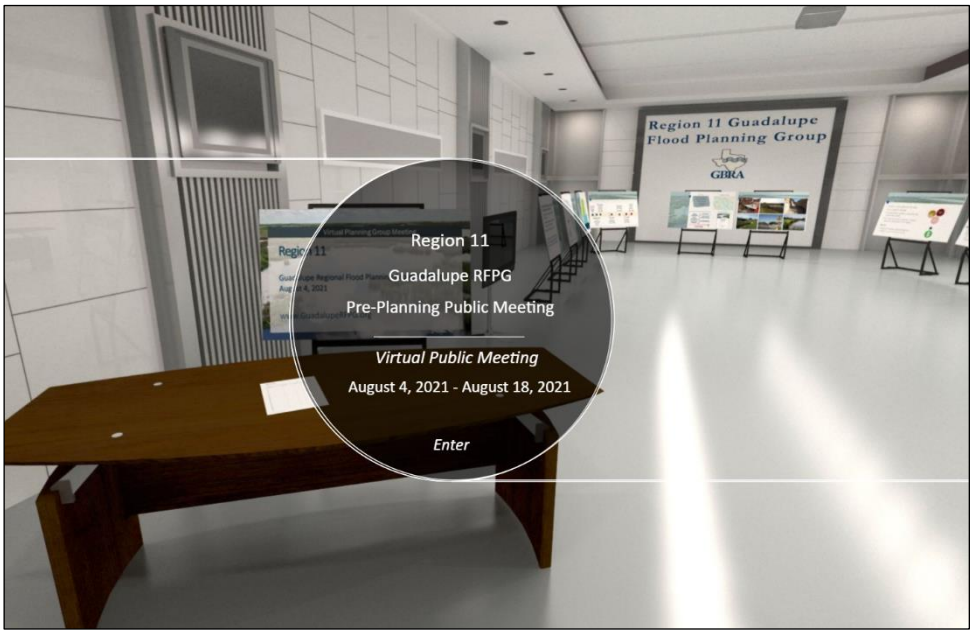
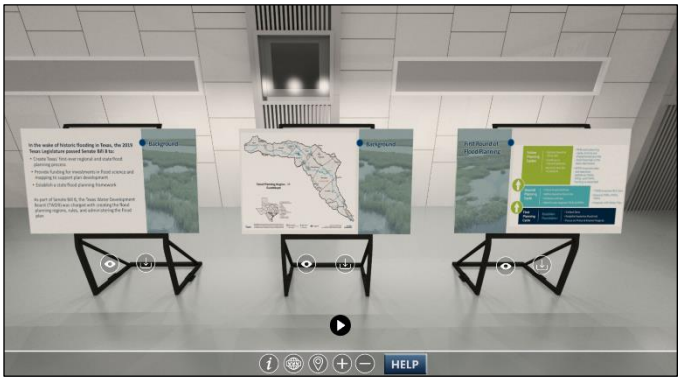
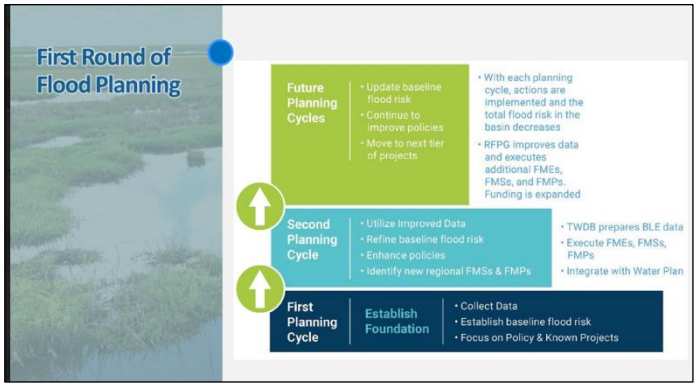


