2023 San Antonio Regional Flood Plan

Flood Planning Region 12

January 10, 2023

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It is not to be used for any other purpose.

REGION 12

SAN ANTONIO REGIONAL FLOOD PLANNING GROUP

Texas Water Development Board

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2023 San Antonio Regional Flood Plan

January 10, 2023

Prepared for San Antonio Regional Flood Planning Group

Administered by San Antonio Regional Flood Planning Group Sponsor:

SAN ANTONIO RIVER AUTHORITY

Prepared By:

HDR

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Final 2023 San Antonio Regional Flood Plan

January 2023

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SAN ANTONIO
RIVER AUTHORITY

January 6, 2023

Reem J. Zoun, PE, CFM, ENV SP
Director of Flood Planning
Flood Planning
Texas Water Development Board

RE: Final Regional Flood Plan Submittal for the San Antonio Regional Flood Planning Group

Director Zoun,

Included in this transmittal are two hard copies and two electronic copies of the Final San Antonio Regional Flood Plan (Flood Plan), including one in searchable portable document format (PDF) and one in Microsoft Word format. Also included are an executive summary, a copy of the TWDB Comment Letter, and the requested geodatabases with spatial data associated with the Flood Plan.

On December 19, 2022, the San Antonio Regional Flood Planning Group (Region 12) approved and authorized the San Antonio River Authority to submit the Final Regional Flood Plan and associated data to the Texas Water Development Board. The Flood Plan was developed in accordance with Texas Water Code and 31 TAC Chapters 361 and 362. Region 12 met all requirements under the Texas Open Meetings Act and Public Information Act during the development of the Flood Plan.

We look forward to enhancing the information presented in the Flood Plan during the amendment process. If you have any questions, please don't hesitate to contact Kendall Hayes at (210) 302-3641 or via email at khayes@sariverauthority.org.

Thank you,

Derek Boese, JD, PMP

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TWDB Comments
TWDB Comments Response Log
Public Comments
Public Draft Plan Comments Response Log

List of Abbreviations

§	Section
ARPA	American Rescue Plan Act
BCA	benefit-cost analysis
BCR	benefit-cost ratio
BCRAGD	Bandera County River Authority and Groundwater District
BFE	Base Flood Elevation
BIL	Bipartisan Infrastructure Law
BLE	Base Level Engineering
BRIC	Building Resilient Infrastructure and Communities
BRWN	Bexar Regional Watershed Management
CDBG-DR	Community Development Block Grant Disaster Recovery Funds
CDBG-MIT	Community Development Block Grant – Mitigation
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan
COG	Council of Governments
CoSA	City of San Antonio
CRS	Community Rating System
CTP	Cooperative Technical Partnership
CWSRF	Clean Water State Revolving Fund
D2MR	Digital Data and Modeling Repository
DFirm	Digital Flood Insurance Rate Map
Dfund	Texas Water Development Fund
DOD	Department of Defense
DS	Downstream
EAP	emergency action plan
EMP	emergency management plan
EPA	United States Environmental Protection Agency
EWP	Emergency Watershed Protection
FEMA	Federal Emergency Management Agency
FIF	Flood Infrastructure Fund
FIMP	Flood Inundation Mapping Program
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
FME	Flood Management Evaluations
FMP	Flood Management Projects
FMS	Flood Management Strategies
FPR	Flood Planning Region
FWSD	Fresh Water Supply District
GIS	geographic information system
GLO	General Land Office
HALT	Highwater Alert Lifesaving Technology
HDR	HDR Engineering, Inc.
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
H&H	hydrologic and hydraulic

HHPD	Rehabilitation of High Hazard Potential Dam Grant Program
HIRA	Hazard Identification Risk Assessment
HMAP	hazard mitigation action plan
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUC	hydrologic unit code
HUD	Housing and Urban Development
LHMPP	Local Hazard Mitigation Plans Program
LID	low impact development
LOMR	Letters of Map Revision
LOS	level of service
LWC	low water crossing
MS4	Municipal Separate Storm Sewer Systems
MAP	Mapping, Assessment, and Planning
MUD	Municipal Utility District
N/A	not applicable
NBI	nature-based infrastructure
NBS	nature-based solution
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NHC	National Oceanic and Atmospheric Administration Hurricane Center
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCS	National Resources Conservation Service
NWS	National Weather Service
O&M	Operation and Maintenance
PA	Public Assistance
PFM	Predictive Flood Model
PUD	Planned Unit Development
RCP	Resilient Communities Program
RFC	River Forecast Centers
RFP	Regional Flood Plan
RFPG	Regional Flood Planning Group
SAFE	San Antonio Flood Emergency
SAFPR	San Antonio Flood Planning Region
SAR	San Antonio River
SARA	San Antonio River Authority
SCS	Soil Conservation Service
SFHA	Special Flood Hazard Areas
SFP	State Flood Plan
SLFRF	State and Local Fiscal Recovery Funds
SLR	sea level rise
STORM	Safeguarding Tomorrow through Ongoing Risk Mitigation
SUD	Special Utility District
SVI	Social Vulnerability Index
SWCD	Soil and Water conservation District
TAC	Texas Administrative Code
TBD	to be determined

TCEQ	Texas Commission on Environmental Quality
TDA	Texas Department of Agriculture
TDEM	Texas Division of Emergency Management
TFMA	Texas Floodplain Management Association
TNRIS	Texas Natural Resources Information System
TSSWCB	Texas State Soil and Water Conservation Board
TWDB	Texas Water Development Board
TxCDBG	Community Development Block Grant
TxDOT	Texas Department of Transportation
US	Upstream
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WCID	Water Control and Improvement Districts
WS	Watershed
WSEL	Water Surface Elevation Level

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ES

Executive Summary

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ES.1 General Description of the Region

In 2019, the 86th Texas Legislature adopted changes to the Texas Water Code Section (§)16.061 that established the regional and state flood planning process. Regional Flood Plans (RFPs) for 15 flood planning regions across the state will be compiled in the 2024 State Flood Plan (SFP). The Texas Water Development Board (TWDB) is charged with overseeing the development of RFPs and SFPs. TWDB appointed a Regional Flood Planning Group (RFPG) for each region, and the San Antonio River Authority (SARA) is the sponsor for the San Antonio Flood Planning Region (SAFPR). Table ES-1 lists the members of the San Antonio RFPG for the first flood planning cycle.

Table ES-1. SAFPR Membership

Member Name	Interest Category	Organization
Voting Members		
Brian Yanta	Agricultural	Goliad County
David Wegmann	Counties	Bexar County
Doris Cooksey	Electric-generating Utilities	CPS Energy
Debbie Reid	Environmental	Greater Edwards Aquifer Alliance
Nefi Garza	Flood Districts	City of San Antonio/Tetra Tech
Cara Tackett	Industries	Pape-Dawson Engineers
Jeffrey Carrol	Municipalities	City of Boerne
Robert Reyna	Municipalities	City of San Antonio
Suzanne Scott	Nonprofit	Nature Conservancy
John Beasley	Public	United States Army Environmental Command
Derek Boese	River Authorities	SARA
Steve Gonzales	Small Business	Neel-Schaffer, Inc.
Jose Reyes	Small Business	Maestas & Associates, LLC
David Mauk	Water Districts	Bandera County River Authority and Groundwater District
Steven Clouse	Water Utilities	San Antonio Water System

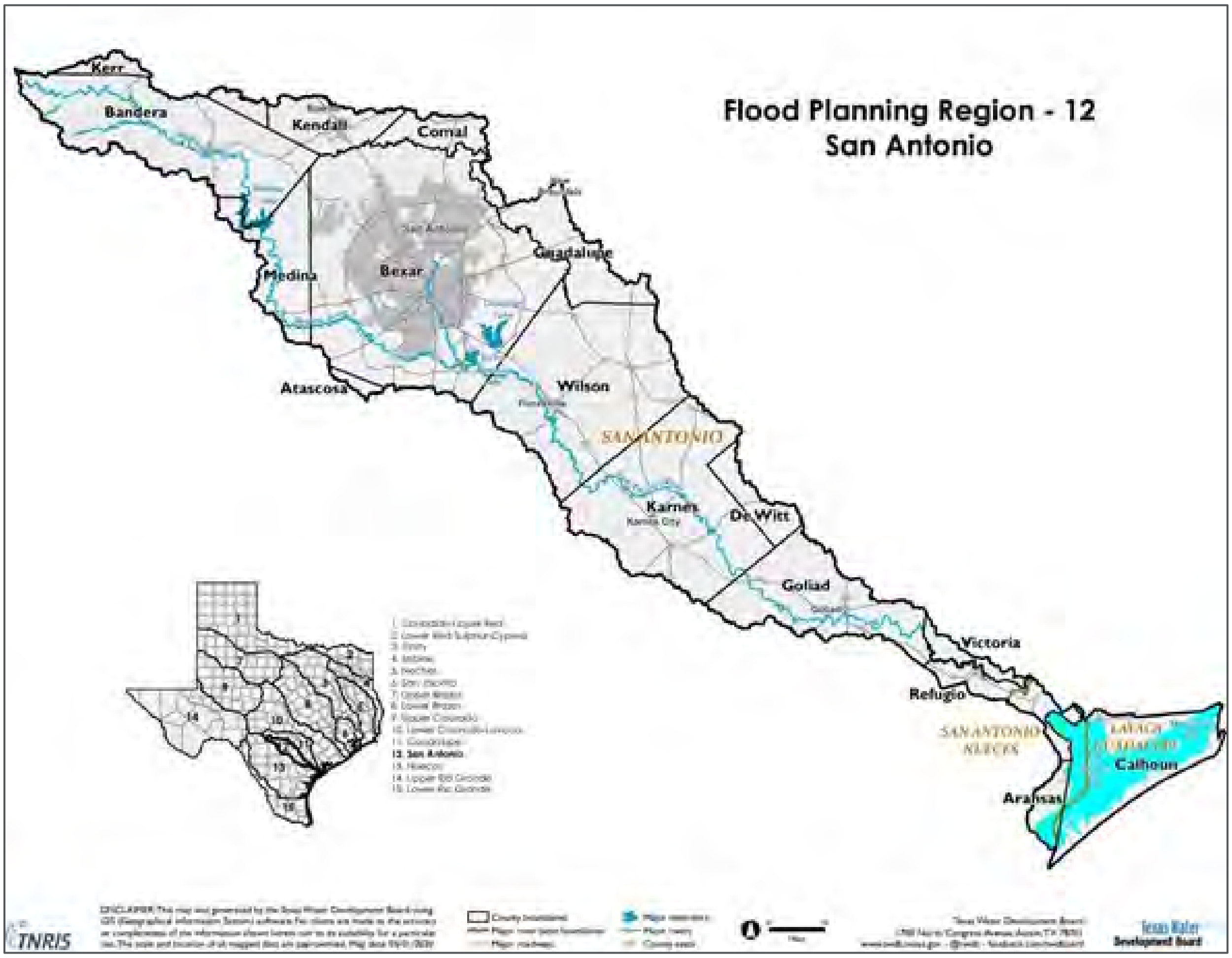
Member Name	Interest Category	Organization
Non-Voting Members		
Marty Kelly	—	Texas Parks and Wildlife Department
Natalie Johnson	—	Texas Division of Emergency Management
James Blount	—	Texas Division of Emergency Management
Jami McCool	—	Texas Department of Agriculture
Jarod Bowen	—	Texas State Soil and Water Conservation Board
Kris Robles	—	General Land Office
Anita Machiavello	—	TWDB
Joel Anderson	—	Texas Commission on Environmental Quality

ES.1.1 General Description

The SAFPR, Flood Planning Region (FPR) 12, consists of parts of Aransas, Atascosa, Bandera, Bexar, Calhoun, Comal, DeWitt, Goliad, Guadalupe, Karnes, Kendall, Kerr, Medina, Refugio, Victoria, and Wilson Counties. The SAFPR encompasses approximately 4,410 square miles (Figure ES-1), and is bounded on the west and south by TWDB FPR 13 (Nueces), on the north by TWDB FPR 11 (Guadalupe), and on the east by the Gulf of Mexico.

The planning area contains 110 entities, including 49 cities, 16 counties, 4 river authorities, and 41 additional entities with flood-related authority. The total population within the SAFPR is approximately 2,212,988, who live primarily within the San Antonio metropolitan area. Outside of the San Antonio area, the SAFPR is largely rural in nature, although significant growth is occurring in the portions of Comal, Guadalupe, Kendall, and Wilson Counties that lie within the planning region. The population of those four counties and Bexar County contain almost 97 percent of the total population of the region. Overall, the region is expected to grow by 40 percent between 2020 and 2050 to a population of approximately 3,095,520.

Figure ES-1. San Antonio FPR



Source: Texas Water Development Board, Flood Planning website, https://www.twdb.texas.gov/flood/planning/index.asp

ES.1.2 Existing Infrastructure Assessment

The San Antonio RFP collected information regarding natural features and constructed major infrastructure as well as added this information to a geographic information system geodatabase. This infrastructure includes rivers, wetlands, sinkholes, dams, levees, many miles of storm drains, and two large-diameter flood diversion tunnels. The existing infrastructure was assessed as functional, nonfunctional, and deficient. Five dams are considered nonfunctional, and three levee systems are considered deficient.

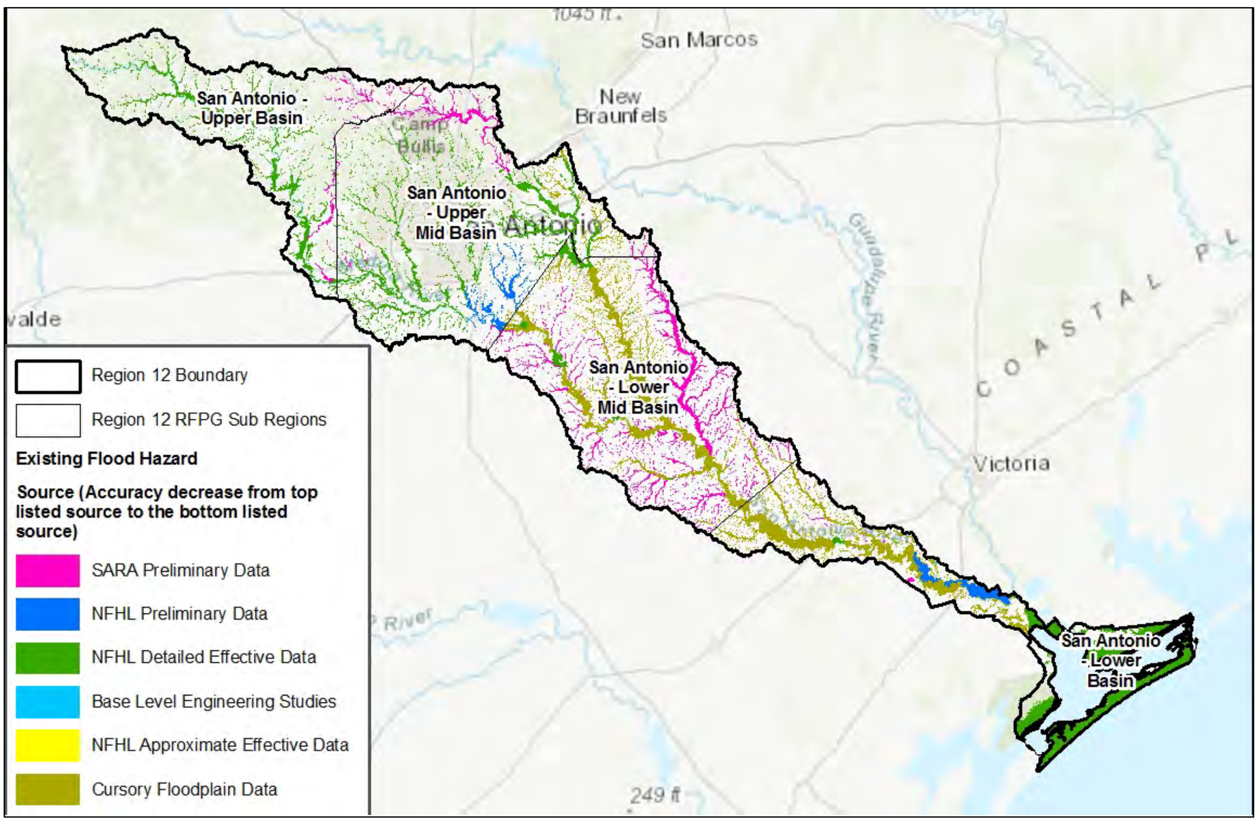
ES.2 Flood Risk Analysis

The San Antonio RFP determined the existing and future condition flood risk. The total flood risk is composed of three components: hazard, exposure, and vulnerability. Hazard defines the location, magnitude, and frequency of flooding. Exposure defines who and what might be harmed. Vulnerability identifies vulnerable communities and critical facilities.

ES.2.1 Inundation Boundary Models

The flood inundation boundaries are defined for the entire region using best available data, including detailed and approximate modeling and mapping data. Detailed models used for inundation mapping include National Flood Hazard Layer (NFHL) and SARA Preliminary Data. Part of the basin is based on approximate data, which includes Base Level Engineering (BLE), NFHL approximate, and Cursory Floodplain Data. BLE is estimated to be available for the entire basin by 2023. See Figure ES-2 for source of flood inundation boundaries used in the San Antonio RFP.

Figure ES-2. Source of Flood Modeling and Mapping Data



ES.2.2 Future Condition Analysis

A future condition flood risk analysis was performed to approximate the flood hazard extents projected in 30 years' time, or the year 2050, based on a "no-action" scenario specified by the TWDB.

ES.2.2.1 Inland Future Condition

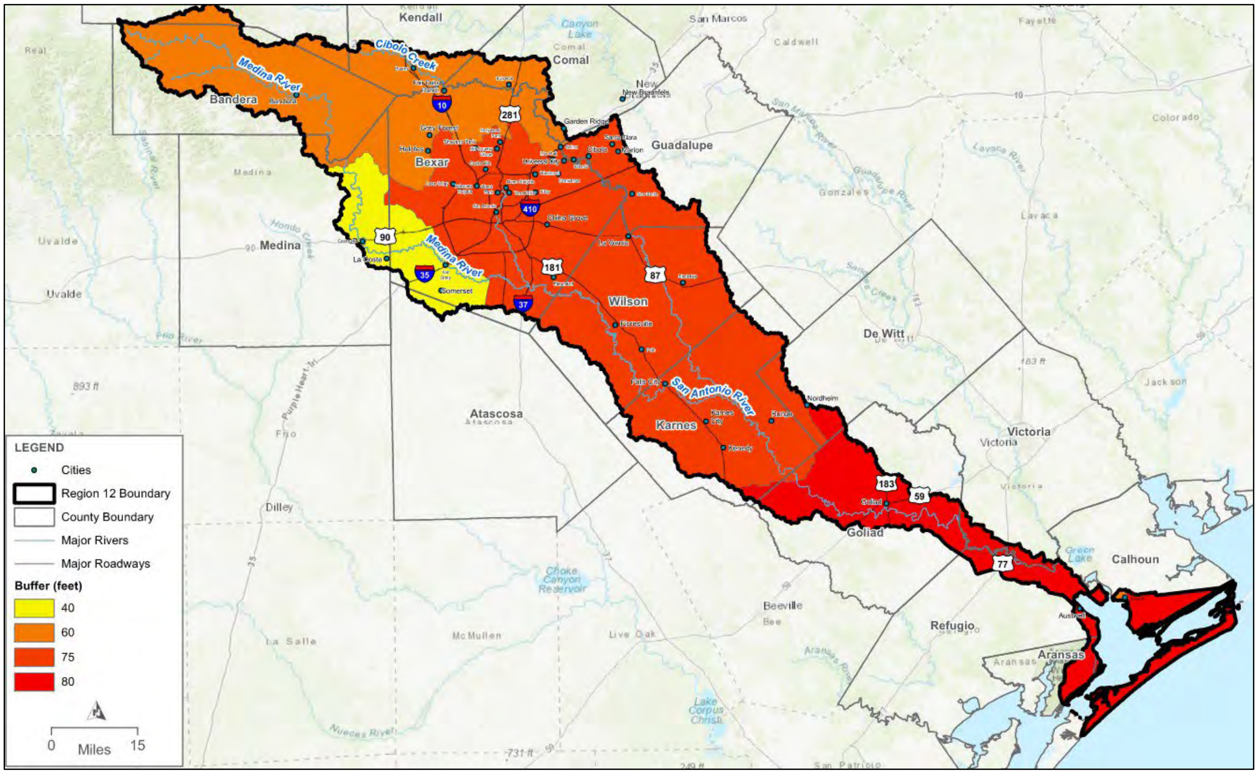
History has demonstrated that flood hazards tend to increase over time in populated areas due to projected increases in impervious cover, anticipated sedimentation in flood control structures, and other factors that result in increased or altered flood hazards. As a result, the future condition flood hazard area was defined based on an expected increase in flooding extents and magnitude across the SAFPR. The existing 0.2 percent flood risk areas were used as well as the future 1 percent flood risk areas as outlined by the TWDB. Existing studies on climate change and their effects on flows and water surface elevation level (WSEL) within the SAFPR were used to calculate the future 0.2 percent flood risk area given as a buffer value. Horizontal flood risk area buffers were calculated based on urbanization levels, location within the region, and general land slope. From the analysis, four buffers were applied to the SAFPR streams-based spatial location within the SAFPR: Upper, Mid, Coastal, and Medina River.

ES.2.2.2 Coastal Future Condition

Relative sea level rise (SLR) is also considered a significant factor in the future condition flood risk along the coastline. Based on best available data from the National Oceanic and Atmospheric Administration's *Global and Regional Sea Level Rise Scenarios for the United States* (2022 update)[1] a 1- to 2-foot relative SLR was estimated for the 2050 relative SLR condition. This 1- to 2-foot SLR matches closely with the future rise in riverine WSELs; therefore, the riverine buffer in the coastal region of 160 feet (80 feet on each side) was used for the future flood risk area development. Figure ES-3 shows the final buffer criteria.

[1] National Oceanic and Atmospheric Administration. 2017. NOAA Atlas 14 Point Precipitation Frequency Estimates. United States Department of Commerce, NOAA, National Weather Service, Office of Water Prediction. Page last modified April 21, 2017. Available at https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html.

Figure ES-3. Final Buffer Criteria

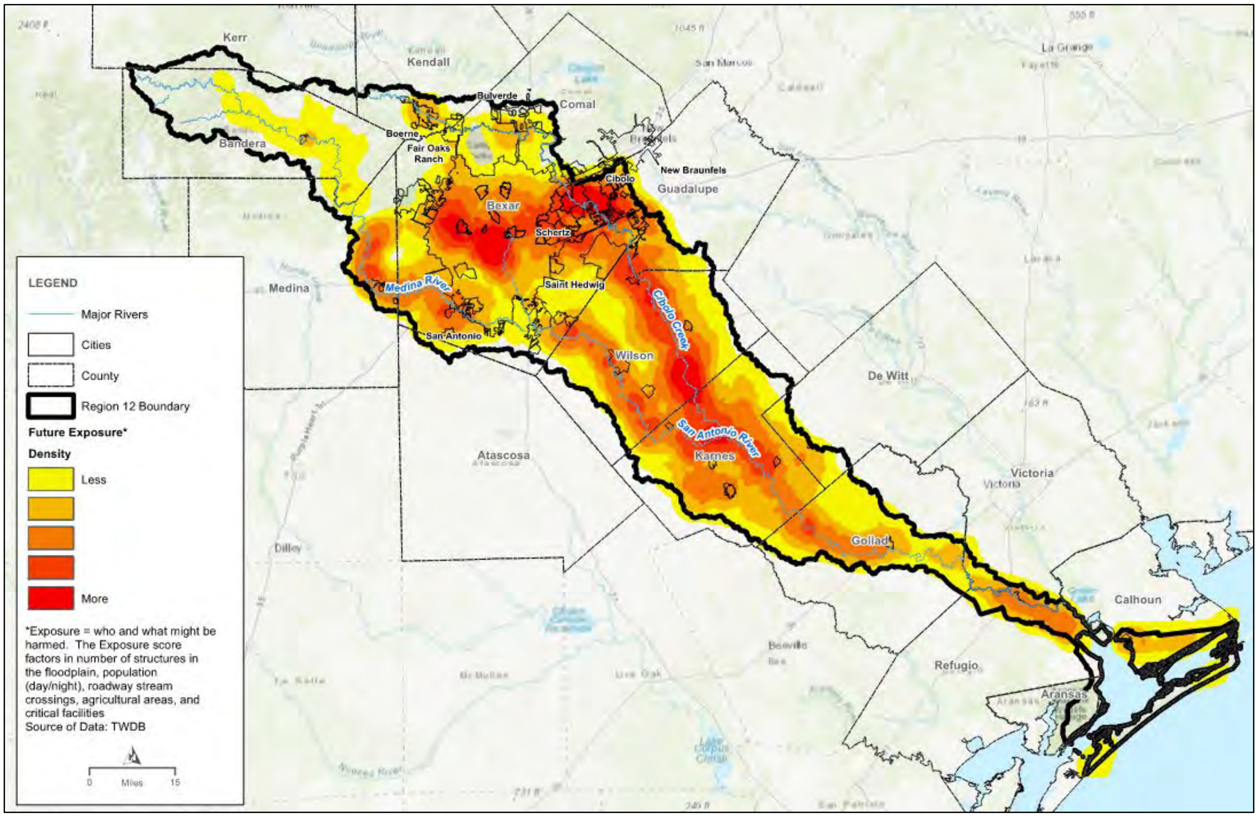


ES.2.3 Flood Exposure Analyses

In existing conditions, 19,120 structures, 753.07 miles of roadway, 2,767 roadway crossings, and 79.75 square miles of agricultural land are at potential risk of flooding from the 1 percent annual chance storm event. In future conditions, the number of existing structures exposed within the 1 percent flood risk area is expected to increase to 26,653 structures. However, this does not include the potential for construction of new structures built within the floodplain within areas with unregulated development.

From both existing and future analyses, several hot spots for flood exposure appear to be (1) the urban areas around the Cibolo and Medina Rivers, due to the density of development and total population in those areas; and (2) the confluence of the San Antonio and Cibolo Rivers, due to the magnitude of flood volume on each respective creek and similarity in watershed size. Additionally, flooded roadways and agricultural areas are found throughout the region, and impacts due to the loss of function within these areas should not be understated. Flood exposure for existing conditions is shown in Figure ES-4.

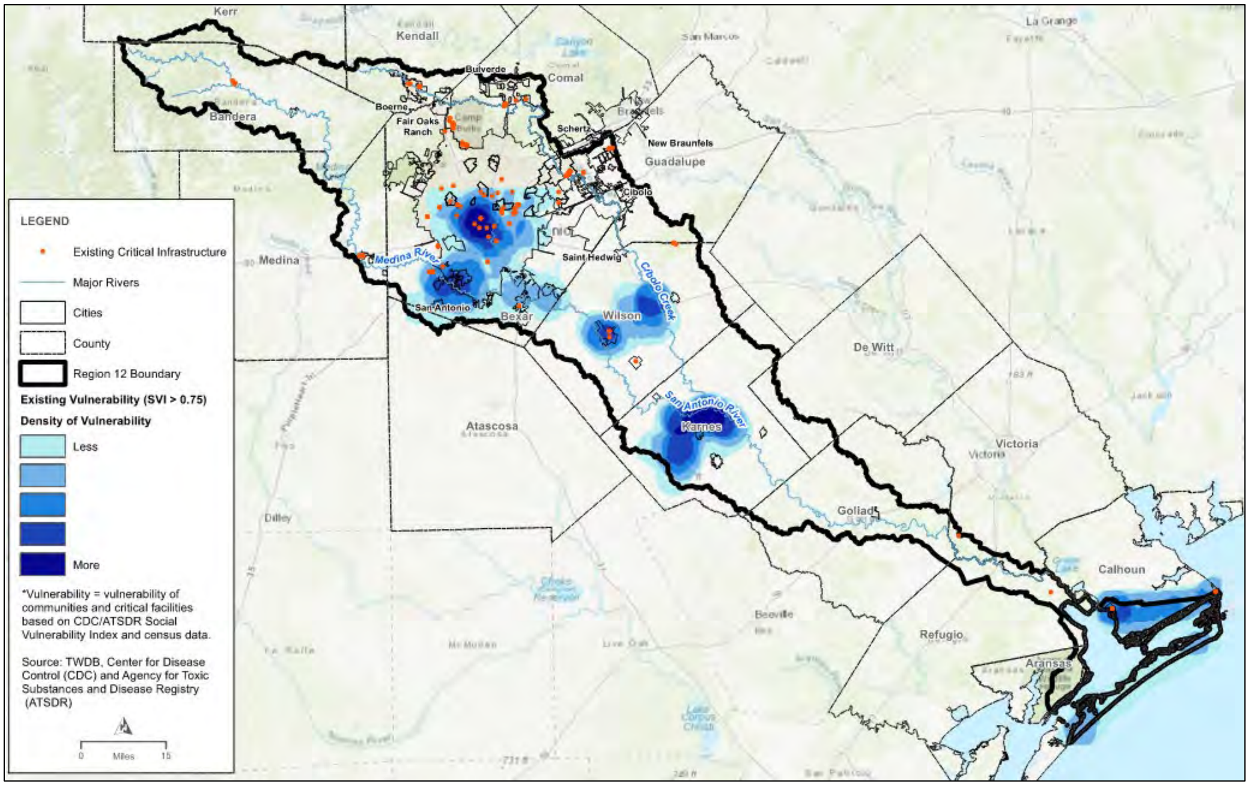
Figure ES-4. Existing Condition Flood Exposure Heat Map



ES.2.4 Vulnerability Analysis

Social Vulnerability Index (SVI) values from the Centers for Diseases Control were used to identify communities that may be less resilient and need more support before, during, or after disasters. SVI values were provided for all structures located within the region, and an evaluation was undertaken to determine where vulnerable structures are at flood risk within the basin. Additionally, the location of critical facilities at risk of flooding was also evaluated. Critical facilities include schools, hospitals, police stations, and fire stations. The analysis determined that 191 critical facilities are at risk of 1 percent annual chance storm event flood inundation. This increases to 220 critical facilities at risk in the future condition. Figure ES-5 shows hot spots for structural flooding in vulnerable areas. The potential effects from flooding could be higher in areas of high SVI value and critical infrastructure due to damage to the infrastructure and potential lack of services after the flooding event.

Figure ES-5. Existing Condition Vulnerability Heat Map



ES.3 Floodplain Management Practices and Flood Protection Goals

ES.3.1 Evaluation and Recommendation on Floodplain Management Practices

One of the goals of the San Antonio RFP is to evaluate and make recommendations on forward-looking floodplain management, land use, and economic practices. These practices play a key role in preventing the creation of additional flood risk in the future.

ES.3.1.1 Extent of Local Regulations and Development Codes

The level of floodplain management practices was identified as “strong,” “moderate,” “low,” or “none” based on criteria provided by the TWDB. Out of the 110 entities, 6 are classified as having a strong level, 27 are classified as having a moderate level, 30 are classified as having a low level of floodplain management practices, and zero are classified as none.

The level of floodplain management enforcement was identified as high, moderate, low, or none based on criteria provided by the TWDB. The San

Antonio region gathered 15 entity enforcement levels. Out of those 15 entity enforcement levels, 5 are classified as having a high level, 8 are classified as having a moderate level, 1 is classified as having a low, and 1 is classified as none as it did not have floodplain management enforcement.

ES.3.1.2 Minimum Floodplain Management Regulations

Minimum floodplain management regulations include compliance with Texas Water Code §16.3145 and the Federal Emergency Management Agency's (FEMA's) National Flood Insurance Program (NFIP) participation.
Section 16.3145 requires the adoption of necessary ordinances or orders for a city or county to be eligible for participation in the NFIP. NFIP participation is a wide-spread practice within the SAFPR, with 97 percent of cities and counties participating.

ES.3.1.3 Higher Floodplain Management Standards

Higher floodplain management standards can include an assortment of practices to further reduce flood risk above and beyond minimal standards. The Texas Floodplain Management Association (TFMA) produced a guide for higher standards in 2018 that describes 32 higher standard practices that, if implemented, would reduce flood risks[2]. According to the TFMA 2019 higher standard survey, of the 63 NFIP participating entities, a total of 32 entities have adopted higher standards[3].

ES.3.1.4 Recommended Floodplain Practices

The San Antonio RFPG does not have the authority to enact or enforce floodplain management, land use, or other infrastructure design standards. Thus, the San Antonio RFPG aims to encourage implementation of recommended floodplain practices by local entities in the region with flood-related authority. The San Antonio RFPG recommends that entities that are not currently NFIP participants should adopt at least the minimum standards and take the necessary steps to become active NFIP participants. Higher standards are outlined in the goals found in Section 3.2.2 Goals. The San Antonio RFPG recommends those goals as higher standards for entity floodplain management practices.

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[2] TFMA. 2018. A Guide for Higher Standards in Floodplain Management. May 2018. Available at https://www.tfma.org/page/documents-reports.

[3] TFMA. 2019. 2019 Higher Standards Survey Summary. Available at https://www.tfma.org/page/documents-reports.

ES.3.2 Floodplain Mitigation and Floodplain Management Goals

The San Antonio RFPG developed short- and long-term goals with the objective to protect against the loss of life and property. The short-term goals have a target date of 10 years (or 2033), and the long-term goals have a target date of 30 years (or 2053). These 33 goals identify specific and achievable flood mitigation and floodplain management goals that, when implemented, will demonstrate progress toward the overarching objective to protect life and property. When determining the flood mitigation and floodplain management goals, the San Antonio RFPG established six overarching goal categories.

1. Education and Outreach
2. Flood Warning and Readiness
3. Flood Studies and Analysis
4. Flood Prevention
5. Non-Structural Flood Infrastructure Projects
6. Structural Flood Infrastructure Projects

Once implemented, the specific goals detailed in this section will fulfill the TWDB's overarching goals of identifying and reducing the risk and impact to life and property as well as avoiding increasing or creating new flood risk by addressing future development within the areas known to have existing or future flood risk.

ES.4 Flood Mitigation Needs Analysis

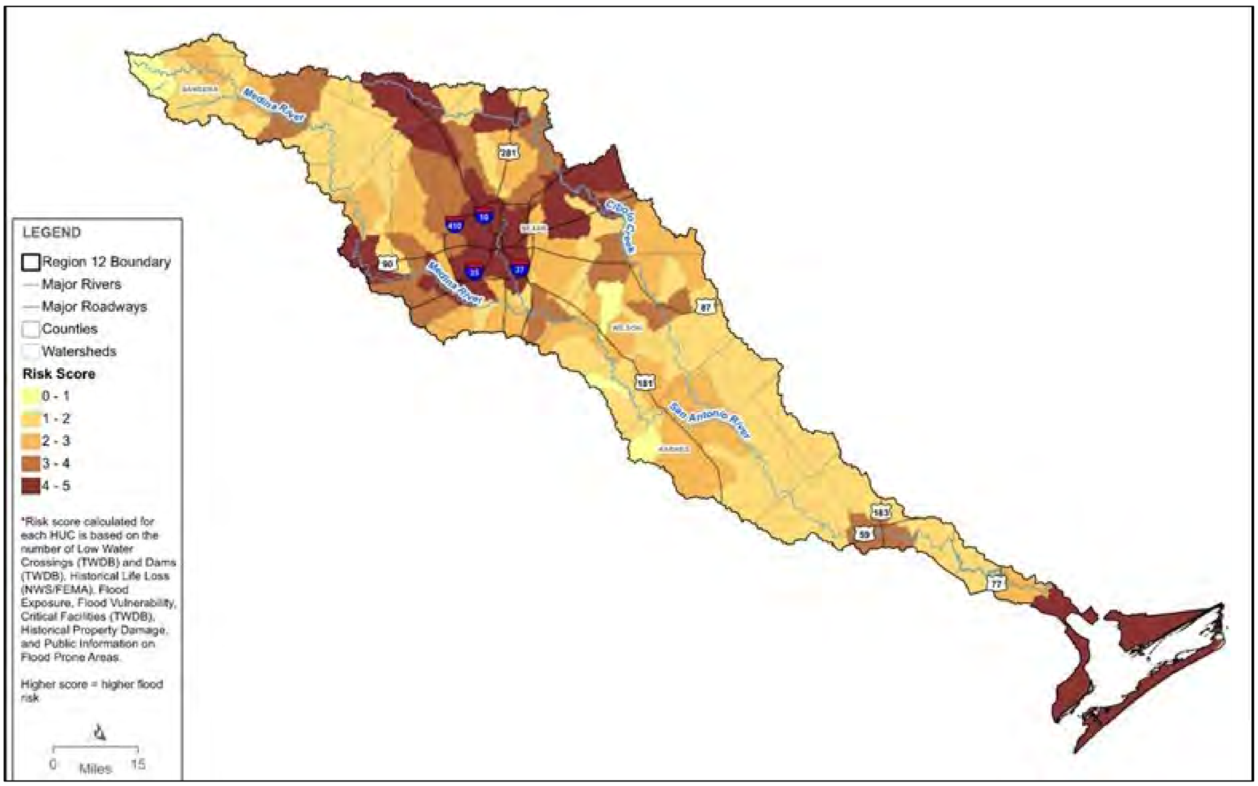
The San Antonio RFPG performed an assessment and identified flood mitigation needs. This analysis identified where the greatest flood risk knowledge gaps exist as well as where known flood risk and flood mitigation needs are located within the SAFPR. This analysis resulted in information that guided the identification of flood mitigation actions.

ES.4.1 Greatest Flood Risk and Flood Mitigation Needs

The areas of greatest known flood risk and flood mitigation needs within the SAFPR are defined as areas with elevated levels of risk to property and life. The level of risk is defined by looking at the location and magnitude of flooding from the 1 percent (100-year) and 0.2 percent (500-year) annual chance flood event (flood hazard), who and what may be harmed (flood exposure), and what communities and critical facilities may be vulnerable (flood vulnerability).

An analysis of known flood risk data was performed based on 180 hydrologic unit code (HUC)-12 individual watersheds. The flood risk data related to property damage and life loss risk was evaluated for each watershed within the SAFPR. This included assigning weighting percentages to data on historical property damage, historical life loss, property damage in terms of exposure and vulnerability, and life loss potential at low water crossings (LWCs) and downstream of hydraulically inadequate or deficient potential hazardous dams. As a result of this analysis, each watershed was assigned a score of 0 to 5, with no risk represented by a score of zero and the highest risk represented by a score of 5 (see Figure ES-6).

Figure ES-6. Overall Flood Risk per HUC-12 Watershed



ES.5 Identification, Evaluation, and Recommendation of Flood Mitigation Actions

The regional flood planning efforts identified, evaluated, and recommended flood management actions, which include flood mitigation projects (FMPs), flood management evaluations (FMEs), and flood management strategies (FMSs). Flood management actions were identified to reduce the risk identified in the existing and future condition flood risk analyses, to address flood mitigation and floodplain management goals as well as the greatest flood risk and flood mitigation needs.

An FMP is a proposed project, either structural or nonstructural, that has non-zero capital costs or other non-recurring costs and, when implemented, will reduce flood risk and mitigate flood hazards to life or property. An FME is a proposed flood study of a specific, flood-prone area that is needed to assess flood risk and/or determine whether potentially feasible FMSs or FMPs occur. An FMS is a proposed plan to reduce flood risk or mitigate flood hazards to life or property, and typically includes flood mitigation education and outreach, buyout programs, and flood management regulations.

ES.5.1 Identification of Flood Mitigation Actions

The San Antonio RFPG developed a proposed process to identify and select flood mitigation actions. To identify flood mitigation actions, a review of previous relevant flood studies was conducted, stakeholder outreach was conducted, and an evaluation was performed to determine additional studies needed to address the greatest known flood risk, flood mitigation needs, and unmet floodplain mitigation and floodplain management goals. A list of 16 prior relevant studies were reviewed, which included many regional hazard mitigation action plans and other flood-related master plans.

ES.5.2 Evaluation and Recommendation of Flood Mitigation Actions

The San Antonio RFPG created a Technical Subcommittee tasked with establishing a selection methodology, implementing the evaluation and selection process, and reporting their findings and recommendations back to the San Antonio RFPG for formal approval. The methodology included screening all potential flood mitigation actions based on the general process and any other additional considerations established by the Technical

Subcommittee. On June 27, 2022, the San Antonio RFPG voted to recommend FMEs, FMPs, and FMSs as presented.

ES.5.2.1 Recommended Flood Management Projects, Evaluations and Strategies

A total of 28 potential FMPs were identified and evaluated by the San Antonio RFPG. Of these, all were recommended, representing a combined total of $464,800,000 of flood mitigation infrastructure projects need across the region.

A total of 163 potential FMEs were identified and evaluated by the San Antonio RFPG. Of these, all were recommended, representing a combined total of $794,400,000 of FME needs across the region. The recommended FMEs include 141 project planning/evaluation projects, 20 watershed planning projects, and 2 flood resiliency projects.

A total of 19 potential FMSs were identified and evaluated by the San Antonio RFPG. Of these, all were recommended, representing a combined total of $999,000 of FMS needs across the SAFPR. The recommended FMSs include 11 education and outreach projects, 7 regulatory and guidance projects, and 1 flood measurement and warning projects.

ES.6 Impact and Contribution of the Regional Flood Plan

RFPs must include a regionwide assessment of the potential contributions and impacts that implementation of the RFP can be expected to have on water supplies and the State Water Plan. As part of this analysis, each FMS and FMP was reviewed to determine whether potential impacts could occur to existing water supplies or the availability of water supplies. Impacts include potential contributions to, as well as reductions in, water supply and availability.

ES.6.1 Impacts of Regional Flood Plan

Impacts are determined before and after RFP implementation of recommended flood mitigation actions relative to existing and future flood risk. The comparison of before and after RFP implementation estimates 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 (that might otherwise arise if no changes were made to floodplain policies) will be avoided through RFP implementation, including recommended changes/improvements to the region's floodplain management policies.

The evaluation estimated the implementation of recommended FMPs could benefit 3,582 exposed structures, 912 square miles, 22 LWCs, and 13 miles of road at risk in the future 100-year flood hazard.

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

A coordinated effort with representatives from multiple regional water planning groups occurred to identify water management strategies that could be impacted. Those regional water planning groups include Region J (Plateau), Region L (South Central Texas), and Region N (Coastal Bend). The San Antonio RFPG has not identified any negative impacts to the State Water Plan. However, it was determined that three FMPs were located over the Trinity Aquifer and have the potential to add to water supply availability.

ES.7 Flood Response Information and Activities

Flood response information was gathered through stakeholder outreach to flood-related authorities within the SAFPR. Flood response activities, preparedness, response, and recovery measures were then summarized for the various entities within the basin. The plan also summarizes state and federal agency roles in flood response support and provides a description of various means by which data is collected and disseminated in a flood event. This information is provided to help others within the basin develop flood response and recovery programs. Note, the San Antonio RFP only summarizes the nature and types of flood response preparations within the basin, including recovery, but does not perform analyses or other activities related to planning for disaster response or recovery.

ES.7.1 Emergency Information

The National Weather Service, local news stations, and radio stations are vital components in relaying real-time information to residents of inclement weather and flooding. They can also alert residents to LWC closings, dam or levee breaches, and other potential dangers. They can also issue flood watches, warnings, and emergency notifications. Various entities within the SAFPR maintain websites to provide the public with real-time information about flooded streets and places to avoid.

ES.7.2 Alert Systems

Bexar County has implemented a new system known as High Water Alert Life Saving Technology (HALT) to warn drivers about too much water over the road, which would create unsafe conditions. A sensor detects rising water depth, initiating flashing lights or a combination of gates and lights once a certain depth is reached. The county has installed more than 150 HALT systems in the community, monitoring road conditions 24 hours per day, 7 days per week. In addition to lights and gates, the county has set up an interactive website[4] with information and a map displaying the status of all the county's LWCs at any given time. The City of San Antonio (CoSA) has a similar system called SAFE ROUTE[5], which monitors LWCs and provides alternative routes to local drivers.

Rain and stream gages are useful for a variety of flood warning systems that cities, counties, and the region employ to keep citizens informed. SARA's Predictive Flood Model (PFM) is a continuous simulation software that ingests Next Generation Weather Radar weather radar rainfall estimates; gages rainfall and stream level; runs VFlo model hydrology and hydraulics to estimate stream flow, depth, velocity, maximum flood inundation, and swift-water rescue risk; and produces short-term stream forecasts at selected warning points anywhere within the inundation grid. The recently expanded warning system covers all of Bexar County with stream-related products. The PFM also provides gage-adjusted radar rainfall totals and forecasts for the entire San Antonio River basin. The PFM dynamic hydraulic models produce alerts and flood inundation maps every 15 minutes.

In collaboration with the United States Geological Survey (USGS), Bandera County River Authority and Ground Water District developed a tool set in 2018 that provides a flood warning system for Bandera County. The tool set consists of streamflow-gage monitoring network, a Hydrologic Engineering Center River Analysis System that creates a well calibrated hydraulic model of the Medina River. It has the ability to generate flood inundation maps in the USGS Flood Inundation Mapping Program (FIMP) website and a Decision Support System. The hydraulic model of Medina River at and near Bandera was created using high resolution digital elevation data, aerial photographs, field surveys on structure and channel cross sections, and the stage-discharge rating curve that was established at the Bandera Station. This information was used to develop 29 flood-inundation maps showing potential inundation areas and depths for stages ranging from 10 to 38 feet. The river

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[4] BEXARflood.org

[5] https://gis.sanantonio.gov/OEM/SAFE/index.html

is continuously measured at all gages every 15 minutes, and data are transmitted every hour to a satellite. This information is publicly accessible through the USGS FIMP[6].

ES.7.3 Local Mitigation and Action Plans

To examine the state of its flood preparedness, the San Antonio RFPG obtained emergency management plans, hazard mitigation plans, and other regional and local flood planning studies from county and local jurisdictions. An emergency management plan is a course of action developed to mitigate the damage of potential events that could endanger an organization's ability to function. Such a plan should include measures that provide for the safety of personnel and, if possible, property and facilities.

The SAFPR has several plans and regulations in place that provide the framework that describes a community's capabilities in implementing mitigation and preparedness actions. These include hazard mitigation action plans (HMAPs), emergency action plans (EAPs), emergency management plans (EMPs), floodplain management plans, and watershed master plans. Table 7-4 in Chapter 7 Flood Response Information and Activities summarizes existing HMAPs and EMPs adopted within the SAFPR. Thirteen Hazard Mitigation Plans and HMAP have been identified for the following areas: Aransas, Bexar, Calhoun, Comal, DeWitt, Guadalupe, Wilson, Karnes, Kendall, Kerr, Medina, Refugio, and Victoria Counties as well as the CoSA.