Figure 10-2: Guadalupe RFPG Social Media Images







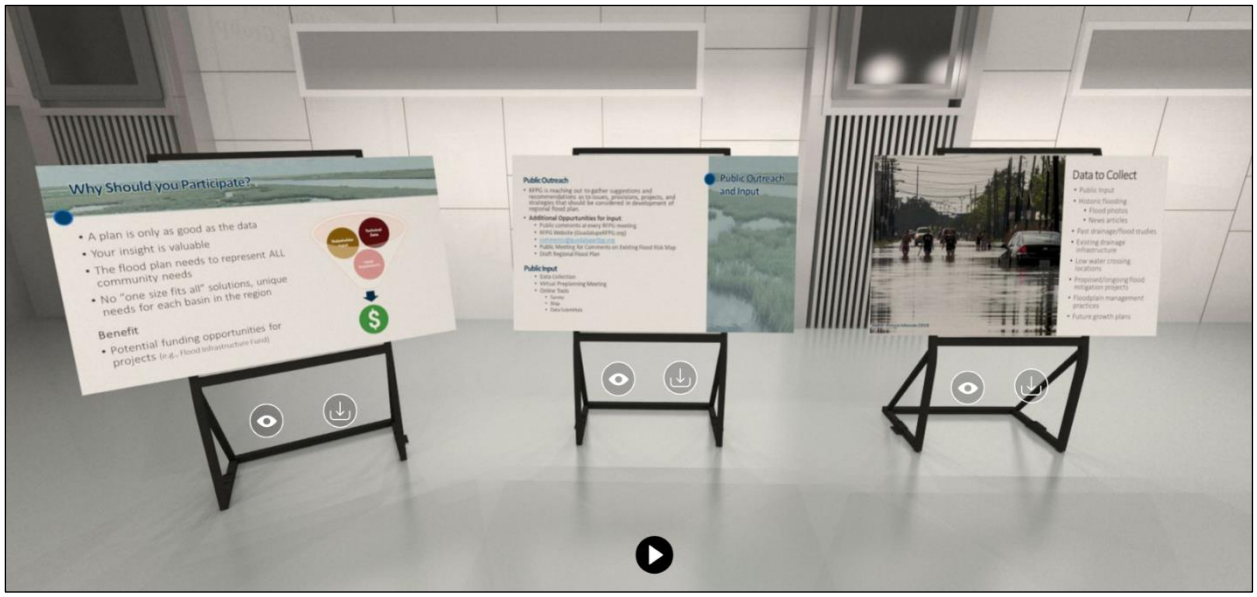


Figure 10-3: Guadalupe RFPG Second Pre-Planning Public Meeting - Virtual Public Meeting Room Images

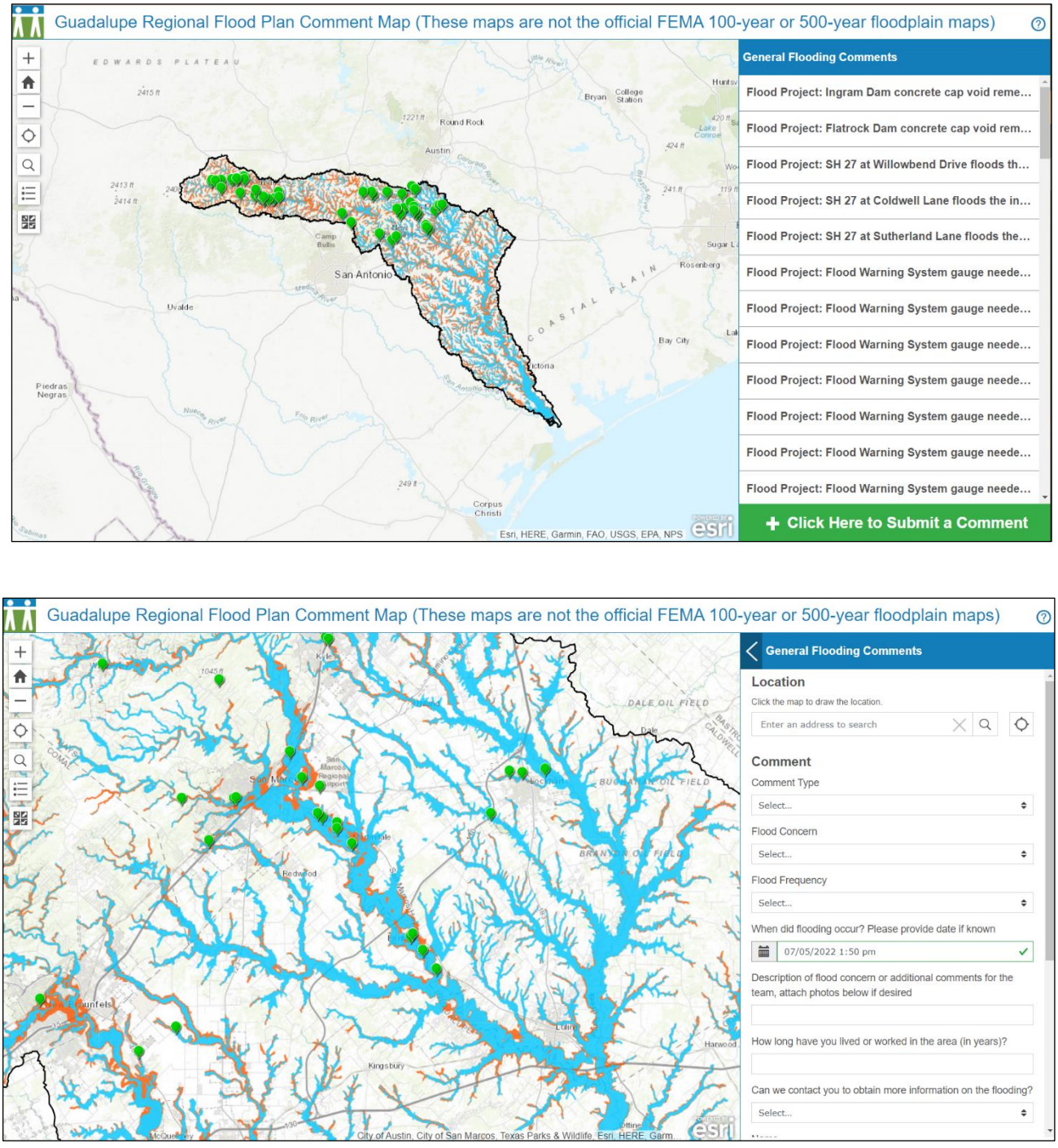
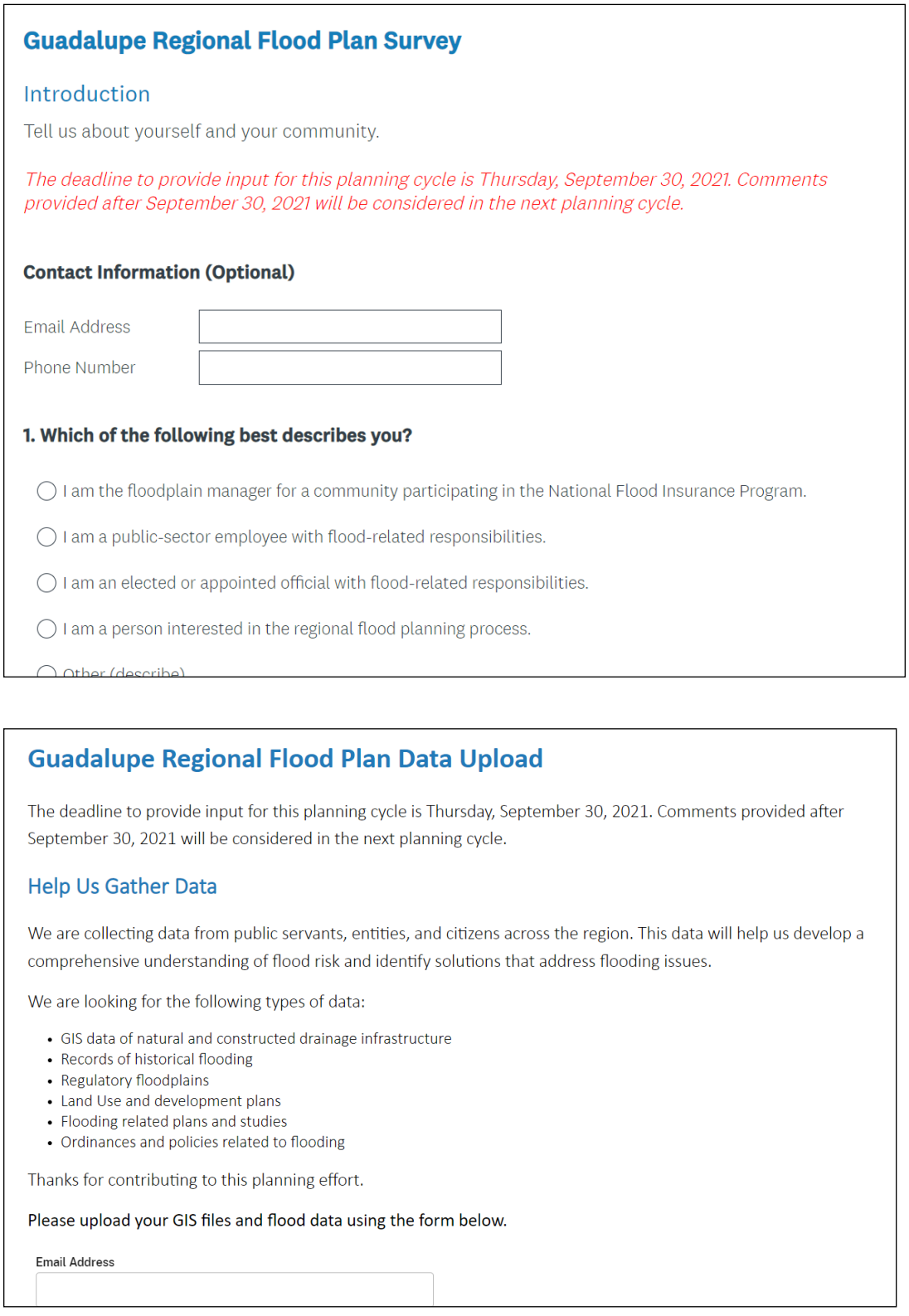