As part of the Texas Commission on Environmental Quality (TCEQ) Dam Safety Program, owners of significant-hazard and high-hazard dams are required to submit an EAP to the TCEQ. Dam EAPs document responsibilities during flood response and identify the flood inundation area. Of the 162 dams within the SAFPR, 71 have EAPs.

The SAFPR'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 SAFPR will be better equipped to implement sound measures for flood mitigation and preparedness.

[6] USGS. 2018. Flood Inundation Mapping (FIM) Program. Available at https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program.

ES.8 Administrative, Regulatory, and Legislative Recommendations

The San Antonio RFPG has provided administrative, regulatory, legislative and regional flood planning process recommendations for inclusion in the 2023 Plan. These recommendations were vetted through a subcommittee and presented and adopted by the planning group. Forty recommendations were provided within the categories of administration/regulatory (12), legislative (11), and Flood Planning Process (17).

The administrative, regulatory, legislative, and flood planning recommendations have been selected and proposed by the San Antonio RFPG to make floodplain management as well as flood mitigation planning and implementation throughout Texas more efficient and logical. From a legislative perspective, funding is one of the greatest challenges. Providing more state legislature-backed funding will allow entities to minimize additional flood risks as well as protect life and property. The administrative recommendations have been proposed to aid entities in their floodplain and stormwater management practices. Many communities are hesitant to enact higher standards due to the concern that future legislative acts will limit their ability to regulate. For future flood planning, recommendations were made to improve future SAFPR efforts. Clarifying and editing current requirements will improve the overall flood planning process and reduce future costs to taxpayers. These recommendations will aid in fulfilling the SAFPR goals discussed in Chapter 3 Floodplain Management Practices and Flood Protection Goals.

ES.9 Flood Infrastructure Financing Analysis

Chapter 9 Flood Infrastructure Financing Analysis is an analysis of the funding for flood-related issues within the SAFPR. Communities within the region were surveyed to determine the needs, costs, and proposed methods of funding to address current flood-related issues. This chapter also presents an overview of common sources of funding for flood mitigation, planning, projects, and other flood management efforts. The methodology, results of the financing survey, and comments regarding the state’s role in financing are also included.

ES.9.1 Local Funding

The communities within the SAFPR are affected by flooding issues and have been proactively addressing many of these issues to the best of their funding ability. Flood studies and projects have been typically funded by individual communities as they apply for available funding through the various state and federal programs and through their own financial resources via fees, taxes, and bonds. These efforts are intended to address local flooding issues typically on a smaller scale for smaller communities and a larger scale for larger communities.

For example, smaller communities such as Castroville, La Vernia, and Floresville have been diligently funding projects with their own funds and with as much state and federal funding that can be obtained. The CoSA's Proposition B in May 2022 was passed to apply $169,873,000 in bonds toward flood control and drainage projects. This was preceded in the city's 2017–2022 Bond Program by an investment that was approximately equal to that amount for flood control and drainage projects. In 2007, Bexar County embarked on a 10-year, $500 million Flood Control Program that constructed more than 50 flood mitigation projects to alleviate some of the area's most pressing flood concerns. Wilson and Karnes Counties received a FEMA Hazard Mitigation Multi-Jurisdictional Assistance grant for planning to reduce long-term risk from natural hazards and disasters. SARA has provided funding for studies through grants and its own general fund investments for flood issues throughout the San Antonio River Basin, such as the 2019 United States Department of Homeland Security's FEMA Cooperative Technical Partnership Program Cooperative Agreement grant for $1,365,400 for flood prevention, mitigation, and protection through mapping updates throughout the basin.

ES.9.2 State Funding

Today, communities have a broader range of state funding sources and programs available due to new grant and loan programs that did not exist as recently as 5 years ago. It is important to note that state 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 within 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 SFP 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 RFP will be included in the overall SFP and will therefore be eligible for this funding source.

ES.9.3 Federal Funding

Multiple avenues are available to receive federal funding through the various federal agencies, including FEMA, United States Department of Housing and Urban Development, United States Army Corps of Engineers, United States Environmental Protection Agency, United States Department of Agriculture, and special appropriations. Recent special appropriations of note include the 2021 American Rescue Plan Act (ARPA) and the 2021 Infrastructure Investment and Jobs Act, also called the Bipartisan Infrastructure Law (BIL). ARPA delivered $350 billion directly to local, state, and tribal governments through the Coronavirus State and Local Fiscal Recovery Funds. The BIL authorized more than $1 trillion for infrastructure spending across the United States and will provide a significant infusion of resources over the next several years into existing federal financial assistance programs, including several of the flood funding programs discussed above.

ES.9.4 Overall Need for Funding

A total of 28 entities within the SAFPR sponsored the FMEs, FMSs, and FMPs that are recommended by the RFPG. These 28 sponsors were contacted about funding needs to implement these projects; to date, 15 sponsors have responded, which represents a response rate of 54 percent.

The total cost for all the FMP, FME, and FMS projects recommended in the RFP is $1,260,123,000. Based on the funding split specified by each sponsor for each project, of this $1,260,123,000, it is projected that $1,061,702,322 in state and federal grant funding is needed for implementation of these projects.

ES.10 Adoption of the Plan and Public Participation

ES.10.1 Public Participation

Public participation has aided every aspect of the San Antonio RFP development, from the identification of flood risks and management and mitigation project needs to the formation of legislative and policy recommendations specific to the SAFPR. The San Antonio RFPG provided opportunity for the public to participate in the regional flood planning process at RFPG meetings and public outreach events. San Antonio RFPG meeting agendas and other meeting materials were posted on the SAFPR website[7] prior to each meeting. The public was invited to speak during public comment periods during each meeting.

The San Antonio RFPG conducted six public meetings throughout the watershed in accordance with TWDB requirements and the approved bylaws. Public meeting summary reports can be found in Appendix C.

The public hearing to receive comments on the *Draft 2023 San Antonio Regional Flood Plan* was held on September 15, 2022, providing sufficient time to accept public comments according to statute to meet the January 10, 2023, deadline for submission of the adopted Final RFP. Hard copies of the Draft RFP were provided as required, and the Draft RFP was posted on the SAFPR website[8] for public review and comment.

ES.10.2 Adoption of Plan

On July 25, 2022, the San Antonio RFPG approved and authorized the submittal of the *Final 2023 San Antonio Regional Flood Plan* and associated data to the TWDB. The Final RFP was developed in accordance with Texas Water Code and 31 Texas Administrative Code Chapters 361 and 362 and conforms with the 39 guiding principles. The San Antonio RFP also met all requirements under the Texas Open Meetings Act and Public Information Act during the development of the Plan.

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[7] https://www.region12texas.org/

[8] https://www.region12texas.org/

1

Planning Area Description

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1 Planning Area Description

[31 TAC Section [§] 361.30-32]

1.1 Background

In 2019, the 86th Texas Legislature passed Senate Bill 8, which established a regional and state flood planning process for 15 identified Flood Planning Regions (FPR) across the state (31 Texas Administrative Code (TAC) Chapters 361 and 362). Information from each of the 15 2023 Regional Flood Plans (RFPs) will be compiled in the 2024 State Flood Plan (SFP). The Texas Water Development Board (TWDB) oversees the development of each RFP and compiles the SFP. The TWDB is also charged with providing funding for investments in flood science and mapping efforts to support development of the RFPs.

The investments and planning efforts represent an important step in Texas flood planning, because:

- Flood risks, impacts, and mitigation costs have never been assessed at a statewide level;
- Flood risks pose a serious threat to lives and livelihoods across the state; and
- Much of the flood risk within Texas is unmapped or based on out-of-date maps.

RFPs are required to be based on the best available science, data, models, and flood risk mapping. When complete, the RFPs will focus both on reducing existing risk to life and property as well as on enhancing floodplain management to avoid increasing flood risk in the future. The first RFPs must be submitted to the TWDB by January 10, 2023. The TWDB will then compile these RFPs into a single SFP and present it to the Texas Legislature in 2024. An updated version of the SFP will be developed every 5 years thereafter.

The TWDB has appointed a Regional Flood Planning Group (RFPG) for each region and has provided them with funding to prepare their plans. The TWDB administers the regional flood planning process through a contract with the planning group's sponsor, which is selected by the RFPG.

The San Antonio Flood Planning Region (SAFPR) sponsor is the San Antonio River Authority (SARA). The Texas Legislature also allocated funding to be distributed by the TWDB for the procurement of technical assistance to develop the RFPs. HDR Engineering, Inc. (HDR) was selected through a competitive process to assist the San Antonio RFPG in developing the 2023 San Antonio RFP.

Stakeholders residing in and representing various interest categories were appointed for each region to provide representation and lead a bottom-up approach to developing the 2023 San Antonio RFP. The San Antonio RFPG's responsibilities include directing the work of the technical consultant, soliciting and considering public input, identifying specific flood risks, and identifying and recommending flood management evaluations, strategies, and projects to reduce risk in their regions. To ensure a diversity of perspectives are included, members represent a wide variety of stakeholders potentially affected by flooding. Interest categories include:

1. Public
2. Nonprofit (category added by the San Antonio RFPG)
3. Counties
4. Municipalities
5. Industries
6. Agriculture
7. Environmental
8. Small Business
9. Electric-generating Utilities
10. River Authorities
11. Water Districts
12. Water Utilities
13. Flood Districts

Table 1-1 lists the members of the San Antonio RFPG for the first flood planning cycle.

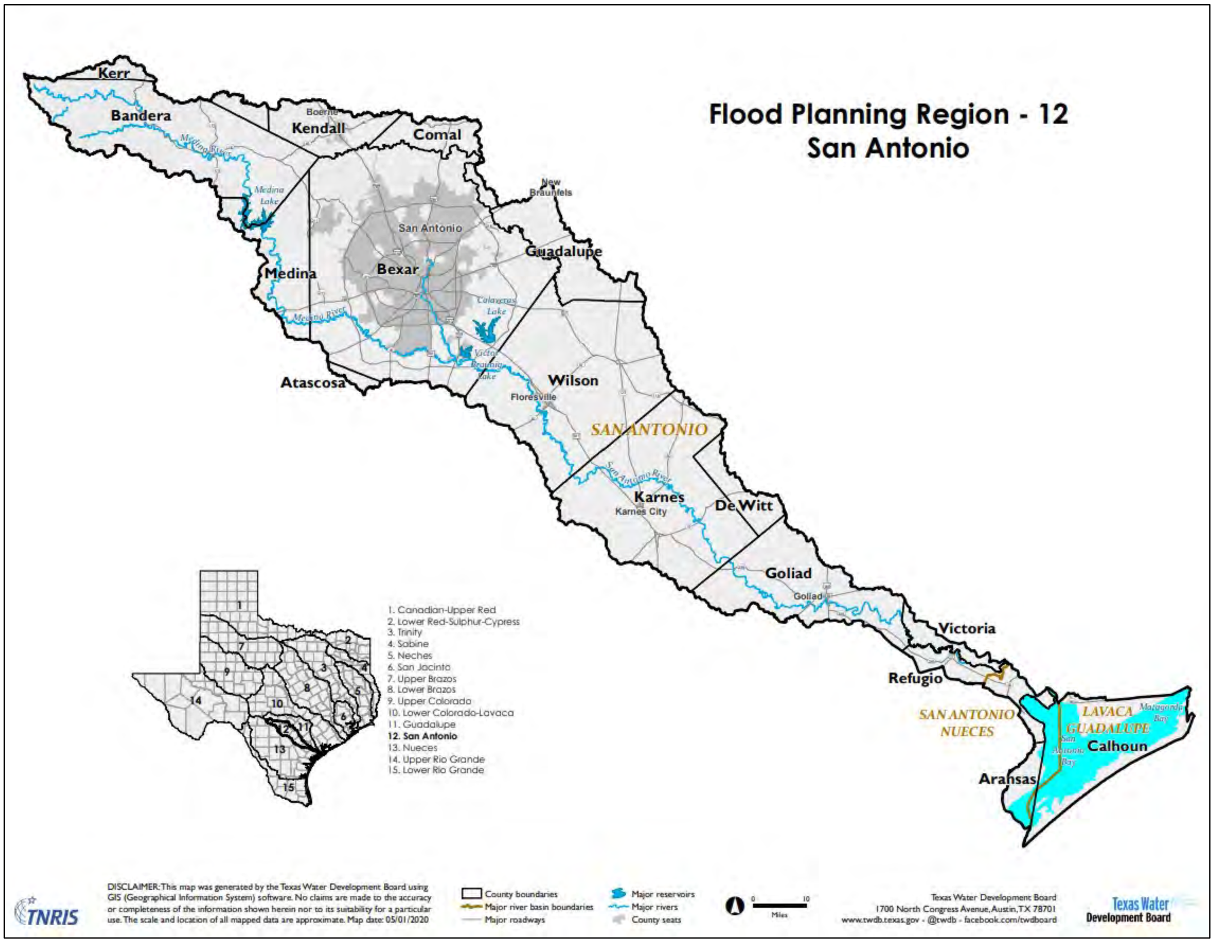
Table 1-1. San Antonio RFPG Members

Member Name	Interest Category	Organization
Voting Members		
Brian Yanta	Agricultural	Goliad County
David Wegmann	Counties	Bexar County
Doris Cooksey	Electric-generating Utilities	CPS Energy

Member Name	Interest Category	Organization
Debbie Reid	Environmental	Greater Edwards Aquifer Alliance
Nefi Garza	Flood Districts	City of San Antonio/Tetra Tech
Cara Tackett	Industries	Pape-Dawson Engineers
Jeffrey Carrol	Municipalities	City of Boerne
Robert Reyna	Municipalities	City of San Antonio
Suzanne Scott	Nonprofit	Nature Conservancy
John Beasley	Public	United States Army Environmental Command
Derek Boese	River Authorities	SARA
Steve Gonzales	Small Business	Neel-Schaffer, Inc.
Jose Reyes	Small Business	Maestas & Associates, LLC
David Mauk	Water Districts	Bandera County River Authority and Groundwater District
Steven Clouse	Water Utilities	San Antonio Water System
Non-Voting Members		
Marty Kelly	—	Texas Parks and Wildlife Department
Natalie Johnson	—	Texas Division of Emergency Management
James Blount	—	Texas Division of Emergency Management
Jami McCool	—	Texas Department of Agriculture
Jarod Bowen	—	Texas State Soil and Water Conservation Board
Kris Robles	—	General Land Office
Anita Machiavello	—	TWDB
Joel Anderson	—	Texas Commission on Environmental Quality

The SAFPR, FPR 12, consists of parts of Aransas, Atascosa, Bandera, Bexar, Calhoun, Comal, DeWitt, Goliad, Guadalupe, Karnes, Kendall, Kerr, Medina, Refugio, Victoria, and Wilson Counties. The SAFPR encompasses approximately 4,410 square miles (Figure 1-1), and is bounded on the west and south by TWDB FPR 13 (Nueces), on the north by TWDB FPR 11 (Guadalupe), and on the east by the Gulf of Mexico. In 2019, this region had a population of approximately 2,212,988.

Figure 1-1. San Antonio FPR



Source: TWDB, Flood Planning website, https://www.twdb.texas.gov/flood/planning/index.asp

1.2 Goal and Purpose of the 2023 San Antonio Regional Flood Plan

All RFPs are to be developed according to 39 guiding principles (see 31 TAC §362.3). The 2023 San Antonio RFP will focus on identifying both existing and future condition flood risks within the SAFPR; evaluating flood hazard exposure to life and property; identifying and evaluating potentially feasible flood management strategies and flood mitigation projects; and presenting recommended strategies and projects that minimize residual flood risk and provide effective and economical management of flood risk to people, properties, and communities as well as associated environmental benefits, among other information.

1.3 San Antonio Regional Flood Planning

Table 1-2 lists the counties considered in the development of the SAFPR, FPR 12. Small portions of Atascosa (FPR 13), Aransas (FPR 13), Kerr (FPR 11), Medina (FPR 13), and Refugio (FPR 13) Counties are also located within the SAFPR, but they were not considered during the development of the San Antonio RFP since the vast majority of each of these counties are in other regions, and they are unlikely to enact county-wide actions specific to the SAFPR. The Town of Tivoli is an unincorporated city that was considered but is not included in the 2023 RFP.

Table 1-2. Counties within the SAFPR

County	County	County	County
Aransas County	Calhoun County	Guadalupe County	Medina County
Atascosa County	Comal County	Karnes County	Refugio County
Bandera County	DeWitt County	Kendall County	Victoria County
Bexar County	Goliad County	Kerr County	Wilson County

Table 1-3 lists the municipalities considered in the development of the SAFPR.

Table 1-3. Municipalities within the SAFPR

Municipality	Municipality	Municipality	Municipality
City of Alamo Heights	City of Falls City	City of La Coste	City of Santa Clara
City of Austwell	City of Floresville	City of Leon Valley	City of Schertz
City of Balcones Heights	City of Garden Ridge	City of Live Oak	City of Seadrift
City of Bandera	City of Goliad	City of Marion	City of Selma
City of Boerne	City of Grey Forest	City of New Berlin	City of Shavano Park
City of Bulverde	City of Helotes	City of New Braunfels	City of Somerset
City of Castle Hills	City of Hill Country Village	City of Nordheim	City of St. Hedwig

Municipality	Municipality	Municipality	Municipality
City of Castroville	City of Hollywood Park	City of Olmos Park	City of Stockdale
City of China Grove	City of Karnes City	City of Poth	City of Terrell Hills
City of Cibolo	City of Kenedy	City of Runge	City of Universal City
City of Converse	City of Kirby	City of San Antonio	City of Von Ormy
City of Elmendorf	City of La Vernia	City of Sandy Oaks	City of Windcrest
City of Fair Oaks Ranch	—	—	—

Table 1-4 lists the 49 other entities outside the county and municipality categories that were considered in the development of the 2023 RFP.

Table 1-4. Other Flood or Water-Related Entities within the SAFPR

Entity	Type
Bandera County River Authority	River Authority
Guadalupe-Blanco River Authority	River Authority
Nueces River Authority	River Authority
San Antonio River Authority	River Authority
Upper Guadalupe River Authority	River Authority
Alamo Area Council of Governments	Other
Bandera County FWSD 1	Other
Bexar-Medina-Atascosa Counties WCID 1	Other
Bexar County WCID 10	Other
Canyon Regional Water Authority	Other
Cibolo Canyon Conservation and Improvement District 1	Other
Cibolo Creek Municipal Authority	Other
Coastal Bend Council of Governments	Other
Comal County WCID 6	Other
Crosswinds at South Lake Special Improvement District	Other
East Central SUD	Other
Ecleto Creek Watershed District	Other
Escondido Watershed District	Other

Entity	Type
Espada Development District	Other
Falcon Point WCID 1	Other
Flying L PUD	Other
Golden Crescent Regional Planning Commission	Other
Green Valley SUD	Other
Hondo Creek Watershed Improvement District	Other
Johnson Ranch MUD	Other
Kendall County WCID 2	Other
Kendall County WCID 2A	Other
Kendall County WCID 3	Other
Kendall County WCID 4	Other
La Salle WCID 1-A	Other
La Salle WCID 1-B	Other
Lerin Hills MUD	Other
Medina County FWSD 1	Other
Medina County WCID 1	Other
Northeast Medina County WCID 1	Other
Port O'Connor MUD	Other
Refugio County Drainage District 1	Other
Refugio County Navigation District	Other
Refugio County WCID 1	Other
Refugio County WCID 2	Other
San Antonio MUD 1	Other
Victoria County Navigation District	Other
West Side Calhoun County Navigation District	Other
Westside 211 Special Improvement District	Other
Wilson County FWSD 1 of Wilson County Texas	Other

Notes: FWSD = Fresh Water Supply District; MUD = Municipal Utility District; PUD = Planned Unit Development; SUD = Special Utility District; WCID = Water Control and Improvement District

The SAFPR includes an area that drains to the San Antonio River and associated tributaries. The San Antonio River originates from springs fed by the Edwards Aquifer in central Bexar County. The Medina River starts at the top of the river basin in Bandera County and joins the San Antonio River along with Cibolo, Leon, and Salado Creeks and numerous tributaries. The river confluences with the Guadalupe River before the combined rivers discharge into San Antonio Bay.

Fourteen groundwater conservation districts are located within the SAFPR, which regulate and manage the use of groundwater resources potentially impacted by flooding.

The SAFPR includes five of the 12 ecoregions identified by Texas Parks and Wildlife Department (TPWD), including the Blackland Prairie, Edwards Plateau, Post Oak Savannah, South Texas Plains, and the Gulf Prairies and Marshes, as shown in Figure 1-2[9].

The SAFPR is dominated by limestone, rocky clay, and sand-based, sandy-loam, highly alkaline soils, which restrict the species of trees that flourish here. The surface of the Blackland Prairie portion of the SAFPR is dominated by limestone and heavy clay soils with an average rainfall of 34 inches. The Edwards Plateau mostly contains clay loam soil which turns into rocky clay or solid limestone beneath the surface with an average rainfall of 25 inches per year. The Post Oak Savannah is primarily clay loam to clay with an average rainfall of 34 inches, leading into the South Texas Plains, which has alkaline to slightly acidic clays and clay loams soil and an average rainfall of 2 inches. Lastly, the Gulf Prairies and Marshes is the southeast portion of the SAFPR, containing sand-based soil with typically high salt content and an average rainfall of 40 inches per year.

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[9] Service, T.A. (2021). Texas Ecoregions. Retrieved from Texas Parks and Wildlife Department: https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions.

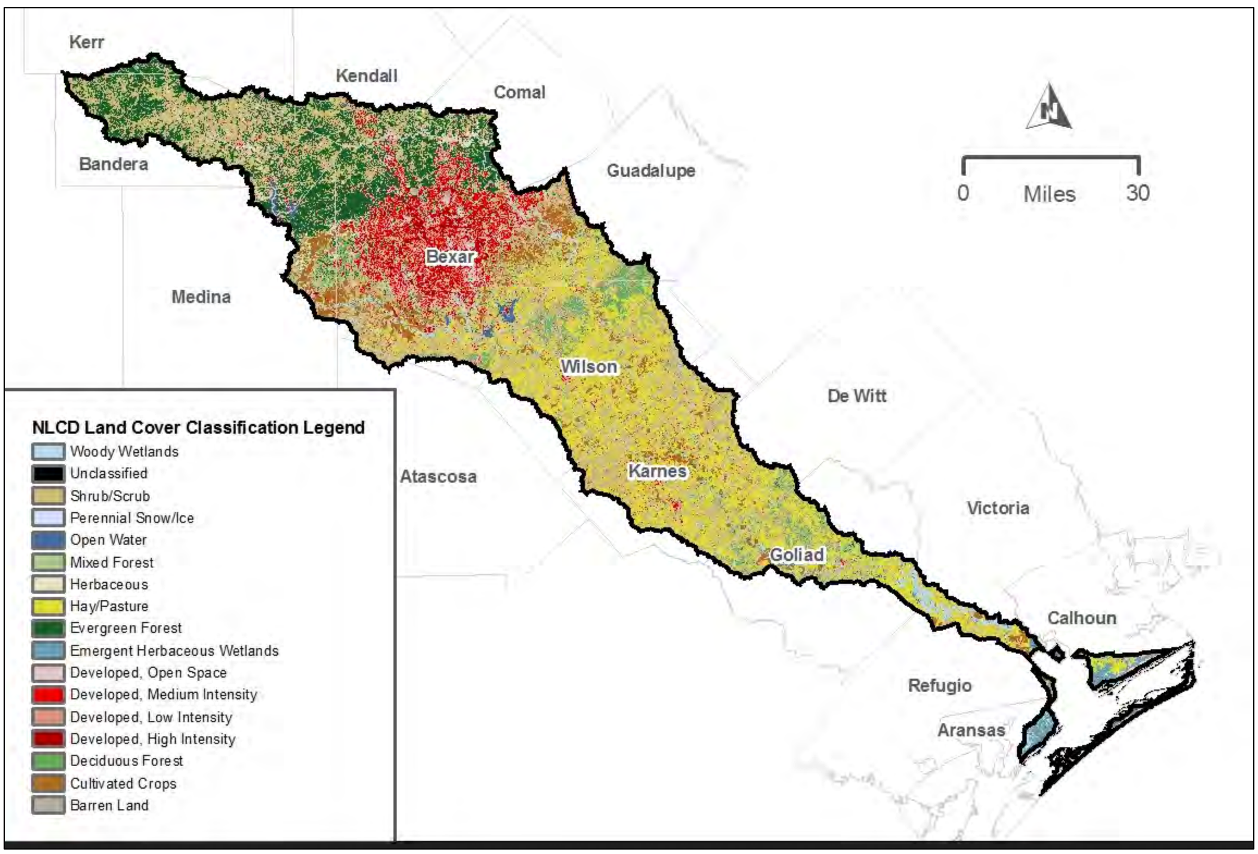
Figure 1-2. Ecoregions within the SAFPR

Source: Texas Parks and Wildlife Department, 2022, https://tpwd.texas.gov/education/hunter-education/online-course/wildlife-conservation/texas-ecoregions

The SAFPR is a productive agricultural region, with most farming and ranching occurring southeast of San Antonio and some ranching activity occurring northwest of San Antonio. Although fewer individuals are exposed to flood hazards in rural areas, the impact of flooding on agriculture and ranching can be severe. Floods can delay planting and ruin crops, kill livestock, and damage barns or other structures, causing significant economic hardship to farmers and ranchers.

Ranchland and farmland are the predominant use of working lands across the SAFPR, as shown in Figure 1-3. Together, ranchland and farmland account for 69.1 percent of the total land area, with ranchland being 60.5 percent and farmland being 8.6 percent.

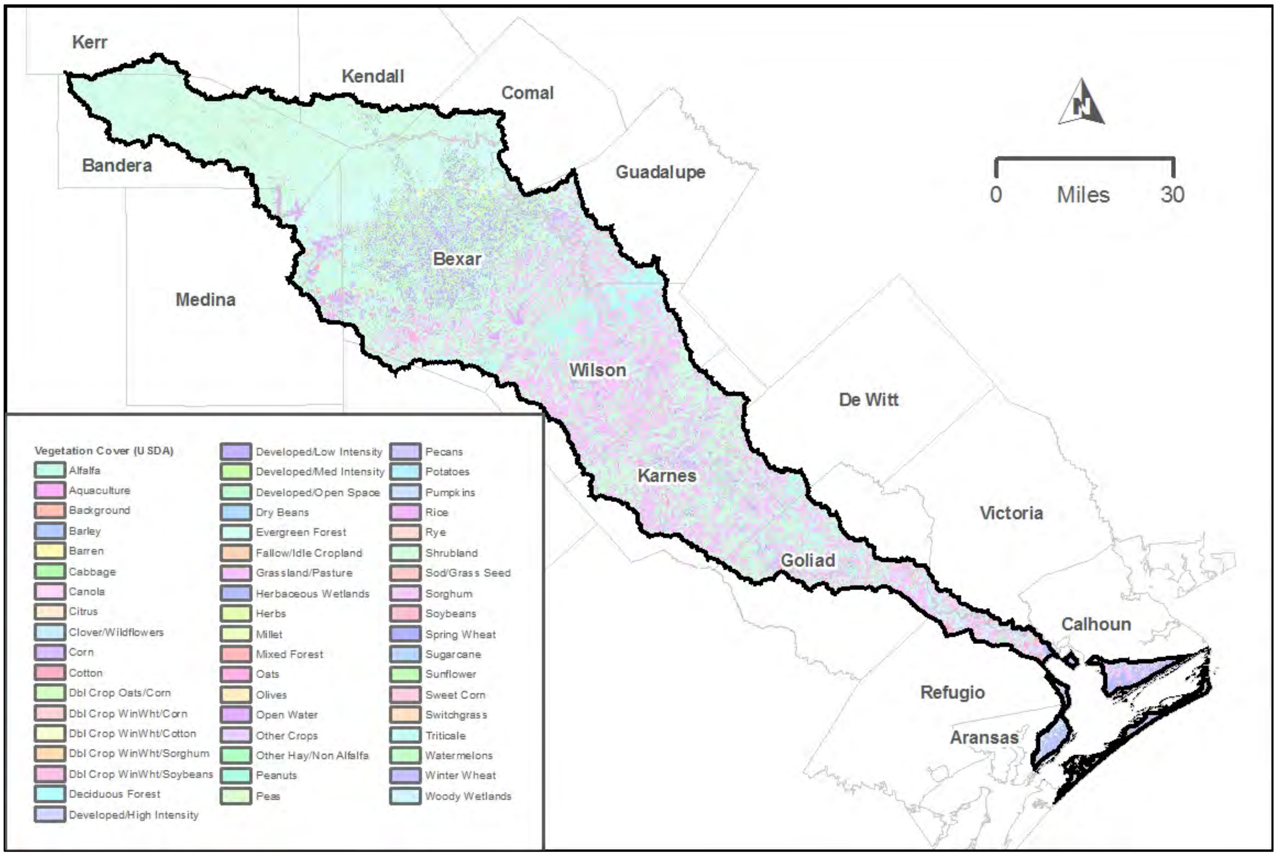
Figure 1-3. SAFPR Land Cover



Source: National Land Cover Database, 2019, https://www.usgs.gov/centers/eros/science/national-land-cover-database

As shown in Figure 1-4, the predominate vegetative cover types by land area are shrub/scrub (37.1 percent), hay/pasture (23.4 percent), cultivated crops (8.6 percent), evergreen forest (i.e., cedar breaks; 7.0 percent), developed areas of varying development intensities (6.2 percent), and deciduous forest (4.4 percent). Emergent herbaceous wetlands, herbaceous woody wetlands, mixed forest, open water, and barren land comprise the remaining 13 percent.

Figure 1-4. SAFPR Vegetation Cover

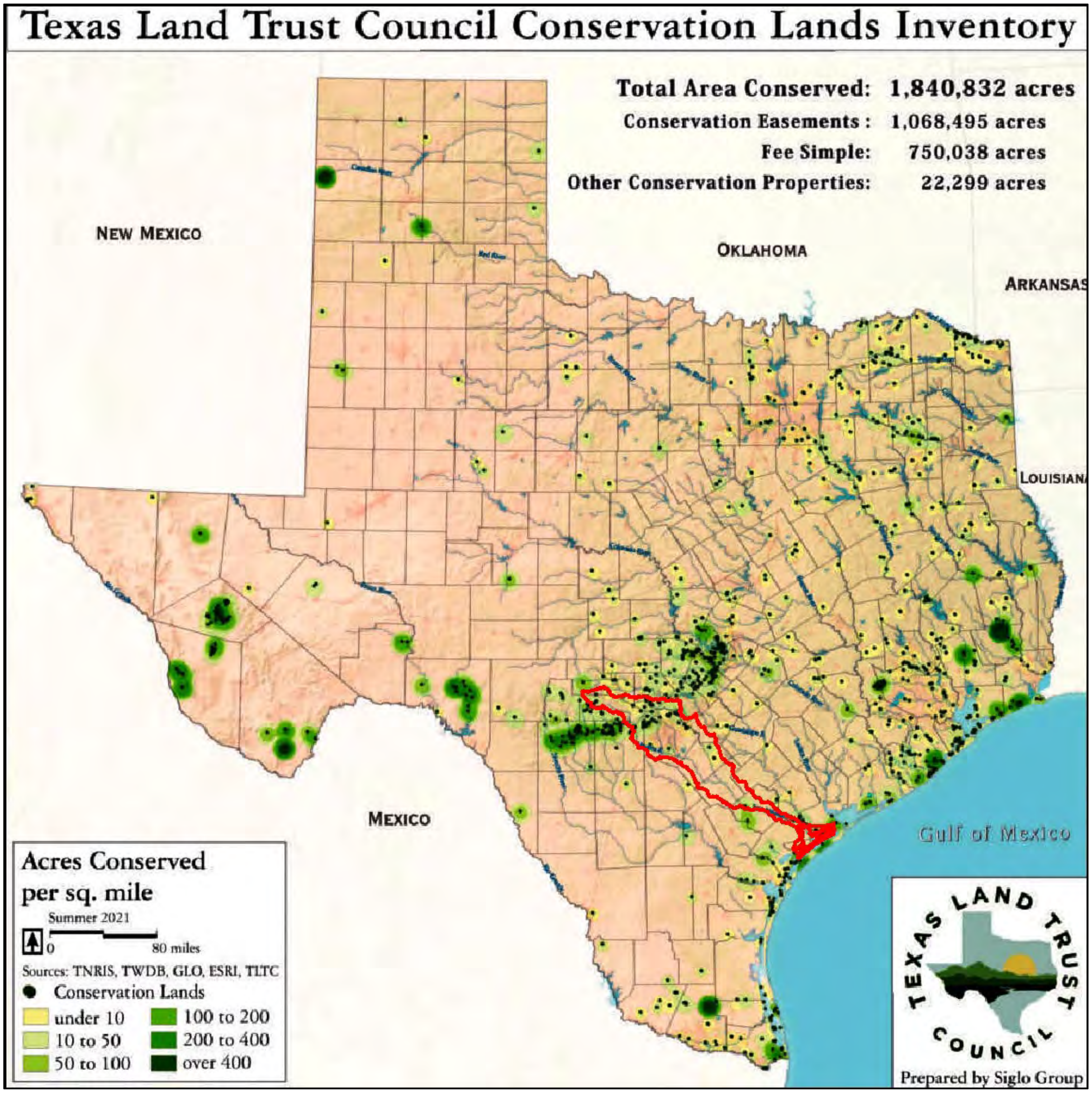


Source: Cropland Data Layer, 2020,
https://www.nass.usda.gov/Research_and_Science/Cropland/Release/

1.4 Conservation Easements

The SAFPR contains conservation lands to enable landowners to protect natural resources for future generations while maintaining private ownership. Conservation lands within the SAFPR are predominately located within the Edwards Plateau region (Figure 1-5).

Figure 1-5. SAFPR Conservation Easements



Source: Texas Land Trust Council, Conservation Lands, 2019, https://texaslandtrustcouncil.org/what-we-do/conservation-lands-inventory/

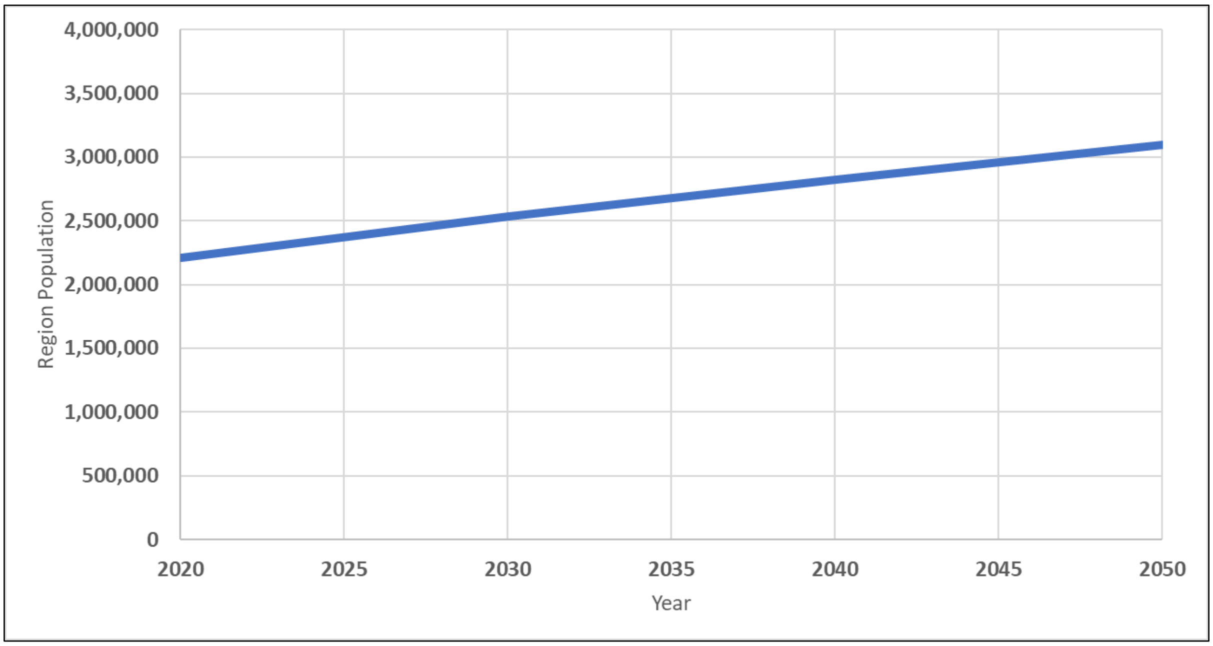
1.5 Socioeconomic Characteristics

Outside of the San Antonio metropolitan area, the SAFPR is largely rural in nature, although significant growth is occurring in the portions of Comal, Guadalupe, Kendall and Wilson Counties, which lie within the planning region. The population of those four counties and Bexar County contain almost 97 percent of the total population of the region. The City of San Antonio (CoSA) and its surrounding suburbs contain roughly 81 percent of the region's population. The next largest group of cities within the SAFPR include

Boerne, Cibolo, Converse, Schertz and Universal City. Many smaller cities are contained within the rural areas of the planning region.

Overall, the region is expected to grow by 40 percent between 2020 and 2050, from a population of 2,212,988 to approximately 3,095,520 (Figure 1-6). This significant amount of growth will lead to extensive expansion of development, adding housing and businesses to support the growing population. As the region experiences population growth, more people will be exposed to flooding, with a greater possibility of that flooding being extreme as permeable land surfaces are replaced with impermeable services associated with development.

Figure 1-6. SAFPR Population Projection



Source: TWDB, Population Projections for Regional Water Planning

Nine counties are projected to grow by at least 20 percent between 2020 and 2050. Kendall County is the fastest growing county within the SAFPR, with a projected growth of 106 percent over the next 30 years (Table 1-5).

Table 1-5. Counties with Highest Projected Growth, 2020–2050

County	2020 Population	2050 Population	% Growth
Kendall	25,519	52,659	106
Guadalupe	90,434	166,790	84
Wilson	53,265	88,957	67
Comal	17,239	27,737	60
Atascosa	1,593	2,287	44
Bexar	1,965,639	2,686,036	37
Medina	12,618	16,232	29
Bandera	23,755	30,173	27
Goliad	4,745	5,937	25

Source: TWDB, Population Projections for Regional Water Planning

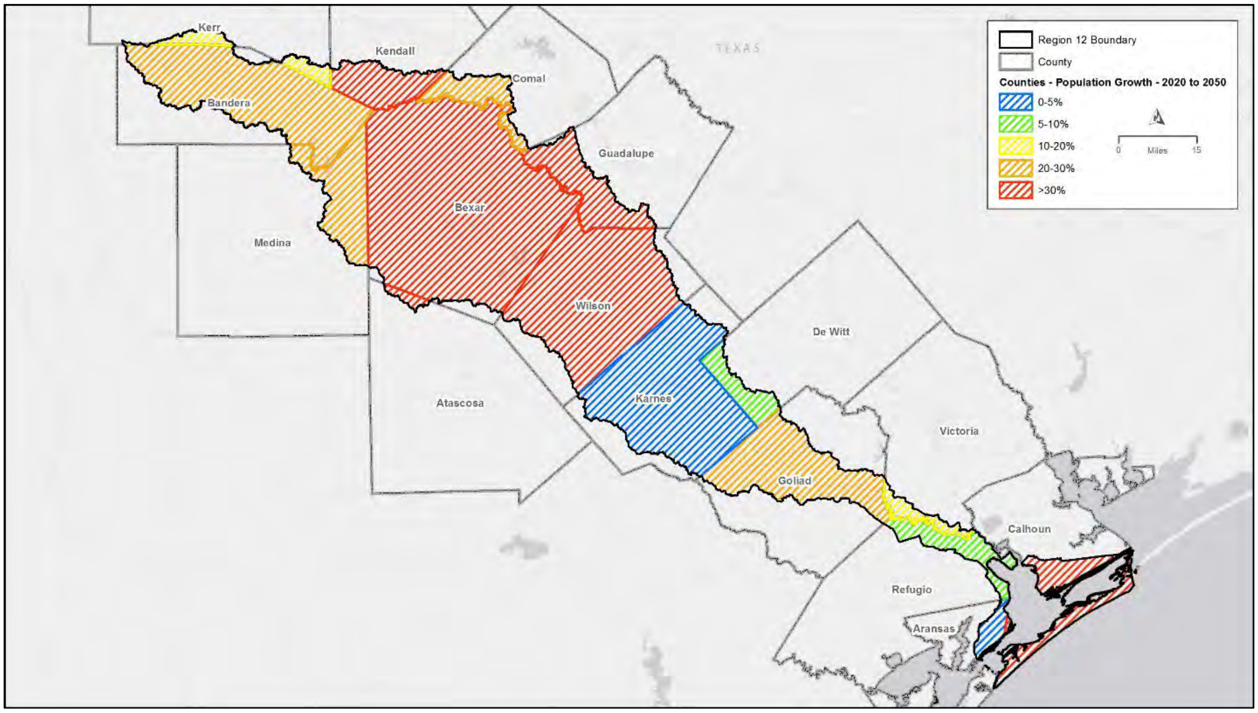
The cities with the highest projected growth as a percentage of 2020 population are Boerne, Elmendorf, Schertz, Cibolo, and Floresville (Table 1-6 and Figure 1-7).

Table 1-6. Cities with Highest Projected Growth, 2020–2050

County	2020 Population	2050 Population	% Growth
Boerne	17,732	28,903	96
Elmendorf	2,160	4,001	85
Schertz	39,245	71,017	81
Cibolo	23,066	38,853	68
Floresville	8,123	13,476	66

Source: TWDB, Population Projections for Regional Water Planning

Figure 1-7. SAFPR Population Growth, 2020–2050



Source: TWDB, Population Projections for Regional Water Planning

The SAFPR area has an economic base centered on trades and services, manufacturing, mining, agriculture, and livestock production. All sectors of the economy have experienced growth in recent years. Table 1-7 provides a county-by-county summary of economic activity in the key sectors most significantly affecting the economy of the SAFPR. A strong trades and services sector, including a thriving tourism industry in San Antonio, accounts for approximately 46 percent of regional economic activity. Fabricated metal products, industrial machinery, and food processing form the core of the manufacturing sector, which accounts for approximately 30 percent of regional economic activity. Oil and gas production dominate the mining sector of the economy and, together, represent approximately 22 percent of the regional economic activity. Beef cattle, corn, and grain sorghum are the dominant agricultural enterprises. The agricultural sector, including both livestock and crops, accounts for approximately 1 percent of regional economic activity.

Trades and services is the leading economic activity within the SAFPR, largely centered around tourism in the San Antonio area. Other counties with large trades and services sectors include Comal, Guadalupe, and Victoria Counties.

In 2017, manufacturing facilities contributed more than $18 billion in sales within the region. The leading manufacturing counties within the region for which data are available are Bexar, Comal, and Guadalupe. Significant economic activity associated with manufacturing also occurs in Atascosa, DeWitt, Goliad, Karnes, Kendall, Medina, and Victoria Counties, although data are withheld to avoid disclosures for individual producers.

This region has many sand and gravel quarries, and is also rich in petroleum products, including oil and natural gas. Much of the stone quarried is used in cement production. The leading cement producing area within the SAFPR is Bexar County. Most of the stone, gravel, and sand mining activities are located within Bexar, Comal, and Victoria Counties. The region also derives a significant portion of its mining income from oil and gas activities. All but Comal and Kendall Counties have some economic activity derived from oil and gas. The leading oil and gas producing counties within the SAFPR are DeWitt, Karnes, and Atascosa.

Much of the cropland within the SAFPR is farmed using dryland techniques, with Medina and Atascosa Counties being the areas with the most irrigated cropland. The leading agricultural producing counties within the SAFPR, by market value of product, are Bexar, Medina, Victoria, and Refugio. The major crops grown within the region include corn and grain sorghum, with wheat soybeans and cotton also being grown.

Table 1-7. County Economic Activity within the SAFPR

County	Trades & Services Economic Activity ($Millions)	Manufacturing Economic Activity ($Millions)	Market Value of all Livestock ($Millions)	Market Value of All Crops ($Million)	Value of Oil Production ($Millions)	Value of Gas Production ($Millions)	Total ($Millions)
Atascosa	464	0	54	21	1,327	94	1,960
Bexar	18,346	14,766	17	51	5	0	33,185
Comal	2,685	960	9	1	0	0	3,655
DeWitt	205	0	32	7	2,924	975	4,143
Goliad	41	0	13	5	13	30	102
Guadalupe	1,965	2,543	53	21	43	0	4,625
Karnes	151	0	18	11	6,409	1,265	7,854
Kendall	1,149	0	11	1	0	0	1,161
Medina	580	0	48	46	6	0	680
Refugio	80	0	11	25	139	35	290
Victoria	2,216	0	24	34	112	15	2,401
Wilson	250	122	56	13	80	2	523
Total	**28,132**	**18,391**	**346**	**236**	**11,058**	**2,416**	**60,579**

Source: United States Department of Commerce 2017
Notes: Determined by using the number of barrels produced as reported to the Texas Railroad Commission times $61.40/barrel (average price for 2018), and by using the cubic feet produced as reported to the Texas Railroad Commission times $3.67/cubic feet (average price for 2018).

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Major types of livestock produced within the area include cattle and calves, beef cattle, and sheep and lambs. The leading livestock producing counties within the SAFPR, by market value, are Wilson, Atascosa, Guadalupe, and Medina.

The median annual household income within the SAFPR ranges from $84,747 in Kendall County to $50,076 in Refugio County, a difference of $34,671. The average household median income of the region is $64,173, or slightly above the state average of $61,874. Approximately seven counties have a median household income value less than the state average. The region also contains several counties that have relatively high median household incomes, with Comal, Guadalupe, Kendall, and Wilson Counties greater than $75,000. These four counties are also projected to have the greatest growth within the SAFPR.

Median household income levels can be affected by many factors, including education levels, opportunity of employment, and location. Overall, the higher median income within the region indicates the average individual affected by floods may be at a financial advantage compared to their state counterparts; however, it is important to remember that several counties have low median income values. Residents in these counties may have a harder time recovering from a flood event.

1.6 Flood-Prone Areas and Major Flood Risks

1.6.1 Flood-Prone Areas

The 1 and 0.2 percent flood risk boundaries were compiled for all waterways with contributing drainage areas larger than 0.10 square mile for the entire region. This complete coverage was due in part to the availability of flood risk boundaries for the entire basin, provided by Cursory Floodplain Data to the TWDB for use in regional flood planning[10]. The most accurate flood risk boundaries were applied when multiple data sets were available.