Figure 10-4: Guadalupe RFPG Interactive Comment Mapping Tool Images



Guadalupe Regional Flood Plan Survey

Introduction

Tell us about yourself and your community.

The deadline to provide input for this planning cycle is Thursday, September 30, 2021. Comments provided after September 30, 2021 will be considered in the next planning cycle.

Contact Information (Optional)

Email Address

Phone Number

1. Which of the following best describes you?

- ◯ I am the floodplain manager for a community participating in the National Flood Insurance Program.
- ◯ I am a public-sector employee with flood-related responsibilities.
- ◯ I am an elected or appointed official with flood-related responsibilities.
- ◯ I am a person interested in the regional flood planning process.
- ◯ Other (describe)

Guadalupe Regional Flood Plan Data Upload

The deadline to provide input for this planning cycle is Thursday, September 30, 2021. Comments provided after September 30, 2021 will be considered in the next planning cycle.

Help Us Gather Data

We are collecting data from public servants, entities, and citizens across the region. This data will help us develop a comprehensive understanding of flood risk and identify solutions that address flooding issues.

We are looking for the following types of data:

- GIS data of natural and constructed drainage infrastructure
- Records of historical flooding
- Regulatory floodplains
- Land Use and development plans
- Flooding related plans and studies
- Ordinances and policies related to flooding

Thanks for contributing to this planning effort.

Please upload your GIS files and flood data using the form below.

Email Address

Figure 10-5: Guadalupe RFPG Stakeholder Survey and Data Upload Tools

10.4 Guadalupe RFPG Meetings

Public involvement and outreach were important considerations in all phases of development for the first RFP. GBRA and the technical consultant team used various strategies and activities to enhance the level of public participation and engagement in meetings and throughout the planning process. **Table 10-3** provides a summary of these strategies implemented by type of Guadalupe RFPG meeting. All Guadalupe RFPG meetings were preceded by required notice and open to the public. Opportunities for public comment were available at the beginning and end of every Guadalupe RFPG meeting, and summaries of comments received were presented at each meeting and included in the meeting materials for each meeting (see **Appendix 10-C.2**.) Communication of information disseminated by GBRA and the technical consultant was facilitated and supported by the GBRA-maintained website and by TWDB information and resources. Throughout the planning process, GBRA and the technical consultant team provided responses to inquiries from the public.

Table 10-3: Guadalupe RFPG Public Involvement Tools and Strategies Used to Support Meetings

Meeting Types	Stakeholder Contact List	Website	Social Media	Eblast	VPM[1]	ICM[2]	Other[3]
Pre-Planning Meetings	✓	✓	✓	✓	✓	✓	✓
Regular Monthly Meetings	✓	✓	✓	✓			
Draft Plan Public Hearing and Public Meetings	✓	✓	✓	✓			
Final Plan Public Meetings	✓	✓	✓	✓			

[1] VPM – Virtual Public Meeting
[2] ICM – Interactive Comment Mapping Tool
[3] Other - Public Survey, Sponsor Questionnaires

10.4.1 Pre-Planning Public Meetings

As required by the TAC, the Guadalupe RFPG held two pre-planning public meetings to solicit public input regarding suggestions and recommendations relating to issues, provisions, projects, and strategies that should be considered during the flood planning cycle and/or input on the development of the regional flood plan. The first pre-planning public meeting was held on March 3, 2021, as an item on their regular monthly RFPG meeting agenda. This meeting was

held at the GBRA River Annex in Seguin, Texas. The second pre-planning public meeting was held on August 4, 2021, in Wimberly, Texas, which is located the central portion of the flood basin. The pre-planning public input meeting was held as an item on their regular monthly RFPG meeting agenda.

There were 61 attendees, (16 Guadalupe RFPG members, seven elected officials, 32 members of the public, one GBRA staff member and eight members of the technical consultant team assisting the Guadalupe RFPG with developing the regional flood plan), at the August 4, 2021, pre-planning meeting. Eleven individuals spoke and provided verbal comments, with one speaker submitting copies of emails and letters concerning flood planning and potential solutions. Twenty-six attendees noted that they received the meeting announcement via email.

The August 4th in-person pre-planning meeting was supplemented by a VPM component to expand public participation opportunities in the flood planning process. The VPM room was open for public use from August 6 – 18, 2021. The average time a user spent in the VPM room was approximately seven minutes. There were 19 people who signed in via the VPM room with six users providing comments via the VPM comment form. Within the VPM room the users also had access to an interactive comment map tool for which nine comments were submitted by three different users. Additionally, users were also able to access a stakeholder survey form from within the VPM room. A summary report of the stakeholder and public comments received in-person at the August 4th meeting, including the emails and letters submitted, are found in **Appendix 10-A**. Additionally, **Appendix 10-C.1** also provides a listing of public comments received in-person, by VPM, and via the interactive comment map. Collectively, in-person and virtually, there were 126 attendees for the pre-planning meeting with 16 individuals providing comments either in-person or via an online tool.

10.4.2 Regular Meetings

The Guadalupe RFPG held regular monthly meetings during the timeframe of 2020 – 2023. These meetings included presentation of materials, discussions, deliberations, voting on specific measures, and public comment. **Table 10-4** provides a summary of all the Guadalupe RFPG public meetings, which includes regular meetings and executive committee meetings. A

compilation of the public comment tracking matrices that were developed to track comments submitted online can be found in **Appendix 10-C.3**. In accordance with Chapter 31 TAC and the Texas Open Meetings Act, the public was notified of Guadalupe RFPG public meetings through postings on the Texas Secretary of State's website as well as the Guadalupe RFPG website. In accordance with Chapter 31 TAC and the Texas Public Information Act, meeting minutes and other Guadalupe RFPG-related documents were posted on the Guadalupe RFPG website. Interested stakeholders that requested to be included in email notices received communications regarding upcoming meetings. Every meeting included a scheduled time for public comment and questions. All the meetings were held in-person, virtually, or by a hybrid format within the flood basin. During the 2020 – 2021 timeframe, the majority of the regular Guadalupe RFPG meetings were held virtually due to precautions being taken related to the COVID-19 pandemic. When the levels of risk decreased for COVID-19, the Guadalupe RFPG continued to use virtual and hybrid meeting formats and eventually transitioned to only in-person meetings.

Photo 10-2: May 10, 2022. Regular Guadalupe RFPG Meeting, online and in-person format. Seguin, Texas.

Photo 10-3: June 27, 2022. Regular Guadalupe RFPG Meeting, in-person only format. Seguin, Texas.