A “floodplain quilt” was obtained from TWDB, consisting of multiple layers of data from various sources available throughout the state that were “quilted” together into a single flood hazard dataset. The floodplain quilt does not typically include localized flooding nor depict complex urban flooding problems. Additionally, new preliminary inundation boundaries were obtained from SARA, which is currently the only detailed flood data that uses the latest

[10] https://www.fathom.global/product/flood-hazard-data-maps/

National Oceanic and Atmospheric Administration (NOAA) Atlas 14[11] rainfall. Flood-prone areas identified through public comments will also be evaluated as the data becomes available.

The following list summarizes the various flood inundation data sets used, in order of most accurate to least accurate, with data sets including the Base Level Engineering (BLE) data and above considered accurate:

- SARA Preliminary Data (submitted to the Federal Emergency Management Agency [FEMA] for review)
- National Flood Hazard Layer (NFHL) Preliminary Data
- NFHL Detailed Effective Data
- BLE Studies
- NFHL Approximate Effective Data
- Cursory Floodplain Data – October 29, 2021
- Public comments

A portion of the SAFPR contains “approximate” 1 percent flood risk boundaries but no 0.2 percent flood risk boundaries (i.e. NFHL Approximate Study Areas). Therefore, for these approximate areas, the Cursory Floodplain Data 1 and 0.2 percent annual chance storm data were used to define flood hazard extents. In 2022, additional preliminary data will be provided by SARA and the entire San Antonio River Basin will have complete BLE coverage. Therefore, existing flood hazard mapping will be updated in its entirety to include Preliminary, Detailed Effective, or BLE-quality data.

Figure 1-8 through Figure 1-11 provide a region-wide depiction of the 1 and 0.2 percent annual chance flood event flood risk area, and the source of flooding for each area, for use in the risk analysis. Additionally, flood risks are described in further detail in Chapter 2 Flood Risk Analysis.

[11] NOAA. 2017. NOAA Atlas 14 Point Precipitation Frequency Estimates. United States Department of Commerce, NOAA, National Weather Service, Office of Water Prediction. Page last modified April 21, 2017. Available at https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html.

Figure 1-8. SAFPR Flood-Prone Areas – Upper Basin

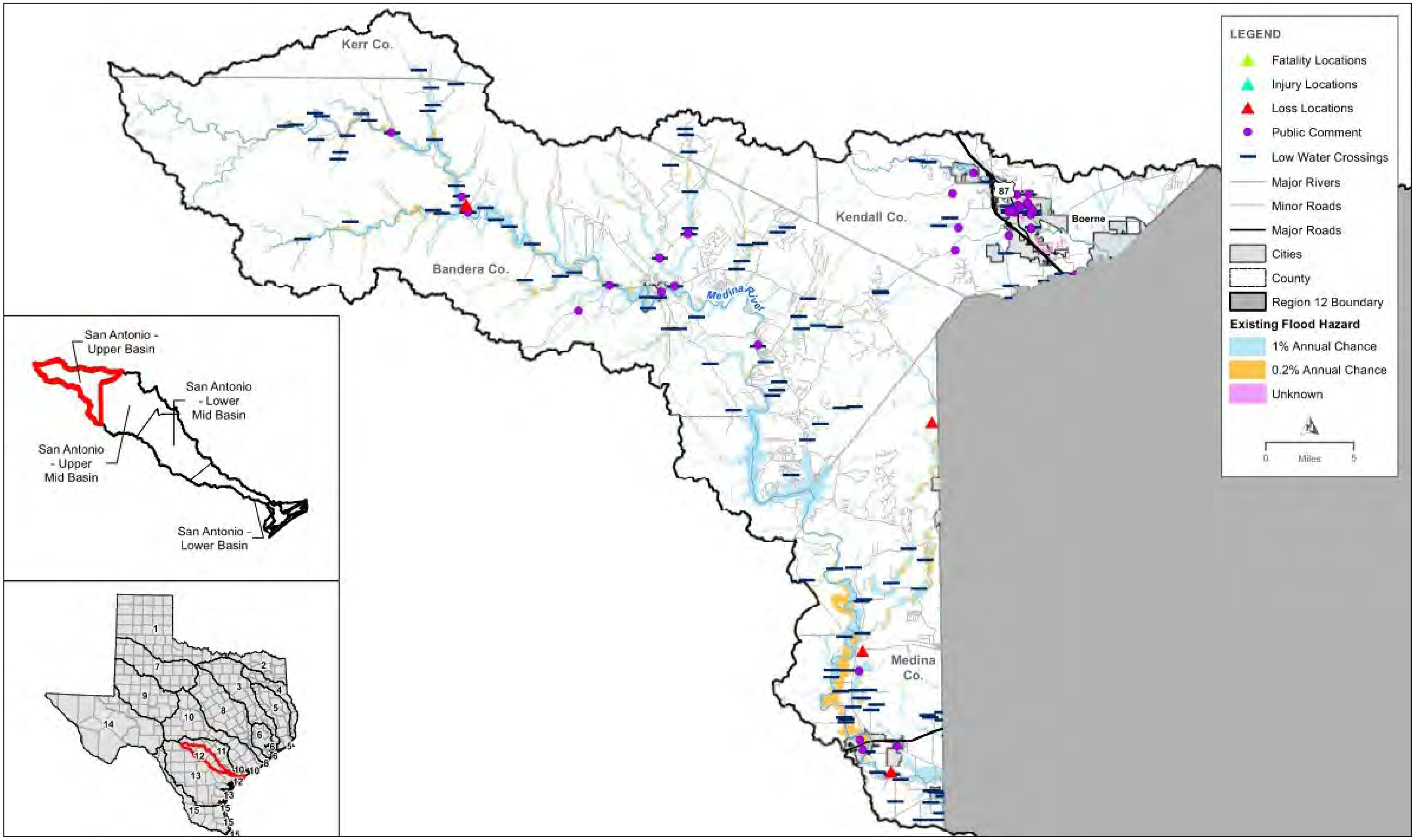


Figure 1-9. SAFPR Flood-Prone Areas – Upper Mid Basin

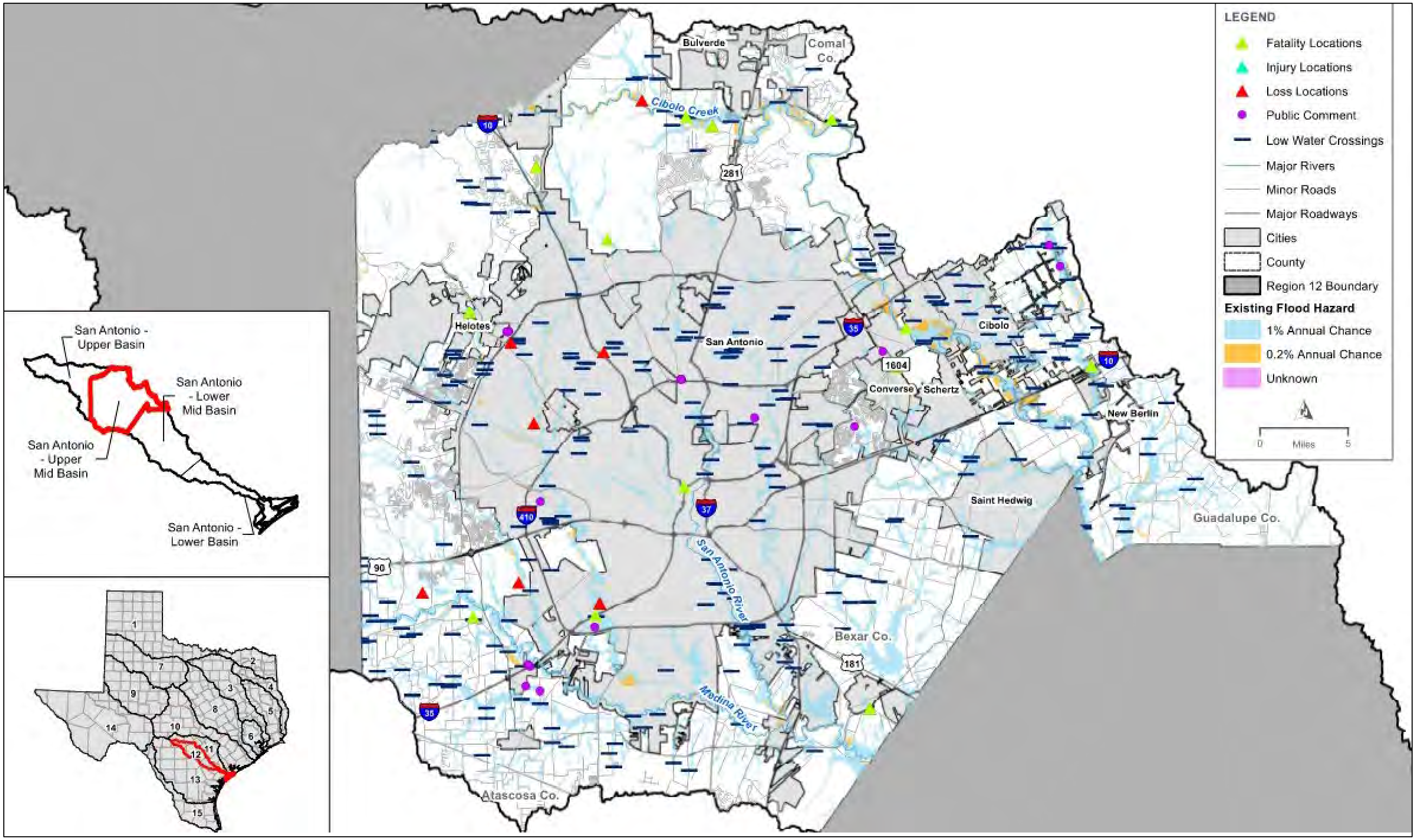


Figure 1-10. SAFPR Flood-Prone Areas – Lower Mid Basin

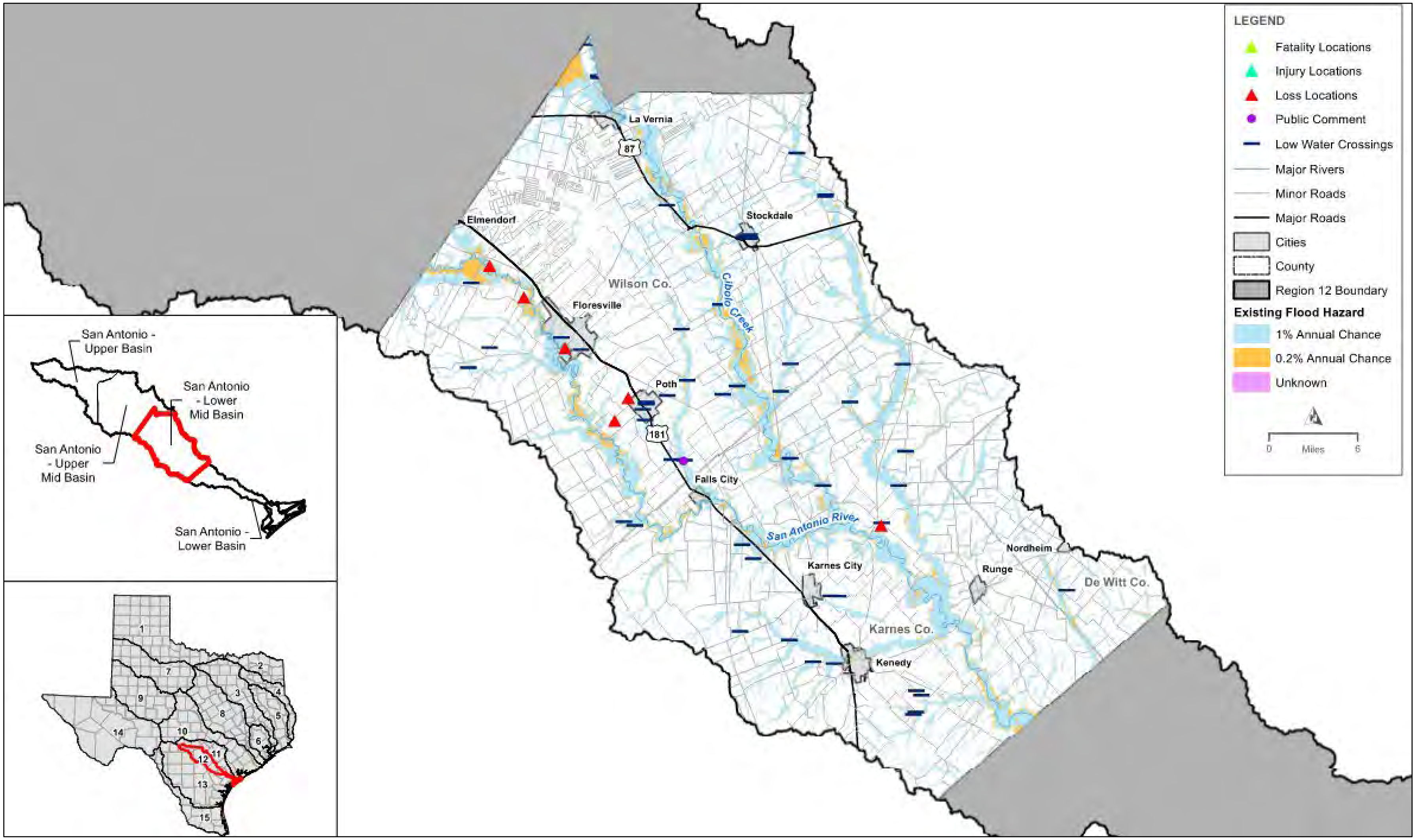
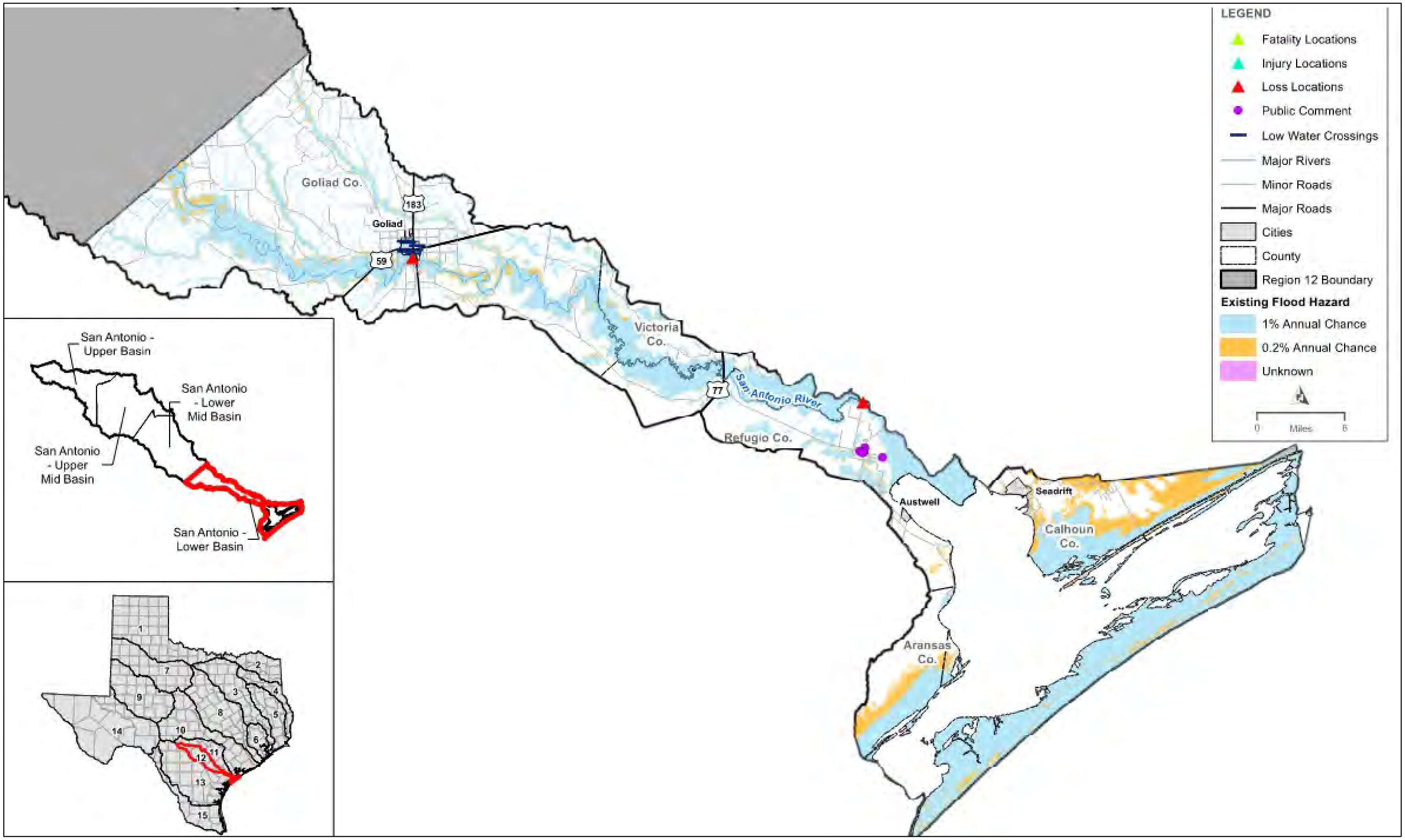


Figure 1-11. SAFPR Flood-Prone Areas – Lower Basin



1.6.2 Additional Flood-Prone Areas

Additional flood-prone areas were identified based on the location of hydrologic features, historic flooding, and/or local knowledge. Additional flood-prone areas were added for the following:

- Local knowledge (stakeholders/citizens)
- Database identifying low water crossings (LWCs) (Texas Natural Resource Information System [TNRIS])
- United States Geological Survey (USGS) gages
- Historical flood data (National Weather Service [NWS], FEMA, Texas Department of Transportation [TxDOT], and complaints reported through the CoSA 311 system)

1.6.3 Local Knowledge

The SAFPR is divided into four subregions (Upper Basin, Upper Mid Basin, Lower Mid Basin, and Lower Basin), as shown in Figure 1-8 through Figure 1-11, to facilitate stakeholder and citizen engagement. The first round of in-person meetings introduced the regional flood planning process and gathered local knowledge regarding flood-prone areas, historical flooding, and flood mitigation projects and needs. Additionally, an interactive online comment map was used to allow stakeholders and citizens the opportunity to identify flood-prone areas for consideration in the San Antonio RFP. Points that were outside of the 1 and 0.2 percent annual chance storm event flood hazard area were delineated as possible flood-prone areas based on the descriptions included in the comments.

1.6.4 Low Water Crossings

LWCs are considered potential flood-prone areas due to their inherent life loss risk during flood conditions. LWCs are defined as where a creek crosses a road that is low enough to be subject to frequent flooding during storm events or during a 50 percent annual chance (2-year) storm event.

A total of 498 LWCs have been identified within the SAFPR. These LWCs are from TNRIS and were last updated in March 2021. The TNRIS data includes locations monitored by the Bexar Flood Website[12], Bexar County Highwater Alert Lifesaving Technology (HALT)[13], and San Antonio Flood Emergency

[12] https://www.bexarflood.org/#!/main/map

[13] https://www.bexar.org/2728/HALT-High-Water-Detection

(SAFE) Route System[14]. Community feedback was used to identify additional problematic LWCs not already included in the TNRIS data. LWCs were all evaluated, some were moved to be more in line with the stream centerline and road centerline, and some were removed that did not correlate with a road that was overtopping. Section 2.1.1 Existing Condition Flood Hazard Analysis describes the evaluation process in more detail.

1.6.5 USGS Gage Data

USGS gage information was used to identify flood-prone areas and evaluate historical flood events. A few key locations were identified along the major rivers and tributaries within the basin. The gages in these locations were evaluated for crucial historical flood events, which are summarized in Table 1-8 in Section 1.7.1 Historical Flooding.

1.7 Key Historical Flood Events

1.7.1 Historical Flooding

Past flood events provide insight regarding the location of flood-prone areas within the basin. Table 1-8 provides a list and brief description of historical flood events within the basin.

Table 1-8. List of Historical Floods

Flood Event	Description
2021 Coastal Flash Floods	In early summer 2021, a series of storms hit the Texas Mid Coastal Counties, causing flash flooding. Victoria and Karnes County USGS gages along the San Antonio River saw record discharge amounts. As a result of this flash flooding, the NWS reports 1 injury and 1 death in Victoria.
2017 Hurricane Harvey	Hurricane Harvey is one of the most expensive storms on record, costing an estimated $24 million in damages to FPR 12 counties.
2016 Floods	Texas was hit by a series of large storms in 2016. Historical USGS gage discharge rates were recorded in Karnes and Victoria Counties along the San Antonio River. The NWS reports 2 flash flood related casualties recorded during this year within the region.

[14] https://gis.sanantonio.gov/OEM/SAFE/index.html

Flood Event	Description
2015 Memorial Day Flood	In May 2015, a slow-moving storm swept Oklahoma and Texas, causing flash flooding throughout the region. Bandera and Victoria County USGS gages along the Medina and San Antonio Rivers recorded historical discharge rates. As a result of this flash flooding, the NWS reports 1 death each in Bexar and Medina Counties.
2015 October Flood	In October 2015, a tornado and large storm ravaged Central Texas. The Wilson County USGS gage on Cibolo Creek saw record discharge amounts. As a result of this flash flooding, the NWS reports 1 death each in Bexar and Comal Counties.
2013 May Floods	May 2013 brought flash floods that affected the whole region. Historical discharge rates were recorded along the San Antonio River in Bexar and Karnes Counties. The NWS reports that flash floods resulted in 3 casualties in Bexar and Guadalupe Counties.
2010 June Floods	Flash floods hit Central Texas in June 2010, making it one of the more costly events the region has endured. An estimated $20 million in damages were reported for Bexar, Comal, and Guadalupe Counties. As a result of this flood, the NWS reports 1 death in Comal County.
2007 Water Year	During a 6-month period in March to September 2007, nearly continuous flooding occurred in Texas. In August, Tropical Storm Erin hit the regions coastal counties. The year 2007 was one of the costliest ever recorded for flood damage. Just in FPR 12, the NWS reports $20 million in damages. From June through August, the NWS reports historical USGS gage discharge rates for the San Antonio River and Cibolo Creek in Bexar and Wilson Counties. The NWS reports that FPR 12 had 10 fatalities within this 6-month period.
2005 Hurricane Rita	Hurricane Rita was the most intense hurricane to pass through the Gulf of Mexico and caused severe coastal flooding. According to the Alamo Area Council of Governments Regional Mitigation Action Plan, it caused severe coastal flooding and led to emergency declarations in Atascosa, Bandera, Bexar, Comal, Guadalupe, Karnes, Kerr, Medina, and Wilson Counties.
2004 November Flash Flood	In November 2004, the region was hit by a costly flash flood that resulted in 2 deaths in Bexar County and set historic peak discharge rates at the USGS gage on Salado Creek in Bexar County.

Flood Event	Description
2002 Flash Floods	In July 2002, flash floods hit the region. Historical USGS discharge rates were recorded all across the region: Medina River in Bandera County, Salado Creek in Bexar County, and San Antonio River in Karnes and Goliad Counties. As a result of these floods, the NWS reports 5 deaths from Bexar and Kendall Counties. Later that year, in November, the NWS reports that extreme flash flooding resulted in 18 injuries in Bexar County.
2001 Floods	In August 2001, Atascosa, Bexar, Comal, Guadalupe, Karnes, Kerr, and Wilson Counties encountered severe flash flooding. Water was reported 6 inches over the 500-year floodplain mark along State Highway 123 in Wilson County. Floods caused an estimated $2 million in damages.
1998 October Flood	South Central Texas experienced record-breaking rainfall in October 1998, making it the costliest flood event for the region. The NWS reports $446 million in damages across the region. The NWS reports 11 casualties in Bexar County and 4,040 injuries total for the region, most of them being in Bexar, Comal, Guadalupe, and De Witt Counties. Historical USGS gage discharge rates were recorded throughout the region, from Medina River in Bandera County all the way down to the coast on the San Antonio River in Goliad. Per the SARA, the completion of the San Antonio River Flood Tunnels in January 1998 significantly reduced the impacts of these flash floods in San Antonio.
1997 June Flash Flood	Heavy rainfall in June 1997 caused flash flooding in South Central Texas. As a result, the NWS reports 4 casualties and 115 injuries across Bexar, Medina, Bandera, Guadalupe, Comal, and Kendall Counties. Historical USGS gage discharge rates were recorded along the Medina River in Bandera and Bexar Counties. This is one of the more costly events for the region, with the NWS reporting $29 million in damages resulting from this event.
1990 July Flood	July 1990 was known as the "wettest" July in San Antonio. One of the largest USGS gage discharge rates was recorded for San Antonio River in Bexar County.
1987 June Flood	The upper counties were hit by a storm in June 1987, setting historical USGS gage discharge rates for the Medina River in Bandera and Bexar Counties.

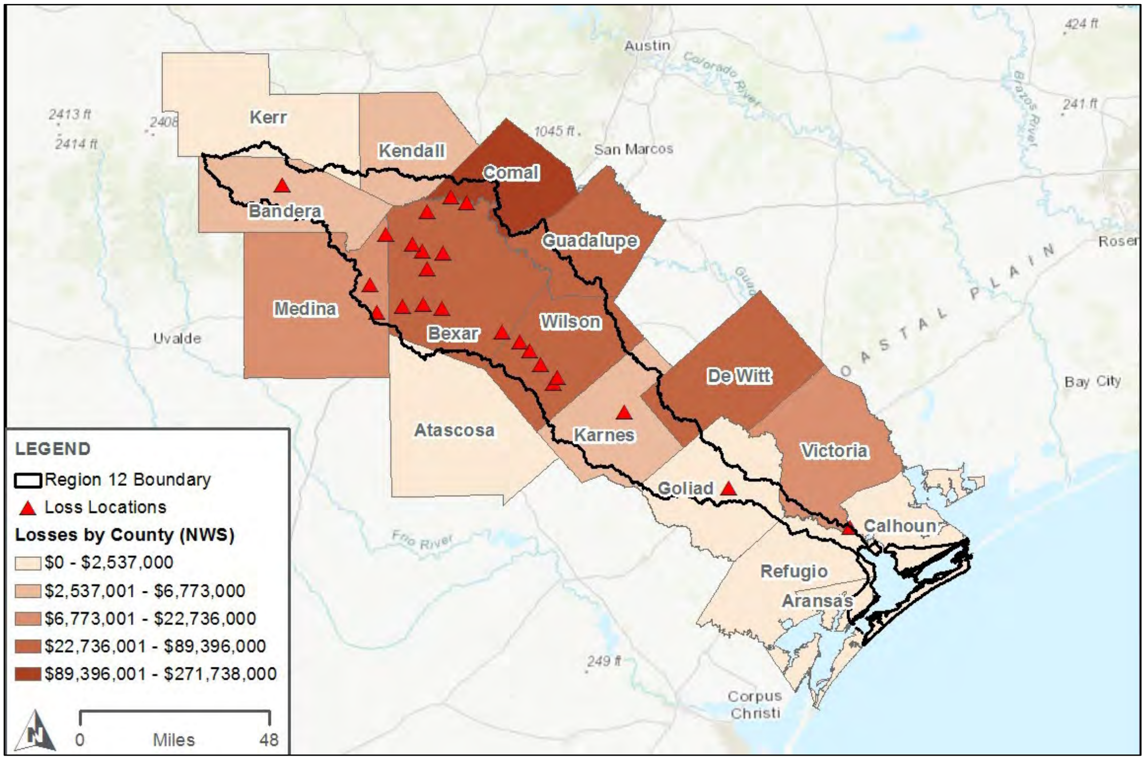
Flood Event	Description
1978 Hurricane Amelia	Hurricane Amelia hit Texas and stalled over the region's upper counties. This storm devastated Bandera County and surrounding areas. Due to this event, the USGS gage on the Medina River in Bandera County recorded the highest discharge rate and water level ever recorded for the region, at 281,000 cubic feet per second and 50 feet.
1967 Hurricane Beulah	Hurricane Beulah hit Texas in September 1967. The storm caused Goliad County to record the highest flow discharge of 138,000 cubic feet per second, the second highest recorded discharge in FPR 12.
1946 San Antonio Flood	A September flood hit Bexar and Karnes Counties in 1946. This event set a historical USGS discharge rate along the San Antonio River in Karnes County. As a result, the SARA reports 4 casualties in San Antonio.
1921 San Antonio Flood	On September 9, 1921, a tropical depression stalled just north of San Antonio, and within hours flooded the creek networks in San Antonio. Due to this event, the SARA reports a total of $3.7 million in damages and more than 51 casualties in San Antonio. This flood sparked construction of the Olmos Dam.
1913 October Flood	A record rainfall of more than 7 inches in 24 hours caused major flooding along the San Antonio River. The CoSA reports flooding along San Pedro and Alazan Creeks. Historical USGS gage levels were recorded in Goliad and Karnes Counties.

Source: CoSA, SARA, NWS

1.7.2 National Weather Service Flood Data

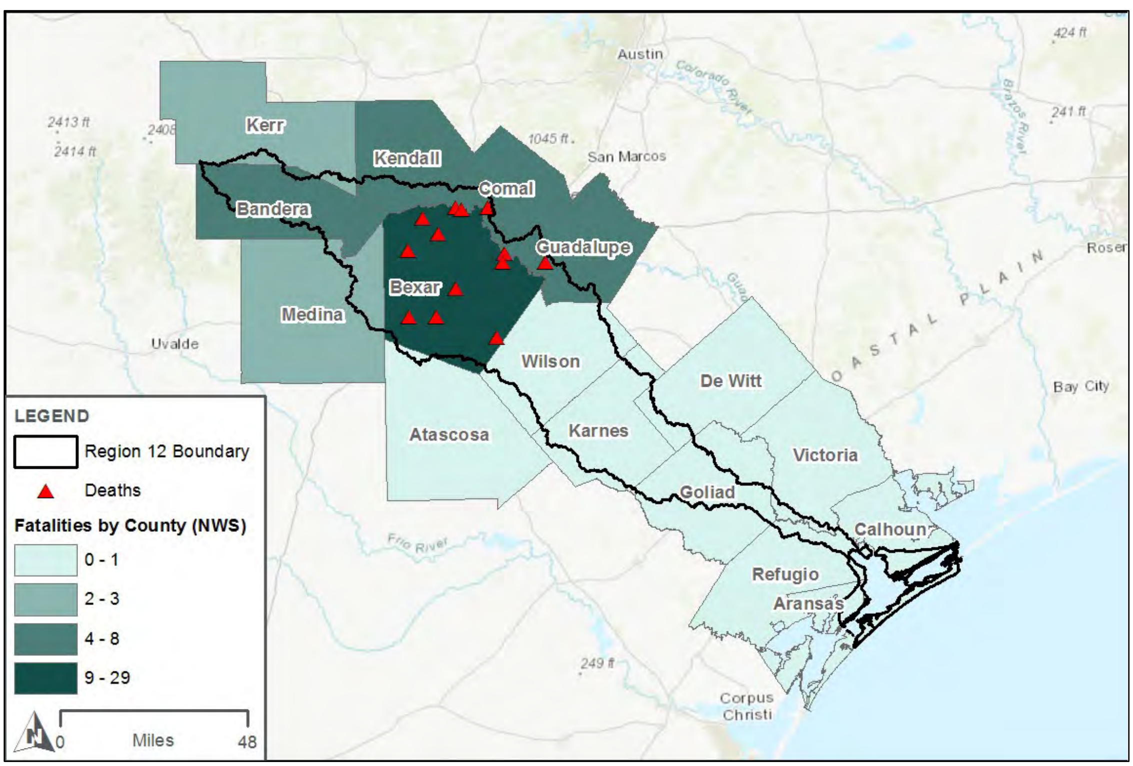
The NWS has documented fatalities, injuries, and property damage as the result of past flood events since 1996. Data summarizing property damage, fatalities, and injuries are shown in Figure 1-12 through Figure 1-14.

Figure 1-12. Property Damage from Flooding, 1996–2021



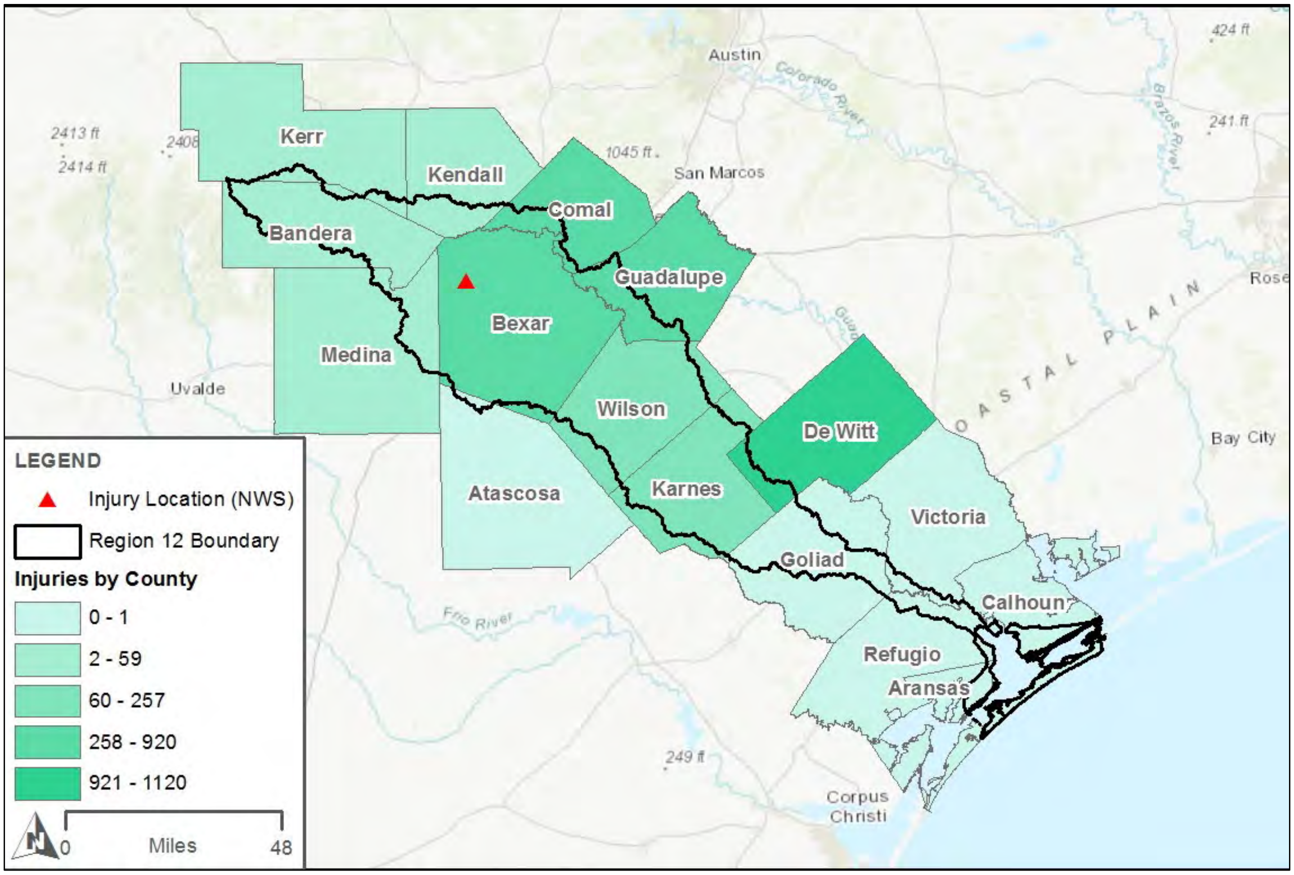
Source: NWS

Figure 1-13. Fatalities from Flooding, 1996–2021



Source: NWS

Figure 1-14. Injuries from Flooding, 1996–2021



Source: NWS

Table 1-9 provides a summary of flood damage data gathered from the NWS, and Table 1-10 reports flood damage in dollars, injuries, and fatalities by year. Table 1-10 uses the same base data as Table 1-9, but it is summarized based on counties. To generate Table 1-9 and Table 1-10, data was collected from the NWS and filtered to highlight damage only generated by rain, storm, and flood.

Table 1-9. Losses Associated with Flooding within the SAFPR by Year, 1996–2021

Flood Year	Damages	Injuries	Fatalities
1996	$76,000	2	1
1997	$32,173,000	115	6
1998	$452,054,000	4,063	17
1999	$446,000	0	0
2000	$1,208,000	8	1
2001	$4,969,000	63	1

Flood Year	Damages	Injuries	Fatalities
2002	$2,300,000	22	5
2003	$528,000	0	0
2004	$1,572,000	1	4
2005	$0	0	0
2006	$2,000,000	0	0
2007	$21,920,000	1	10
2008	$20,000	0	0
2009	$0	0	0
2010	$20,900,000	0	4
2011	$0	0	0
2012	$110,000	0	0
2013	$100,000	0	4
2014	$200,000	0	0
2015	$155,000	0	4
2016	$250,000	0	2
2017	$24,000,000	0	1
2018	$50,000	0	0
2019	$5,000	0	0
2020	$1,455,000	0	0
2021[a]	$690,000	1	1
Total	**$567,181,000**	**4,276**	**61**

Source: NWS
[a] Data as of December 2021.

Table 1-10. Losses Associated with Flooding within the SAFPR by County, 1996–2021

Counties	Percentage of County Area in FPR 12	Damages	Injuries	Fatalities
Aransas	13	$2,537,000	0	0
Atascosa	1	$1,267,000	0	0
Bandera	66	$7,783,000	26	5
Bexar	97	$44,390,000	852	29
Calhoun	27	$1,110,000	0	0
Comal	17	$272,468,000	920	6
De Witt	9	$43,265,000	1,120	0
Goliad	39	$25,000	0	1
Guadalupe	24	$52,083,000	829	8
Karnes	80	$4,584,000	170	0
Kendall	19	$6,846,000	20	6
Kerr	5	$1,253,000	22	3
Medina	15	$17,148,000	59	2
Refugio	13	$0	0	0
Victoria	5	$22,736,000	1	1
Wilson	82	$89,686,000	257	0
Total	**—**	**$567,181,000**	**4,276**	**61**

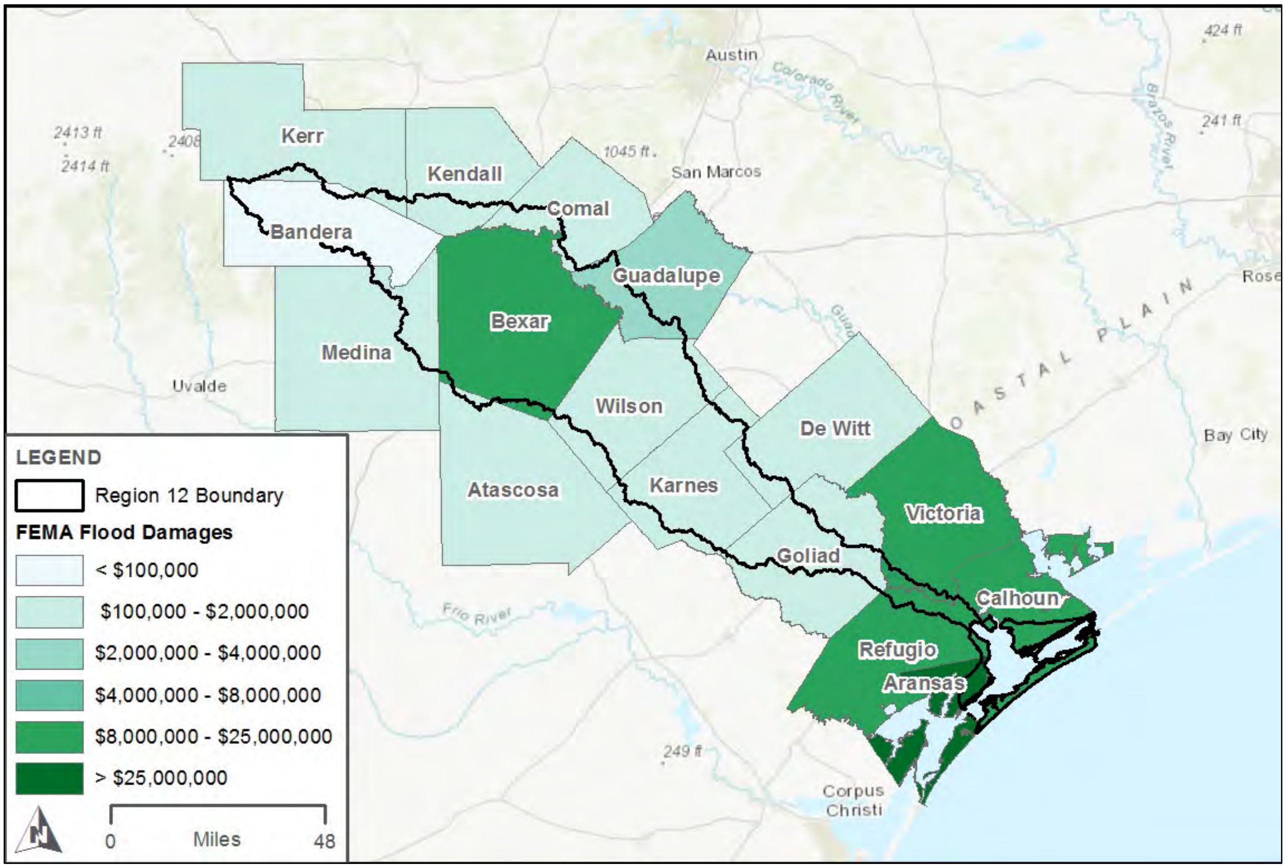
Source: NWS

1.7.3 FEMA Flood Damage Data

FEMA data regarding disaster funding for flood damages was obtained from 1996 to June 2021, see Figure 1-15.

Table 1-11 includes flood-related damages by county. Unlike the gross damage data in Table 1-9 and Table 1-10, data in Table 1-11 is summarized from various federal programs. FEMA funding of four federal programs is summarized by county: Public Assistance Funded Project Summaries, Individuals and Households Program – Valid Registrations, Individual Assistance Housing Registrants – Large Disasters, and Housing Assistance Program.

Figure 1-15. FEMA Flood Assistance to Owners and Renters for Flood Damages, 1996–2021



Source: FEMA

Table 1-11. FEMA Funding for Flood Related Damages by Program, 1996–2021

Counties	Percentage of County Area within SAFPR	Public Assistance Funded Project Summaries	Individuals and Households Program – Valid Registrations		Individual Assistance Housing Registrants – Large Disasters	Housing Assistance Program
		Federal Share Obligated	Flood Damage Amount	Repair Amount	Real Property Damage Amount Observed by FEMA	Owners and Renters Combined Amount
Aransas	13	$75,463,478	$7,328,541	$12,488,979	$55,009,113	$50,412,810
Atascosa	1	$1,663,563	$94,935	$280,715	$226,154	$875,027
Bandera	66	$2,080,777	$0	$0	$79,676	$97,212
Bexar	97	$50,005,333	$2,045,533	$1,317,967	$4,605,858	$19,501,737
Calhoun	27	$23,004,779	$588,398	$3,278,010	$3,723,571	$9,217,394
Comal	17	$6,525,770	$585,521	$172,868	$549,725	$1,539,102
De Witt	9	$4,320,705	$484,243	$435,925	$1,137,800	$1,499,327
Goliad	39	$625,031	$22,554	$636,172	$577,051	$1,554,971
Guadalupe	24	$5,118,692	$741,266	$402,861	$325,694	$2,089,239
Karnes	80	$754,616	$4,580	$530,048	$372,964	$1,128,253
Kendall	19	$712,625	$118,970	$29,522	$160,589	$264,451
Kerr	5	$1,224,307	$0	$0	$140,710	$228,894
Medina	15	$2,679,089	$1,421,149	$843,199	$208,545	$1,484,783
Refugio	13	$28,969,743	$195,479	$2,816,461	$6,029,616	$8,192,161

Counties	Percentage of County Area within SAFPR	Public Assistance Funded Project Summaries	Individuals and Households Program – Valid Registrations		Individual Assistance Housing Registrants – Large Disasters	Housing Assistance Program
		Federal Share Obligated	Flood Damage Amount	Repair Amount	Real Property Damage Amount Observed by FEMA	Owners and Renters Combined Amount
Victoria	5	$34,618,575	$2,070,202	$6,387,900	$9,538,865	$22,614,208
Wilson	82	$2,081,921	$0	$18,564	$218,166	$360,002
Totals	**—**	**$239,849,004**	**$15,701,370**	**$29,639,191**	**$82,904,099**	**$121,059,571**

1.8 Political Subdivisions with Flood-Related Authority

A list of existing political subdivisions within the SAFPR that have flood-related authority is provided in Table 6 Existing Floodplain Management Practices in Appendix A. The list contains 110 entities, including 49 cities, 16 counties, 4 river authorities, and additional entities with flood-related authority. The TWDB provided a list of the National Flood Insurance Program (NFIP) participants within the SAFPR; a total of 63 entities were identified, including 16 counties and 47 cities. All entities participating in the NFIP have floodplain management regulations and have adopted minimum regulations pursuant to Texas Water Code requirements. Out of the 63 entities identified, a total of 32 entities have adopted higher standards according to the Texas Floodplain Management Association 2019 Higher Standards Survey[15]. Further evaluation of these entities and their floodplain management practices is discussed in detail in Chapter 3 Floodplain Management Practices and Flood Protection Goals.

1.9 Flood Risk Local Regulation and Development Codes

Using policies and regulations to reduce the exposure of people and properties to flood risk are forms of nonstructural flood control. By encouraging or requiring communities to avoid developing in flood-prone areas altogether or to take precautions such as increasing building elevations, preserving overflow areas through buffering, and avoiding sensitive natural areas such as wetlands, communities can reduce the likelihood and extent of damages to existing and new development. Local regulations and development codes pertaining to flooding include:

- **Floodplain Ordinances:** Floodplain ordinances regulate development and the impact new development has on a community's floodplain. Community regulations are typically based on FEMA-provided flood hazard information but can also be based on other local sources of data. Participation in the NFIP requires a community to have adopted a floodplain ordinance with minimum requirements established by FEMA.
- **Building Standards:** Building standards may include considerations for structures located within a floodplain, including minimum finish floor elevations and flood proofing requirements. NFIP requirements also set standards for property owners seeking to renovate structures in a

[15] TFMA. 2019. 2019 Higher Standards Survey Summary. Available at https://www.tfma.org/page/documents-reports

floodplain, including those that experience repetitive or severe flood losses.