Table 10-4: Overview of Monthly Guadalupe RFPG Meetings

Meeting Date	Key Discussion Items	Action Items
January 4, 2023	• Adopt Final Plan and Approve for submittal to TWDB • Discussion of Chapter 8 recommendations	• Approval of Chapter 8 recommendations • Adopt Final Plan and Approve for submittal to TWDB
December 7, 2022	• Discussion and potential action regarding budget memorandum No. 1 • Discussion and potential action approving the FME and FMP tables • Discussion and potential action approving additional recommendations to Chapter 8: Legislative, Administrative, and Regulatory Recommendations. • Discussion and possible action approving the list of FMEs for Task 12.	• Approval of budget memorandum • Approval of FME and FMP tables • Approval of four additional recommendations to Chapter 8 • Approval of list of FMEs for Task 12
November 2, 2022	• Discussion and potential action regarding administrative expenses to be submitted to the Texas Water Development Board for reimbursement. • Discussion and potential action regarding the solicitation to fill the vacant voting position in the River Authorities interest category. • Discussion regarding Region 11 RFPG Technical Consultants work and schedule. • Discussion and possible action approving the list of Flood Management Evaluations (FMEs) for Task 12.	• Approval of administrative expenses. • No action regarding the solicitation to fill the vacant voting position in the River Authorities. • Approval of list of FMEs for Task 12.
September 21, 2022	• Presentation • Public Input	• Not a regular public meeting, so no actions were taken.

Meeting Date	Key Discussion Items	Action Items
September 7, 2022	• Discussion regarding Region 11 RFPG Technical Consultants work and schedule. • Discussion and possible action approving the list of Flood Management Evaluations (FMEs) for Task 12.	• No action was taken on this item.
July 27, 2022	• Review and approval of Draft Flood Plan	• Approval of Draft Flood Plan.

June 29, 2022	• Update on Guadalupe RFPG technical consultant work and schedule
	  • Discussion and possible action approving flood mitigation actions of Guadalupe RFP
	  • Discussion and possible action approving Chapters 2-5, 6b, and 7-9
		• Approval of Chapters 2-5, 6b, and 7-9.
		• Approval of flood mitigation actions.

June 1, 2022	• Update on Guadalupe RFPG technical consultant work and schedule • Discussion and possible action approving flood mitigation actions of the Guadalupe RFP	• Approval of flood mitigation actions.
May 10, 2022	• Update on Guadalupe RFPG technical consultant work and schedule • Discussion and possible action approving Chapter 1 of the Guadalupe RFP	• Approval of Chapter 1.
March 30, 2022	• Consideration of Executive Committee's recommendation and consider taking action to fill the Flood Districts interest category position • Update on Guadalupe RFPG technical consultant work and schedule	• Approval to fill flood districts interest category position.

Meeting Date	Key Discussion Items	Action Items
February 9, 2022	• Discussion and possible action regarding administrative expenses to be submitted to TWDB for reimbursement • Consideration of nominations for Guadalupe RFPG Officers for 2022 (Chair, Vice Chair, Secretary and two members-at-large) • Discussion of and solicitation to fill the vacant voting position in the Flood Districts interest category • Discussion and possible action regarding Guadalupe RFPG Technical Consultants work and schedule • Discussion and possible action approving the Technical Memorandum No. 2 to be submitted to TWDB by March 7, 2022	• Election of RFPG Officers for 2022. • Approval of Technical Memorandum No. 2.
December 1, 2021	• Discussion and authorization for the voting planning member travel associated with the TWDB Contract Amendment between TWDB and GBRA • Update on Guadalupe RFPG technical consultant work and schedule • Discussion and possible action approving the Technical Memorandum to be submitted to TWDB by January 7, 2022	• Approval of Technical Memorandum No. 1.
December 1, 2021 *(Executive Committee Meeting)*	• Consideration of RFPG travel costs associated with the grant Contract Amendment 1	• No Action

Meeting Date	Key Discussion Items	Action Items
November 3, 2021	• Consideration of Request for Proposals and Grant Contract Amendment between TWDB and GBRA to incorporate additional funding provided by the legislature • Update on Guadalupe RFPG technical consultant work and schedule	• No Action
October 6, 2021	• Consideration and authorization for GBRA to negotiate and execute a grant contract amendment with TWDB • Consider Executive Committee's recommendation, discussion and consider taking action to fill the Water Utilities interest category position • Update on Guadalupe RFPG technical consultant work and schedule • Discussion and possible action determining flood mitigation and floodplain management goals • Discussion and possible action approving the process for identifying potential FMEs and potentially feasible FMSs and FMPs	• Approval to authorize GBRA to negotiate and execute a grant contract amendment with TWDB and the associated contract amendment between GBRA and the technical consultant.
October 5, 2021 *(Executive Committee Meeting)*	• Discussion of interview process and conduct interviews with nominees for voting vacant position • Discussion, nomination, and consideration of individuals to fill the Water Utilities interest category position	• Approval for electing individuals to fill the Water Utilities interest categories position.

Meeting Date	Key Discussion Items	Action Items
September 8, 2021	• Discussion and possible action regarding the solicitation to fill the vacant voting position in the Water Utilities interest category • Update on Guadalupe RFPG technical consultant work and schedule • Update on Guadalupe RFPG technical consultant work and schedule	• No Action
August 4, 2021	• Discussion and possible action regarding the solicitation to fill the vacant voting position in the Water Utilities interest category • Update on Guadalupe RFPG technical consultant work and schedule	• No Action
June 30, 2021	• Update on Guadalupe RFPG technical consultant work and schedule • Update from GBRA	• No Action
June 2, 2021	• Update on Guadalupe RFPG technical consultant work and schedule • Discussion of second Pre-Planning Public Input Meeting to solicit public input	• No Action
May 5, 2021	• Update on Guadalupe RFPG technical consultant work and schedule • Discussion of second Pre-Planning Public Input Meeting to solicit public input	• No Action