- **Drainage Design Standards:** Adopted drainage design standards set the minimum requirements for stormwater management that must be met prior to the approval of construction plans. Drainage criteria within the SAFPR are typically adopted by municipalities but are also used by counties.
- **Zoning and Land Use Policies:** Planning and zoning ordinances regulate acceptable types of land uses within a community to promote appropriate development, safety, and general welfare. Some communities use zoning and land use ordinances to establish open space requirements, conservation easements, and minimum setbacks from creeks and wetlands to preserve floodplain function and promote sustainable and resilient development.
- **Local and Regional Flood Plans:** Local and regional flood plans analyze a community's flood risk and present how that entity will improve its resiliency. Drainage master plans describe a community's physical and institutional planning environment and establish interjurisdictional roles and responsibilities when many drainage entities are present. Capital Improvement Plans (CIP) identify capital project alternatives for an entity, provide economic analysis for alternatives, and often rank alternatives based on feasibility. The CoSA has completed drainage master plans to develop a drainage CIP organizing future projects.

Local regulations and development codes, as well as their prevalence within the SAFPR, are discussed in detail in Chapter 3 Floodplain Management Practices and Flood Protection Goals.

1.10 Agricultural and Natural Resources Impacted by Flooding

1.10.1 Farming

Flooding or excess precipitation can cause delays in, and reduction of, crop harvest and can erode sediment and nutrients, resulting in partial or sometimes complete crop loss. The impact that flooding has on farming depends on factors, including crop type, stage of the growing or harvesting season when the flood event occurs, and magnitude of flooding. The numerous crop types grown within the SAFPR have varying resiliency to excess precipitation and prolonged ground inundation. Permanent crops, such as trees, tend to be more resilient to excess precipitation and ground inundation than row crops, such as corn or cotton. Within the SAFPR, row crops comprise most of the farming production. Heavy rain before planting can delay planting or prevent planting for the season. Additionally, flooding damages can occur after crops such as cotton or hay have been harvested but not bailed or processed.

1.10.2 Ranching

Ranching activities within the region are also impacted by flooding. Livestock can be swept away, drowned, or injured by flash floods. After a flood, livestock can be particularly susceptible to certain types of parasites and diseases. Excessive rain may cause an increase in vectors, including flies and mosquitos, and cases of foot rot, which is a foot disease of cattle, sheep and goats[16]. Flood events can cause delays in building back livestock herds. Flood damages to livestock silage can reduce livestock head counts.

1.10.3 Natural Resources

The SAFPR contains numerous natural resources, such as wildlife, that can be affected by flood events. As with livestock, wildlife can be injured or killed by flash floods. Severe flood conditions can degrade stream health and affect ecosystems within the region.

However, in some ways, flooding can be a benefit for fields, wetlands, and riparian areas if limited in depth, duration, and velocity. However, typically within this region where flash floods are common, flooding causes erosion of sediment and nutrients, which can cause nutrient overgrowth and algal blooms in water bodies as well as nutrient deficiencies in agricultural lands.

1.11 Existing Local and Regional Flood Plans

Table 1-12 provides a list of previous flood studies considered by the San Antonio RFPG to be relevant to the development of the San Antonio RFP.

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[16] https://www.mla.com.au/research-and-development/dealing-with-natural-disasters/flood-recovery/, accessed March 18, 2022.

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Table 1-12. Previous Local and Regional Flood Plans

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Base Level Engineering	BLE is an efficient modeling and mapping approach that aims to provide technically credible flood hazard data at various geographic scales such as community, county, watershed, and/or state level. These data are meant to complement the current effective FIRM data, but not replace it.	All jurisdictions within the SAFPR	Bandera, Bexar, Karnes, Kendall, Kerr, Goliad, Refugio, Wilson, Medina, Victoria, DeWitt, Atascosa, Aransas, Guadalupe, Calhoun, Comal	Ongoing
City of Boerne Drainage Master Plan	The City of Boerne updated their drainage master plan and updated development code changes. Results identified structures and roadways at risk to flooding during frequent storm events. Total project costs included more than $60.5 million, removed approximately 67% of structures from the 100-year floodplain, and provided 100-year level of service to eight roadways and increased mobility for several others.	City of Boerne	Kendall	2021

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Upper Cibolo Risk MAP Study	These floodplain physical map revisions are based on updated H&H analysis within the SAFPR in the Upper Cibolo watershed. The results are being incorporated into the draft NFHL.	City of Bulverde, City of Boerne, City of Fair Oaks Ranch, City of San Antonio, Bandera County, Bexar County, Comal County, Kendall County	Bandera, Bexar, Comal, Kendall	2021
Lower San Antonio Risk MAP Study	These floodplain physical map revisions are based on updated H&H analysis within the SAFPR in the Lower San Antonio watershed. The results are being incorporated into the draft NFHL.	City of Floresville, City of Kenedy, City of Runge, City of Northeim, City of Goliad, City of Falls City, City of Karnes, City of Poth, City of San Antonio, Bexar County, Dewitt County, Wilson County, Karnes County, Goliad County	Bexar, Guadalupe, DeWitt, Wilson, Karnes, Goliad	2021
San Geronimo Risk MAP Study	These floodplain physical map revisions are based on updated H&H analysis within the SAFPR in the San Geronimo watershed. The results are being incorporated into the draft NFHL.	City of San Antonio, Bandera County, Bexar County, Medina County	Bandera, Bexar, Medina	2021

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Coastal Resiliency Master Plan	Developed by the Texas GLO, the 2019 Texas Coastal Resiliency Master Plan is the second installment of a statewide plan to protect and promote a vibrant and resilient Texas coast that supports and sustains a strong economy and healthy environment for all who live, work, play, or otherwise benefit from the natural resources and infrastructure along the Texas coast.	All jurisdictions within the Texas coastal counties	Aransas, Refugio	2020
Aransas County Multi-Jurisdictional Floodplain Management Plan	The focus of the mitigation action plan is to reduce future losses within Aransas County by identifying mitigation strategies based on a detailed hazard risk analysis, including both an assessment of regional hazards and vulnerability. The mitigation strategies seek to identify potential loss-reduction opportunities. The goal of this effort is to work towards more disaster-resistant and resilient communities throughout Aransas County.	Aransas County	Aransas	2020

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Calaveras Risk MAP Study	These floodplain physical map revisions are based on updated H&H analysis within the San Antonio River Basin in the Calaveras watershed. The results have been incorporated into the preliminary NFHL. FEMA's Flood Datasets are available through the Map Service Center[a]. Flood risk data can be viewed on the SARA Risk MAP Viewer[b].	City of China Grove, City of Elmendorf, City of San Antonio, Bexar County, Wilson County	Bexar, Wilson	2019
Bandera County River Authority and Groundwater District Flood Plan	The BCRAGD Flood Plan defines lines of communication, personnel assignments, safety, special flood conditions and post-flood operations for Bandera County.	All jurisdictions within the BCRAGD	Bandera	2019

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Development of Flood Warning Tool Set for Medina River, Bandera County (TWDB Final Report: Contract No. 1600012035)	The study area encompassed a 23-mile reach of the Medina River from the confluence of Winans Creek to English Crossing Road above Medina Lake. The USGS developed a HEC-RAS model, which applied data from existing streamflow-gaging stations and installed two additional "stage only" streamflow gaging stations along the headwaters of the North and West Prongs of the Medina River. A flood atlas, consisting of a library of flood-inundation maps for a range of streamflow conditions, was developed and included on the USGS FIMP website[c]. The flood inundation maps depict estimates of the areal extent and depth of flooding corresponding to selected water levels (stages) at the USGS streamflow-gaging station 08178880 Medina River at Bandera, Texas.	All jurisdictions within BCRAGD	Bandera	2019

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Aransas County Texas Multi-Jurisdictional HMAP	This plan covers 2 counties, 8 cities, and 2 school districts. The purpose of the plan is to minimize or eliminate long-term risks to human life and property from known hazards, and to break the cycle of high cost disaster response and recovery within the planning area.	Aransas County	Aransas	2019
Medina Risk MAP Study	These floodplain physical map revisions are based on updated H&H analysis within the San Antonio River Basin in the Medina River watershed. The results have been incorporated into the effective NFHL. FEMA's Flood Datasets are available through the Map Service Center[d]. Flood risk data can be viewed on the SARA Risk MAP Viewer[b].	City of Bandera, City of Castroville, Kerr County, Bandera County, Medina County	Bandera, Kendall, Kerr, Medina	2018

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Hazard Identification, Risk Assessment and Consequence Analysis	The HIRA is the first step in evaluating natural and technological hazards that exist. It serves as a basis for the development plans, public education programs, and responder training and exercises. It also lays a foundation to begin mitigation efforts to minimize these identified potential threats.	Bexar County, City of San Antonio	Bexar	2017
City of San Antonio Local Drainage Master Plan	In 2016, SARA teamed with CoSA to develop a Drainage Master Plan of previously documented potential projects within city limits in order to identify candidates for the 2017 bond program.	City of San Antonio	Bexar	2016
Bexar Risk MAP Study – Ft Sam Trib, Airport Trib, and UNT 1 to Martinez A	Floodplain physical map revisions based on updated H&H analysis within the San Antonio River Basin in the Medina River watershed. The results have been incorporated into the effective NFHL. FEMA's Flood Datasets are available through the Map Service Center[d]. Flood risk data can be viewed on the SARA Risk MAP Viewer[b].	City of San Antonio, City of Terrell Hills, Bexar County	Bexar	2015

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
City of San Antonio HMP	The goal of the 2021 City of San Antonio HMP is to minimize or eliminate the long-term risk to human life and property from known hazards by identifying and implementing cost-effective mitigation actions[e].	City of San Antonio	Bexar	2021
Bexar County HMP	The focus of the Bexar County HMP is to identify activities to mitigate hazards classified as “high” or “moderate” risk, as determined through a detailed hazard risk assessment conducted for Bexar County and the participating jurisdictions[f].	Bexar County, City of Alamo Heights, City of Balcones Heights, City of Castle Hills, City of China Grove, City of Converse, City of Elmendorf, City of Fair Oaks Ranch, City of Grey Forest, City of Helotes, City of Hill Country Village, Town of Hollywood Park, City of Kirby, City of Leone Valley, City of Live Oak, City of Olmos Park, City of Saint Hedwig, City of Sandy Oaks, City of Schertz, City of Shavano Park, City of Somerset, City of Terrell Hills, City of Universal City, City of Von Ormy, and City of Windcrest	Bexar	2017

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Holistic Watershed Masterplans	SARA has worked with partner agencies since 2009 to complete Watershed Master Plans for the Upper San Antonio River, Leon Creek, Salado Creek, Medina River, Lower San Antonio River, and Cibolo Creek watersheds. The Master Plans have two primary objectives: identify needs and opportunities related to flood risk, water quality issues, low impact development, stream restoration, nature-based park planning, mitigation banking, and conservation easements; and develop and assess proposed projects to address the identified needs and preserve identified opportunities. The Watershed Master Plan Viewer[g] displays data produced in the various Master Plan reports, as well as other useful reference data. It is intended to be used as a visualization tool to assist the public, stakeholders, and decision-makers in understanding both watershed issues and potential solutions.	All jurisdictions within Bexar, Karnes, Wilson, and Goliad Counties	Bexar, Goliad, Karnes, Wilson	2009–2015

Previous and Relevant Flood Study	Description	Jurisdictions Covered	Counties	Year
Bexar, Wilson, Karnes, and Goliad County-Wide 2010 Flood Insurance Studies	The FEMA NFHL data was digitized and updated with new terrain, survey, hydrologic, and hydraulic data. FEMA's Flood Datasets are available through the Map Service Center[d].	All jurisdictions within Bexar, Wilson, Karnes, and Goliad Counties	Bexar, Wilson, Karnes, Goliad	2010
City Master Plans	These include City Master Plans for the Cities of Boerne, Fair Oaks, Castroville, La Coste, La Vernia, and Floresville.	City of Boerne, Fair Oaks, Castroville, La Coste, La Vernia	Kendall, Bexar, Medina, Wilson	2020, 2021, 2022

[a] Map Service Center, https://msc.fema.gov/portal/advanceSearch
[b] SARA Risk MAP Viewer, https://www.arcgis.com/apps/webappviewer/index.html?id=0b13614f13124257bfe589a459ba84fe
[c] USGS FIMP website, https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program
[d] FEMA Map Service Center, https://msc.fema.gov/portal/advanceSearch
[e] City of San Antonio HMP, https://www.saoemprepare.com/Plans/HMAP
[f] Bexar County HMP, https://cms3.revize.com/revize/leonvalleynew/government/community_development/floodplain_management/docs/Ordinance%20No.%202017-58.pdf
[g] Watershed Master Plan Viewer, https://sara-tx.maps.arcgis.com/apps/webappviewer/index.html?id=1cc5aae56ef145b69aab7dc1b6e52597
Notes: BCRAGD = Bandera County River Authority and Groundwater District; FIMP = Flood Inundation Mapping Program; GLO = General Land Office; H&H = hydrologic and hydraulic; HEC-RAS = Hydrologic Engineering Center River Analysis System; HIRA = Hazard Identification Risk Assessment; HMAP = Hazard Mitigation Action Plan; HMP = Hazard Mitigation Plan; MAP = Mapping, Assessment, and Planning

1.12 Assessment of Existing Infrastructure

Background knowledge of the SAFPR's existing natural and structural flood infrastructure provides context in identifying strategies and flood planning recommendations throughout the planning process. This section details the natural flood mitigation features and major flood infrastructure within the SAFPR. Applicable natural features and infrastructure are summarized in Table 1-13.

Table 1-13. Natural Features and Constructed Major Flood Infrastructure

Flood Infrastructure	Source/Description	Condition
Natural Features[a]		
Rivers, tributaries, and functioning floodplains	National Hydrography Dataset	Functional
Functioning floodplains	Floodplains from TWDB compiled "flood quilt"	Functional
Wetlands	National Wetland Inventory	Functional
Sinkholes	National Hydrography Dataset	Functional
Alluvial fans	None Identified	N/A
Playa lakes	None Identified	N/A
Constructed Major Infrastructure		
Levees	United States Army Corps of Engineers	Deficient
Stormwater tunnels	CoSA	Functional
Flood tunnel	CoSA	Functional
Stormwater canals	None Identified	N/A
Dams that provide flood protection	Texas Commission on Environmental Quality, National Resources Conservation Service, and SARA	Functional/Nonfunctional/Unknown

Flood Infrastructure	Source/Description	Condition
Detention and retention ponds	Numerous sources, including Texas Commission on Environmental Quality and individual municipalities and counties	Unknown
Storm drain systems	Individual municipalities and counties	Unknown
Nature-based solutions	CoSA	Functional

[a] 31 TAC §361.31 states that RFPs must include a general description of the location, condition, and functionality of natural features and constructed major infrastructure within the FPR. Several of these do not exist within the SAFPR, including vegetated dunes; sea barriers, walls and revetments; and tidal barriers and gates.
Notes: N/A = not applicable

Existing flood infrastructure within the SAFPR consists of both natural features and constructed features, which are owned and managed by numerous entities, including both governmental entities and individual property owners. Flood infrastructure may include nonstructural measures such as natural area preservation, buyout of repetitive flood loss properties, or flood warning systems, and includes major public infrastructure like flood control dams. The TWDB Flood Data Hub[17] provides data to assist with identifying flood management infrastructure. The SAFPR's geodatabase was populated with available information from the TWDB as well as other state and federal sources. The multiple data sources were reviewed and amended to include one data point per location if duplication occurred across datasets.

1.12.1 Natural Features

Urbanization and overuse of rangeland can reduce the permeability of soil, making land less efficient at detaining stormwater and infiltrating rainfall into the soil profile. In more urbanized areas, drainage infrastructure is designed to collect and concentrate stormwater, which can increase the velocity and intensity of runoff, leading to higher and faster flood flow peaks, stream degradation, and reduced stormwater quality.

As land fragmentation in some areas of the SAFPR increases due to urbanization, oil and gas development, and other factors, focused land

[17] https://www.twdb.texas.gov/flood/planning/data.asp, accessed March 18, 2022.

management efforts will be necessary to continue to receive the flood control benefits provided by open land. The United States Army Corps of Engineers' (USACE) Engineering with Nature program[18] aims to bring natural and engineered processes together to deliver more efficient and sustainable projects. Local, state, and federal governments manage local, state, and regional parks and lands as well as wildlife management areas within the SAFPR that form part of the region's natural infrastructure.

When left in their natural state, open lands are typically efficient at managing rainfall. Rainfall is slowed by vegetation, which allows rainfall an opportunity to infiltrate into the soil. Rangeland performs this function effectively. However, rainfall on cropland may pool and runoff comparatively more quickly. Well-designed parklands in more urban areas can attain nearly the same rate of stormwater capture and detention as lands in undeveloped areas. For engineered natural features to effectively achieve flood mitigation, they are often designed to form part of an interconnected network of open space containing predominantly natural areas, which is known as low impact development (LID)[19] or green infrastructure. These practices can be defined as replicating natural processes to capture stormwater runoff where even small changes in developed areas can lessen downstream flooding.

1.12.1.1 Rivers, Tributaries, and Functioning Floodplains

Streams and rivers and their associated floodplains have the natural flood storage capacity to contribute significantly to overall flood control and management. The natural hydrologic features operate as a single, integrated, natural system. When this system is disrupted, effects can cascade through the watershed, increasing flood risk. Floodplain maintenance in an undeveloped state provides rivers and streams the ability to store the maximum volume of floodwater and reduce flood peak volumes. Preservation of a natural, integrated system of waterways and floodplains also serves a valuable function in urban areas.

With a length of approximately 240 miles, the San Antonio River is a tributary of the Guadalupe River and the main stream within the SAFPR. The San Antonio River's watershed drains an area of approximately 4,194 square miles. It flows generally southeast through Bexar, Wilson, Karnes, Goliad, and Refugio Counties before emptying into the Guadalupe River right before the combined rivers discharge into San Antonio Bay. Other significant rivers and

[18] https://ewn.erdc.dren.mil/, accessed March 21, 2022.

[19] https://lowimpactdevelopment.org/, accessed March 21, 2022.

streams within the SAFPR include the Medina River, Cibolo Creek, and Salado Creek.

The SAFPR's lakes, reservoirs, parks, and preserves serve as important components of the ecosystem, encompassing a wide variety of plants, animals, and physical features that are imperative for the continued ecological health of the region. These water bodies and natural areas retain water during flood events. These types of natural flood infrastructure are generally located in or close to floodplain areas throughout the basin, with higher concentrations being located along or close to major rivers and tributaries.

1.12.1.2 Karst Features

Recharge-related sinkhole and discharge-related flooding are associated with karst topography. Rapid urban development on karst usually increases the mass on the land surface, which increases the chance of collapse through sinkholes. Even if no sinkholes are visible in a karst region, continuing karstic development under urban areas can affect building foundations. Additionally, impervious paved surfaces in urban areas can block infiltration, altering native groundwater flow paths. In some situations, karst features can rapidly infiltrate surface flood waters and provide flood reduction capabilities. Water quality control measures and flood management should occur simultaneously to prevent groundwater contamination.

1.12.2 Constructed Flood Infrastructure

Major constructed flood infrastructure ranges from dams and levees to municipal drainage systems, which consist of constructed channels and storm drain systems. It also includes nature-based solutions (NBS).

1.12.2.1 Reservoirs

Impounded water features such as reservoirs serve many purposes, including flood risk reduction, recreation, and water supply for municipal, industrial, irrigation, and fire protection purposes. The three major reservoirs (greater than 5,000 acre-feet storage capacity) located within the SAFPR are shown in Table 1-14.

Table 1-14. Major Reservoirs within the SAFPR

Reservoir	Location
Calaveras Lake	Bexar County, 20 miles southeast of downtown San Antonio
Medina Lake	Medina and Bandera County, approximately 12 miles southeast of the City of Bandera
Victor Braunig Lake	Bexar County, 17 miles south of downtown San Antonio

1.12.2.2 Dams

Additional dams on smaller tributaries exist across the SAFPR and were identified from several sources, including the Texas State Soil and Water Conservation Board (TSSWCB), Texas Commission on Environmental Quality (TCEQ), and USACE. Several dams were designed and constructed by the Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service (SCS). While information was not available in the readily available documentation, the function of these dams often was for flood control. However, these smaller dams still provide large amounts of detention; for example, the dams along the San Antonio River provide more storage than the Olmos Dam. All identified dams have been included as part of the SAFPR's infrastructure inventory and are also listed below in Table 1-15.

Table 1-15. State Regulated Dams within the SAFPR

Dam Name	Dam Name	Dam Name
Alamo Angus Ranch Lake Dam	Escondido Creek WS SCS Site 3 Dam	Or Mitchell Lake 1 Dam
Armstrong Lake Dam	Escondido Creek WS SCS Site 4 Dam	Purple Sage Ranch Lake
Army Residence Community Dam	Escondido Creek WS SCS Site 5 Dam	Riley Lake Dam
Baker Lake Dam	Escondido Creek WS SCS Site 6 Dam	Rock Cliff Dam
Ballasetal Lake Dam	Escondido Creek WS SCS Site 7 Dam	Salado Creek WS NRCS Site 15r Dam
Blue Wing Lake Dam	Escondido Creek WS SCS Site 8 Dam	Salado Creek WS SCS Site 1 Dam

Dam Name	Dam Name	Dam Name
Boerne Public Park Dam	Escondido Creek WS SCS Site 9 Dam	Salado Creek WS SCS Site 10 Dam
Brooklyn Street Lock and Dam	Garrison Ranch Lake Dam	Salado Creek WS SCS Site 11 Dam
Calaveras Creek Dam	Grothaus Lake Dam	Salado Creek WS SCS Site 12 Dam
Calaveras Creek WS SCS Site 10 Dam	H and K Lake Dam	Salado Creek WS SCS Site 13a Dam
Calaveras Creek WS SCS Site 3 Dam	Harmark Lake Dam	Salado Creek WS SCS Site 13b Dam
Calaveras Creek WS SCS Site 5 Dam	Heimsath Cemetery Lake Dam	Salado Creek WS SCS Site 2 Dam
Calaveras Creek WS SCS Site 6 Dam	Hidden Springs Dam	Salado Creek WS SCS Site 4 Dam
Calaveras Creek WS SCS Site 7 Dam	Hondo Creek WS SCS Site 1 Dam	Salado Creek WS SCS Site 5 Dam
Calaveras Creek WS SCS Site 8 Dam	Hondo Creek WS SCS Site 2 Dam	Salado Creek WS SCS Site 6 Dam
Calaveras Creek WS SCS Site 9 Dam	Hondo Creek WS SCS Site 3 Dam	Salado Creek WS SCS Site 7 Dam
Canvasback Lake Dam	Jc Webb Dam	Salado Creek WS SCS Site 8 Dam
Cassin Lake Dam	Kilroy Lake Dam	Salado Creek WS SCS Site 9 Dam
Circle Dot Dam	Kirby Lake Dam	San Geronimo Creek Recharge Dam
Color Spot Nurseries Dam	Lions Park Lake Dam	Scott Lake Dam
Connally Lake No. 1 Dam	Love Creek Dam	Singing Hills Unit 1 Detention Dam
Connally Lake No. 2 Dam	Luckey Lake Dam	Tx No Name No. 19 Dam
Crea Brothers Lake Dam	Martinez Creek WS SCS Site 1 Dam	Tx No Name No. 6 Dam
Denman Park Dam	Martinez Creek WS SCS Site 2 Dam	Upper Cibolo Creek WS SCS Site 1 Dam

Dam Name	Dam Name	Dam Name
Ecleto Creek WS NRCS Site 3 Dam	Martinez Creek WS SCS Site 3 Dam	Upper Cibolo Creek WS SCS Site 2 Dam
Ecleto Creek WS NRCS Site 9a Dam	Martinez Creek WS SCS Site 4 Dam	Upper Cibolo Creek WS SCS Site 3 Dam
Ecleto Creek WS SCS Site 10 Dam	Martinez Creek WS SCS Site 5 Dam	Upper Cibolo Creek WS SCS Site 4 Dam
Ecleto Creek WS SCS Site 4 Dam	Martinez Creek WS SCS Site 6a Dam	Victor Braunig Dam
Ecleto Creek WS SCS Site 6 Dam	Medina Diversion Lake Dam	Walton Lake Dam
Elmendorf Lake Dam	Medina Lake Dam	Water Turkey Lake Dam
Escondido Creek WS SCS Site 1 Dam	Mitchell Lake Dam	White Lake Dam
Escondido Creek WS SCS Site 10 Dam	Montague Lake Dam	White Lake Dam
Escondido Creek WS SCS Site 11 Dam	Mosher Big Lake Dam	White Ranch Lake Dam
Escondido Creek WS SCS Site 12 Dam	New Espada Lake Dam	Wildlake Dam
Escondido Creek WS SCS Site 13 Dam	Okeefe Dam	Woodlawn Lake Dam
Escondido Creek WS SCS Site 2 Dam	Olmos Dam	—

Notes: WS = Watershed

1.12.2.3 Weirs

Weirs are low-lying blockades, similar to dams; however, instead of stopping water significantly, the structures configuration is used to slow down or alter the water flow for various purposes. Weir structures constructed for flood control purposes were identified throughout the SAFPR.

1.12.2.4 Levees

Levees are human-made embankments that artificially contain flood flows to a restricted floodplain. More than 1 million Texans and $127 billion worth of property are protected by levees, including 51 USACE levee systems. Eight levees are located within the SAFPR: three are part of the Guadalupe River levee system, four are a part of the Refugio County levee system, and one is located in Victoria and Calhoun Counties.

1.12.2.5 Stormwater Management Systems

Stormwater management systems serve to manage both the quantity and quality of the water that drains into natural waterways. The TCEQ regulates the discharge of municipal separate storm sewer systems (MS4) through the two sets of permits administered under the Texas Pollutant Discharge Elimination System, known as Phase I (large and medium) or Phase II (small) MS4 permits. To be subject to MS4 permit requirements, a municipality must own and operate storm drainage infrastructure. Phase I MS4 requirements apply to incorporated cities that have populations exceeding 100,000 as of the 1990 census. Phase II MS4 requirements apply to all smaller "urbanized" areas, defined by the Bureau of the Census as containing 50,000 persons or more using either the 2000 or 2010 Census. San Antonio and all communities within the SAFPR boundaries are under Phases I and II MS4 permit requirements. Based on population size, no other communities met the TCEQ MS4 requirements.

1.12.2.6 Flood Tunnels

Flood tunnels are used to convey large quantities of flood water through an underground tunnel to reduce flood risk. These tunnels are typically used in densely populated areas where the existing stormwater system is close to full capacity. Within the SAFPR, two flood tunnels currently protect the downtown area of the CoSA. These tunnels run beneath the city along San Pedro Creek and the San Antonio River.

1.12.2.7 Nature-Based Solutions

As previously mentioned, NBSs include preserving the natural ecosystem, but in more developed urban areas where preservation is no longer possible, reconstruction and restoration can be used. One prime example of this is the Mission Reach, an 8-mile stretch of the San Antonio River turned into a riparian woodland ecosystem.

1.12.3 Assessment of Condition and Functionality of Existing Infrastructure

The general location, description, level of service (LOS), functionality, deficiency, and owning/operating entities for each identified natural flood mitigation feature and constructed major flood infrastructure are summarized in Table 1-13 and the geographic information system (GIS) geodatabase.

Additional information for significant or deficient/nonfunctional features or infrastructure are detailed in subsequent sections as necessary.

The TWDB defines infrastructure functionality as follows:

- Functional infrastructure is defined as serving its intended design LOS.
- Nonfunctional infrastructure is defined as not providing its intended or design LOS.
- Deficient is defined as infrastructure or natural features in poor structural or nonstructural condition that need replacement, restoration, or rehabilitation.

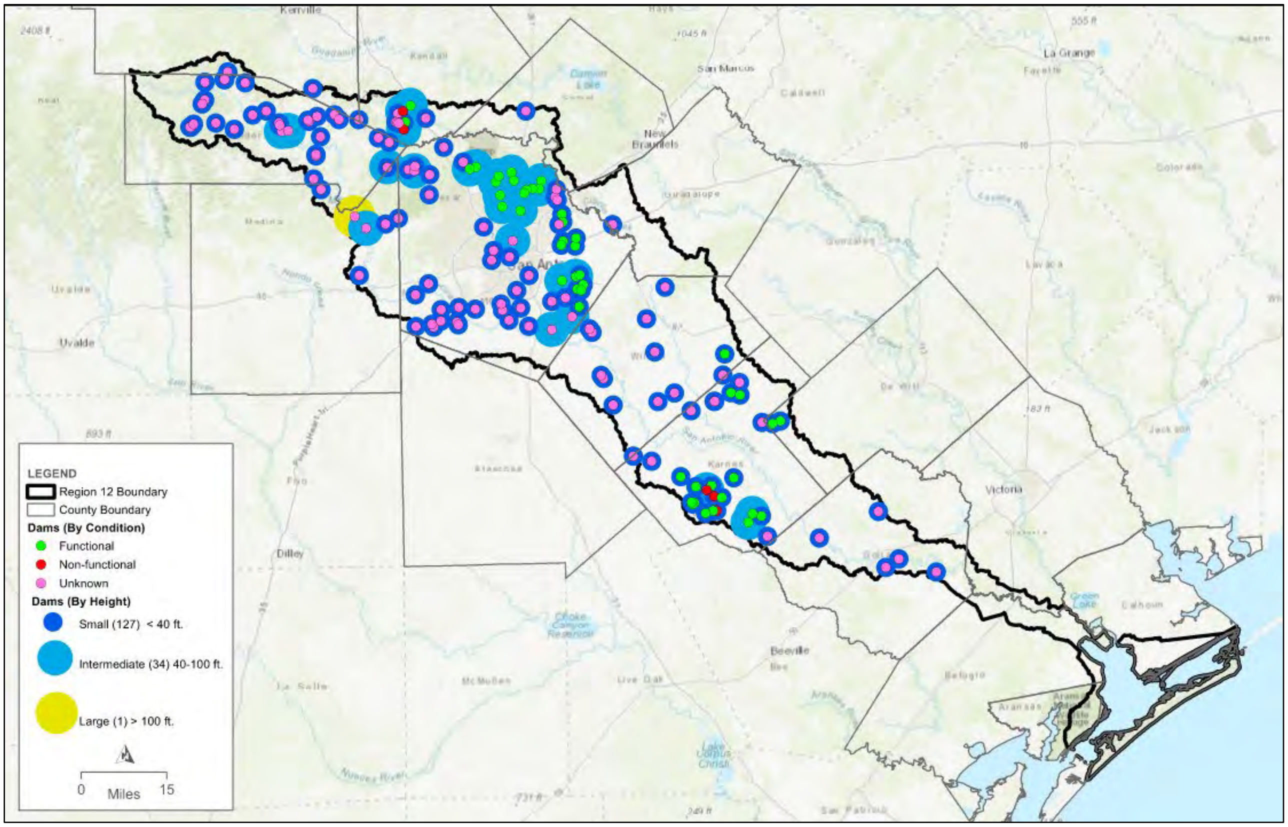
1.12.3.1 Nonfunctional or Deficient

Information compiled and responses provided to stakeholder outreach has been limited to date. Two explanations for nonfunctional and deficient infrastructure include lack of funding for a stormwater utility and higher design standards adopted since the construction of existing stormwater drainage systems. Many municipalities lack a dedicated funding source for stormwater projects, operations, and maintenance; however, Texas state law provides a mechanism for municipalities to establish a dedicated revenue source for drainage through the implementation of a stormwater utility fee.

1.12.3.2 Dam Safety Assessment

In 2019, the Association of State Dam Safety Officials estimated the cost to rehabilitate all nonfederal dams in Texas at approximately $5 billion. The TSSWCB estimates approximately $2.1 billion is needed to repair or rehabilitate dams included in the Small Watershed Programs. A dam is classified as high hazard if its failure could cause significant loss of life, serious damage to structures, or disruption to important public utilities or transportation facilities. A dam's hazard classification is not an assessment of condition. The TCEQ maintains condition data for nonfederal dams as part of the Texas Dam Safety Program; however, information about the condition of many dams is not publicly available. Of the 7,200 nonfederal dams in Texas, more than 3,200 are exempt from dam safety requirements, representing almost half of nonfederal dams. Of the 162 dams located within the SAFPR, 5 do not meet the TCEQ requirements: Escondido Creek Watershed (WS) SCS Sites 1, 2, and 4, and Upper Cibolo Creek WS SCS Sites 2 and 4.
Figure 1-16 shows the dams located within the SAFPR.

Figure 1-16. Dams Located within the SAFPR



Source: USACE, National Inventory of Dams, https://nid.usace.army.mil/#/

1.12.4 Proposed or Ongoing Flood Mitigation Projects

Table 2 Summary of Proposed or Ongoing Flood Mitigation Projects in Appendix A and the attached GIS database includes a general description of the location, source of funding, and anticipated benefits of proposed or ongoing flood mitigation projects within the SAFPR including:

- New structural flood mitigation projects currently under construction,
- Nonstructural flood mitigation projects currently being implemented, and
- Structural and nonstructural flood mitigation projects with dedicated funding to construct and the expected year of completion.

The data for this section are derived from two primary sources: the SAFPR's existing Hazard Mitigation Plans and a stakeholder survey. Gaps and limitations exist within the data. Overall, it only represents a small number of the communities within the basin and few data were provided on individual projects. Additional information for proposed or ongoing flood mitigation projects are detailed in subsequent sections as necessary. Table 2 Summary of Proposed or Ongoing Flood Mitigation Projects in Appendix A and Map 2 Proposed or Ongoing Flood Mitigation Projects (2.1 Task 1 – Planning Area

Description) in Appendix B depicting where these projects are occurring within the SAFPR.

1.12.4.1 Structural Projects under Construction

The cities of San Antonio, Schertz, and Cibolo have developed recent drainage master plans with lists of drainage capital improvement projects, some of which have been constructed and others that are still awaiting funding. Responses from other communities regarding projects under construction were insufficient to provide additional details regarding these projects. Chapter 5 Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects provides a more detailed assessment of current and potential projects.

1.12.5 Implementation of Nonstructural Flood Mitigation Projects

Information obtained from stakeholder outreach has been limited to date. The top goal cited by respondents has been implementing protective standards and policies, followed by identifying and communicating flood risk, restoring failing infrastructure, and implementing flood warnings and responses. Chapter 3 Floodplain Management Practices and Flood Protection Goals includes further information regarding the region's goals and practices, and Chapter 5 Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects describes implementation of nonstructural flood mitigation projects.

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2

Flood Risk Analysis

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2 Flood Risk Analysis

The objective of this task was to perform a comprehensive flood risk analysis for the SAFPR. Flood risks were assessed for the 1 and 0.2 percent annual chance storm events. The analysis was performed for existing conditions of the region, as well as a future condition scenario that considers changes in flood hazards over the 30-year planning horizon. The overall flood risk analysis is composed of three separate but related evaluations, including:

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

The following sections describe the process undertaken to determine and quantify flood hazards within the region and present the results of the evaluation, including a summary of the types and magnitude of flooding and the communities most susceptible to its harmful effects. TWDB-required Table 3 Existing Condition Flood Risk Summary Table and Table 5 Future Condition Flood Risk Summary Table by County, in Appendix A, summarize the quantitative results of this analysis by county within the region.

2.1 Existing Condition Flood Risk Analysis

2.1.1 Existing Condition Flood Hazard Analysis

The purpose of the existing condition flood hazard analysis was to identify and compile a comprehensive outlook of existing flood hazards within the SAFPR. To date, no full-coverage evaluation of flood risk has ever taken place within the SAFPR or State of Texas. It should be noted that extensive mapping has occurred within the SAFPR, and only two tributaries around the City of Boerne were identified as having insufficient mapping data.

The output of the flood hazard analysis is a map of flood hazard areas that are subject to several types of flooding during the 1 and 0.2 percent annual chance storm events. This effort is not regulatory in nature, and the results of this evaluation do not affect NFIP insurance requirements or premiums. Rather, this exercise is intended to gather a single, comprehensive set of best available information on actual flood risk within the SAFPR to help communities understand their current risks and better prepare in the event of a flood.

2.1.1.1 Types of Flood Hazards within the SAFPR

To plan for a flood, it is important to understand the types of flooding an area faces. Each type of flooding is different in how it occurs, how it is forecast, and the damages it can cause. This evaluation considered several different types of flooding in identifying the flood hazard areas.

Riverine Flooding: Riverine flooding is 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 to the receiving waters, either locally and/or in upstream watershed areas.

Pluvial Flooding: Pluvial floods can occur when the inflow of stormwater exceeds the capacity of drainage natural and human-made drainage systems, causing flooding of streets, property, and nearby structures. One common misconception about flooding is that one must be located near a body of water to be at risk. Yet pluvial, or surface, floods are not caused by swelling rivers. Pluvial flooding, as defined in this plan, normally occurs in urban environments. Pluvial flooding also includes flash floods, where high velocity surface waters sweep through low-lying areas.

Coastal Flooding: Coastal flooding occurs when normally dry, low-lying land is flooded by seawater.

Playa Flooding: Playa flooding occurs when playas overtop and flood surrounding areas.

2.1.1.2 Possible Flood Prone Areas

This analysis also considers potentially flood-prone areas that the San Antonio RFPG identifies outside previously mapped flood hazard areas. They can be identified through the location of hydrologic features, historic flooding, and/or local knowledge. Since the cause and recurrence of flooding within these areas is uncertain, separate flood hazard areas have been developed and are listed with “unknown” flood frequency in this analysis.

The SAFPR is subject to the danger of swift-moving flood waters in riverine areas due to the steepness of the land and narrow channels. This causes fast-moving, deep, flood waters that cause costly destruction to communities and infrastructure in low-lying areas. Pluvial flooding, or urban flooding, is also a source of significant flooding exposure, particularly in the cities of San Antonio, Boerne, Bandera, and Karnes.

Additionally, possible flood prone areas were identified through multiple sources of data. The first was through identification of the SAFPR LWCs compared to known flood hazard areas. Those areas that had low-lying roads intersecting waterways would be considered LWCs. There were 498 LWCs defined within the SAFPR. LWC points outside the 1 and 0.2 percent annual chance storm event flood hazard area were delineated as possible flood-prone areas since their status as LWCs indicates a likely flood risk at these locations, even if it is not mapped.

The second source of data was comments on an ArcGIS Online web map where the public could report areas of flooding. This web-based map was shared on the San Antonio RFPG website[20], as well as emailed to community officials within the SAFPR. Points that were outside the 1 and 0.2 percent flood risk areas were delineated as possible flood-prone areas based on the description included in the comment.

The third source of data was the historical flood data for the SAFPR that was gathered through a variety of local and national entities. USGS gage information was used to identify flood-prone areas and evaluate historical flood events based on flow surges. Other historical flood data was pulled from the NWS, FEMA, TxDOT, publications on historical flood events, and CoSA 311 complaints. These sources provided areas of concern, project areas, and past flood data. This data was used to map out previous and updated flood risk areas as well as determine the damage cost from major past storm flooding events.

2.1.1.3 Existing Hydrologic and Hydraulic Model Availability

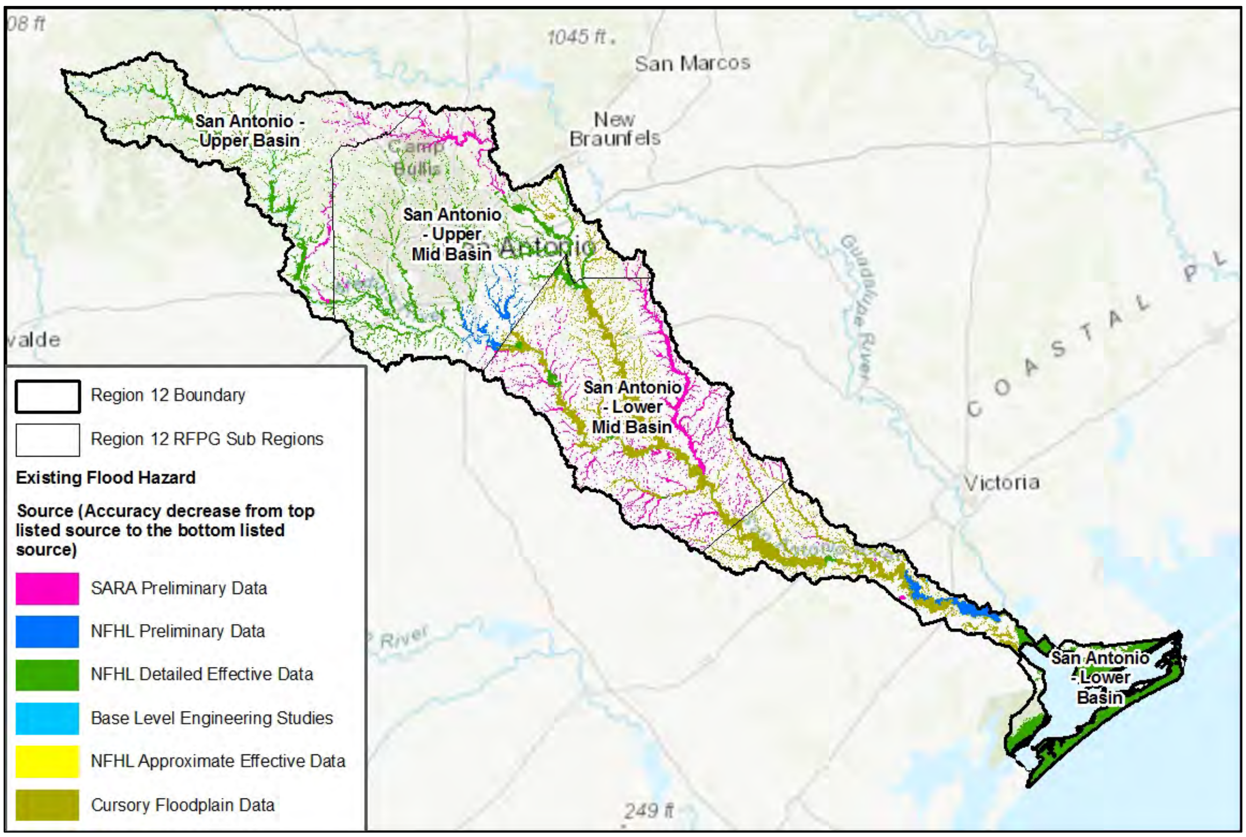
The development of the flood hazard areas relied on floodplain modeling and mapping information from existing sources from all the counties within the SAFPR, rather than the development of new flood hazard information. Hydrologic and hydraulic (H&H) models used for the purposes of defining flood risk boundaries are available for the entire region, as summarized in Figure 2-1. These models can be located on the SARA Digital Data and Model Repository (D2MR) website[21]. The SARA D2MR serves as a centralized location for the storage, management, and dissemination of H&H models and data related to the FEMA Digital Flood Insurance Rate Maps (DFirm) and subsequent updates. Most of the H&H models found on the D2MR website use Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) and Hydrologic Engineering Center River Analysis

[20] https://www.region12texas.org/

[21] https://d2mr.sara-tx.org/

System (HEC-RAS) software. The D2MR website provides the public with standard web tools to navigate and access information related to the effective FEMA DFirm and supporting models. The D2MR also serves as a document management system to control and track the information being provided to and edited by consulting engineers as part of the FEMA Letter of Map Revision (LOMR) Review Partnership. The mapping component of the D2MR application provides users the ability to search by address, cross streets, stream name, watershed name, FEMA panel, or Letter of Map Change. The D2MR application empowers the public to get involved with the regional flood control strategies and interact with SARA to better prepare for and respond to flooding.

Figure 2-1. Existing Flood Model Data



2.1.1.4 Best Available Data Determination

To assist RFPGs with the flood hazard analysis, the TWDB prepared a statewide, GIS dataset that is composed of the most recent flood hazard data in Texas, referred to as the “floodplain quilt.” The floodplain quilt “quilts” together data from several sources, including SARA Preliminary Data, FEMA NFHL information developed from detailed and approximate flood studies, and FEMA BLE data.

The 1 and 0.2 percent flood risk areas were defined for all waterways with contributing drainage areas larger than 0.10 square mile for the entire basin. This complete coverage was due in part to the availability of Cursory Floodplain Data boundaries for the entire basin. Where multiple data sets were available, the most accurate risk boundaries were applied. The 'floodplain quilt' was obtained from TWDB. The "floodplain quilt" does not typically include localized flooding or complex urban flooding problems. Additionally, new preliminary inundation boundaries were obtained from SARA, which is currently the only detailed flood data that uses the latest NOAA Atlas 14[22] rainfall. In addition, flood prone areas identified through public comments will be evaluated as the data becomes available. As of July 8, 2022, 65 comments have been received.

The following list summarizes the various flood inundation data sets used in their order of accuracy from most accurate to least accurate, with data sets including the BLE data and above considered accurate.

1. SARA Preliminary Data (submitted to FEMA for review)
2. NFHL Preliminary Data
3. NFHL Detailed Effective Data
4. BLE Studies
5. NFHL Approximate Study Areas
6. Cursory Floodplain Data – October 29, 2021
7. Public Comments

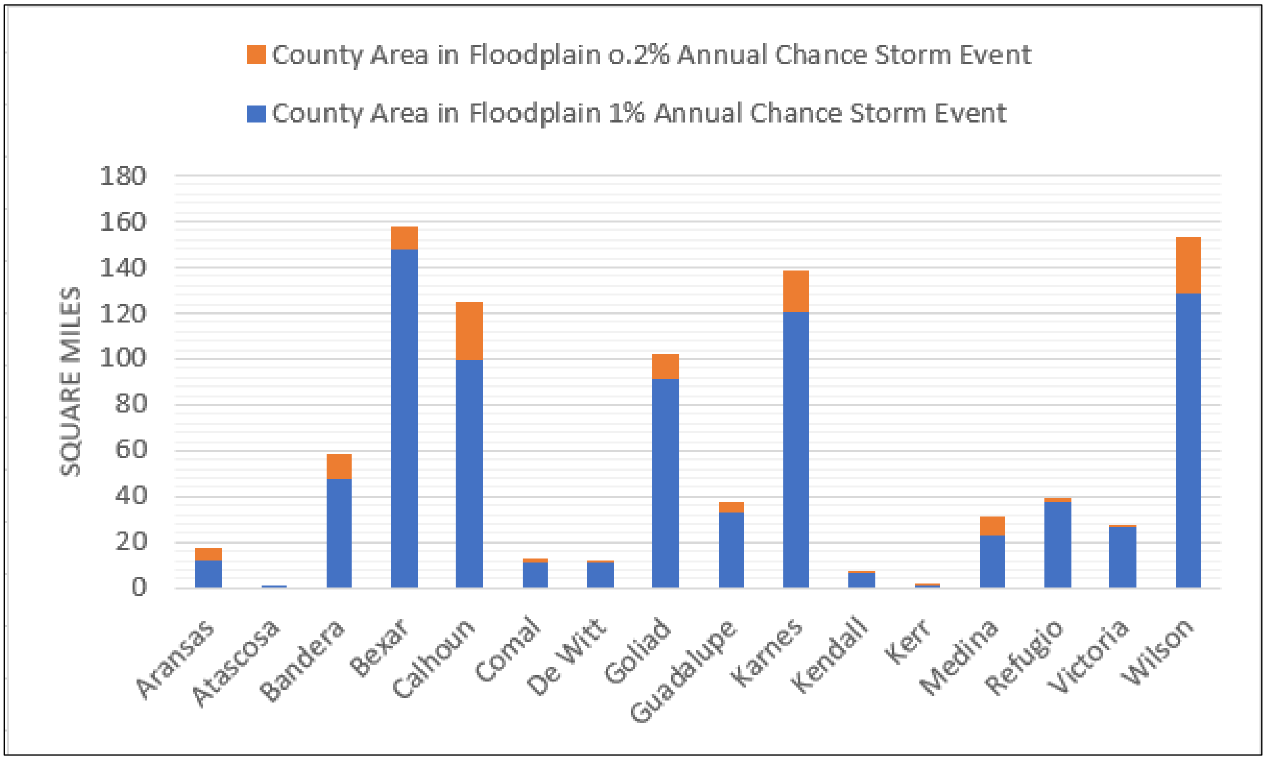
A portion of the SAFPR contains approximate 1 percent flood risk boundaries but no 0.2 percent flood risk boundaries (i.e., NFHL Approximate Study Areas). Therefore, for these approximate areas, the Cursory Floodplain Data 1 and 0.2 percent annual chance storm event data were used to define flood hazard extents. By the end of 2022, SARA will provide additional preliminary data, and the entire San Antonio River basin will have complete BLE coverage. Therefore, existing flood hazard mapping will be updated in its entirety to include Preliminary, Detailed Effective, or BLE quality data.