Meeting Date	Key Discussion Items	Action Items
April 13, 2021	• Discussion, evaluation, and possible action concerning the technical consultant procurement for Guadalupe RFPG • Update and discussion of responses to the request for qualifications • Discussion of recommendation from the Executive Committee for the selection of a technical consultant • Authorizing the GBRA to negotiate and execute a contract with the selected firm to provide technical consulting services with the development of the Guadalupe RFP	• Approval of the technical consultant procurement for RFPG. • Approval to authorize the GBRA to negotiate and execute a contract with the selected firm to provide technical consulting services with the development of a regional flood plan.
March 30, 2021 *(Executive Committee Meeting)*	• Discussion, evaluation, and action concerning the technical consultant procurement for the Guadalupe RFPG • Discussion and presentations by technical consulting firms' statements of qualifications in response to the request for qualifications to initiate procurement process for a technical consultant • Discussion of recommendation to the full RFPG for a selection of a technical consultant to provide services for the development of a RFP for the Guadalupe RFPG	• No Action
March 3, 2021	• Update from Region 10 Lower Colorado-Lavaca RFPG and Region 12 San Antonio RFPG Liaisons • Update from GBRA regarding status of the Regional Flood Planning Grant contract with TWDB and the request for qualifications to initiate the procurement process for a technical consultant	• No Action

Meeting Date	Key Discussion Items	Action Items
February 3, 2021	• Consideration of Executive Committee's recommendation for nominations and approval for the vacant voting and non-voting positions	• Approval to fill the Public Interest category position, and the vacant voting positions of River Authorities, Municipalities, Counties and Electric Generating Utilities interest groups.
January 25, 2021 *(Executive Committee Meeting)*	• Discussion of interview process and conduct interviews with nominees for voting and non-voting vacant positions • Nomination and consideration of individuals to fill the Counties interest category position; discussion, nomination and consideration of individuals to fill the Electric Generating Utilities interest category position • Consideration of a recommendation to the full RFPG for the appointment to fill the vacant non-voting member position in the public interest group	• Approval to fill the vacant Voting positions of River Authorities, Municipalities, Counties, Electric Generating Utilities, River Authorities, and Municipalities interest category positions. • Approval to fill the Counties interest category position, Electric Generating Utilities interest category position, the vacant non-Voting member position in the public interest group category position.
January 6, 2021	• Consideration of nominations for RFPG members to be non-voting liaisons to Regions 10 & 12 • Consideration of proposed request for qualifications for the GBRA to initiate procurement for a technical consultant	• Approval of RFPG members to be non-voting liaisons to Region 10 & Region 12. • Approval of the proposed request for qualifications for the GBRA to initiate procurement for a technical consultant.

Meeting Date	Key Discussion Items	Action Items
December 2, 2020	• Consideration of nominations for RFPG Vice Chair and Secretary • Consideration of nominations for two members-at-large to serve on the Executive Committee • Discussion and possible action to add additional voting and non-voting positions to the RFPG • Update from GBRA regarding status of Regional Flood Planning Grant contract with TWDB • Discussion of technical consultant procurement process and Scope of Work posted with TWDB • Discussion of a GBRA hosted a public website and public comment methods	• Approval to elect RFPG Vice Chair and Secretary. • Approval of nominations for two members-at-large to serve on the Executive Committee. • Approval to add additional voting and non-voting positions to the RFPG.
November 4, 2020	• Discussion of bylaws • Consideration of nominating and electing regional flood planning group Chair or Interim Chair • Consideration of selecting a planning group sponsor to act on behalf of the regional flood planning group • Consideration of additional, region-specific public notice requirements, if any, that might be necessary to ensure adequate public notice in the region	• Approval to elect regional flood planning group Chair or Interim Chair. • Approval of nominations for Chair or Interim Chair by members. • Selection of a planning group sponsor.

10.4.3 Draft Plan Meetings

Chapter 31 TAC statutory requirements state that a RFPG shall hold one or more public meetings to obtain input from the public on the Draft Guadalupe Regional Flood Plan (RFP). The first 30-day comment period occurred on August 8, 2022 – September 6, 2022. The official public hearing on the draft Guadalupe RFP was held on September 7, 2022. Details on this meeting are described later in this section. The second 30-day comment period occurred on September 8, 2022 – October 7, 2022. To supplement the 30-day meeting notice and the 60-day public comment period required by the TWC and 31 TAC, to promote awareness of the public meeting(s), and to help encourage public and stakeholder participation and input, , the Guadalupe RFPG elected to hold a second public meeting for the purposes of gathering input on the draft Guadalupe RFP. Towards this end, the technical consultant team and Region 11 administrative agent GBRA conducted the following outreach tasks listed below in **Table 10-5.**

Table 10-5: Overview of Outreach Efforts for Draft Guadalupe Regional Flood Plan

Tasks	Completed on
Posted Draft RFP on **website** prior to start of comment period. 30-day comment period starts on August 8th.	August 5, 2022
Published Legally Required Public Hearing Notice. TAC requires legal notice to be posted 30 days prior to the Sep. 7th meeting.	August 5, 2022
Posted **hard copy** of Draft RFP at three locations 30 days prior and 30 days following the Sep. 7th meeting.	August 5, 2022
Press Release #1. GBRA issued press release announcing the RFPG's approval of the Draft RFP. Outlets, such as the Upper Guadalupe River Authority, published the information from the press release in late August.	August 2, 2022
1st Social Media Post - described 1) Draft RFP available for public, 2) upcoming meetings on draft plan (Sep 7th and Sep 21st), and 3) upcoming start of comment period. GBRA posted online. Planning members shared posts.	August 11, 2022
1st Eblast - same as social media messaging	August 3, 2022
Additional Outreach by Email: Adjacent RFPGs, COGs, Regional Water Planning Groups	August 3, 2022
Media Advisory #1: GBRA issued Media Advisory #1 announcing the upcoming Sep 7th public hearing.	August 31, 2022
2nd Social Media Post - described 1) the Draft RFP available for public, 2) reminder on upcoming meeting on Draft RFP (Sep 7th), and 3) reminder about open comment period. GBRA posted online. Planning members shared posts.	September 7, 2022
2nd Eblast - same as social media messaging	August 31 2022
Additional Outreach by Email: Adjacent RFPGs, Council of Governments, Regional Water Planning Groups	August 31 2022

Tasks	Completed on
Media Advisory #2: GBRA issued Media Advisory # 2 announcing the upcoming Sep 21st public input meeting.	September 14, 2022
3rd Social Media Post - described 1) Draft RFP available for public, 2) upcoming end of comment period ending and 3) reminder on upcoming second public input meeting on Draft RFP (Sep 21st). Planning members shared posts.	September 14, 2022
3rd Eblast - same as social media messaging	September 14, 2022
Additional Outreach by Email: Adjacent RFPGs, Council of Governments, Regional Water Planning Groups	September 14, 2022

Summaries of these two public input meetings are described below.

First Public Input Meeting/Public Hearing on the Draft RFP

Wednesday, September 7, 2022, at 4:30 p.m.
Location: Upper Guadalupe River Authority (UGRA) Auditorium, 125 Lehmann Dr, Kerrville, TX 78028

Nineteen citizens or representatives from local governments, such as the City of Kerrville and the Upper Guadalupe River Authority, attended this first public input meeting/public hearing in Kerrville. Three media representatives, including representatives from the Kerrville Daily Times, West Kerr Current, and the Hill Country Community Journal and one elected official from the Kendall County WCID #1 also attended. After Chairman Miller reviewed the process for giving public comments and opened the floor to attendees, Ms. Betty Murphy and Mr. Emmanuel Flatten, private citizens, presented their concerns about flooding in Comfort, Texas – a small town located in the western portion of Region 11. After Chairman Miller opened the floor for any additional public comment, Mr. Flatten presented more detail on the causes of the flooding problems in Comfort, Texas.

Notices and materials prepared for the September 7th Public Hearing on the Draft Guadalupe RFP can be found in the following Appendices:

- **Appendix 10-D.1** – Legal Notice for September 7, 2022, Public Hearing on Draft RFP
- **Appendix 10-D.2** – Public Presentation for September 7, 2022, Public Hearing on Draft RFP
- **Appendix 10-D.3** – Minutes for September 7, 2022, Public Hearing on Draft RFP

Second Public Input Meeting

Wednesday, September 21, 2022, at 4:30 p.m.
Location: The University of Houston-Victoria (UHV) Northwest Campus, 1604 E. Airline Rd., Victoria, TX 77901

Four citizens and a representative from the Victoria County Groundwater Conservation District (VCGCD) and one elected official from the VCGCD attended the meeting. After Chairman Miller reviewed the process for giving public comments and opened the floor to attendees, Bruce Miller, Grace Renken, and Kenneth Schustereit, private citizens, presented their concerns about flooding in lower Guadalupe River basin. After Chairman Miller opened the floor for any additional public comment, Mr. Schustereit presented his perspective on the cause of the flooding problems in the lower Guadalupe River basin.

In summary, during the 60-day comment period (August 8th through October 7th), five private citizens provided verbal comments at the public input meetings and three private citizens provided written comments. After the end of comment period, an additional four comments were provided.

Public input received at the September 7th Public Input Meeting/Public Hearing and September 21st Public Input Meeting on the Draft RFP can be found in the following Appendix:

- **Appendix 10-E** - Public and State Agency Comments and Responses on Draft Flood Plan

10.4.4 Final Plan Meetings

After the second public input meeting, the RFPG held regular planning group meetings on November 2, and December 7, 2022, and January 4, 2023. For each meeting, the technical consultant team and GBRA notified the public of the meeting date, time, and location through eblasts, and social media.

At the November 2nd meeting, the technical consultant team provided a summary of the verbal comments received at the public input meetings, the written comments received during the public comment period (August 8, through October 7, 2022) on the Draft RFP and a summary of the TWDB comments received on October 25, 2022. The TWDB comments on the Draft RFP can be found in Appendix 10-E.

At the December 7th meeting, the technical consultant team presented the comment response log that summarizes the responses to all comments on the Draft Flood Plan. The final Draft RFP was issued on December 19th and on December 30th, the Guadalupe RFPG members provided their final comments on the plan. On January 4th, the Guadalupe RFPG adopted the Final Regional Flood Plan and approved for submittal to the TWDB.

10.5 Interregional and Agency Coordination

The Guadalupe FPR is adjacent to the Region 10 Lower Colorado Lavaca Flood Planning Region and the Region 12 San Antonio Flood Planning Region. To the extent necessary, coordination with each of these regions was accomplished through Chair correspondence, regional flood planning group liaisons, and/or technical consultant collaboration. The liaisons from the Guadalupe RFPG were Ronald Fieseler serving as the Liaison to Region 10 and Annalisa Peace serving as the Liaison to Region 12. Subjects of coordination, correspondence, or collaboration included updates on current or planned flood management strategies, potential flood planning evaluations needed, and other relevant topics of discussion. The Guadalupe RFPG is aware of no interregional conflicts involving the findings and conclusions of the Guadalupe RFP.