[22] NOAA. 2017. NOAA Atlas 14 Point Precipitation Frequency Estimates. United States Department of Commerce, NOAA, National Weather Service, Office of Water Prediction. Page last modified April 21, 2017. Available at https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html.

2.1.1.5 Identified Existing Flood Hazard Areas

Figure 2-2 shows the flood hazard area under existing conditions. Refer to Figure 1-8 through Figure 1-11 in Chapter 1 for additional reference. These floodplains cover more than 925 square miles, or 18 percent of the SAFPR land area. Of the mapped flood hazard area, 800 square miles are inundated during the 1 percent annual chance storm event, and an additional 125 square miles are inundated during the 0.2 percent annual chance storm event. Figure 2-2 presents the total flood hazard area by county. Overall, the counties of Bexar, Wilson, and Karnes have the highest total flood hazard area, with more than 400 square miles of flood hazard in these counties alone.

Figure 2-2. Existing Area Located in Floodplain



2.2 Existing Conditions Data Gaps

As previously described, the majority of the SAFPR has extensive mapping coverage. However, two identified tributaries around the City of Boerne are not mapped. Besides those two tributaries, no other mapping gaps were present. This information is presented visually in Map 5 Existing Condition Flood Hazard – Gaps in Inundation Boundary Mapping, including Identification of Known Flood-Prone Areas (2.2.A.1 Existing Condition Flood Hazard Analysis) in Appendix B.

2.2.1 Existing Condition Flood Exposure Analysis

Once the existing condition flood hazard areas were defined by given model data, the existing condition flood exposure analysis was performed to identify the people and property at risk. This analysis was completed using an automated GIS process that intersected various data sources with the flood hazard area boundaries to create the various flood exposure feature classes for the different feature types. The analysis considered exposure of different types of existing development within the flood hazard area, including:

1. Buildings: including residential and non-residential structures, those structures identified as critical facilities, and the associated population at risk. The population at risk evaluated both the day and night population estimates for each structure, with the higher of the two values being used to estimate the population in the flood hazard area.
2. Roadways: including estimated number of road crossings and total roadway length inundated by flooding. Those road crossings identified as LWCs were specifically identified, as these crossings are generally overtopped by floodwaters more frequently.
3. Agricultural Areas: including the total area of farming and ranching lands within the flood hazard area.

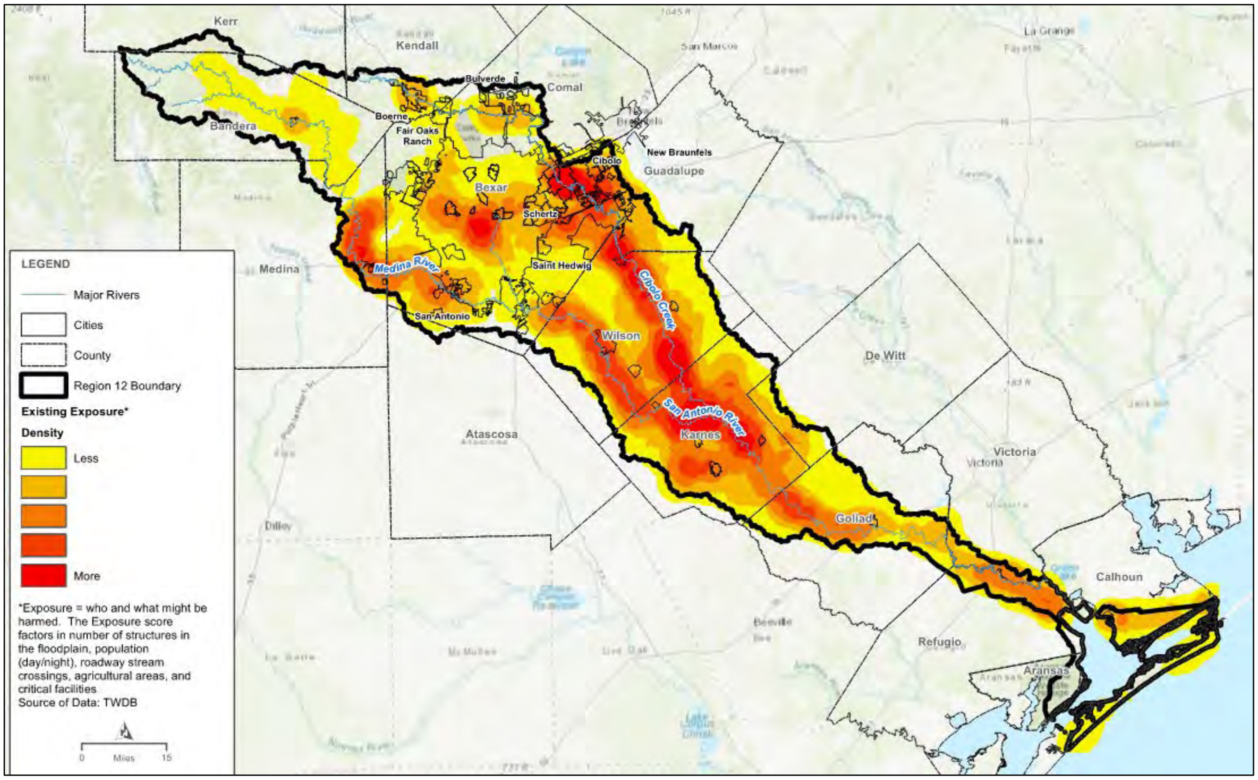
2.2.1.1 Flood Exposure Due to Existing Levees or Dams

The analysis also required the consideration of population and property located in areas where existing levees or dams do not meet FEMA accreditation as inundated by flooding without those structures in place. Of the four levee systems, three are identified as not meeting FEMA accreditations and one is unknown. However, it is assumed that the current floodplain limits properly reflect the flood protection benefits of these structures.

2.2.1.2 Existing Flood Exposure Summary

The following sections describe the results of the existing flood exposure analysis, with a summary in Table 2-1. From this analysis, several hot spots for flood exposure appear to be (1) the urban areas around the Cibolo and Medina Rivers due to the density of development and total population in those areas, and (2) the confluence of the San Antonio and Cibolo Rivers due to the magnitude of flood volume on each respective creek and similarity in watershed size. Additionally, flooded roadways and agricultural areas are found throughout the region, and the impacts due to the loss of function in these areas should not be understated. A heat map was produced to illustrate the flood exposure within the SAFPR as shown in the Figure 2-3.

Figure 2-3. Existing Condition Exposure Heat Map



Residential Properties

The number of residential structures within the floodplain for the SAFPR are relatively higher than surrounding regions due to the SAFPR being highly urbanized with dense residential areas. There are 13,695 residential structures within the 1 percent annual chance storm event floodplain and an additional 5,519 residential structures contained within the 0.2 percent annual chance storm event floodplain. This large number can be attributed to the region containing the heavily populated San Antonio area, containing 10,204 residential structures within the 1 and 0.2 percent annual chance storm event floodplain. The number of residential properties within the existing flood hazard area by county is summarized in Table 2-1.

Non-Residential Properties

Non-residential properties are public and private properties not used as permanent residential dwellings. Non-residential properties within the flood hazard area follow a similar exposure pattern as residential structures. Of the 16 counties within the SAFPR, 15 have non-residential structures within the floodplain. A total of 7,439 non-residential structures are within the floodplain. Table 2-1 summarizes the number of non-residential structures by county within the existing flood hazard area.

Table 2-1. Summary of Structures within the Existing Flood Hazard Areas

County	Area in Floodplain (square miles)	Number of Structures in Floodplain	Residential Structures in Floodplain	Pop. (day-time)	Pop. (night-time)	Pop.	Roadway Crossings (#)	Roadways Segments (miles)	Agricult-ural Areas (square miles)	Critical Facilities (#)
1% Annual Chance Storm Event										
Aransas	12.217	0	0	0	0	0	0	7.477	0.016	0
Atascosa	0.962	57	51	32	95	95	17	2.205	0.045	0
Bandera	47.944	938	567	788	1027	1027	246	61.398	1.105	1
Bexar	148.206	11261	8309	52003	31084	52003	1277	353.048	10.087	95
Calhoun	99.621	949	699	332	647	647	11	14.475	1.002	2
Comal	10.877	363	269	817	426	817	64	15.022	0.503	34
De Witt	10.927	22	6	3	8	8	58	6.976	0.483	0
Goliad	91.113	177	62	102	204	204	119	30.113	12.497	0
Guadalupe	33.497	2239	1768	8128	5336	8128	157	65.287	4.876	42
Karnes	120.558	336	161	195	422	422	286	58.800	22.649	0
Kendall	6.970	628	398	1812	1650	1812	58	12.465	0.067	5
Kerr	1.267	20	8	6	17	17	7	1.053	0.034	0
Medina	23.166	478	299	401	550	550	81	20.457	5.024	1
Refugio	37.193	163	67	101	166	166	10	10.128	2.712	1
Victoria	26.582	30	11	9	19	19	9	5.101	1.858	1
Wilson	129.100	1459	1020	1449	1823	1823	367	89.064	16.790	9
Total	**800.20**	**19120**	**13695**	**66178**	**43474**	**67738**	**2767**	**753.07**	**79.75**	**191**

County	Area in Floodplain (square miles)	Number of Structures in Floodplain	Residential Structures in Floodplain	Pop. (day-time)	Pop. (night-time)	Pop.	Roadway Crossings (#)	Roadways Segments (miles)	Agricultural Areas (square miles)	Critical Facilities (#)
0.2% Annual Chance Storm Event										
Aransas	5.574	0	0	0	0	0	0	5.592	0.017	0
Atascosa	0.000	0	0	0	0	0	0	0.000	0.000	0
Bandera	10.705	663	290	551	637	637	20	20.348	0.179	4
Bexar	9.328	2347	1895	7839	5583	7839	26	44.710	1.762	8
Calhoun	25.328	604	457	338	316	338	13	18.604	0.785	2
Comal	2.121	286	238	665	323	665	6	4.639	0.097	0
De Witt	1.556	25	8	3	9	9	5	1.412	0.077	0
Goliad	11.125	110	33	56	130	130	5	8.297	1.297	0
Guadalupe	4.080	1570	1355	8080	5882	8080	9	20.323	0.765	3
Karnes	17.822	227	94	123	172	172	50	27.294	3.222	0
Kendall	0.826	333	208	2510	707	2510	0	4.626	0.027	5
Kerr	0.348	14	2	0	6	6	0	0.239	0.006	0
Medina	8.525	751	553	1603	1104	1603	3	20.828	4.217	5
Refugio	1.894	16	2	8	22	22	1	2.096	0.444	0
Victoria	0.998	7	3	1	2	2	0	0.557	0.048	0
Wilson	24.111	580	381	370	799	799	34	34.763	5.197	2
Total	**124.34**	**7533**	**5519**	**22147**	**15692**	**22812**	**172**	**214.33**	**18.14**	**29**

County	Area in Floodplain (square miles)	Number of Structures in Floodplain	Residential Structures in Floodplain	Pop. (day-time)	Pop. (night-time)	Pop.	Roadway Crossings (#)	Roadways Segments (miles)	Agricult-ural Areas (square miles)	Critical Facilities (#)
Combined 1 and 0.2% Flood Risk Total	**924.54**	**26653**	**19214**	**88325**	**59166**	**90550**	**2939**	**967.40**	**97.88**	**220**

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Public Infrastructure

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 they may continue to function and provide services during and after a flood event. 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, and schools. Table 2-1 shows critical infrastructure located within the SAFPR in relation to the 1 and 0.2 percent annual chance storm events.

Roadway impacts are also evaluated through the length of roadway within the floodplain and the amount of roadway crossings affected, as summarized in Table 2-1. Flooded roadways pose a substantial risk to motorists, as more than half of all flood-related drownings 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 case of an evacuation.

Other impacts to public infrastructure are not specifically quantified in this analysis due to the lack of publicly available data for most of these infrastructure types. However, some general impacts and expected loss of function for these infrastructure types are outlined in the Expected Loss of Function section below.

MAJOR INDUSTRIAL AND POWER GENERATION FACILITIES

A total of 87 buildings are within the 1 and 0.2 percent annual chance storm event existing flood hazard that are marked as industrial facilities; none are classified as critical. Within the flood hazard area, 14 facilities are associated with power generation. All 14 power generation facilities are marked as critical.

CRITICAL FACILITIES

A total of 220 critical facilities are within the existing flood hazard area, 83 percent of which are in Bexar, Comal, and Guadalupe Counties. The two most common types of facilities within the flood hazard area are schools and Department of Defense (DOD) military facilities. Total critical facilities by county are summarized in Table 2-1.

ROADWAY CROSSINGS

A large amount of urbanized area is within the SAFPR, leading to 2,939 roadway crossings being within the flood risk area. A vast network of rivers and tributaries are within the flood risk area, meaning several major river crossings are found along these transportation corridors.

ROADWAY SEGMENTS

Bandera, Bexar, Guadalupe, Karnes, and Wilson Counties all have more than 60 miles of road segment within the existing flood hazard area. Every county has more than 1 mile of road segment within the flood hazard area, totaling 967 miles of road segment within the SAFPR. Most of the roadway segments affected are in Bexar County due to the San Antonio metropolitan area.

AGRICULTURAL AREAS

The county with the most agricultural areas within the floodplain is Karnes County, with slightly more than 25 square miles out of the total 98 square miles. Bexar, Goliad, and Wilson Counties also have more than 10 square miles of agricultural area. All the remaining counties have much smaller amounts of agricultural areas within the floodplain (most less than 1 square mile).

To evaluate the value of land exposed, average values for agricultural land within Texas were identified using the 2020 United States Department of Agriculture (USDA) Land Values Summary. This summary included an average value of $1,980/acre for non-irrigated cropland and $1,680/acre for pasture. Within the entire region are 2,326 square miles of cropland and 6,324 square miles of ranchland. From these values, a weighted average cost for agricultural land was identified as $1,760/acre. Within the entire flood hazard area, approximately 5.5 million acres, or $9.7 billion of crops and pasture, are exposed.

2.2.1.3 Expected Loss of Function

The impacts of flooding on lives and livelihoods are often felt not just during a flood event but long afterward. As communities assess damages after a flood, several different types of impacts must be evaluated. Historical flood impacts, including dollar values of damages as well as known injuries and losses of life are quantified in Chapter 1 Planning Area Description. This section presents a qualitative assessment of the types of flood impacts and the expected losses of function in both the public and private sectors.

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 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. These impacts are lessened at lower 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. The World Health Organization states that two-thirds of flood-related deaths worldwide are due to drowning, but other impacts can also have negative implications for human health[23]. Direct effects of flooding include heart attacks, drowning from traveling 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, population displacement, and disruption of livelihoods. Hospital preparedness is important during flooding. Natural disasters can cause both damage to existing infrastructure and increase in the number of patients who need assistance[23].

Water Supply and Wastewater Treatment

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 supply systems results in both direct costs (repairing pipes, contamination of the network) and indirect costs (service disruptions impacting people outside of flood waters)[24]. The indirect impacts can reach up to three times as many people as were directly flooded[25].

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[23] World Health Organization. 2014. Flood and Health: Fact sheets for health professionals.

[24] Arrighi, Chiara; Tarani, Fabio; Vicario, Enrico; and Castelli, Fabio. 2017. Flood impacts on water distribution network. *Natural Hazards and Earth System Sciences*. Pp. 2109-2123.

[25] Arrighi, Chiara; Tarani, Fabio; Vicario, Enrico; Castelli, Fabio. 2017. “Flood impacts on water distribution network.” Natural Hazards and Earth System Sciences. Pp. 2109-2123.

Several impacts from flooding also occur on wastewater systems. For houses using septic tanks, sewage can be carried back into the house through piping in some flood events, which will cause physical damage and could introduce disease-causing bacteria and viruses[26]. This is particularly a concern in rural areas that often do not have a community wastewater collection system. Flooding can also damage the wastewater system, and if untreated wastewater is released, environmental and water-quality damage can occur[27]. Wastewater treatment plants can be impacted by flooding through loss of power, damage to the plant, and personnel being unable to safely reach the plant[28]. If systems are damaged in a flood, people can be left without adequate wastewater management systems until they can be repaired. A local example of negative flooding impact on the water supply is the Bandera and La Vernia Wastewater Treatment Plant, which are currently within the 1 percent flood risk area and create issues for residents when shut down due to flooding.

Utilities and Energy Generation

Damage to power lines and electricity distribution equipment from floating debris and inundation are some of the direct impacts of flooding on utilities and energy. Due to road impacts, maintenance and repair can also be delayed. Electricity disruptions also affect other aspects of energy production since oil and gas pipeline disruptions are often due to power outages after severe weather events[29].

[26] Heger, Sara; and Anderson, Jim. 2018. How to Assess and Rehabilitate Flooded Onsite Systems. *Onsite Installer*. September 24, 2018.

[27] Heger, Sara; and Anderson, Jim. 2018. How to Assess and Rehabilitate Flooded Onsite Systems. *Onsite Installer*. September 24, 2018.

[28] Nielsen, Julia. 2018. Tips for Flood-Proofing Wastewater Treatment Plants. *Innova*. October 17, 2018. Available at https://atsinnovawatertreatment.com/blog/flood-proof-wastewater-treatment-plant/.

[29] United States Environmental Protection Agency. No Date. Climate Change Impacts on Energy. Available at https://climatechange.chicago.gov/climate-impacts/climate-impacts-energy#:~:text=Flooding%20and%20intense%20storms%20can%20damage%20power%20lines,serious%20impacts%20on%20other%20energy%20systems%20as%20well.

Transportation and Emergency Services

Flooding can cause immediate impacts to transportation systems by causing delays or disruptions due to inundated and damaged infrastructure[30]. On a greater scale, these conditions affect the region's economics. Due to roads being unsafe for travel, closed, or submerged, connectivity is reduced, deviated, or canceled for people, goods, and services[31]. For these reasons, flood impacts on transportation infrastructure have consequences throughout the region, in both flooded and dry areas.

Flooding has a negative impact on emergency services. Due to inaccessible roads and increased traffic congestions, it can take a longer time to get to people in need[32]. Within England, researchers found that 84 percent of the population can be reached within 7 minutes for emergency situations; however, in a 30-year flood scenario, it drops to 70 percent, and in a 100-year event, it drops even lower to 61 percent[33]. A local example is the United States Highway 281 being closed due to Olmos Dam backing up water during 1998 and 2013 floods.

2.2.2 Existing Conditions Vulnerability Analysis

After completing the flood exposure analysis, the populations and structures exposed to flooding within the identified flood hazard area were analyzed to determine their vulnerability to flooding. Vulnerability was assessed using the Social Vulnerability Index (SVI) scale. Several factors are evaluated to determine an area's Social Vulnerability, which measures a person's or group's "capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard,"[34] based on their relative vulnerability.

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[30] Rebally, Aditya; Valeo, Caterina; He, Jianxun; and Saidi, Saeid. 2021. Flood Impact Assessments on Transportation Networks: A Review of Methods and Associated Temporal and Spatial Scales. *Frontiers in Sustainable Cities*.

[31] Rebally, Aditya; Valeo, Caterina; He, Jianxun; and Saidi, Saeid. 2021. Flood Impact Assessments on Transportation Networks: A Review of Methods and Associated Temporal and Spatial Scales. *Frontiers in Sustainable Cities*.

[32] Loughborough University. 2020. Flooding impacts emergency response time in England. *Phys Org*. May 19, 2020.

[33] Loughborough University. 2020. Flooding impacts emergency response time in England. *Phys Org*. May 19, 2020.

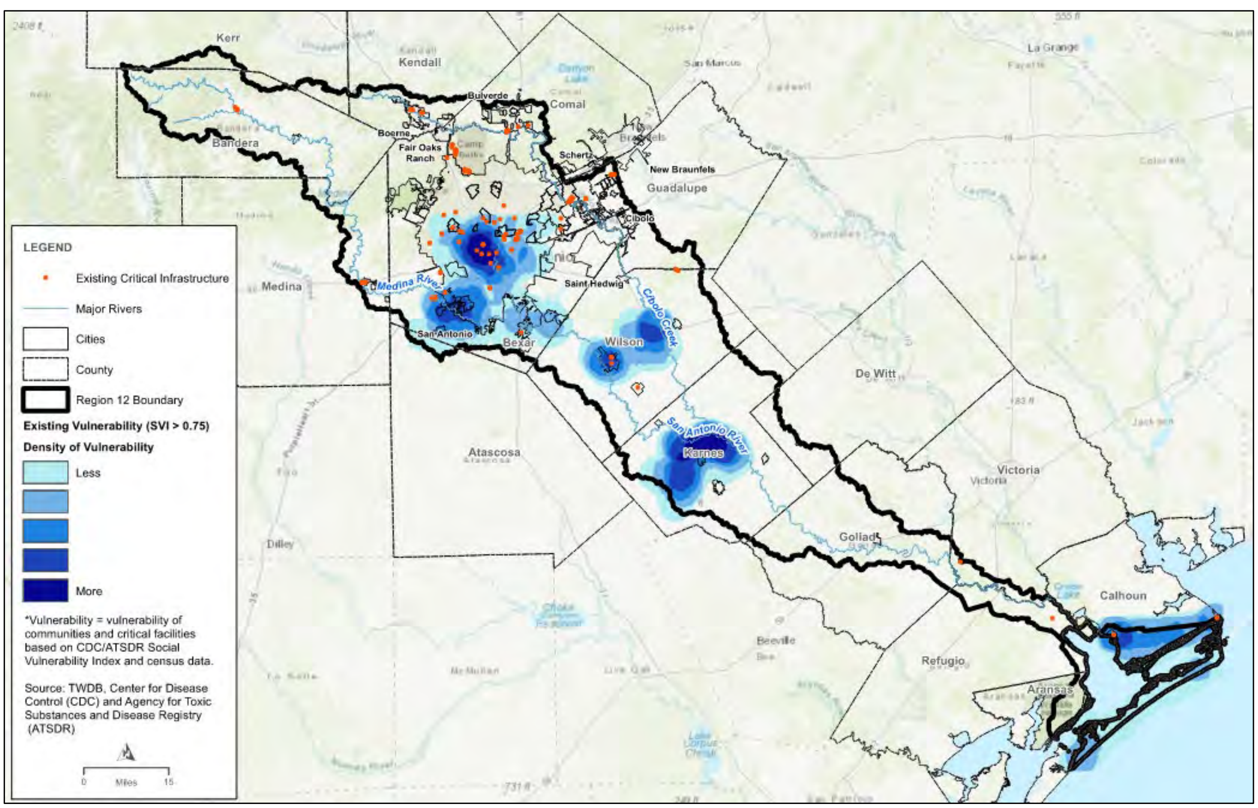
[34] Wisner, Ben; Piers Blaikie; Terry Cannon; and Ian Davis. 2004. The Challenge of Disasters and Our Approach. In *At Risk: Natural hazards, people's vulnerability and disasters*, 2nd edition, edited by Ben Wisner, Piers Blaikie, Terry Cannon and Ian Davis. Pp. 3-48. London; New York: Routledge.

The SVI is a standard system developed by the Centers for Disease Control and Prevention (CDC) for assigning a Social Vulnerability score at a census-tract basis. 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. Knowledge of a community's SVI allows planners to better prepare for emergency events ranging from disease outbreaks, hurricanes, and exposure to dangerous chemicals. A score of 0.75 or greater indicates that a community is highly vulnerable to impacts from a natural disaster.

TWDB provided a building dataset that included SVI values for each building. SVI was also assigned to the other exposure features (LWCs, critical infrastructure, etc.) based on the average SVI of the surrounding census tract. Based on the exposure features within 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.

The results of the analysis are summarized in Figure 2-4. The potential effects from flooding could be higher in areas of high SVI value and critical infrastructure due to damage to the infrastructure and potential lack of services after the flooding event.

Figure 2-4. Existing Condition Vulnerability Heat Map



2.2.3 Resilience of Communities Located within a Flood-Prone Area

The average SVI of features within floodplains or flood-prone areas per county is provided in Table 3 Existing Condition Flood Risk Summary Table in Appendix A. Locations of high SVI areas located within floodplains or flood-prone areas are shown in Figure 2-4. Vulnerable areas include:

1. Most vulnerable areas: Calhoun, Atascosa, and Refugio Counties
2. Other vulnerable areas: San Antonio, Floresville, and Von Ormy

2.3 Future Condition Flood Risk Analysis

In addition to quantifying the current flood risk, it is helpful to consider the change in flood risk over the course of the planning horizon to help communities plan ahead for new or increased risks. With this concept in mind, a future condition flood risk analysis was performed for the SAFPR.

The future condition flood risk analysis included two components: projected increases in flood hazard, and additional exposure/vulnerability. The first step was to define a future flood hazard area boundary to identify areas of existing development that, while not currently at risk of flooding during the 1 or 0.2 percent annual chance storm events, may be at risk of flooding during these events in the future. The second step was to identify areas that face an increase in future flood risk due to new development or redevelopment that may occur in these areas. The methods employed to evaluate future risk and the results of the analysis are explored in the following sections.

2.3.1 Future Condition Flood Hazard Analysis

History has demonstrated that flood hazards tend to increase over time in populated areas due to projected increases in impervious cover, anticipated sedimentation in flood control structures, and other factors that result in increased or altered flood hazards. As a result, the future condition flood hazard area was defined based on an expected increase in flooding extents and magnitude across the region.

The TWDB has provided several methods to determine the future flood hazard layer. The first step of this task is to identify areas within the region where future condition H&H model results and maps already exist. Currently within the SAFPR, detailed FEMA studies include a future 1 percent flood risk area. However, they were developed using future land use shapefiles created by Bexar County and the CoSA. This process differs from the method proposed by the TWDB and does not consider climatic changes. Therefore, one of the following four methods must be used to identify the future flood risk across the region:

1. Increase water surface elevation based on projected percent population increase (as a proxy for land development)
2. Use the existing 0.2 percent annual chance floodplain as a proxy for the future 1 percent annual chance storm event
3. Use a combination of Methods 1 and 2 or an RFPG-proposed method
4. Request TWDB for a Desktop Analysis

Flood Planning Region (FPR) 12 employed Methods 2 and 3, described further in this section.

2.3.1.1 Future Conditions Based on “No Action” Scenario

It must be noted that these estimated changes in flood hazard extents are meant to represent the “30-year, no action” scenario for the purpose of evaluating the potential magnitude for future flood risk. This information will in no way be used for floodplain mapping for regulatory purposes, such as local (municipal) floodplain management and development regulation, or in any way by FEMA or the NFIP. This is simply a planning level analysis for the purpose of supporting the regional flood planning process.

2.3.1.2 Methods for Developing the Future Flood Hazard Layer

Future flood conditions represent projected conditions 30 years into the future, or year 2050, and can be influenced by several factors, such as:

- Precipitation climate change
- Rising sea levels
- Population growth and associated development increases (impervious cover)
- Natural stream migration changes to existing waterways
- Implementation of constructed drainage infrastructure

The existing 0.2 percent flood risk areas were used as a proxy for the future 1 percent flood risk areas in areas where future 1 percent flood risk areas did not exist, per Method 2 in TWDB’s guidance. Method 3, a San Antonio RFPG method, was used to calculate the 0.2 percent future storm event risk area, given as a buffer value. For the 0.2 percent annual chance future conditions floodplain, HDR used the 2018 *San Antonio River Basin Future Precipitation Study,* developed by SARA, which estimates the 0.2 percent annual chance storm event rainfall total will increase 3.8 inches in 20 years and 5.1 inches in 40 years.

As part of separate effort with SARA, HDR used the precipitation study information along with draft hydrology models for the major watersheds currently being developed by SARA as part of a county-wide floodplain remapping effort within the SAFPR to estimate peak discharges. This analysis showed the average increase in the 0.2 percent annual chance storm event peak flows throughout the basin were between 30 and 40 percent for the 20- and 40-year future projections, respectively. From this data, HDR estimated a 35 percent increase in 0.2 percent annual chance storm event peak flows for a 30-year future event. With this estimated flow increase, HDR evaluated the horizontal increase in 0.2 percent annual chance floodplain top-widths using selected HEC-RAS models in various locations throughout the watershed. Below is a more detailed explanation of how the future flood hazard conditions were calculated.

Hydraulic Model Updates

The system hydraulic models were updated by increasing the 0.2 percent annual peak flows by 35 percent, as established above. However, due to variations in model versions, boundary conditions, and level of detail, some specific modifications were made to execute the hydraulic models.

All selected stream effective hydraulic models, except Salado Creek and Upper San Antonio River, downloaded from SARA's D2MR, were provided in their original HEC-RAS format (versions 3.1.2 and 4.0). At the time of this analysis, SARA provided draft hydraulic models for the Salado Creek and Upper San Antonio River systems developed as part of SARA county-wide floodplain remapping effort, which were provided in HEC-RAS (version 5.0.7). For the purpose of this exercise, all models were executed in HEC-RAS (version 4.1 or later), which allow for Defined Results Tables with "Left and Right Station" results, as needed for the top-width assessment. A comparison between the HEC-RAS results (versions 3.1.2/4.0 versus 4.1) existing 0.2 percent annual chance storm event showed less than 0.01 percent difference in peak Water Surface Elevation Level (WSEL); therefore, the version change posed no impact to hydraulic results.

Hydraulic models with boundary conditions defined as known WSEL were left unchanged for this analysis based on a sensitivity analysis performed on Ojo De Aqua at the Lower San Antonio River confluence in Karnes County. The Ojo De Aqua hydraulic model was simulated assuming an unchanged known WSEL boundary condition and updated boundary condition based on future 0.2 percent annual chance peak flows along the Lower San Antonio River to evaluate potential changes due to boundary condition assumptions. Based on the results, less than a 0.01 percent change in WSEL occurred on the first two to three cross sections. Therefore, it was determined leaving the boundary conditions as is had no effect on the comparison objective of this exercise.

Due to the type of available study, some models only had the 1 percent annual chance storm event present and not the 0.2 percent annual chance storm event needed for the assessment. Seguin Branch LOMR was one of the models that did not have the 0.2 percent annual chance storm event, so this flow was pulled from the HEC-HMS hydrology model downloaded from SARA D2MR. However, it is presumed that this HEC-HMS model is not the same model that was used to establish the HEC-RAS models 1 percent annual chance storm event peak flows. The HEC-HMS 1 percent annual chance storm event peak flows were within 4 percent of the HEC-RAS peak flows (8,541 versus 8,860 cubic feet per second), so the 0.2 percent annual chance storm event peak flow data from the HEC-HMS was used to determine the top-width difference. Following the completion of this process, where 0.2 percent results were lacking, it was determined a more efficient method would be needed to complete the exercise within the project time constraints. In comparing surrounding hydraulic models with both 1 and 0.2 percent annual chance storm event peak flows, a conversion multiplier was established to determine the existing 0.2 percent annual chance peak flow from the 1 percent annual chance peak flows when not available. A summary of the hydraulic models, 1 to 0.2 percent annual chance multipliers, and reasoning are included in Table 2-2.

Hydraulic models were run with the above considerations and modifications, and the existing and future 0.2 percent annual chance storm event peak WSEL results were compared.

Table 2-2. HEC-RAS Models Using Multipliers

<table>
<tr><th>RAS Model</th><th>0.2% Flows Increase Criteria</th><th>Reason</th></tr>
<tr><td>Cibolo Wilson Co</td><td>43%</td><td rowspan="2">• US: Lower Cibolo HEC-RAS average 43%
• DS: SAR Lower Karnes average 43%</td></tr>
<tr><td>Cibolo Karnes Co</td><td>43%</td></tr>
</table>

RAS Model	0.2% Flows Increase Criteria	Reason
Ecleto	66%	• Smaller reaches like Marcelinas and Seguin are higher average than larger reaches; Cibolo and SAR • Ecleto similar geo-location to Marcelinas • SAR Lower Goliad higher average than US SAR Lower Karnes; therefore, assume Manahuilla and Cabeza increase from Ecleto to DS
Manahuilla	67%	
Cabeza	68%	

Notes: DS = Downstream; SAR = San Antonio River; US = Upstream

Hydraulic Model Assessment

As explained above, some variations occurred in the hydraulic model updates, but the same assessment of the peak WSEL was implemented for all modeled streams.

Existing and future 0.2 percent annual chance storm event results were compared based on top-width and WSEL differences. Averages for both were calculated for each modeled stream. To develop a refined average, outlier data was not considered to avoid skewing results. Outlier data consisted of top-width differences greater than 500 feet, WSEL differences greater than 5 feet, and any result where the WSEL was not contained within the cross section.

Each hydraulic model was categorized based on urbanization levels, location within the region, and general land slope to develop geospatial watershed relationships. Some of the longer reaches with varying categories were split for this assessment. Urbanization levels were defined as “Urban” if most of the reach passed through cities, or “Rural” if the reach was primarily passing through undeveloped/agriculture land. Location was divided by “Upper,” north of San Antonio and North San Antonio; “Mid,” mid San Antonio to edge of Bexar County; “Lower,” Wilson and Karnes Counties; and “Coastal,” DeWitt and Goliad Counties. Slopes were generalized into ranges less than 0.1, 0.1 to 0.2, 0.2 to 0.5, and greater than 0.5 percent. Averages from each of the categories can be found in Table 2-3.

The average increases in top-width would be applied to the existing 0.2 percent flood risk area as a horizontal buffer to develop the future 0.2 percent flood risk area.

Table 2-3. Assessment Categories and Results for the Existing and Future 0.2 Percent Annual Chance Comparison

Assessment Category	Category Type	Total Top-Width Difference (feet)	One Side Top-Width Difference (feet)	WSEL Difference (feet)
Urbanization	Urban	119	59	2
	Rural	152	76	2
Location	Upper	118	59	2
	Mid	156	78	2
	Lower	140	70	2
	Coastal	154	77	2
Slope	$x \geq 0.005$	90	45	2
	$0.002 \leq x < 0.005$	148	74	2
	$0.001 \leq x < 0.002$	147	74	2
	$x < 0.001$	169	85	3
Medina	—	67	33	4
Average	—	**139**	**70**	**2**

Results

Using the results developed from the top-width exercise, a buffer criteria was established based on stream spatial location within the region to develop the future 0.2 percent flood risk area. Final criteria areas were refined to the following boundaries:

- Upper: North of North Loop 1604 from Culebra Road to Interstate 35
- Mid: South of North Loop 1604 to south of Karnes County
- Coastal: South of Karnes County to the Gulf of Mexico
- Medina: Includes reaches and tributaries not evaluated in the assessment

Based on initial results of Medina tributaries evaluated in the top-width assessment, result differences were noted to be significantly lower than top-width results and higher than WSEL differences compared to all other reaches. This can be attributed to the steep terrain and channel bank slopes. Therefore, a separate buffer criterion was established for the Medina watershed.

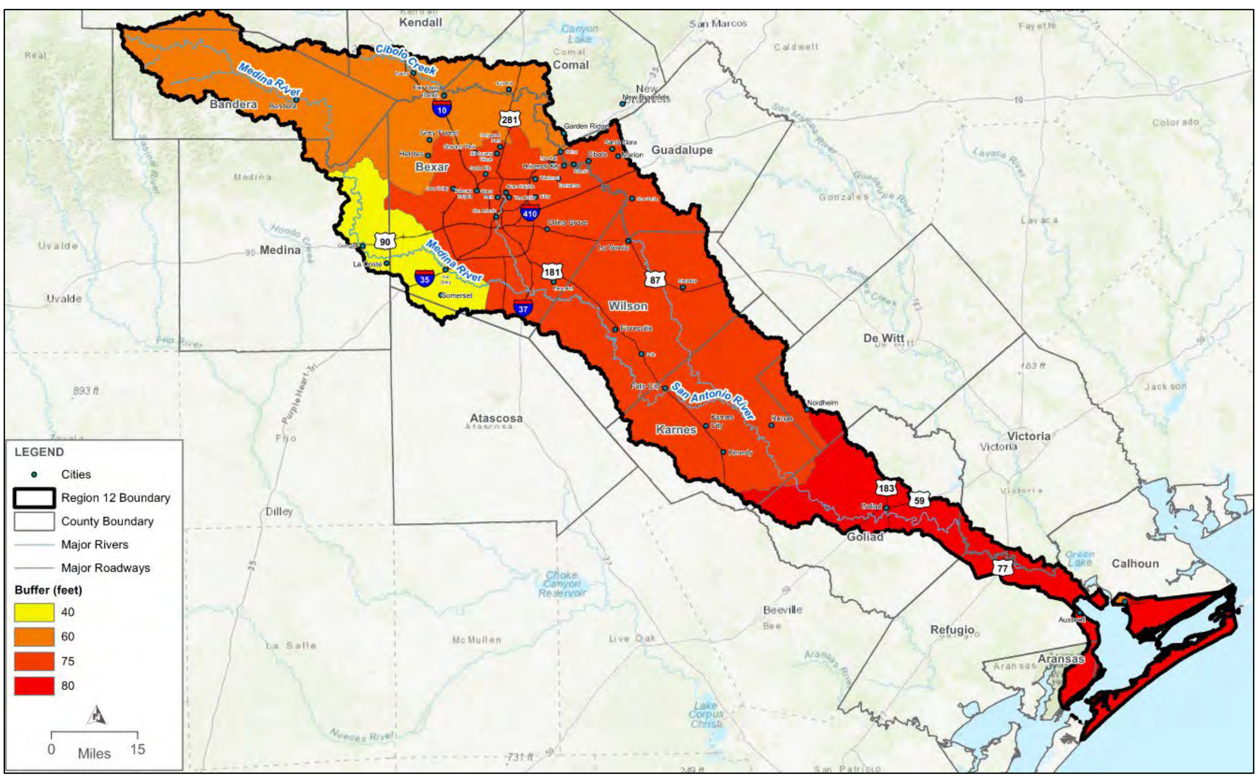
The final criteria set is in Table 2-4 and Figure 2-5. The buffer is the top-width increase that should be applied to each side of the existing 0.2 percent annual chance storm event floodplain to develop the future 0.2 percent annual chance storm event floodplain.

Table 2-4. Final Criteria for the 0.2 Percent Future Floodplain Buffer

Criteria	Type	Buffer[a] (feet)
Location	Medina	40
	Upper	60
	Mid	75
	Coastal	80

[a] Buffer is applied to each side of the floodplain.

Figure 2-5. Final Criteria for the 0.2 Percent Future Floodplain Buffer



2.3.1.3 Coastal Future Conditions

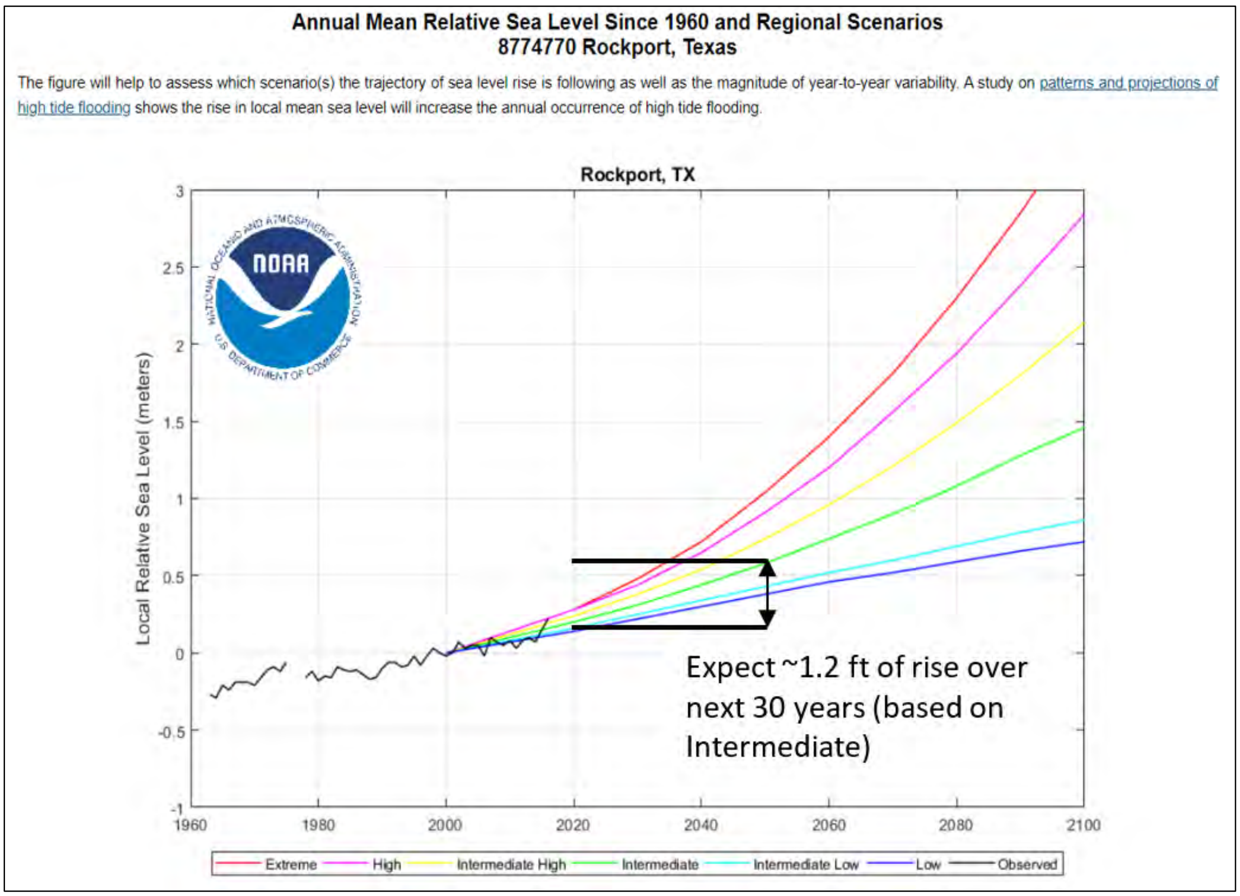
Relative sea level rise (SLR) is also considered a significant factor in the future condition flood risk along the coastline. For this study, relative sea level change is estimated on best available existing data. The following data sources are currently available and were reviewed for this task:

- National Research Council (NRC) (1987) *Responding to Changes in Sea Level: Engineering Implications*: The NRC study developed SLR/sea level change scenarios. This study was leveraged by the USACE and NOAA, and is the main resource for all present-day estimates.
- NOAA (2017) *Global and Regional Sea Level Rise Scenarios for the United States* (TR NOS CO-OPS 083): NOAA has developed a tool to calculate the approximate SLR computed from the most recent Intergovernmental Panel on Climate Change and modified NRC projections. NOAA computed five scenarios, including "high," "intermediate-high," "intermediate," "intermediate-low," and "low." These SLR scenarios are presented in Figure 2-6. Table 2-5 provides a comparison of NOAA and USACE sea level rise scenarios. This data can be extrapolated from graphs and applied to a digital terrain model.
- NOAA (2022) *Sea Level Rise Technical Report*: NOAA developed an update to the 2017 report and data.
- USACE (2013) *Incorporating Sea Level Change in Civil Works Programs* (ER 1100-2-8162): This source provides design guidelines for incorporating the direct and indirect physical effects of projected future sea level change across the project life cycle in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects and systems of projects.
- USACE Sea-Level Change Curve Calculator (Version 2021.12): The USACE developed a tool to calculate the approximate SLR for three scenarios including "high," "intermediate," and "low."
- General Land Office (GLO) (2021) *Coastal Texas Protection and Restoration Feasibility Study Final Report* (short title: Coastal Texas Study): This study uses the NOAA 2017 data and prepared inundation mapping for entire Texas coast. The inundation mapping is based on various scenarios, including: 100- and 500-year storm events modeled and future conditions with no mitigation (i.e., a "no action") scenarios available for years 2035 and 2085.

Table 2-5. Comparison of NOAA and USACE Sea Level Rise Scenarios

NOAA Scenarios	USACE Scenarios	Description
Low	Low	Linear historic SLR
Intermediate-Low	Intermediate	NRC Curve I – Moderate Greenhouse Gas Emission
Intermediate	—	NRC Curve I – High Greenhouse Gas Emission
Intermediate-High	High	NRC Curve III – Moderate Glacier Melt
High	—	NRC Curve III – High Glacier Melt

Figure 2-6. Annual Mean Relative Sea Level Scenarios – Rockport, Texas



Source: NOAA 2017

NOAA's *Global and Regional Sea Level Rise Scenarios for the United States* (2017 with 2022 update) provides the most relevant technical data related to SLR. When considering the various scenarios of SLR, the "intermediate-low" scenario has a high likelihood of occurrence based on predicted outcomes and includes scientifically reasonable considerations for increased greenhouse gas emissions, ocean thermal expansion, and land-based subsidence/uplift. However, the “intermediate” scenario is the most typical scenario selected for design. It includes considerations for past observed sea level trends and global effects due to moderate increases in greenhouse gas emissions. Table 2-6 compares the NOAA and USACE data to understand what the expected SLR is for the San Antonio region at the 30-year projected time frame.