During the monthly RFPG meetings, group members who held positions in other flood planning regions provided updates on the progress of those regions. These updates helped to facilitate discussions concerning timelines, different approaches being used across the regions. In addition, they provided opportunities for these group members to share insights about the processes in different regions, allowing for the technical consultant team to consider different methodologies or further coordination with other regions.

In addition to the previously mentioned official avenues of coordination, many regions had ongoing communication across the regions to facilitate the flood planning process. This coordination helped guide many aspects of the planning efforts. With the regional flood planning effort being in its inaugural cycle, there were shared conversations how to best execute the scope of work and an exchange of guidance on technical aspects of the plan. Coordination across the flood planning regions was key to ensure that the regional flood plans could be combined into a cohesive state flood plan. Region 11's lead technical consultant Freese and Nichols, Inc. was a prime consultant in six Flood Planning Regions (including Region 11) and was a subconsultant in six other Flood Planning Regions. All of the firm's Project Managers, Deputy Project Managers and production staff held weekly meetings throughout the planning process, for the purposes of exchanging best practices and technical tools, review project milestones and deliverables, and optimize workload.

Coordination with TWDB was facilitated through technical consultant conference calls. TWDB hosted multiple calls throughout the planning process to facilitate the exchange of best practices, provide additional guidance, and allow time for questions and discussion between the technical consultants for the various regions and agency staff. TWDB also hosted periodic Chair meetings to provide updates and guidance on contractual agreements, schedules, and technical deliverables. When there was an update to share, Chair Miller or GBRA staff would provide updates to the Guadalupe RFPG at their monthly meetings.

Before the technical consultant team submitted both Technical Memorandum No. 1 and Technical Memorandum No. 2 on behalf of the Guadalupe RFPG, a call was hosted by TWDB, for the technical consultant teams, to answer commonly asked questions and facilitate discussion between regions. Although TWDB staff guided the call agendas and answered many of the questions, there was also significant coordination between the regions on approaches and datasets to be used that helped identify solutions to problems that had been encountered across the regions during this first flood planning cycle.

Two additional calls were held before the submittal of the draft regional flood plans. These calls helped identify TWDB's expectations for the upcoming submittal and identified some issues that were present in the technical memorandum submittals throughout the state. The discussion facilitated by these calls allowed for an opportunity for regions to coordinate and discuss shared problems and solutions.

10.6 Flood Planning Guidance Principles

The regional flood planning process is governed by 39 overarching guidance principles, as described in 31 TAC §362.3. **This RFP conforms with each of these guidance principles, including the requirement that the RFP will not negatively affect any neighboring areas.** This RFP adequately provides for the preservation of life and property and the development of water supply sources, where applicable. Additionally, the planning group met all requirements under the Texas Open Meetings Act and Public Information Act. The provisions of each principle are addressed in the report sections outlined in **Table 10-6**.

Table 10-6: Alignment of RFP with 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
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 4/5
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

Guidance Principle ("The regional and state flood plans:…")		RFP Section(s)
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
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 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
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 structure failures, slow rise flooding, ponding, flash flooding, and coastal flooding, including relative sea level change and storm surge;	Chapter 1, 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 flooding of critical facilities or transportation routes or for other reasons, including levels of risk or project size, determined by the RFPG;	Chapter 4/5
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 RFP;	Chapter 4/5, Chapter 6
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 4/5

Guidance Principle ("The regional and state flood plans:…")		RFP Section(s)
12	shall include the estimate of costs and benefits at a LOD sufficient for RFPGs and sponsors of FMPs to understand project benefits and, when applicable, compare the relative benefits and costs, including environmental and social benefits and costs, between feasible options;	Chapter 4/5
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 4/5
15	shall be supported by state agencies, including TWDB, GLO, TCEQ, TSSWCB, TPWD, and the TDA, working cooperatively to avoid duplication of effort and to make the best and most efficient use of state and federal resources;	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 4/5
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, that lead to long-term mitigation of flood risk;	Chapter 4/5
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
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 FMSs and projects recommended by the RFPGs that are based upon identification, analysis, and comparison of all FMSs the RFPGs determine to be potentially feasible to meet flood mitigation and floodplain management goals;	Chapter 4/5

Guidance Principle ("The regional and state flood plans:…")		RFP Section(s)
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 3
25	shall be consistent with the 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 4/5
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 RFP;	Chapter 4/5
31	shall include ongoing flood projects that are in the planning stage, have been permitted, or are under construction;	Chapter 1
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 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

Guidance Principle ("The regional and state flood plans:…")		RFP Section(s)
35	shall consider protection of vulnerable populations;	Chapter 4/5
36	shall consider benefits of flood management strategies to water quality, fish and wildlife, ecosystem function, and recreation, as appropriate;	Chapter 2, Chapter 4/5, Chapter 6
37	shall minimize adverse environmental impacts and be in accordance with adopted environmental flow standards;	Chapter 4/5, Chapter 6
38	shall consider how long-term maintenance and operation of flood strategies will be conducted and funded; and	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 4/5