Table 2-6. Water Surface Elevation Increase (feet) Projected from 2020 to 2050

NOAA Scenarios	USACE Scenarios	USACE 2013[a]	NOAA 2017[b]	NOAA 2022[b]	Description
Intermediate-Low	Intermediate	0.7	0.9	1.0	NRC Curve I
Intermediate	—	—	1.2	1.1	—
Intermediate-High	High	1.5	1.6	1.3	NRC Curve II

[a] https://cwbi-app.sec.usace.army.mil/rccslc/slcc_calc.html
[b] https://coast.noaa.gov/sir/

GLO’s 2021 Coastal Texas Study used the NOAA 2017 data to prepare inundation mapping for the entire Texas coast for several different scenarios and various projections into the future (Figure 2-7). None of the modeled scenarios precisely match the 30-year projection required by the RFP. However, the Year 2035 “low” and Year 2085 “intermediate” scenarios result in a SLR of approximately 2 feet.

Figure 2-7. Coastal Texas Study Relative Sea Level Change Projections

Coastal Texas Protection and Restoration Feasibility Study Final Report — 1. Introduction

Year	Pier 21 (Region 1) Low	Pier 21 (Region 1) Intermediate	Pier 21 (Region 1) High	Rockport (Regions 2 and 3) Low	Rockport (Regions 2 and 3) Intermediate	Rockport (Regions 2 and 3) High	Port Isabel (Region 4) Low	Port Isabel (Region 4) Intermediate	Port Isabel (Region 4) High
2017	0	0	0	0	0	0	0	0	0
2035	0.4	0.5	0.8	0.3	0.4	0.8	0.2	0.3	0.7
2085	1.4	2.1	4.4	1.2	1.9	4.1	0.8	1.5	3.8
2135	2.5	4.2	9.8	2.0	3.8	9.4	1.4	3.2	8.8

Table 1.1: Relative Sea Level Change Projections (feet)

This 1- to 2-foot SLR matches closely with the future rise in riverine WSELs (as seen in Section 2.3.1 Future Condition Flood Hazard Analysis); therefore, the buffers shown in Table 2-4 of 80 feet on each side (or total of 160 feet) were used in the future mapping limits development.

2.3.1.4 Identified Future Flood Hazard Areas

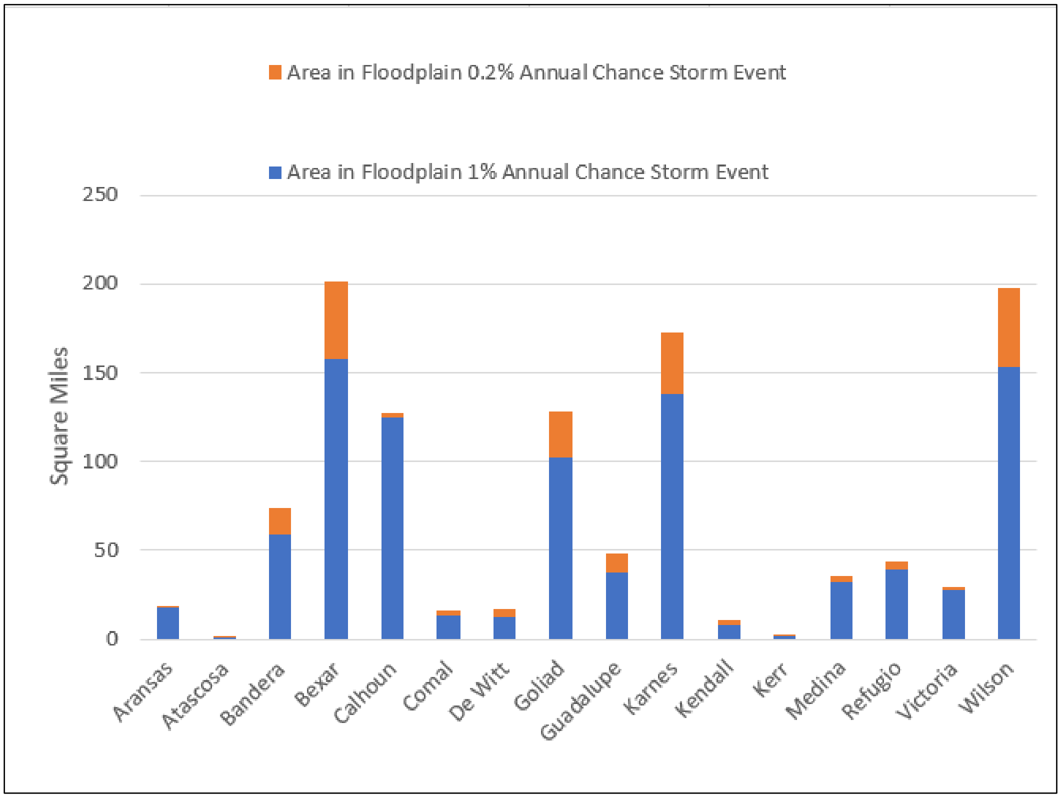
Using the method described previously, the maps for the future 1 and 0.2 percent flood risk areas were developed in GIS. A comparison of the existing and future flood risk area is presented in Table 2-7. An additional 200 square miles of flood risk area is added to the floodplain with estimated future conditions, or an increase of 22 percent.

Table 2-7. Existing and Future Flood Hazard Comparison

Flood Hazard Area	Total Existing Area (square miles)	Total Future Area (square miles)	Area Change (square miles)	Area Change (%)
1%	800.2	925.57	125.37	16
0.2%	124.34	199.32	74.98	60
Total	**925.54**	**1124.89**	**200.35**	**22**

The total future condition flood risk area is summarized by county in Figure 2-8. As with existing conditions, Bexar, Calhoun, Goliad, Bandera, Wilson, and Karnes are the counties with significantly high total area in both the 1 and 0.2 percent annual chance storm events. The future area in square miles inundated under future conditions is represented in Figure 2-8. Due to the methodology selected, most of the increase in floodplain is from more urbanized counties. Of the counties located in SAFPR, the flood hazard area increased the most in Wilson, Bexar, and Karnes Counties.

Figure 2-8. Future Area Located within Floodplain



2.3.1.5 Future Conditions Data Gaps

FPR 12 used detailed study floodplains and the buffer to develop the future modeling extents; not all existing detailed mapping within the SAFPR has detailed future conditions. As a result, large portions of FPR 12 are considered to be a data gap under future conditions.

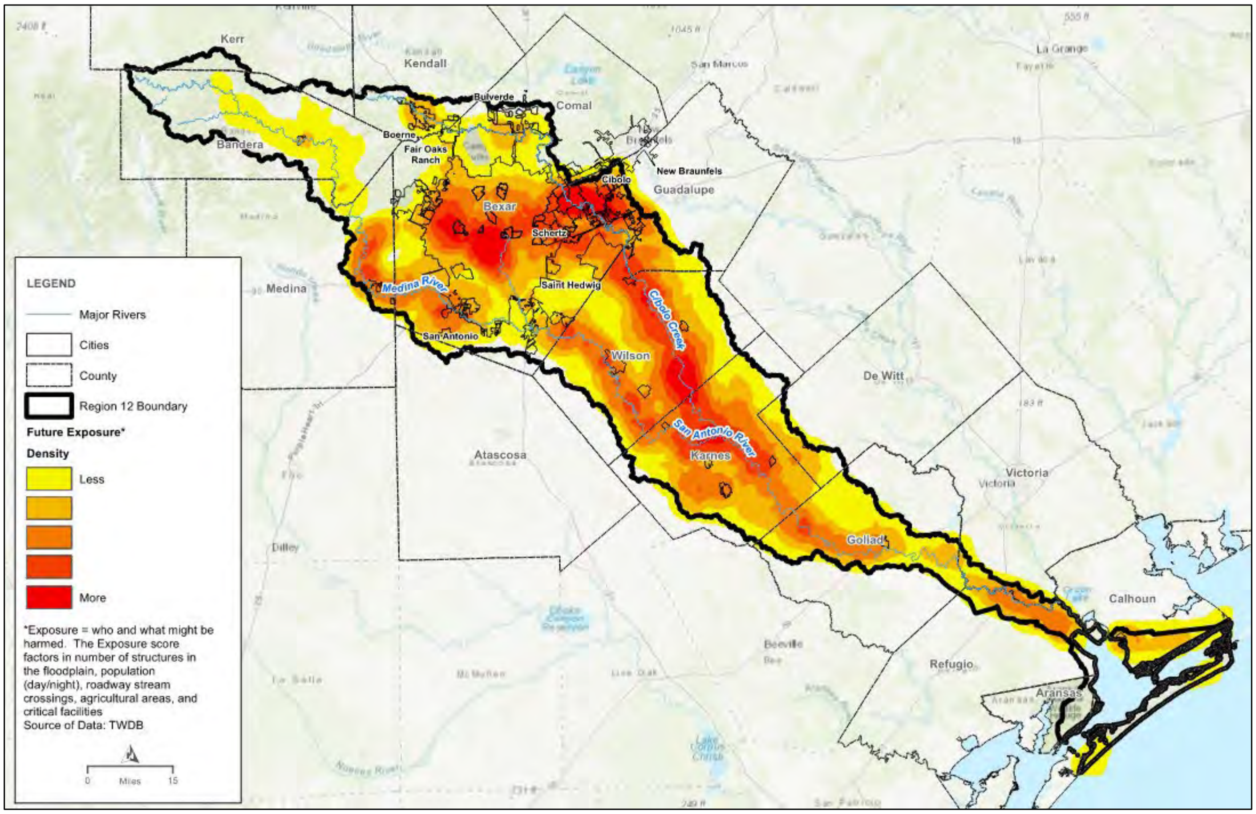
2.3.2 Future Condition Flood Exposure Analysis

The same flood exposure analysis procedure was followed to quantify exposure under future conditions. This exposure was only quantified for existing development as it compared to the future condition flood hazard area. It is difficult to quantify exposure of future development due to the inherent uncertainty in the exact location of development and changes in population. However, an effort was made to evaluate areas of future development and provide qualitative information regarding potential exposure in these areas.

2.3.2.1 Future Flood Exposure Summary

The following sections describe the results of the future flood exposure analysis through the same series of maps that is presented for existing flood exposure. The Cities of San Antonio, Boerne, Bandera, and Karnes continue to have a high concentration of flood exposure within the SAFPR. The urban areas around the San Antonio River, Medina River, and Cibolo Creek have the highest concentration of flood exposure within the SAFPR due to the density of development and total population in these areas. However, other portions of the SAFPR see a greater density of flood exposure as compared to existing conditions. A heat map illustrating the future conditions flood exposure within the SAFPR is shown in Figure 2-9.

Figure 2-9. Future Condition Exposure Heat Map



Residential Properties

Table 2-8 summarizes residential property exposure by county. Those counties with the largest increase in number of residential structures affected are the most urbanized counties within the SAFPR (Bexar, Wilson, Guadalupe, and Bandera). The total number of residential structures that are exposed to future floodplains greatly increases from 19,214 to close to 42,841 structures.

Non-Residential Properties

Table 2-8 summarizes non-residential property exposure by county. While the total number of non-residential properties contained in the future flood hazard area did not increase as dramatically as residential properties, urbanized counties still saw an increase. Bexar, Wilson, Guadalupe, and Bandera

Counties, which saw high residential building increases, are also represented in some of the highest increases of non-residential properties within the same areas. The total increase in non-residential property exposed to future 1 and 0.2 percent annual chance storm events is 5,224 structures.

Public Infrastructure

A total of 872 buildings are marked as public infrastructure within the future flood hazard, 347 more than within the existing flood hazard. Within this group, 402 buildings are critical facilities and discussed further below. Most of these buildings are located within municipalities, with a large portion found within San Antonio.

MAJOR INDUSTRIAL AND POWER GENERATION FACILITIES

A total of 167 buildings within the future flood hazard are marked as industrial, 80 more than within the existing mapped flood hazard. Of those marked as Industrial facilities, none are classified as critical facilities. Within the future flood hazard area, 35 facilities are associated with power generation. Similar to the existing power generation facilities, all 35 facilities are considered critical facilities.

CRITICAL FACILITIES

A total of 402 critical facilities are within the future flood hazard area, 182 more than within the existing flood hazard.

Table 2-8 shows a count for each type of critical facility, and Figure 2-10 shows the location of these facilities. The two most common types of facilities within the flood hazard area are schools and DOD facilities.

ROADWAY CROSSINGS

The number of roadway stream crossings within the future flood hazard area are greatest where more urbanization exists, such as Bexar, Bandera, Wilson, and Karnes Counties (Table 2-8). The number of crossings within the future 1 and 0.2 percent annual chance storm event flood hazard area is 4,108, putting more than a thousand more roadway crossings within the future flood zones. As mentioned previously, this increase in stream crossings per county is associated with a greater extent of urban area becoming exposed under the future flooding scenario.

AGRICULTURAL AREAS

Table 2-8 shows the relative number of agricultural areas inundated by flooding under future conditions by county. The amount and value of agricultural areas impacted by flooding increased by 11.8 percent in the future flood hazard condition to 110 square miles and almost $5 billion, respectively. Of the counties located primarily in SAFPR, the counties with the largest increase are Bexar, Wilson, Karnes, and Medina. These areas saw larger increases in overall floodplain size, so this increase is expected for the area.

ROADWAY SEGMENTS

Similar to the roadway crossings, Bexar, Bandera, Wilson, and Karnes Counties have the most miles of roadway within the future hazard area. This can be attributed to an increase in urbanized flooding within the future flood scenario. All the counties in SAFPR have roadways that would be inundated in the future by the 1 and 0.2 percent annual chance storm events. A total of 1,571 miles of roadway are exposed to flood risk in future assessments.

AGRICULTURAL AREAS

Table 2-8 shows the relative number of agricultural areas inundated by flooding under future conditions by county. The amount and value of agricultural areas affected by flooding increased by 11.8 percent in the future flood hazard condition to 110 square miles and almost $5.0 billion, respectively. Of the counties located primarily within the SAFPR, the counties with the largest increase are Bexar, Wilson, Karnes, and Medina. These areas saw larger increases in overall floodplain size, so this increase is expected for the area.

Potential Flood Mitigation Projects

The future condition flood exposure analysis also required the consideration of impacts from flood mitigation projects in progress with dedicated construction funding that are scheduled for completion prior to the adoption of the next SFP. A total of 46 proposed and ongoing projects have been identified within the SAFPR that meet this criteria.

Major cities within the SAFPR have CIPs and stormwater fees, which may lead to the implementation of additional local stormwater projects. However, these projects do not have specific allocations, so they were not considered in the development of the future flood hazard layer since their construction is not guaranteed. Additionally, these projects will have a minor impact on the floodplain and will not result in major impacts on regional flood risk.

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Table 2-8. Summary of Structures within the Future Flood Hazard Areas

County	Area in Flood-plain (square miles)	Number of Structures in Flood-plain	Resident-ial Structures in Flood-plain	Pop. (daytime)	Pop. (night-time)	Pop.	Roadway Crossings (#)	Roadway Segments (miles)	Agricult-ural Areas (square miles)	Critical Facilities (#)
1% Annual Chance Storm Event										
Aransas	17.791	0	0	0	0	0	0	13.069	0.033	0
Atascosa	0.962	57	51	32	95	95	17	2.205	0.045	0
Bandera	58.648	1601	857	1339	1664	1664	266	81.746	1.284	5
Bexar	157.539	13608	10204	59842	36667	59842	1303	397.758	11.849	103
Calhoun	124.950	1553	1156	670	963	963	24	33.078	1.787	4
Comal	13.000	649	507	1482	749	1482	70	19.661	0.600	34
De Witt	12.484	47	14	6	17	17	63	8.388	0.560	0
Goliad	102.239	287	95	158	334	334	124	38.410	13.794	0
Guadalupe	37.577	3809	3123	16208	11218	16208	166	85.629	5.640	45
Karnes	138.381	563	255	318	594	594	336	86.113	25.871	0
Kendall	7.798	961	606	4322	2357	4322	58	17.109	0.093	10
Kerr	1.615	34	10	6	23	23	7	1.292	0.039	0
Medina	31.692	1229	852	2004	1654	2004	84	41.284	9.241	6
Refugio	39.090	179	69	109	188	188	11	12.255	3.156	1
Victoria	27.580	37	14	10	21	21	9	5.658	1.906	1
Wilson	153.218	2039	1401	1819	2622	2622	433	123.846	21.987	11
Total	**924.57**	**26653**	**19214**	**88325**	**59166**	**90379**	**2971**	**967.50**	**97.89**	**220**

County	Area in Flood-plain (square miles)	Number of Structures in Flood-plain	Resident-ial Structures in Flood-plain	Pop. (daytime)	Pop. (night-time)	Pop.	Roadway Crossings (#)	Roadway Segments (miles)	Agricult-ural Areas (square miles)	Critical Facilities (#)
0.2% Annual Chance Storm Event										
Aransas	1.059	0	0	0	0	0	0	2.897	0.003	0
Atascosa	0.232	22	19	9	30	30	2	0.472	0.012	0
Bandera	15.181	1095	631	938	1363	1363	58	22.146	0.098	5
Bexar	43.917	22277	19061	94501	74892	94501	358	237.517	2.056	149
Calhoun	2.335	121	104	11	49	49	8	8.941	0.111	0
Comal	2.660	441	382	980	797	980	22	9.525	0.055	1
De Witt	4.341	44	12	5	18	18	25	9.799	0.242	0
Goliad	25.613	263	114	434	400	434	89	40.699	1.106	3
Guadalupe	10.807	1483	1251	4468	4033	4468	61	37.138	1.644	10
Karnes	34.492	471	204	408	416	416	267	80.011	3.441	0
Kendall	3.025	536	391	1612	1868	1868	17	6.922	0.016	3
Kerr	0.899	47	19	5	19	19	1	0.832	0.008	0
Medina	3.988	285	171	288	413	413	7	7.419	0.522	1
Refugio	4.722	78	27	234	130	234	13	20.397	0.722	3
Victoria	1.968	22	12	6	25	25	4	4.586	0.119	0
Wilson	44.082	1666	1229	1941	2478	2478	205	115.094	2.928	7
Total	**199.32**	**28851**	**23627**	**105840**	**86931**	**107296**	**1137**	**604.40**	**13.08**	**182**

County	Area in Floodplain (square miles)	Number of Structures in Floodplain	Residential Structures in Floodplain	Pop. (daytime)	Pop. (nighttime)	Pop.	Roadway Crossings (#)	Roadway Segments (miles)	Agricultural Areas (square miles)	Critical Facilities (#)
Combined 1 and 0.2% Flood Risk Total	**1123.88**	**55504**	**42841**	**194165**	**146097**	**197675**	**4108**	**1571.90**	**110.97**	**402**

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2.3.3 Future Conditions Vulnerability Analysis

The vulnerability analysis for future conditions was performed in the same manner as the existing analysis but considered the future condition flood exposure features.

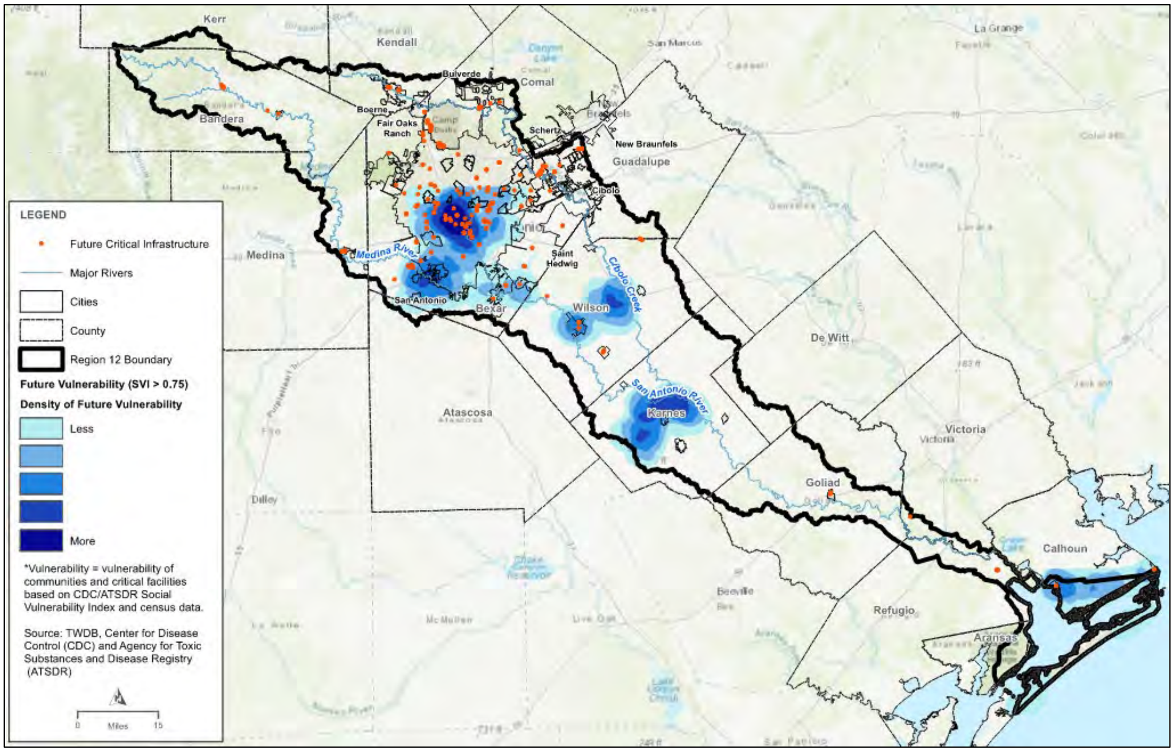
After completing the flood exposure analysis, the populations and structures exposed to flooding within the identified flood hazard area were analyzed to determine their vulnerability to flooding. Vulnerability was assessed using the SVI scale. Several factors are evaluated to determine an area's Social Vulnerability, which measures a person's or group's "capacity to anticipate, cope with, resist and recover from the impacts of a natural hazard,"[35] based on their relative vulnerability. The SVI is a standard system developed by the CDC for assigning a social vulnerability score at a census-tract basis. 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. Knowledge of a community's SVI allows planners to better prepare for emergency events ranging from disease outbreaks, hurricanes, and exposure to dangerous chemicals. A score of 0.75 or greater indicates a community is highly vulnerable to impacts from a natural disaster.

TWDB provided a building dataset that included SVI values for each building. SVI was also assigned to the other exposure features (LWCs, critical infrastructure, etc.) 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.

The results of the analysis are summarized in Figure 2-10. The potential effects from flooding could be higher in areas of high SVI value and critical infrastructure due to damage to the infrastructure and potential lack of services after the flooding event.

[35] Wisner, Ben; Piers Blaikie; Terry Cannon; and Ian Davis. 2004. The Challenge of Disasters and Our Approach. In *At Risk: Natural hazards, people's vulnerability and disasters*, 2nd edition. Pp. 3-48. London; New York: Routledge.

Figure 2-10. Future Condition Vulnerability Heat Map



2.3.4 Resilience of Communities Located within a Flood-Prone Area

The average SVI of features within floodplains or flood-prone areas per county is provided in Table 5 Future Condition Flood Risk Summary Table by County in Appendix A. Locations of high SVI areas located within floodplains or flood-prone areas are shown in Figure 2-10. Vulnerable areas include:

1. Most vulnerable areas: Calhoun, Atascosa, and Refugio Counties
2. Other vulnerable areas: San Antonio, Floresville, and Von Ormy

3

Floodplain Management Practices and Flood Protection Goals

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3 Floodplain Management Practices and Flood Protection Goals

The San Antonio RFPG was tasked with evaluating current floodplain management practices/recommending future floodplain management practices (Task 3A) and recommending flood mitigation goals (Task 3B). The following sections detail the process and findings of the San Antonio region to accomplish this chapter's tasks.

3.1 Evaluation and Recommendations on Floodplain Management (361.35)

The initial effort under Task 3A was to collect and perform an assessment of current floodplain management regulations within the region (i.e., floodplain ordinances, court orders, drainage design standards, and other related policies). The TWDB provided floodplain ordinances as well as a summary of the Texas Floodplain Management Association's (TFMA) Higher Standards Survey results by entities who participated. Floodplain management regulations not provided by TWDB that were readily available on the regulatory entities' websites were also collected. Parallel to this effort, a web-based survey was sent out to each regulatory entity within the SAFPR to gather additional information. All information collected was used to evaluate the current floodplain management and land use practices within the SAFPR.

3.1.1 Extent to Which Current Floodplain Management and Land Use Practices Impact Flood Risks

Policies, regulation, and regional trends are some of the different aspects of floodplain management and land use practices. Implementing these aspects improves protection of life and property. However, different entities can vary greatly from one another on floodplain management and land use practices. The minimum standards for development in and around the floodplain can be found in the NFIP, which is managed by FEMA.

Congress created the NFIP in 1968 through the National Flood Insurance Act of 1968 to provide federally subsidized flood insurance protection. Since its creation, the NFIP has been updated on multiple occasions to strengthen it. Title 44 of the Code of Federal Regulations (CFR) includes the rules and regulations of the NFIP. Title 44 CFR Part 60 establishes the minimum criteria that FEMA requires for NFIP participation, which includes identifying special flood hazard areas within the community, and the minimum standards for floodplain development.

Cities and counties work with FEMA to establish Base Flood Elevations (BFEs) and Special Flood Hazard Areas (SFHAs) along rivers, creeks, and large tributaries that are shown on Flood Insurance Rate Maps (FIRMs). Communities use the FIRM, BFE, and SFHA data in their floodplain permitting processes as a requirement for participating in the NFIP. Insurance agents use FIRMs to determine flood risk, which determines the flood insurance rate for individual properties.

The region’s entities can establish their own policies, standards, and other practices for managing the land use areas of flood risk. Any entities participating in the NFIP have the authority and responsibility to permit or deny the development of SFHAs. They can adopt and enforce higher standards than the FEMA NFIP minimum standards to better protect people and property from flooding. FEMA supports entities who choose to establish higher standards to better protect life and property.

Cities and counties who participate in the NFIP program can purchase NFIP flood insurance to reduce the economic impacts of floods[36]. Renters can also purchase NFIP “contents only” flood insurance policies to cover the cost of their belongings in the event of flood damage. NFIP participation also makes the community eligible for disaster assistance following a flood event.

3.1.1.1 Existing Population and Property

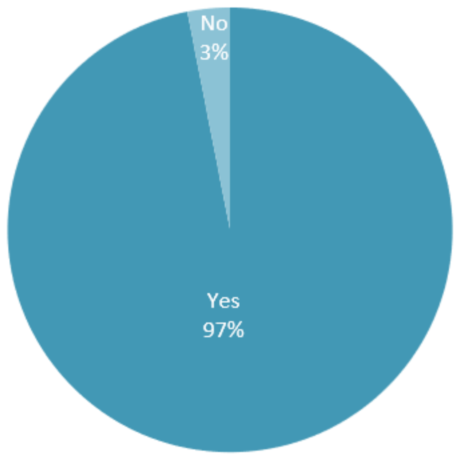
Multiple resources were considered in determining the extent to which current floodplain management and land use practices impact flood risk to existing populations and properties. Cities and communities have the authority to approve floodplain ordinances or court orders, respectively. A total of 110 existing political subdivisions within the SAFPR have flood-related authority. These include cities, counties, river authorities, and additional entities with flood-related authority.

Of the 110 existing political subdivisions in the SAFPR, 16 counties and 49 cities, totaling 65, are eligible NFIP participants. NFIP participating communities are required to have a floodplain ordinance or court order that meets or exceeds the minimum standards set out in the NFIP. Of the 65 eligible entities, 63 are NFIP participants. NFIP participants are limited to cities and counties, so the results discussed in the rest of this chapter are

[36] https://www.fema.gov/flood-insurance

limited to those entities. Figure 3-1 shows the percentage of entities within the region that participate in the NFIP.

Figure 3-1. Percentage of NFIP Participating Entities within the SAFPR



The minimum standards set out in 44 CFR Part 60 state that buildings are required to be constructed at or above the BFE, provide for floodproofing options for nonresidential buildings, and mandate provisions specific to the elevation and anchoring of manufactured houses. While the minimum standards are in place for flood protection, these standards may be based on maps that were developed with outdated topography, rainfall, and runoff data. Therefore, standards adopted based on these sources could result in limited protection from flood damages.

While adopting only minimum standards has a chance of providing flood damage protection, cities and counties can adopt “higher” standards to improve the extent of flood damage protection. In the TWDB Exhibit C guidance document, the term “higher” standard is defined as freeboard, detention requirements, or fill restrictions. FEMA defines freeboard as additional height above the BFE that serves as a factor of safety when determining the elevation of the lowest floor. The BFE is the elevation of surface water resulting from a flood that has a 1 percent chance of occurring in any given year. The BFE is typically based on FEMA FIRMs (maps) and associated Flood Insurance Studies (models). However, the BFE can be based on localized data developed by the community that may not be incorporated into a FEMA mapping product.

The TFMA performs a Higher Standards Survey every year of cities and counties to document which entities have adopted higher standards.

According to the TFMA Higher Standards Survey in 2019 [37], and additional research performed, 31 entities in the San Antonio region are reported as having freeboard requirements of 1 or more feet above the BFE, two entities have no freeboard requirement, and all other entities require elevation to or above the BFE. A breakdown of the freeboard requirements are shown in Table 3-1. Of the cities and counties that have a freeboard requirement, the majority require the BFE plus 1 foot.

Table 3-1. Freeboard Requirements for Cities and Counties within the SAFPR

Freeboard Requirements	Number of Entities	Percent
At or above BFE	34	52
1 foot above BFE	20	31
1.5 feet above BFE	2	3
2 feet above BFE	6	9
3 feet above BFE	1	2
None	2	3
Total	**65**	**100**

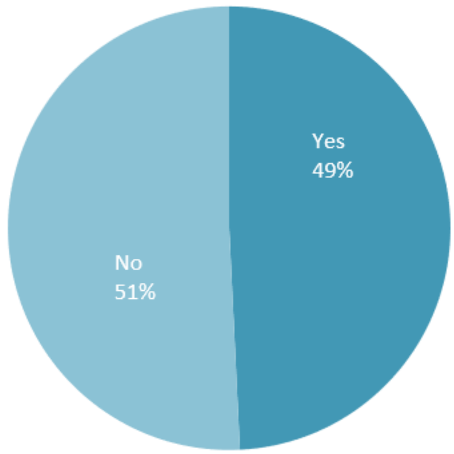
In addition to freeboard requirements, some cities and counties enforce other higher standards such as:

- New developments perform detailed studies to establish BFE data when not available
- Stormwater detention
- Limitations to criteria variance within designated floodways
- Local floodplains identify risk outside FEMA flood zones
- Drainage way protection zones provide resilience against storms that exceed current design standards
- Ultimate development design criteria

Of the 63 NFIP participating entities, a total of 32 entities have adopted higher standards. Figure 3-2 demonstrates that nearly half of the region's entities require some form of higher standards.

[37] TFMA. 2019. 2019 Higher Standards Survey Summary. Available at https://www.tfma.org/page/documents-reports

Figure 3-2. Percentage of SAFPR Entities Requiring Higher Standards



Within the NFIP, FEMA manages the Community Rating System (CRS) program[38]. The CRS program is a voluntary program in which the cities and counties can participate. The more flood risk reduction activities in which an entity participates, the more points it earns. The points translate to a CRS score that ultimately provides residents and businesses within the jurisdiction the opportunity to receive a discount of flood insurance premiums. The flood insurance savings encourages residents and businesses to purchase flood insurance to protect buildings and contents.

As of October 2022, the SAFPR will have four entities participating in the CRS. These communities have a CRS class ranging between 6 and 8, and represent a 5 to 20 percent savings on flood insurance premiums. Per TWDB Technical Guidance, these communities qualify as having "Strong" floodplain management standards. The list of CRS participating entities is provided in Table 3-2.

[38] https://www.fema.gov/floodplain-management/community-rating-system

Table 3-2. SAFPR Entities Participating in the Community Rating System Program

Entity	CRS Class	% Discount for Structures within Special Flood Hazard Area	% Discount for Structures Located Outside Special Flood Hazard Area
Guadalupe County	8	10	5
City of Live Oak	7	15	5
City of New Braunfels	8	10	5
City of San Antonio	6	20	10

An additional portion of the data collection effort included a question that asked survey participants to select the description that best represented their impression of the enforcement level of their floodplain regulations. The TWDB Exhibit C described enforcement levels as the following:

- High – actively enforces the entire ordinance; performs many inspections throughout the construction process; issues fines, violations, and Section 1316s where appropriate; and enforces substantial damage and substantial improvement
- Moderate – enforces much of the ordinance, performs limited inspections, and is limited in issuance of fines and violations
- Low – provides permitting of development within the floodplain, may not perform inspections, and may not issue fines or violations
- None – does not enforce floodplain management regulations

From the survey responses and other data collection efforts, the SAFPR gathered 15 entity enforcement levels. Following the TWDB Technical Guidance, the remaining entities were not categorized because their level of enforcement is unknown. Table 3-3 summarizes the 15 collected responses.

Table 3-3. Level of Enforcement of Floodplain Regulations within the SAFPR

Level of Enforcement	Number of Responses	Percent
High	5	33
Moderate	8	53
Low	1	7
None	1	7
Total	**15**	**100**

Using the data collected, the level of floodplain management practices were identified as "strong," "moderate," "low," or "none" based on the following criteria provided by the TWDB:

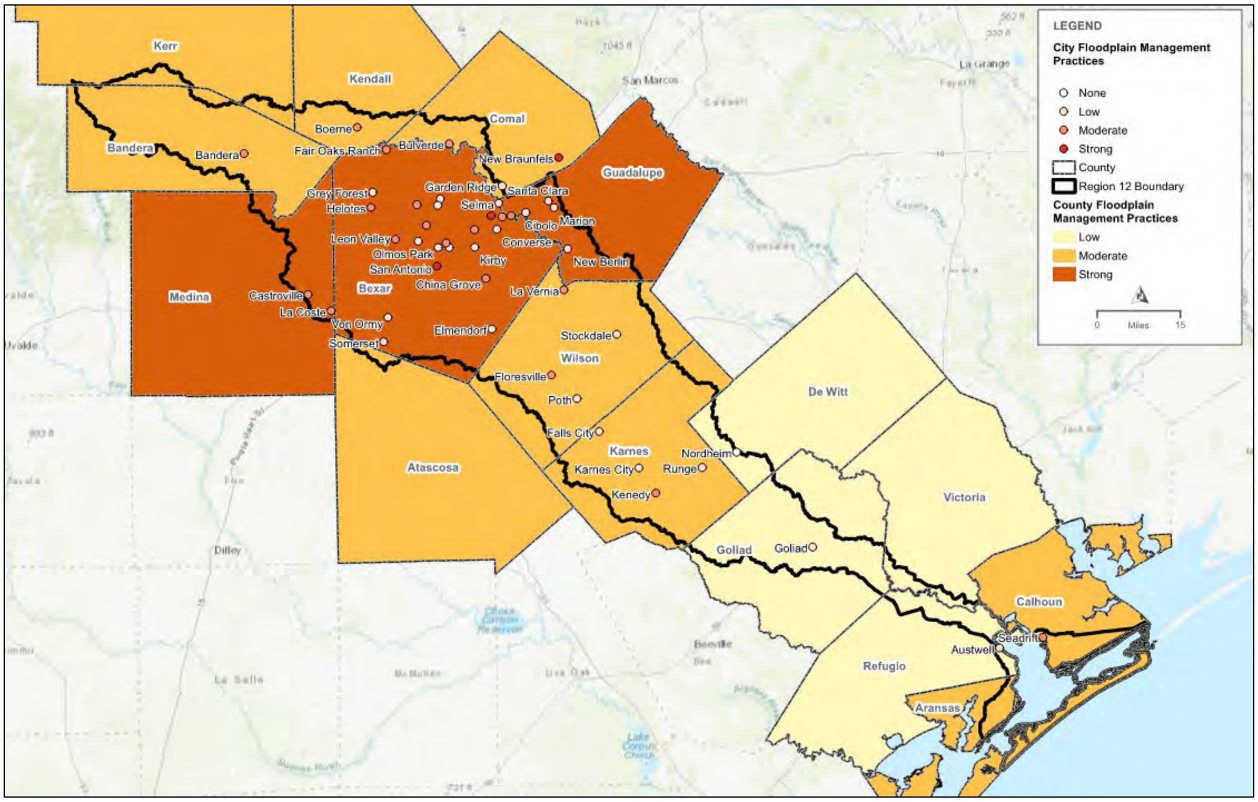
- Strong – significant regulation that exceeds NFIP standards with enforcement, or community belongs to the CRS
- Moderate – some higher standards, such as freeboard, detention requirements, or fill restrictions
- Low – regulations meet the minimum NFIP standards
- None – no floodplain management practices in place

Of the 65 NFIP eligible entities, 6 entities are classified as "strong," 27 entities are classified as "moderate," and 30 entities are classified as "low" regarding their level of floodplain management practices. The remaining two entities are classified as "none." Table 3-4 and Figure 3-3 summarize the results of the floodplain management practices. TWDB-required Table 6 Existing Floodplain Management Practices in Appendix A provides details considered for each community and county in determining the appropriate description of overall floodplain management practices.

Table 3-4. Floodplain Management Practices for NFIP Eligible Communities within the SAFPR

Description	Number of Communities and Counties	Percent
Strong	6	8
Moderate	27	43
Low	30	46
None	2	3
Total	**65**	**100**

Figure 3-3. Floodplain Management Practices for NFIP Eligible Communities within the SAFPR



Although 97 percent of the entities within the SAFPR are NFIP participants, a significant gap still occurs between key floodplain management practices and certain communities that could enhance their floodplain management policies.

3.1.1.2 Future Population and Property

Future floodplains are uncertain. However, it is anticipated that the future floodplains will look different from existing floodplains in many areas within the SAFPR. The H&H models used to generate floodplain maps are regularly being updated with new topography, survey, precipitation, runoff, and other data as development occurs within and around floodplains. For future population growth and development within and around the floodplain, areas without maps or with outdated floodplain maps and models are at a greater danger of increased flood risk. Incorporating the existing and future floodplains will provide cities and counties with additional direction as to where population and development should be directed to protect people and property.

The existing floodplain ordinances or court orders that include higher standards may continue to protect life and property if they are enforced appropriately. At the same time, future floodplain models and maps will need to be updated with best available data and advanced modeling techniques to effectively assess risk. The combination of applying higher standards and best available data should translate into life and property savings in the future.

Correctly designed detention and retention ponds are often required to mitigate the impacts that impervious surfaces and more efficient drainage infrastructure have on the runoff from a developed property. The standard engineering design requirement is to manage runoff so that it discharges from the developed property at the existing rate that it leaves the property in its natural state. Incorporating this requirement may help mitigate increased runoff in the future, which in turn can reduce future flood hazard exposure.

Another way communities can prepare and protect future life and property is to include a future conditions scenario in watershed and stream studies. Typically, the future conditions scenario is based on a defined time in the future, often 30 years, or is based on the area's fully developed land conditions. Additionally, future conditions may include rainfall greater than current design criteria to reflect the increased rainfall depth trends seen in rainfall records and known as non-stationarity. Applying a future conditions scenario to studies essentially adds a factor of safety to the area to help better protect the current areas from future flood risk.

An additional factor of safety that can be implemented to reduce future flood hazard exposure is freeboard. Freeboard is the term used for additional height provided above the BFE, as discussed in Section 3.1.1.1 Existing Population and Property. Even if the BFE changes in the future, freeboard could allow the structure to remain above the future flood water surface level.

3.1.2 Consideration of Recommendation or Adoption of Minimum Floodplain Management and Land Use Practices

For this task, the San Antonio RFPG is required to consider the possibility of recommending or adopting consistent minimum floodplain management standards and land use practices regionwide. Recommended practices encourage entities with flood control responsibilities to establish minimum floodplain management standards over the next several years, while the adoption of minimum standards requires entities to have adopted the minimum standards before their floodplain management strategies (FMSs), floodplain management evaluations (FMEs), and floodplain management projects (FMPs) could be considered for potential inclusion within the RFP. After considering and analyzing the data collected for Task 3A, the SAFPR decided to encourage floodplain management and land use practices rather than recommending entities to adopt higher standards.

The San Antonio RFPG recommends that entities that are not currently NFIP participants should adopt at least the minimum standards and take the necessary steps to become active NFIP participants.

Higher standards are also outlined in the goals found in Section 3.2.2 Goals. FPR 12 recommends those as higher standards for entity floodplain management practices. In support of entities looking to evaluate and advance their floodplain management practices through higher standards, entities can refer to Table 11 Regional Flood Plan Flood Mitigation and Floodplain Management Goals in Appendix A for example statements of additional higher standards.

As in other chapters of this report, the TWDB requires a detailed table of existing floodplain management practices within the region. The TWDB-required Table 6 Existing Floodplain Management Practices in Appendix A has been populated for all cities and counties within the SAFPR.

3.2 Flood Mitigation and Floodplain Management Goals (361.36)

One of the critical components of the inaugural SFP process was the development of flood mitigation and floodplain management goals. The objective of Task 3B is to define and select a series of goals that will serve as the drivers of the regional flood planning effort. The San Antonio RFPG put considerable effort into discussing and selecting a series of goals that it felt were the most beneficial for the region.

As stated in the Guidance Principles in 31 TAC §362.3, the main goal of the regional floodplain plans must be “to protect against the loss of life and property”, which is further defined as:

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

With the guidance principles in mind, the San Antonio RFPG must set goals that are achievable by the region’s entities. Once implemented, the goals must demonstrate progress towards the overarching goal set by the state. This section summarizes the flood mitigation and floodplain management goals determined by the San Antonio RFPG.

3.2.1 Flood Mitigation and Floodplain Management Goal Categories

When determining the flood mitigation and floodplain management goals, the San Antonio RFPG established six overarching goal categories. The categories were established to better define and clarify the individual goals set forth by the San Antonio RFPG. The goals and goal categories build upon TWDB's regional flood planning guidance and provide a comprehensive framework for future strategy development focused on reducing flood risk to people and property, while not negatively affecting neighboring areas. The six goal categories include:

1. Education and Outreach
2. Flood Warning and Readiness
3. Flood Studies and Analysis
4. Flood Prevention
5. Non-Structural Flood Infrastructure Projects
6. Structural Flood Infrastructure Projects

3.2.2 Goals

The six goal categories are detailed below. They include specific goal statements that can be achieved and measured in either the short term (10 years) or long term (30 years). Per TWDB requirements and guidelines, the goals selected by the RFPG must include the information listed below:

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

The goals must be specific and achievable flood mitigation and floodplain management goals that when implemented will demonstrate progress towards the overarching goal. The following were considered in the development of the goals:

- Guidance Principles as listed in 31 TAC §362.3
- The existing condition flood risk analyses

- The future condition flood risk analyses
- The consideration of current floodplain management and land use approaches
- Input from the public
- Understanding of the residual risk of each goal (i.e., the remaining risk)

The flood mitigation and floodplain management goals were developed by the SAFPR Technical Subcommittee and approved by the San Antonio RFPG at the Planning Group Meeting on November 16, 2021. The adopted goals apply to the entire flood planning region; no sub-regional goals were identified. The information requirements listed above are presented for each goal in Table 11 Regional Flood Plan Flood Mitigation and Floodplain Management Goals in Appendix A.

3.2.2.1 Goal Category 1: Education and Outreach

This category intends to increase the number of flood education and outreach opportunities across the region. Public education and outreach may incorporate a variety of methods, from publishing newsletter articles to hosting booths at in-person events. Communities that participate in FEMA's CRS program typically have significant public outreach elements in their stormwater programs as they receive credit for doing so. The CRS program is described in Section 3.1.1.1 Existing Population and Property. The education and outreach category increases education and outreach opportunities, improves flood hazard awareness, encourages SAFPR entities to review their floodplain management practices, and promotes the protection of people and property by better preparing the region entities for future flooding events. Additional higher standards for floodplain management practices that promote these goals can be found in Table 11 Regional Flood Plan Flood Mitigation and Floodplain Management Goals in Appendix A**.** Table 3-5 includes four specific goals for this category.

Table 3-5. Education and Outreach Goals

Goal ID	Goal Statement	Goal Term
12000001	Track existing public outreach and education activities to improve awareness of flood hazards and benefits of flood planning, including nature-based solutions in the region and ensure at least six additional occurrences per year.	Short Term (10 Year)
12000002	Increase to 12 per year or maintain public outreach and education activities to improve awareness of flood hazards and benefits of flood planning, including nature-based solutions in the region.	Long Term (30 Year)
12000003	Increase the proficiency of stakeholders and floodplain managers across the region through training from Region 12 entities, TFMA, ASFPM, and FEMA. Improve 50% of FPM knowledge of nature-based solutions, floodplain preservation, and cost/benefit of traditional structural solutions, including providing certificates.	Short Term (10 year)
12000004	Increase the proficiency of stakeholders and floodplain managers across the region through training from Region 12 entities, TFMA, ASFPM, and FEMA. Improve 100% of FPM knowledge of nature-based solutions, floodplain preservation, and cost/benefit of traditional structural solutions, including providing certificates.	Long Term (30 year)

3.2.2.2 Goal Category 2: Flood Warning and Readiness

This category aims to improve the overall flood warning and readiness across the SAFPR by reducing flood deaths and high-water rescues as well as improving response time of flood warning notifications across the region. Improving flood warning and readiness involves multiple entities and departments, and will provide timely warning of impending flood danger. Table 3-6 includes six specific goals for this category.

Table 3-6. Flood Warning and Readiness Goals

Goal ID	Goal Statement	Goal Term
12000005	Support the development of a regionally coordinated warning and emergency response program that can detect the flood threat and provide timely warning of impending flood danger to reduce flood deaths and high-water rescues across the region.	Short Term (10 Year)
12000006	Support the development of a regionally coordinated warning and emergency response program that can detect the flood threat and provide timely warning of impending flood danger to reduce flood deaths and high-water rescues across the region.	Long Term (30 Year)
12000007	Increase the number of flood gages (rainfall, stream, reservoir, etc.) in the region to provide localized information to emergency responders as well as storage and accessibility of data to agencies.	Short Term (10 year)
12000008	Increase the number of flood gages (rainfall, stream, reservoir, etc.) in the region to provide localized information to emergency responders as well as storage and accessibility of data to agencies.	Long Term (30 year)
12000009	Increase the number of entities that communicate real-time flood warnings to the public. Leverage mobile phone navigation apps to provide real-time rerouting for the public.	Short Term (10 year)
12000010	Increase the number of entities that communicate real-time flood warnings to the public. Leverage mobile phone navigation apps to provide real-time rerouting for the public.	Long Term (30 year)

3.2.2.3 Goal Category 3: Flood Studies and Analysis

The intent of this goal category is to increase the overall number and extent of flood studies and analyses. Updating floodplain maps and studying or restudying streams with best available data improves flood hazard awareness and the protection of people and property. By better understanding the current and potential future status of flood hazard areas, entities can use flood studies and analyses to better manage their development. It also allows them to use more accurate data to pursue flood hazard mitigation projects and funding for them. Table 3-7 includes six specific goals for this category.

Table 3-7. Flood Studies and Analysis Goals

Goal ID	Goal Statement	Goal Term
12000011	Establish a baseline and increase the number of entities which utilize Atlas 14 (Volume 11) or best available data from NOAA revised rainfall data as part of revisions to design criteria and flood prevention regulations by 50% percent. (Region specific)	Short Term (10 Year)
12000012	Increase the number of entities which utilize/adopt Atlas 14 (Volume 11) or best available data from NOAA revised rainfall data as part of revisions to design criteria and flood prevention regulations by 100%. (Region specific)	Long Term (30 Year)
12000013	Increase the number of entities that conduct detailed studies to update their local flood risk by 25%.	Short Term (10 Year)
12000014	Increase the number of entities that conduct detailed studies to update their local flood risk by 100%.	Long Term (30 Year)
12000015	Decrease the average age of FEMA Flood Insurance Rate Maps (NFHL/FIRMs/FIS) to less than 10 years.	Short Term (10 Year)
12000016	Establish a baseline number of existing studies and process for analyzing watersheds to identify existing Natural Flood Mitigation Features (NFMF) such as headwaters, buffers, and conservation easements.	Short Term (10 Year)

3.2.2.4 Goal Category 4: Flood Prevention

The intent of this goal category is to increase the overall extent of flood prevention. Entities that try to prevent flooding will reduce the risk of future floods and see less severe damages from flooding events. Preventative flood measures are a way to protect life and property before flooding occurs. Preventative measures also warrant better overall floodplain management effects, which can be seen in the five specific goals for this category shown in Table 3-8.

The Region 12 RFPG committee has identified a gap in flood risk and flood mitigation knowledge related to nature-based infrastructure (NBI) across the SAFPR. The committee recognizes that NBI provides significant, low-cost flood mitigation, and many NBI areas also serve as the source of groundwater recharge within the SAFPR sustaining the water supply for many communities. Protecting and enhancing NBI where appropriate provides benefits for flood peak attenuation, ecosystem services, groundwater recharge, and recreational value typically at a lower cost than constructed solutions. NBI provides both monetary and non-monetary benefits that should be accounted for in flood mitigation planning.

Table 3-8. Flood Prevention Goals

Goal ID	Goal Statement	Goal Term
12000017	Increase the number of participating Community Rating System (CRS) entities in the FPR by 5.	Short Term (10 Year)
12000018	Increase the rating of participating entities within Community Rating System (CRS) in the FPR by 100%.	Long Term (30 Year)
12000019	Increase the number of entities which regulate to the 1% annual chance future conditions floodplains as part of new development and redevelopment by 10%.	Short Term (10 year)
12000020	Increase the number of entities which regulate to the 1% annual chance future conditions floodplains as part of new development and redevelopment by 50%.	Long Term (30 year)
12000021	Increase the number of entities above the established baseline that have adopted a holistic watershed approach using existing Natural Flood Mitigation Features (NFMF) such as headwaters, buffers, and conservation easements for flood risk reduction as a basis for comprehensive subdivision regulations.	Short Term (10 year)

3.2.2.5 Goal Categories 5 and 6: Flood Infrastructure Projects

Flood infrastructure projects can reduce flood risks and hazards through the maintenance and rehabilitation of existing infrastructure. This can occur for structural infrastructure projects, nonstructural projects, and a combination of structural/nonstructural projects. Twelve specific goal statements were created for this category. These goals directly align with TWDB's overarching goal of the protection of life and property. Of the 12 goal statements listed below, goals 12000022, 12000023, 12000024, and 1000025 are nonstructural infrastructure goals. Goal statements 12000028, 12000029, 12000030, 12000031, 12000032, and 12000033 are nonstructural infrastructure goals. Goal statements 12000026, and 12000027 are structural/nonstructural infrastructure goals. Table 3-9 includes 12 specific goals for this category.

Table 3-9. Flood Infrastructure Project Goals

Goal ID	Goal Statement	Goal Term
12000022	Establish a baseline and increase the number of acres of publicly protected open space by 10 % as part of land conservation and acquisitions to reduce future impacts of flooding.	Short Term (10 Year)
12000023	Increase the number of restored acres of publicly protected open space land in the region.	Long Term (30 Year)
12000024	Reduce the number of NFIP repetitive-loss properties in the FPR by 25%.	Short Term (10 year)
12000025	Reduce the number of NFIP repetitive-loss properties in the FPR by 75%.	Long Term (30 year)
12000026	Reduce the number of existing (2022) residential properties in the future 1% annual chance floodplain by 10%.	Short Term (10 year)
12000027	Reduce the number of existing (2022) residential properties in the future 1% annual chance floodplain by 50%.	Long Term (30 year)
12000028	Reduce the number of vulnerable critical facilities located within the existing and future 1% annual chance (100-year) floodplain by 50%.	Short Term (10 year)
12000029	Reduce the number of vulnerable critical facilities located within the existing and future 1% annual chance (100-year) floodplain by 100%.	Long Term (30 year)
12000030	Identify the eligible top 50 vulnerable roadway segments and low water crossings located within the existing and future 1% annual chance (100-year) floodplain.	Short Term (10 year)
12000031	Eliminate or mitigate the eligible top 50 vulnerable roadway segments and low water crossings located within the existing and future 1% annual chance (100-year) floodplain.	Long Term (30 year)
12000032	Increase the number of structural projects by 10% that include a NBS or Green Infrastructure (GI) component.	Short Term (10 year)
12000033	Increase the number of structural projects by 50% that include a NBS or Green Infrastructure (GI) component.	Long Term (30 year)

3.2.3 Benefits and Residual Risk after Goals are Met

The goals were developed by the San Antonio RFPG to set the stage for actions that can be quantified and measured in the future regional and state flood planning cycles. Future data collection efforts and the implementation of FMPs/FMEs/FMSs can be used to establish baseline data for future measurements to determine the progress toward achieving the SAFPR's goals. Once implemented, the specific goals detailed in this section will fulfill the TWDB's overarching goals of identifying and reducing the risk and impact to life and property as well as avoiding increasing or creating new flood risk by addressing future development within the areas known to have existing or future flood risk. Beyond protecting against the loss of life and property, the goals offer several benefits, including protecting infrastructure, water supply, the environment, and sustainability. The types of benefits are presented in Table 3-10.

Table 3-10. Flood Planning Goal Benefits

Types of Benefits[a]	Overarching Goal Categories					
	Flood Education and Outreach	Flood Warning and Readiness	Flood Studies and Analysis	Flood Prevention	Non-Structural Flood Infrastructure	Structural Flood Infrastructure
Protect life	Potential Benefit	Direct Benefit	Potential Benefit	Potential Benefit	Direct Benefit	Direct Benefit
Protect infrastructure	–	Potential Benefit	Potential Benefit	Direct Benefit	Potential Benefit	Direct Benefit
Protect property	–	Potential Benefit	Potential Benefit	Direct Benefit	Direct Benefit	Direct Benefit
Protect the environment	Potential Benefit	–	Potential Benefit	Direct Benefit	Direct Benefit	Direct Benefit
Protect/enhance the water supply	–	–	–	Potential Benefit	Potential Benefit	Potential Benefit
Sustain the economy	–	Potential Benefit	–	Potential Benefit	Direct Benefit	Potential Benefit
Realize multiple benefits[a]	–	–	–	Potential Benefit	Potential Benefit	Potential Benefit
Increase public awareness	Direct Benefit	Direct Benefit	Potential Benefit	Potential Benefit	Potential Benefit	Potential Benefit
Build community support	Direct Benefit	Direct Benefit	Potential Benefit	Potential Benefit	–	–

[a] Multiple benefits could include improvements to flood protection while improving water supply and increasing public recreation opportunities.

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However, it is recognized that it is not possible to protect against all potential flood risks. In selecting the flood risk reduction goals, the San Antonio RFPG is inherently determining the accepted residual risk for the SAFPR. In general, residual risks for flood risk reduction goals could be characterized as follows:

1. While a new development may be constructed outside the 1 percent annual chance floodplain, flood events of greater magnitude will inundate areas beyond those preserved as a floodplain.
2. Flood events may exceed the LOS 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 it. Limitations placed on local government by the state legislature reduce the ability to adopt locally defined best approaches to protect the community.
5. The lack of local enforcement of floodplain regulations also creates risk.
6. In the representative government, policy changes that adversely affect budgets, prior plans, assets, and standards are always a possibility.
7. Practical (time and money) limits of understanding and precision associated with studies, models, and plans are a possibility.
8. Human behavior is unpredictable; people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons.

As in other chapters of this report, the TWDB requires a detailed table of the recommended flood mitigation and floodplain management goals. The TWDB-required Table 11. Regional Flood Plan Flood Mitigation and Floodplain Management Goals is in Appendix A.

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4

Assessment and Identification of Flood Mitigation Needs

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4 Assessment and Identification of Flood Mitigation Needs

This chapter identifies the greatest flood risk knowledge gaps and known flood risks within the SAFPR. The flood mitigation needs analysis identifies where the greatest flood risk knowledge gaps exist as well as where known flood risk and flood mitigation needs are located within the SAFPR. This information guides the identification of potentially feasible flood mitigation actions.

4.1 Greatest Flood Risk Knowledge Gaps

The greatest flood risk knowledge gaps for the SAFPR have been identified as areas within the region where:

- Flood inundation boundaries are either not defined or are considered inaccurate
- Flood studies have not occurred in the recent past and are not ongoing or proposed
- Flood management practices do not exist or are not enforced effectively

4.1.1 Flood Inundation Boundary Gaps

Flood inundation boundaries are used to define the location and magnitude of flooding. Without accurate flood inundation boundaries, the existing flood risk is not well understood, and controlling future risk through floodplain management regulations is difficult. Flood inundation boundaries based on recent detailed H&H models are considered accurate. Refer to Chapter 2 Flood Risk Analysis Figure 2-1, which depicts where the largest modeling gaps occur within the SAFPR. The lower half of the SAFPR does not have accurate flood mapping available, and only approximate and/or Cursory Floodplain Data are available.

4.1.2 Flood Studies and Ongoing Project Gaps

Flood studies are used to identify existing and future flood risks, and often recommend solutions and actionable steps to reduce those risks. Flood mitigation projects are crucial to reducing risks within an area. Generally, flood studies and projects have occurred or are occurring for counties throughout the SAFPR. Current major flood studies and projects include the following:

- GLO Flood Studies

- City-wide Drainage Improvements
- County-wide Drainage Improvements
- TxDOT Crossing Improvements

Refer to Table 2 Summary of Proposed or Ongoing Flood Mitigation Projects in Appendix A and Map 2 Proposed or Ongoing Flood Mitigation Projects (2.1 Task 1 – Planning Area Description) in Appendix B, depicting where these projects are occurring within the SAFPR.

4.1.3 Floodplain Management Practices

Enacting floodplain management practices (regulation and enforcement) is effective in preventing activities that will result in increased flood risk in the future. Examples include requiring a floodplain permit for development activity within the floodplain and/or requiring building finished floor elevations to be 1 foot above the 1 percent annual chance storm event elevation. Without floodplain management practices, it is difficult to mitigate future flood risks. Refer to Chapter 3 Floodplain Management Practices and Flood Protection Goals Figure 3-3 and Table 3-4, which depict where the level of floodplain management practices are unknown or considered "low." This includes rural areas near the coast and away from the major population center of San Antonio.

4.2 Greatest Known Flood Risk and Flood Mitigation Needs

The areas of greatest known flood risk and flood mitigation needs within the SAFPR are defined as areas with elevated levels of risk to property and life. The level of risk is defined by identifying the location and magnitude of flooding from the 1 and 0.2 percent annual chance flood event (flood hazard), who and what may be harmed (flood exposure), and what communities and critical facilities may be vulnerable (flood vulnerability). The details of the flood hazard, exposure, and vulnerability analyses are fully described in Chapter 2 Flood Risk Analysis.

4.2.1 Flood Hazard

The flood hazard analysis defined the 1 and 0.2 percent annual chance storm event boundaries for the entirety of the SAFPR's rivers and associated tributaries with contributing drainage areas greater than 1 square mile. The existing condition flood hazard is depicted on a sub-region level in Map 4 Existing Condition Flood Hazard (2.2.A.1 Existing Condition Flood Hazard Analysis) in Appendix B.

4.2.2 Flood Exposure

The flood exposure analysis indicated roughly 26,633 structures at potential risk of flooding from the 1 and 0.2 percent annual chance flood event. From this analysis, several critical areas for flood exposure appear to be (1) the urban areas around the Cibolo and Medina Rivers due to the density of development and total population in those areas, and (2) the confluence of the San Antonio and Cibolo Rivers due to the magnitude of flood volume on each respective creek and similarity in watershed size. Additionally, flooded roadways and agricultural areas are found throughout the SAFPR, and the impacts due to the loss of function in these areas should not be understated. A map produced to illustrate flood exposure within the SAFPR is shown in Map 6 Existing Condition Flood Exposure (2.2.A.2 Existing Condition Flood Exposure Analysis) in Appendix B.

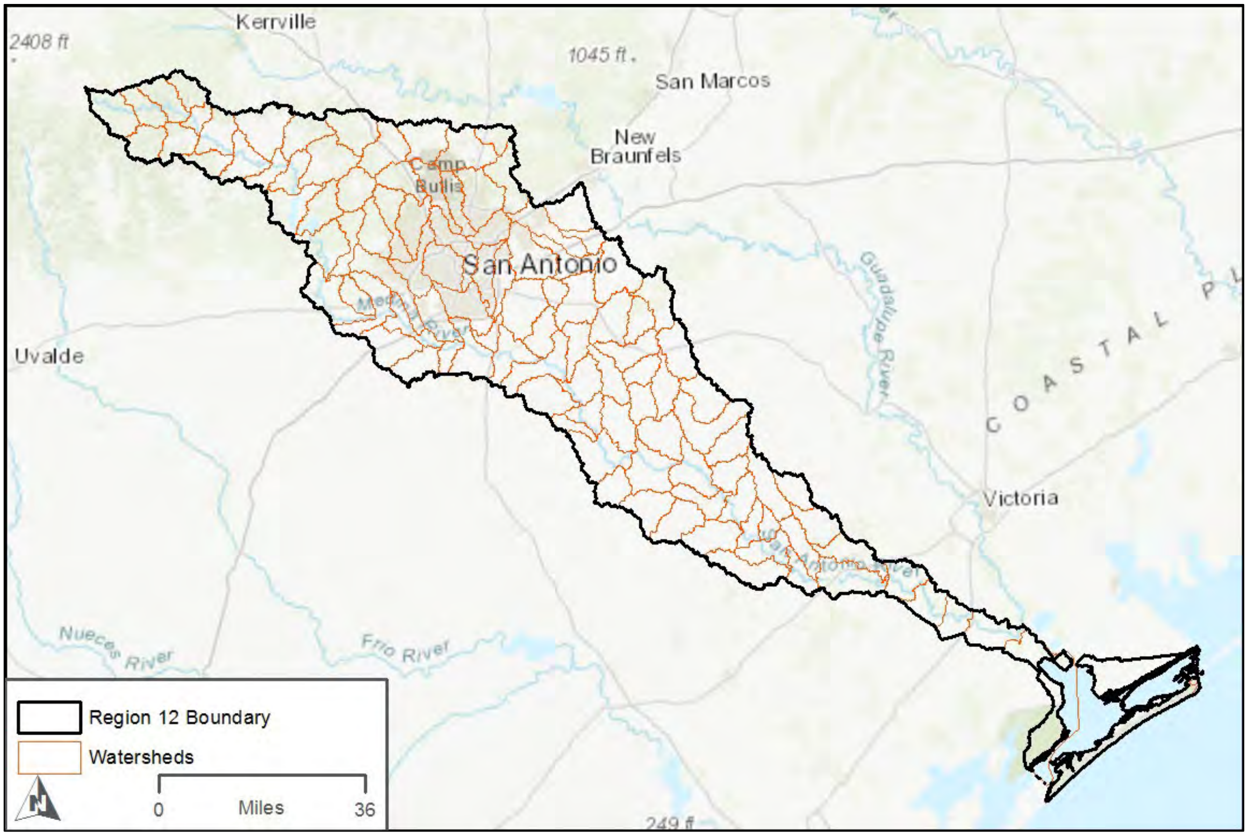
4.2.3 Flood Vulnerability

The flood vulnerability analysis identified roughly 220 critical facilities in the 1 and 0.2 percent annual chance storm event inundation and, in general, mirrored the exposure analysis in terms of critical areas as shown in Map 7 Existing Condition Flood Vulnerability including Critical Infrastructure (2.2A.3 Existing Condition Vulnerability Analysis) in Appendix B. The most vulnerable locations are on the outskirts of the CoSA and at the confluence of the San Antonio and Cibolo Rivers in Karnes County.

4.2.4 Greatest Known Flood Risk Analysis

The main objectives of Task 4A are to identify the areas of greatest known flood risk and areas where the greatest lack of flood risk knowledge exists. The Task 4A analysis is based on a geospatial process that combines information from multiple datasets. The geospatial process was developed in a GIS based on the data collected in Tasks 1 through 3. The geospatial assessment was conducted at a Hydrologic Unit Code (HUC)-12 watershed level of detail, consistent with TWDB guidelines and rules. An HUC is a unique code assigned to watersheds within the United States. As the watersheds have longer unique codes. The smallest unit of division used to identify a watershed is 12 digits or a HUC-12. The SAFPR has 180 HUC-12 watersheds, with an average area of 3.94 square miles.

Figure 4-1. SAFPR HUC-12 Watersheds



A total of nine data categories were used in the geospatial analysis. A scoring range was determined for each data category based on the statistical distribution of the data. A scoring scale of one to five was adopted, and each HUC-12 was assigned an appropriate score for each category. The scores for each HUC-12 under each category were then added to obtain a sum. The sum of the component scores was then assigned a one to five score that was used to reveal the areas of greatest known flood risk and need for mitigation activities. The following sections briefly describe the data categories included in the assessment and how each HUC-12 watershed was scored. Note that the objective of the Task 4A process is to determine the risk factors present within a given HUC-12 and to what degree. The Task 4A process does not necessarily 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.

4.2.4.1 Analysis Categories and Matrix

The following nine risk factors were used to calculate the total risk score:

1. Exposed Buildings: Exposure data representing the number of building structures located within the best available 1 and 0.2 percent annual chance flood inundation boundaries.
2. Exposed Critical Facilities: Vulnerability data representing critical facilities such as hospitals, schools, fire and police stations, and others, identified in the “exposure” layer above.
3. Exposed LWCs: Data as provided by the TNRIS and verified with floodplain limits.
4. Inundated Roadway Length: The length of roadway inundated in each HUC-12 watershed.
5. Nonfunctioning Dams and Levees: Data representing potentially hazardous dams that have been identified as either hydraulically inadequate or deficient by the TCEQ as well as levees that have been identified as unaccredited.
6. Fatalities: Flood-related fatality data collected by the NWS since 1996.
7. Inundated Agricultural Area: The inundated area used for agriculture in each HUC-12 watershed.
8. Social Vulnerability of Exposed Buildings: Vulnerability data representing the number of building structures identified in the “exposure” layer above within a high vulnerability area (i.e., SVI > 0.75).
9. Public Comments: Reported flooding problems collected from public comments.

The nine categories applied in this analysis were selected based on their inherent reflection of either risk or absence of information for each of the SAFPR's HUC-12 watersheds and are described in the sections below. Each category and its respective categories and score distributions are shown in Table 4-1. The geospatial assessment was conducted using the existing condition 1 percent annual chance event because that is the most representative of current conditions.

Table 4-1. Risk Scoring Criteria

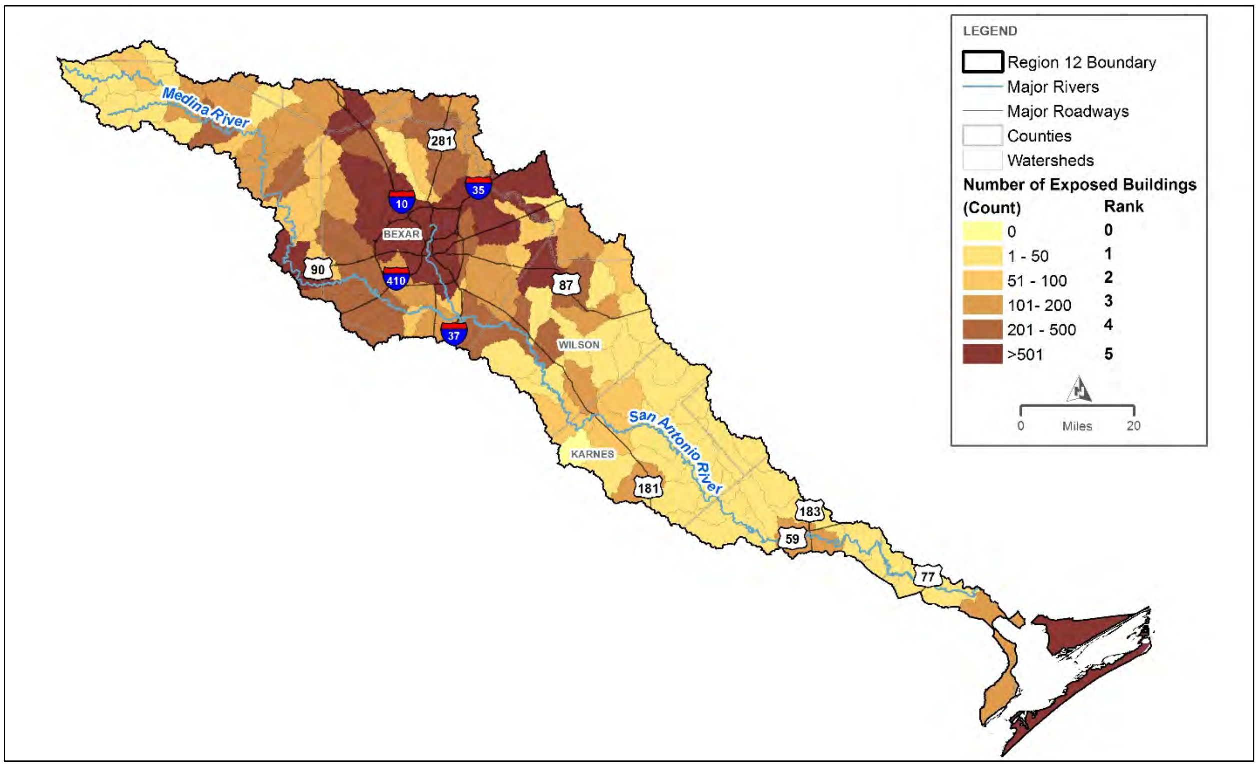
Criteria	Points Scored					
	0	1	2	3	4	5
Number of Exposed Buildings	0	1–50	51–100	101–200	201–500	501+
Number of Exposed Critical Facilities	0	1–5	6–10	11–15	16–20	20+
Number of Exposed LWCs	0	1–2	3–5	5–8	8–11	12+
Miles of Inundated Roadway Segments	0	0.1–5	5.1–10	10.1–15	15.1–25	>25
Number of Nonfunctioning Dams and Levees	0	N/A	N/A	1	N/A	2+
Number of Lives Lost Due To Flooding (Fatalities; NWS)	0	N/A	N/A	N/A	N/A	1+
Square Miles of Inundated Agricultural Land	0	0–0.5	0.5–1	1–1.5	1.5–4	4+
Average SVI of Exposed Buildings	0	0–0.2	0.2–0.4	0.4–0.6	0.6–0.8	0.8–1
Number of Public Comments Received	0	1	2	3	4	5+

Notes: N/A = Not Applicable

4.2.4.2 Exposed Buildings

The TWDB provided a building dataset used in Chapter 2 Flood Risk Analysis to conservatively identify buildings with a footprint within the existing condition 1 percent annual chance event floodplain. Using this exposed building dataset, each HUC-12 was populated with the number of exposed buildings located within each HUC-12 boundary. The exposed building counts ranged widely across the region, with rural HUC-12s having only a few buildings within the floodplain, while urban HUC-12s may have more than 500 exposed buildings. The scoring associated with the number of exposed buildings per watershed and the scoring results are displayed in Figure 4-2. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of exposed buildings. These watersheds are located within more urban areas of Bexar County near San Antonio, and along the coast.

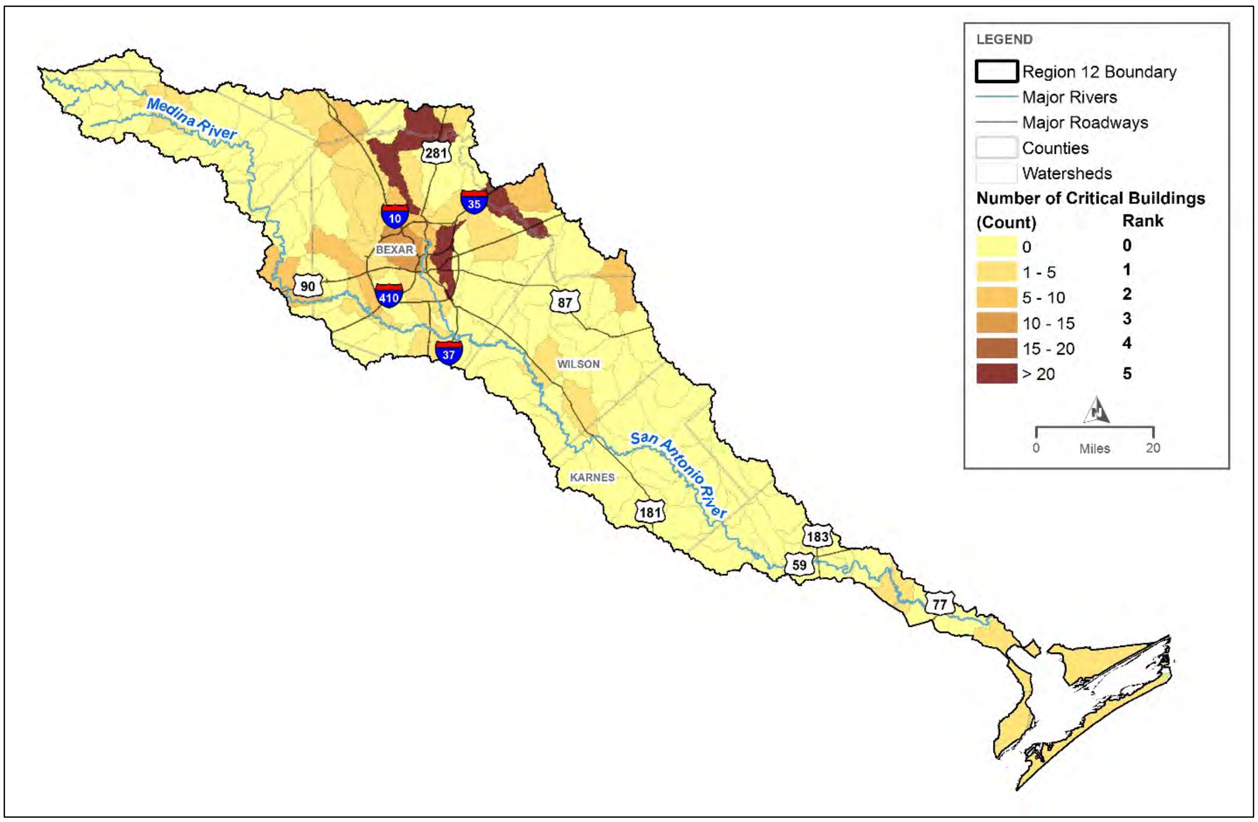
Figure 4-2. Exposed Buildings Risk Score within Region 12



4.2.4.3 Exposed Critical Facilities

The exposure analysis in Chapter 2 Flood Risk Analysis conservatively identified critical facilities with a footprint within the existing condition 1 percent annual chance event floodplain. Using this exposed critical facility dataset, each HUC-12 was populated with the number of exposed critical facilities located within each HUC-12 boundary. The exposed critical facility counts are relatively low across the region; however, six watersheds with five or more critical facilities are potentially at risk of flooding. The scoring associated with the number of exposed critical facilities per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-3. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of exposed critical facilities.

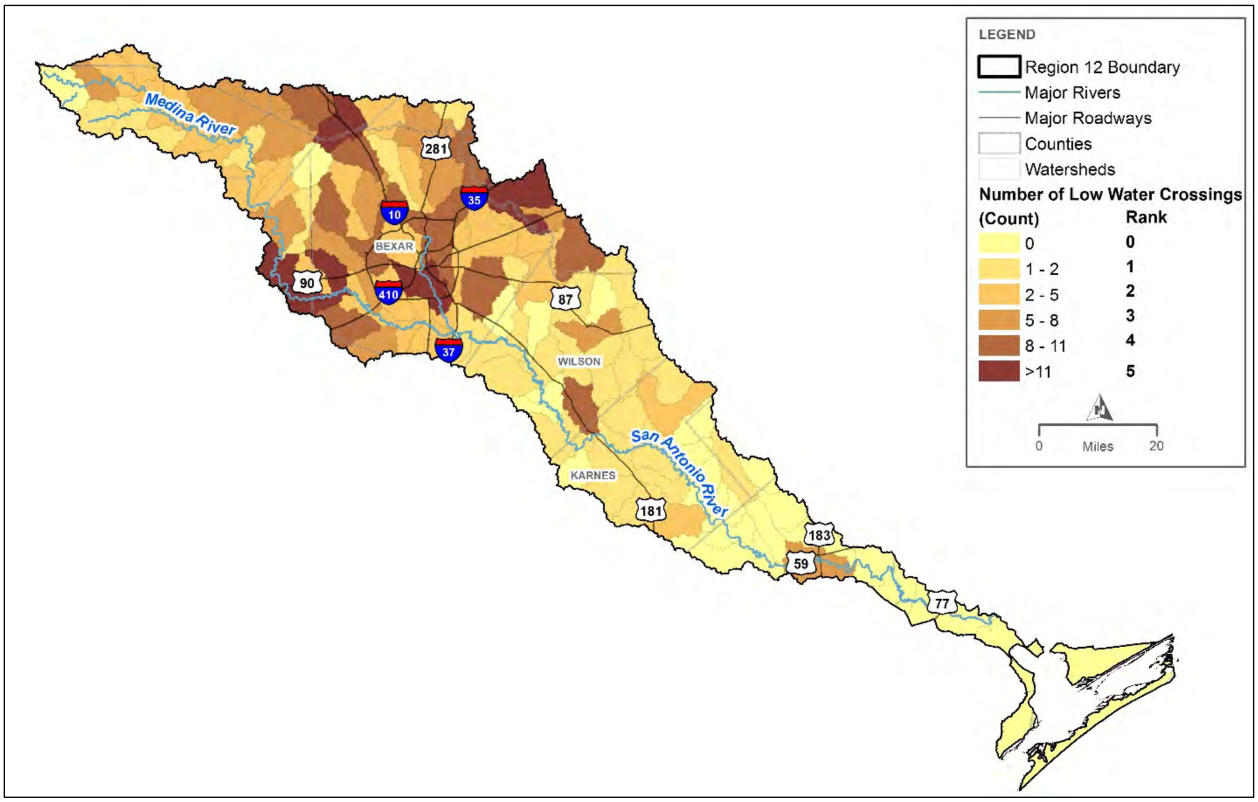
Figure 4-3. Exposed Critical Facilities Risk Score within Region 12



4.2.4.4 Exposed Low Water Crossings

The exposure analysis in Chapter 2 Flood Risk Analysis identified LWCs located within the existing condition 1 percent annual chance (100-year) event floodplain. Using this exposed LWC dataset, each HUC-12 was populated with the number of exposed LWCs located within each HUC-12 boundary. The exposed LWC counts are relatively low across the region; however, 10 watersheds have 16 or more exposed LWCs. The scoring associated with the number of exposed LWCs per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-4. The darkest tan- and brown-shaded watersheds represent the HUC-12s with the greatest number of exposed LWCs.

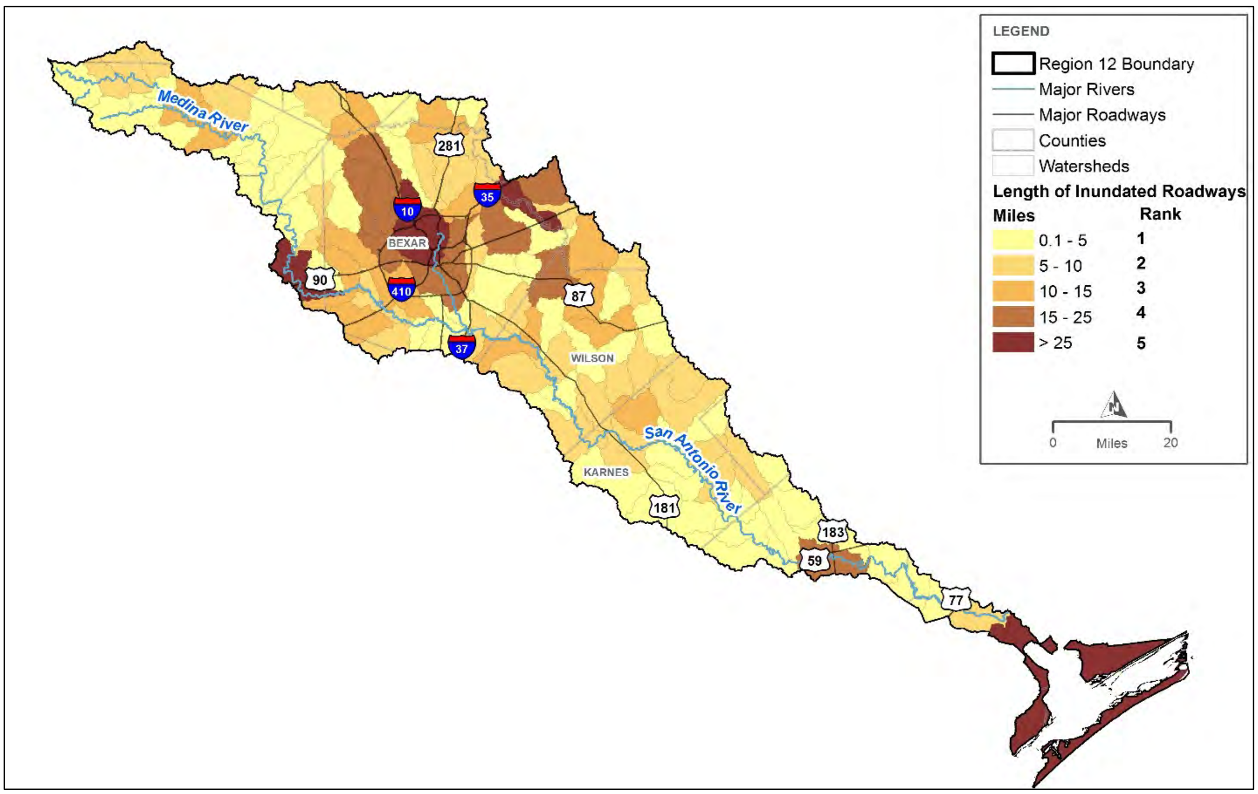
Figure 4-4. Exposed LWCs Risk Score within Region 12



4.2.4.5 Inundated Roadway Segments

As described in Chapter 2 Flood Risk Analysis, inundated roadway segments were identified by clipping the TxDOT geospatial linework with the existing condition 1 percent annual chance floodplain. Using this dataset, each HUC-12 was populated with the miles of inundated roadway segments located within each HUC-12 boundary. The inundated roadway mileage ranged widely across the region, with the majority of HUC-12s having less than 5 miles of roadway within the floodplain, while coastal HUC-12s may have more than 30 miles of inundated roadway segments. The scoring associated with the miles of inundated roadway segments per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-5. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of inundated roadway segments.

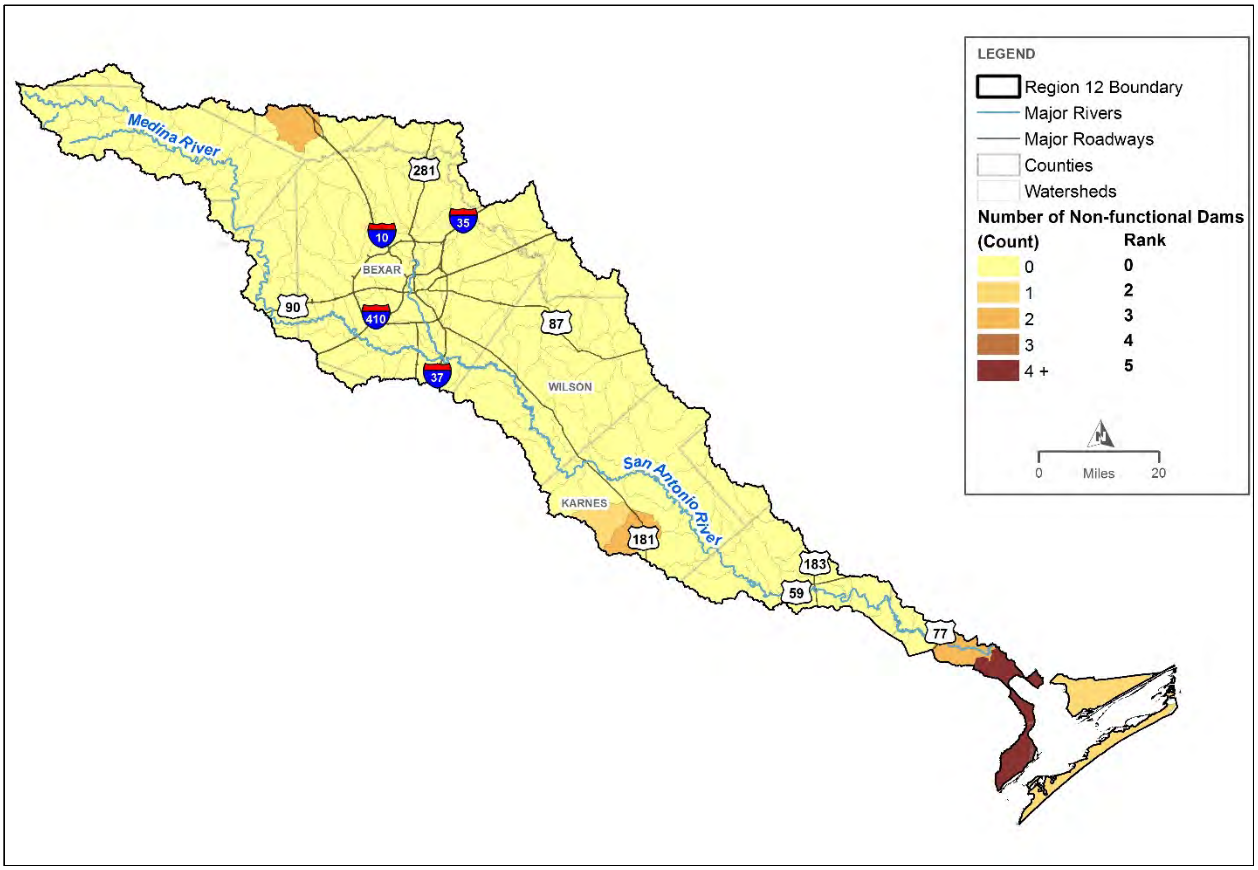
Figure 4-5. Inundated Roadway Segments Risk Score within Region 12



4.2.4.6 Nonfunctional Dams and Levees

Levees data within the SAFPR was obtained from the 2020 National Levee Database[39] developed by the USACE. Dams data within the SAFPR was obtained from the 2020 National Inventory of Dams[40] developed by the USACE. Only the dams and levees that were hydraulically inadequate or deficient were used. Although many HUC-12s contained dams and levees, most HUC-12s did not contain structurally deficient or hydraulically inadequate dams and levees. The scoring associated with nonfunctional dams and levees is displayed in Table 4-1, and the scoring results are displayed in Figure 4-6. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of nonfunctional dams and levees.

Figure 4-6. Nonfunctional Dams and Levees Risk Score within Region 12



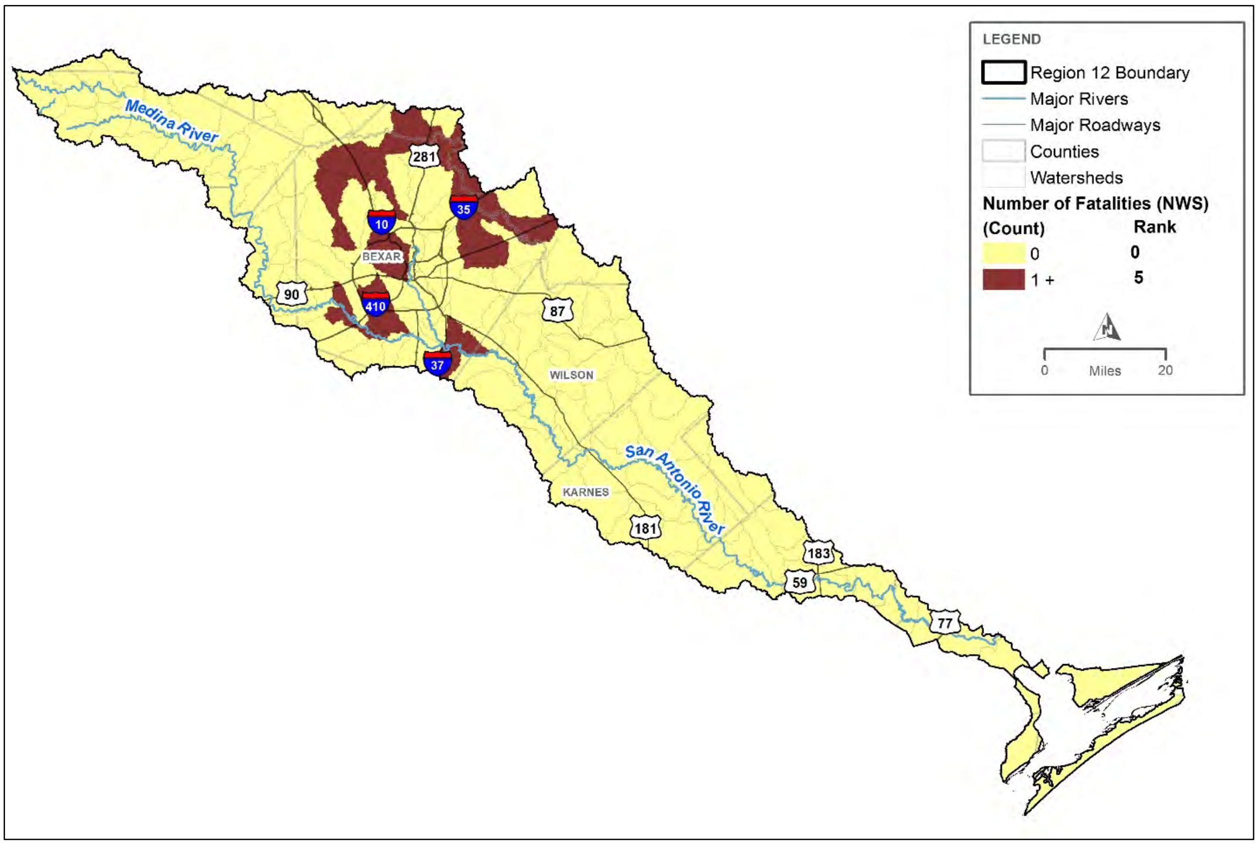
[39] https://levees.sec.usace.army.mil/#/

[40] https://nid.usace.army.mil/#/

4.2.4.7 Fatalities

Fatalities data within the SAFPR was obtained from the NWS. Most HUC-12s do not contain reported fatalities. The majority of fatalities were clustered around the San Antonio metro area. The scoring associated with fatalities is displayed in Table 4-1, and the scoring results are displayed in Figure 4-7. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of fatalities.

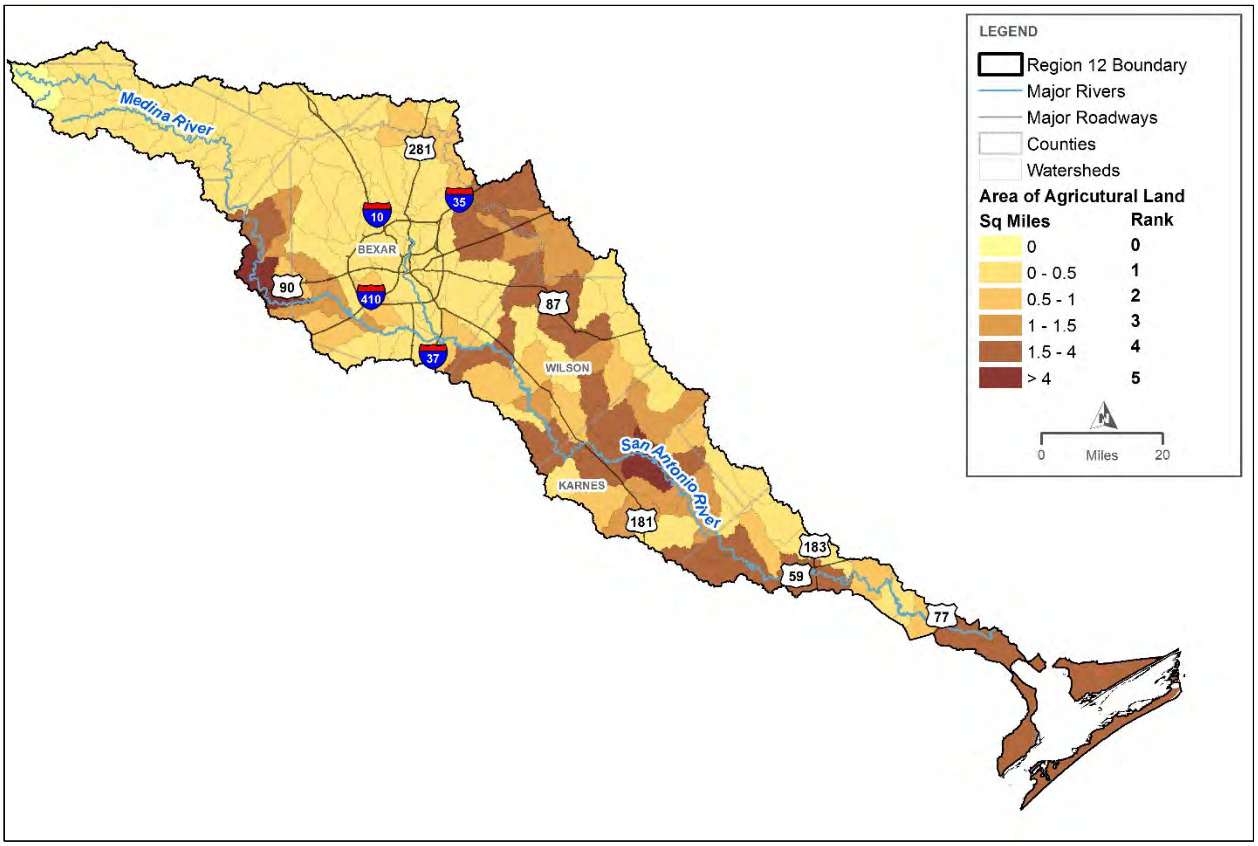
Figure 4-7. Fatalities Risk Score within Region 12



4.2.4.8 Inundated Agricultural Areas

Agricultural land use data within the SAFPR was obtained from the 2020 Texas Cropland Data layer[41] developed by the USDA National Agricultural Statistics Service. The exposure analysis in Chapter 2 Flood Risk Analysis identified agricultural areas with a footprint within the existing condition 1 percent annual chance event floodplain. Using this dataset, each HUC-12 was populated with the square miles of inundated agricultural areas within each HUC-12 boundary. As anticipated, the urban watersheds display less inundated agricultural areas than the rural watersheds. The scoring associated with the square miles of inundated agricultural areas per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-8. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of inundated agricultural areas.

Figure 4-8. Inundated Agricultural Areas Risk Score within Region 12

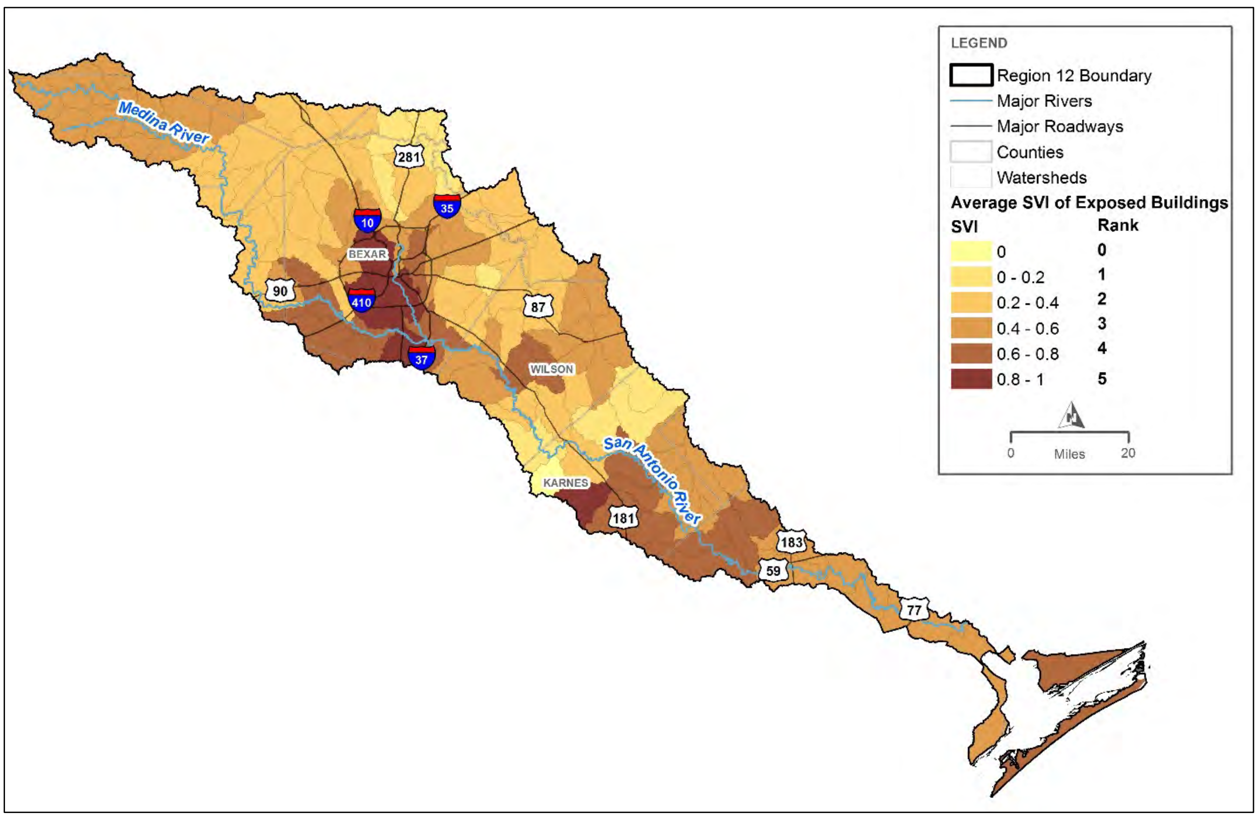


[41] https://www.nass.usda.gov/Research_and_Science/Cropland/Release/

4.2.4.9 Average Social Vulnerability Index (SVI)

Social vulnerability is the measure of the capacity to weather, resist, or recover from the impacts of a hazard in the long and short term. SVI values are present within the building footprints dataset provided by the TWDB and used in the existing condition vulnerability analysis discussed in Chapter 2 Flood Risk Analysis. Using the SVI values for the exposed building dataset, each HUC-12 was populated with the average SVI within each HUC-12 boundary. Higher SVI values represent watersheds with greater vulnerability, while lower SVI values represent watersheds with higher resilience. The scoring associated with the SVI of exposed buildings per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-9. The darkest brown-shaded watersheds represent the HUC-12s with the greatest social vulnerability.

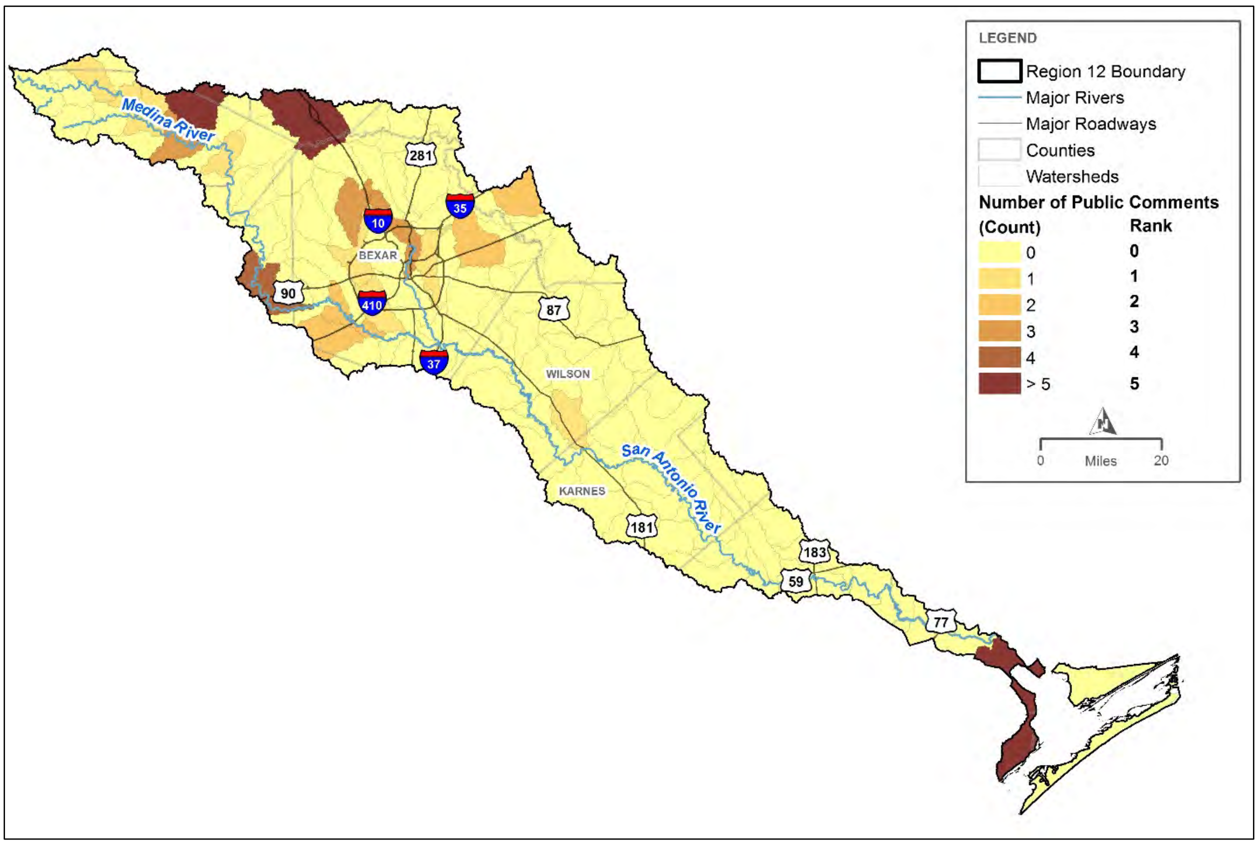
Figure 4-9. Average SVI for Exposed Buildings Risk Score within Region 12



4.2.4.10 Public Comments

The public comments dataset within the SAFPR was obtained from the public outreach efforts described in Chapter 10 Public Participation and Adoption of Plan. Most of the comments were provided via the interactive web map developed for SAFPR to collect stakeholder comments on areas of flood risk in the SAFPR. While only a few comments were received, the San Antonio RFPG thought it was important to note them when evaluating the highest potential for flood risk within the SAFPR. The scoring associated with the public comments received per watershed is displayed in Table 4-1, and the scoring results are displayed in Figure 4-10. The darkest brown-shaded watersheds represent the HUC-12s with the greatest number of comments received.

Figure 4-10. Public Comments Risk Score within Region 12



4.2.4.11 Mitigation Needs Analysis Results

The process and scoring methodology described above were implemented across the entire SAFPR. The objective was to determine the areas of greatest known flood risk and flood mitigation needs. The San Antonio RFPG understands that this exercise in the evaluating of flood threat to the region is not a standard flood risk analysis, should only be use for flood planning purposes, and should not be used to evaluate scoring/ranking of projects. For each HUC-12 within the SAFPR, the scores from the nine categories in the assessment matrix were added to obtain a total score shown in Table 4-2.

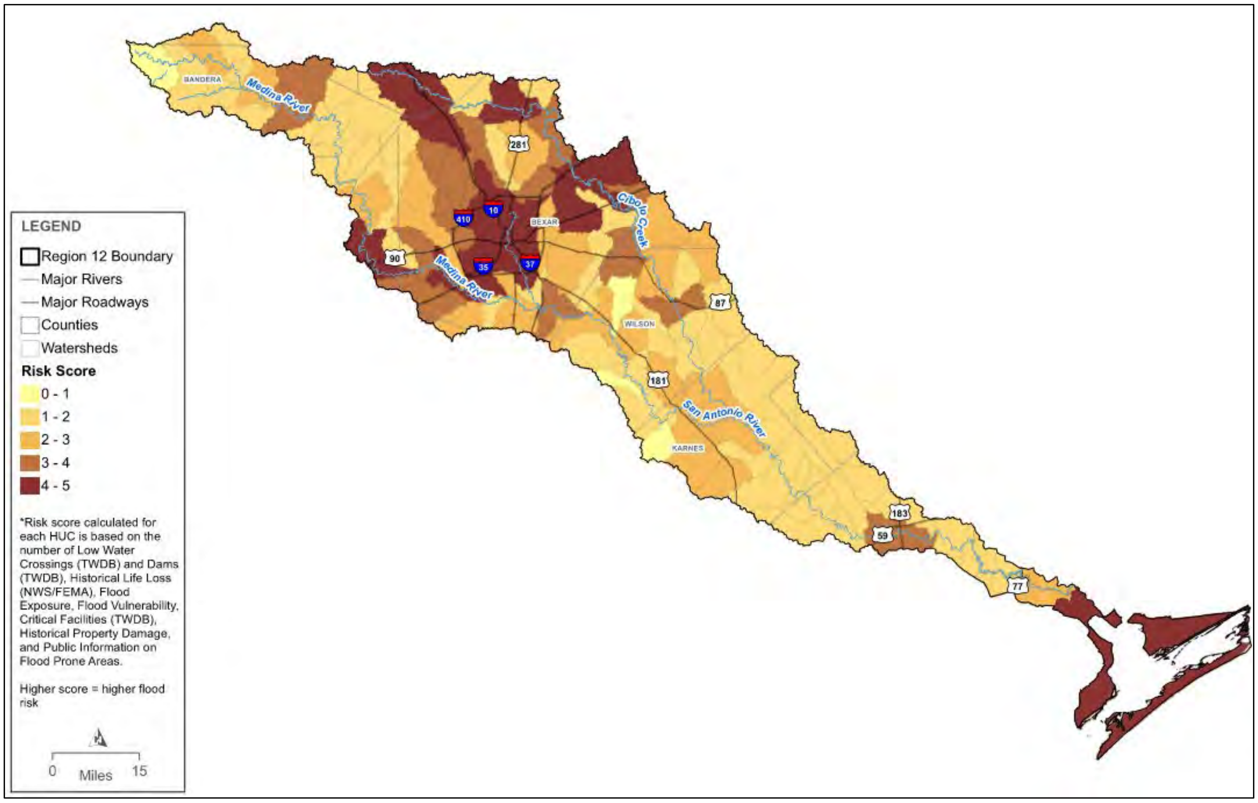
Table 4-2. San Antonio RFPG Flood Risk Score

Total Points	Risk Score
1–5	1
6–10	2
11–15	3
15–20	4
20+	5

Flood risk scores for each HUC-12 watershed within the SAFPR are shown in Figure 4-11. No risk is represented by a score of zero and the highest risk is represented by a score of 5. Risk scores of 2 or greater are considered moderate or high risk. The highest risk areas within the SAFPR are centralized in and around Bexar County as well as the coastal areas.

Based on the distribution of the final scores in this preliminary assessment, the watersheds with the greatest risk of flooding and the need for flood management and mitigation activities are displayed in the darkest brown shading. It is important to note that low-scoring HUC-12 watersheds likely have flood risks, but the risk is relatively low compared to the others.

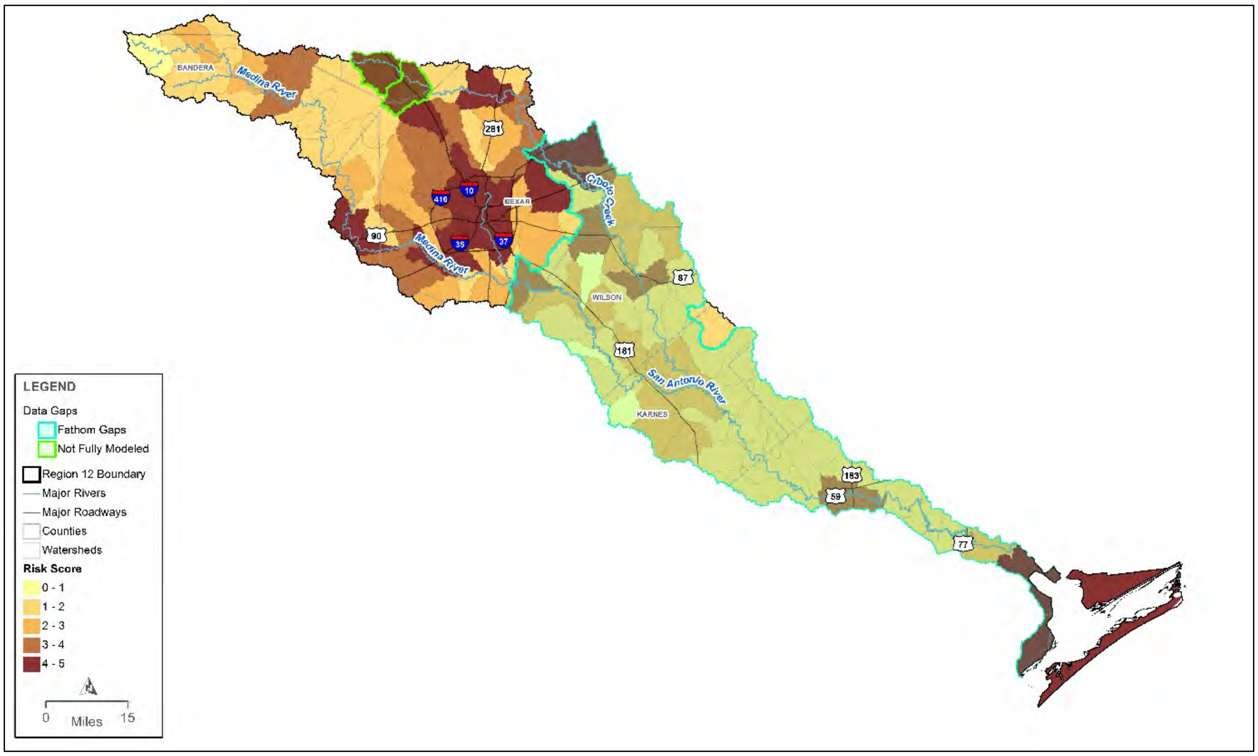
Figure 4-11. Overall Flood Risk per HUC-12 Watersheds within Region 12



4.2.4.12 Flood Mitigation Needs – Modeling Gaps

Figure 4-12 overlays where flood modeling gaps have been identified with the overall flood risk. Multiple high flood risk areas are identified within the upper and lower basins. Two tributaries in the City of Boerne surround areas that are not mapped, each in a different HUC, totaling two HUCs with some portion not mapped. In the lower basin, Cursory Floodplain Data was used for the 0.2 percent annual storm event flood boundaries. A total of 53 HUCs were identified as using Cursory Floodplain Data. Investment in detailed H&H models should be prioritized in the gap areas with the highest overall flood risk.

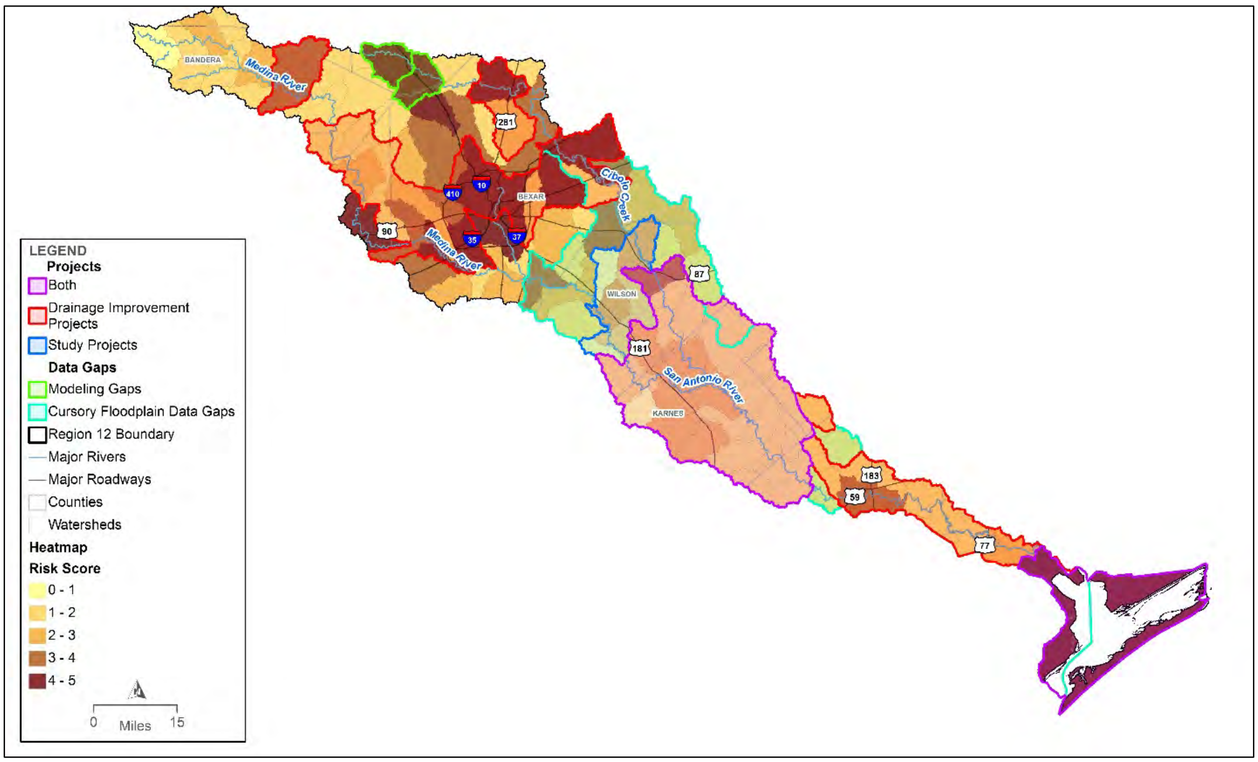
Figure 4-12. Modeling and Mapping Gaps Overlay with Overall Flood Risk within Region 12



4.2.4.13 Flood Mitigation Needs – Flood Study/Project Gaps

Mapping and modeling gaps make it difficult to determine the accurate flood risk for an area; these gaps can be mitigated with studies. High flooding risk areas can be reduced by incorporating flood mitigation projects. Figure 4-13 displays where ongoing or proposed flood studies/projects have been identified overlapping the overall flood risk and the modeling gaps. This map shows many ongoing flood mitigation efforts occurring across the SAFPR that could both fill the gaps and reduce the risk. Investment in flood studies or projects within the remaining gap areas with high flood risk is recommended.

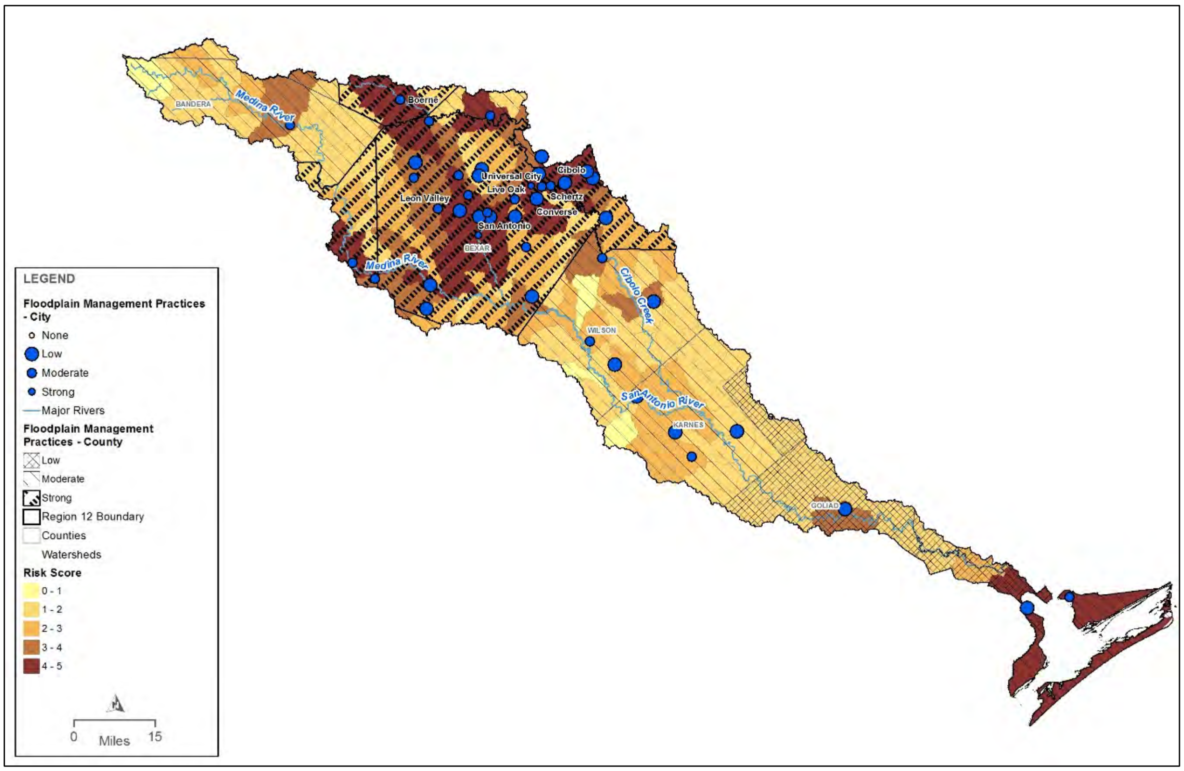
Figure 4-13. Flood Study/Project Gaps Overlay with Overall Flood Risk within Region 12



4.2.5 Flood Mitigation Needs – Floodplain Management Gaps

Figure 4-14 overlays where the level of flood management practice is none or low with the overall flood risk. Flood management practices should be enhanced in areas with a high flood risk and no or low levels of floodplain management. Examples would be the enhancement of floodplain management in the lower basin, where the levels for both cities and counties are low to moderate.

Figure 4-14. Floodplain Management Overlay with Overall Flood Risk within Region 12



5

Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects

5 Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects

This chapter's objective is to focus on Tasks 4B and 5 as prescribed in the SFP rules and guidelines. The scope of Task 4B involves the identification and assessment of potential FMEs as well as potentially feasible FMSs and FMPs. The scope of Task 5 involves further evaluation of identified FMEs, FMSs, and FMPs through a final recommended list of such actions to be incorporated into the San Antonio RFP.

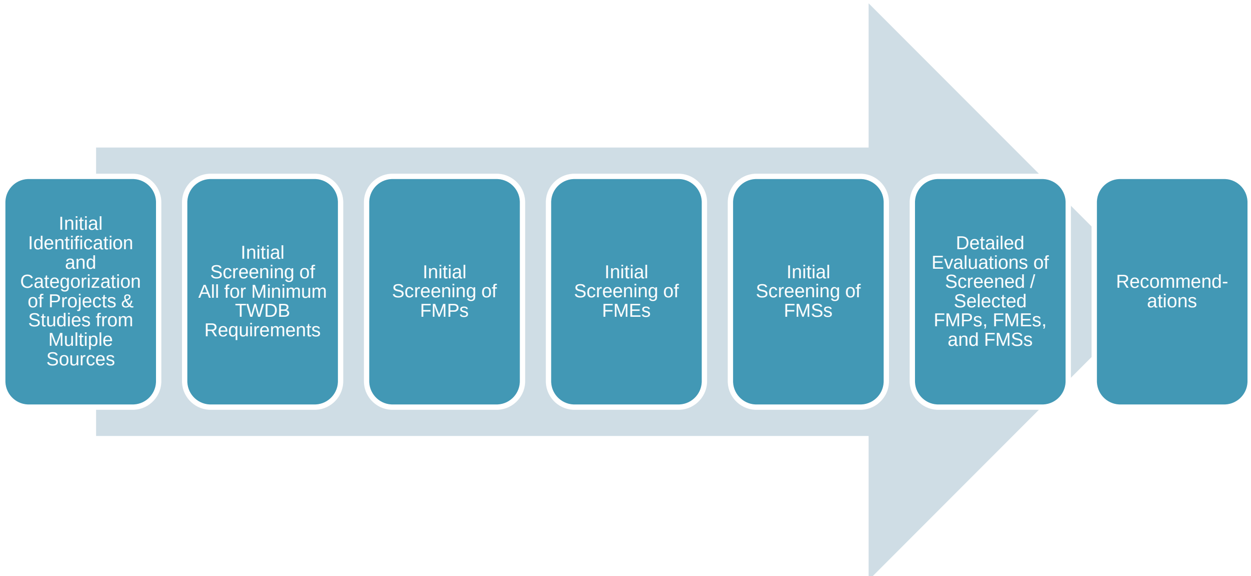
Tasks 4B and 5 build on subsequent Tasks 1 through 4A, with the ultimate objective of recommending FMEs, FMSs, and FMPs that:

- Reduce flood risk identified in Task 2 – Existing and Future Conditions Flood Risk Analyses
- Address flood mitigation and floodplain management goals established in Task 3 – Evaluation and Recommendation of Flood Mitigation and Floodplain Management Practices and Goals
- Address flood mitigation needs identified in Task 4A – Flood Mitigation Needs Analysis

The San Antonio RFPG adopted a process for screening and evaluating FMEs, FMSs, and FMPs (or flood mitigation actions), as summarized in Figure 5-1, based on requirements and guidance within the SFP rules and guidelines, including region-specific interpretations and preferences. The San Antonio RFPG formed a "Task 5" Technical Committee in accordance with SFP rules to oversee the process and eventual recommendations from the technical consultant.

The SFP rules and guidelines allow for some region-specific flexibility and interpretation when recommending FMPs, FMEs, and FMSs for the RFP. The San Antonio RFPG's general approach to this flexibility was to be more inclusive as opposed to being more restrictive for this first cycle of the RFP. The following sections summarize the process and results of Tasks 4B and 5 for the SAFPR; Figure 5-1 shows the outlined process that will be discussed in this chapter.

Figure 5-1. Identification, Evaluation, and Recommendation Process



5.1 Identification and Evaluation of Potential FME, FMP, and Potentially Feasible FMS

FMEs, FMPs, and FMSs are broadly categorized as "flood risk reduction projects or practices" in the *Technical Guidelines*. Once potential flood risk reduction actions were preliminarily identified, a high-level screening process was used to confirm that potential actions had been sorted into their appropriate categorization.

5.1.1 Process to Identify FMEs, FMPs, and FMSs

The goal is to define and evaluate a wide range of potential actions to identify and mitigate flood risk across the SAFPR. These actions have been broadly categorized into the following three distinct types of actions as defined by the SFP rules and guidelines:

- FME: A proposed flood study of a specific flood-prone area that is needed to assess flood risk and/or determine whether potentially feasible FMSs or FMPs exist.
- FMP: A proposed project, either structural or nonstructural, that has non-zero capital costs or other non-recurring cost and, when implemented, will reduce flood risk, or mitigate flood hazards to life or property.
- FMS: A proposed plan to reduce flood risk or mitigate flood hazards to life or property.

The *Technical Guidelines* also list several potential project types for each subcategory, summarized below in Table 5-1.

Table 5-1. FMP, FME, FMS Project Types

Flood Risk Reduction Project Category	Project Types
FME	• Watershed Planning • H&H Modeling • Flood Mapping Updates • Regional Watershed Studies • Engineering Project Planning • Feasibility Assessments • Floodproofing • Preliminary Engineering (alternative analysis and up to 30 percent design) • Property or Easement Acquisition • Regulatory Requirements for Reduction of Flood Risk • Studies on Flood Preparedness
FMP	Structural: • LWCs or Bridge Improvements • Infrastructure (channels, ditches, ponds, stormwater pipes, etc.) • Regional Detention • Regional Channel Improvements • Storm Drain Improvements • Reservoirs • Dam Improvements, Maintenance, and Repair • Flood Walls/Levees • 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, LID, green infrastructure, playas improvements • Comprehensive Regional Project – includes a combination of projects intended to work together Non-Structural: • Property or Easement Acquisition • Elevation of Individual Structures • Flood Readiness and Resilience • Flood Early Warning Systems, including stream gages and monitoring stations • Floodproofing • Regulatory Requirements for Reduction of Flood Risk

Flood Risk Reduction Project Category	Project Types
FMS	None specified; at a minimum, RFPGs should include as FMSs any proposed action that the group would like to identify, evaluate, and recommend that does not qualify as either a FME or FMP. Five general categories were identified by the San Antonio RFPG: • Flood mitigation education and outreach • Area-wide LWC flood mitigation studies and projects • Buyout program identification and funding • Regional flood warning measures development • Flood management regulation strengthening

Identifying potential FMEs and potentially feasible FMPs and FMSs begins with completing the flood mitigation analysis (Chapter 4 Assessment and Identification of Flood Mitigation Needs) to identify the areas with the greatest gaps in flood risk knowledge and the areas of greatest known flood risk. Based on the results of this analysis, several sources of data were used to develop a list of potential flood risk reduction actions that may address the basin's needs. The data includes information compiled under previous tasks:

- Existing flood infrastructure, flood mitigation projects currently in progress, and known flood mitigation needs (Task 1);
- Existing and future flood risk exposure and vulnerability (Tasks 2A and 2B);
- Floodplain management and flood protection goals and strategies developed by the RFPG for the SAFPR (Tasks 3A and 3B); and
- Stakeholder input.

The initial list of potential actions (FMP, FME, FMS) identified for screening and evaluation were collected from three primary sources:

1. Data collected from initial introductory community outreach,
2. Other community drainage master plans or CIPs, and
3. Hazard Mitigation Plans for each community within the region.

Table 5-2 documents the sources from which projects were collected.

Table 5-2. List of Studies Relevant to the RFP

Source	Jurisdiction	Counties	Source Year
Barbara Drive Drainage Study	CoSA	Bexar	2021
Boerne Master Drainage Plan	City of Boerne	Kendall	2021
Castroville Drainage Master Plan	City of Castroville	Medina	2022
Cibolo Creek Watershed Holistic Master Plan	City of Bulverde, CoSA, Wilson County	Bexar, Comal, Wilson, Wilson/ Guadalupe	2018
City of Bulverde Mapping Improvements Cibolo Creek Tributary 19 Drainage Report	City of Bulverde	Comal	2016
City of Bulverde Mapping Improvements Indian Creek Drainage Report	City of Bulverde	Comal	2016
City of Bulverde Mapping Improvements Lewis Creek Watershed Phase 2 Alternative Analysis Drainage Report	City of Bulverde	Comal	2016
City of Fair Oaks Ranch Master Drainage Plan	City of Fair Oaks Ranch	Bexar	2018
Holbrook Road Preliminary Engineering Report	CoSA	Bexar	2021
Holistic Watershed Master Plan Wilson, Karnes, and Goliad Counties	City of Falls City, City of Kenedy	Karnes	2015

Source	Jurisdiction	Counties	Source Year
Holistic Watershed Master Plan Wilson, Karnes, and Goliad Counties, Flood Issues Volume	Goliad County, Karnes County	Karnes, Goliad	2015
Huebner Creek Continuing Authorities Program 205	City of Leon Valley	Bexar	2021
Judson and Lookout Project Narrative	CoSA	Bexar	2016
Karnes and Wilson Counties Hazard Mitigation Plan	City of Falls City, City of Floresville, City of Karnes, City of Kenedy, City of La Vernia, City of Poth, City of Runge, City of Stockdale, Karnes County, La Vernia Independent School District, Wilson County	Karnes, Wilson	2020
Leon Creek Watershed Master Plan Phase 3	CoSA	Bexar	2011
Medina County Hazard Mitigation Action Plan Adopted	City of La Coste	Medina	2020
Medina River Holistic Watershed Master Plan	CoSA, Medina County	Bexar, Medina	2015
Overall Preliminary Drainage Report	La Vernia	Wilson	2022
CoSA Stormwater Planning Studies (Bond Project Summary Sheet)	CoSA	Bexar	2010–2022
Projects for Flood Risk in Helotes	City of Leon Valley	Bexar	2016

Source	Jurisdiction	Counties	Source Year
Salado Creek Watershed Master Plan Report Phase 1	CoSA	Bexar	2011
SARA: Projects for Flood Risk Reduction Helotes	City of Helotes	Bexar	2016
Thames Drainage Channel Improvements	CoSA	Bexar	2016
Upper San Antonio River Master Plan	CoSA	Bexar	2013–2021
Upper Woodlawn Lake Drainage Study	City of Balcones Heights	Bexar	2014
Wilson County Watershed Master Plan	City of Floresville, City of La Vernia, City of Poth, City of Stockdale, Wilson County, Wilson County/ TxDOT	Wilson	2012

The San Antonio RFPG is aware of the TWDB's Flood Infrastructure Fund (FIF) Category 1 studies within the SAFPR. At the time of this report, no FMEs have been identified by those studies; however, the San Antonio RFPG will be coordinating with the FIF project teams during future amendments of the San Antonio RFP.

5.1.1.1 Flood Mitigation Projects

One of the primary objectives of the SFP is to identify and fund flood mitigation projects for implementation; therefore, identifying FMPs that meet SFP criteria and requirements for inclusion into the SFP is a top priority. Per the TWDB rules, of the four common phases of emergency management, the regional flood planning process focuses primarily on mitigation projects but may also include preparedness projects.

An FMP, by TWDB definition, is "a proposed project that has a non-zero capital cost or other non-recurring costs and that when implemented will reduce flood risk and mitigate flood hazards to life or property." FMPs are further categorized as either structural or nonstructural.

Structural FMPs

Structural FMPs are defined as building or modifying infrastructure to change flood characteristics to reduce flood risk. They are infrastructure projects with advanced analysis and 30 to 100 percent design development, including construction plans, specifications, and cost estimates. Structure FMPs include one or a combination of the following project types:

- Culvert/Bridge Improvements
- Channel Improvements
- Flood Detention
- Flood Walls/Levees
- Flood Diversion
- Storm Drain Improvements
- Coastal Protections

Culvert and Bridge Improvements: Typical culvert and bridge improvements address roadway flooding at waterways ranging from large riverine crossings to roadway crossings at smaller creeks and streams. LWCs are defined by the TWDB rules as roadway creek crossings that are overtopped by a 50 percent annual chance storm event (2-year storm). Bridges and culverts that have insufficient area to convey higher flows tend to overtop frequently, preventing the passage of vehicles during high flow times and producing excess backwater that may result in flooding of upstream properties. Bridges and culverts that overtop frequently pose a significant threat to public safety as most flood-related deaths occur at these types of crossings. Culvert and bridge improvement FMPs are often part of larger flood risk reduction projects (such as channel widening projects) and not necessarily just single LWC projects.

Channel Improvements: Channel improvements generally lower flood levels by improving the hydraulic efficiency of a stream or roadside channel by enlarging, straightening, and/or reducing the channel friction by smoothing the contours and/or lining of the channel banks and removing obstructions. Channel improvements can reduce flood risk to large populations but can require significant modifications to mitigate 1 percent annual chance floods (100-year floods). Channel improvement projects typically require land acquisition, and can be costly and difficult to permit and implement within urbanized areas. Channel improvements can incorporate nature-based natural channel design techniques to help provide ecological function uplift and reduce environmental impacts as well as erosion risk. In urban settings, channel improvements can include recreational, cultural, and educational features providing socioeconomic benefits.

Flood Detention: Typical flood detention projects are regional in scale, ranging from large flood control reservoirs to smaller regional flood detention ponds, and can provide benefit to relatively large populations and/or agricultural areas. Regional flood detention facilities require significant storage volume to mitigate 1 percent annual chance floods (100-year floods) requiring large tracts of land, and can be costly and difficult to implement in urban areas. They also require long-term operation and maintenance (O&M) costs. Flood detention can reduce flood risk and provide additional benefits such as recreation and water supply, but can create dam safety risks and environmental impacts.

Floodwalls/Levees: Levees and floodwalls confine out-of-bank flows to areas along rivers and streams to reduce flood risk to properties located within the natural flood plain. The confinement of floodwaters using levees or floodwalls considerably alters the characteristics of flood flows. Reduction of natural valley storage capacity within the floodplain can increase peak discharges for a given flood and increase flood damages downstream of a project. Land must be reserved behind levees or floodwalls for ponding areas, and impounded water must be retained or pumped over the levee. Levees are most applicable where the floodplain is wide and development is located a considerable distance from the channel. Levees can cause catastrophic damage if overtopped by a flood greater than their design flood. Therefore, the design flood for levees is typically the 100-year flood at a minimum, with additional freeboard to reduce risk of overtopping. Levees and floodwall facilities can require significant land acquisition and can be costly and difficult to implement in urban areas. They require closures at road and railroad crossings as well as interior drainage measures such as stormwater pump stations. They also require long-term O&M costs typically associated with FEMA certification. Levees and floodwalls can reduce flood risk but can create levee safety risks, environmental impacts, and negative socioeconomic impacts.

Flood Diversions: Typical flood diversion projects include diversion channels or diversion conduits (tunnels). Diversion channels intercept flood waters upstream of populated areas and convey them safely above ground to a discharge point downstream of the populated areas. They require significant land acquisition and can be difficult and costly to build in urbanized areas. Diversion tunnels convey floodwater underground to reduce flood risk to large, populated areas. They also require long-term O&M costs. Flood diversions can reduce flood risk but can cause downstream hydrologic and environmental impacts.

Storm Drain Improvements: Excessive street flow within urbanized areas can cause flooding of residential and commercial structures; safety issues to traffic; damage to pavement; and, in some cases, life loss. Installing new storm drain systems to collect runoff and convey it underground to a receiving stream is a typical solution for improving street flow and diverting stormwater around problem areas. Storm drain improvements can reduce flood risk to large populations, but can require significant sizes of conduit or box sections to mitigate 1 percent annual chance floods (100-year floods). Storm drain improvement projects typically require other measures to mitigate increases in flood discharges to downstream areas and can be costly and difficult to implement in urbanized areas.

Coastal Protections: Coastal flood protections reduce flood risk to large populations from coastal storm surges and combined riverine and coastal effects. Typical coastal protections include coastal levees, dikes, and seawalls and often include beach erosion countermeasures such as riprap revetments. Similar to inland levees and floodwall facilities, coastal protections can require significant land acquisition, and can be costly and difficult to implement within urban areas. They require closures at road and railroad crossings as well as interior drainage measures such as stormwater pump stations. They also require long-term O&M costs typically associated with FEMA certification. Coastal protections can reduce flood risk but can create levee safety risks, environmental impacts, and negative socioeconomic impacts.

Nature-Based Features: FMPs can include nature-based features as part of flood mitigation solutions where applicable, including, but not limited to, stream and coastal restorations, wetlands, natural channel design, other green infrastructure elements, and land preservation. These types of solutions can provide some flood control benefits in urban settings; NBSs into existing projects generally can provide flood risk reduction to 1 percent annual chance flood hazards (100-year floods) if the site conditions are appropriate. They also improve stormwater quality, provide ecological function uplift, and reduce riverine and coastal erosion risk.

Nonstructural FMPs

Nonstructural FMPs are flood mitigation projects or actions that change the way people interact with flood risk and move people out of harm’s way. These types of projects do not involve modifications to the watershed or flood infrastructure; therefore, they do not have adverse impacts on adjacent areas or environmental impacts. Nonstructural FMPs include one or a combination of the following project types:

- Regulatory Improvements
- Floodplain Evacuation (Property Acquisition/"Buyouts")
- Flood Warning
- Floodproofing
- Flood Readiness and Resilience

Regulatory Improvements: Adoption of regulations by local governments provide legal measures to control development in flood-prone areas and prevent the occurrence of future drainage-related problems. Regulatory improvements create or improve local regulatory requirements such as floodplain development ordinances and drainage design criteria related to planning, zoning, land development, and building codes. Regulatory improvements include requirements of those proposing new developments or redevelopment to identify flood hazard areas and keep people out of them. This type of nonstructural FMP has very low capital cost compared to structural FMPs. Regulation of flood-prone land increases the likelihood that such property will be properly used in the best interest of public health, safety, and welfare. However, such regulations offer no relief for existing development.

Floodplain Evacuation: Floodplain evacuation involves acquiring real property at high risk of incurring flood damage and loss of life. Typically referred to as floodplain "buyouts," these can be voluntary or involuntary. One major advantage of this type of FMP is that it eliminates flood risk, leaving no residual risk. Buyouts are costly up front, but typically have no long-term O&M costs. Buyouts can provide environmental enhancements by creating open space, riparian restoration, and park land, but can also have negative socioeconomic impacts.

Flood Warning: Typical flood warning measures or systems provide means for temporary evacuation of flood hazard areas during floods to reduce flood risk. These types of measures range from simple stream gages and warning signals to more complex early flood warning systems that can forecast floods and warn large populations to evacuate. Flood warning systems save lives but do not save property. This type of nonstructural FMP has low capital costs compared to structural FMPs.

Flood Proofing: Floodproofing generally consists of providing watertight coverings for door and window openings of habitable structures, raising structures in place, raising access roads and escape routes, constructing levees and floodwalls around individual or groups of buildings or critical infrastructure, and waterproofing walls as well as mechanical and electrical equipment. Floodproofing is more easily applied to new construction and more applicable where flooding is infrequent and of short duration, low velocity, and shallow depths. Floodproofing is appropriate for locations where other structural flood mitigation alternatives are not feasible. Floodproofing can mitigate risk from 1 percent annual chance floods (100-year floods) but does not eliminate all flood risk.

Flood Readiness and Resilience: Typical flood readiness and resilience projects or actions focus on improving flood preparedness and response to save lives, and include developing flood response plans, flood or hurricane evacuation plans, and flood or dam emergency action plans. This type of nonstructural FMP has low capital costs compared to structural FMPs.

5.1.1.2 Flood Management Evaluations

An FME, by TWDB definition, is “a proposed flood study of a specific, flood-prone area that is needed in order to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.” Three general categories of FMEs are described below. An FME may include any or all of these study elements or phases.

Flood Hazard Modeling and Mapping/Risk Identification Studies: These FMEs are studies to quantify flood risk within areas where significant flood risk is thought to exist, but do not have flood risk data or have insufficient flood risk data. An example of this type of FME is a floodplain modeling and mapping study of a chronic flood-prone area with a certain population at risk that has not been studied before.

Flood Mitigation Alternatives Analysis/Feasibility Studies: These FMEs involve using flood hazard and flood risk data for a known flood problem area to evaluate structural and nonstructural flood mitigation alternatives or project types, such as the FMP types described above, to provide the most flood risk reduction benefit for the least amount of capital cost. These FMEs include a benefit-cost analysis (BCA), and include evaluations of other factors such as environmental constraints and permitting requirements, land acquisition and utility relocation requirements, constructability and other constraints, and public input and social factors.

Preliminary Engineering Studies: Once a flood-prone area has been studied and a preferred flood mitigation alternative or set of alternatives have been identified from a feasibility study, a preliminary engineering study of these alternatives would develop at least a 30 percent level design, including initial plans, permitting assessments, and refined capital cost estimates.

Potential FMPs that have previously been studied within the region but do not meet the standards set by the TWDB for FMPs will fall into this category of FME.

5.1.1.3 Flood Management Strategies

Proposed actions that did not qualify as an FMP or FME were considered as "strategies." The term FMS is not a typical term used in the flood mitigation industry; however, in a few cases, community sponsor-specific strategies were provided to the San Antonio RFPG that met the TWDB definition. An FMS, by TWDB definition, is "a proposed plan to reduce flood risk or mitigate flood hazards to life or property. A flood management strategy may or may not require associated Flood Mitigation Projects to be implemented." Regional or subregional FMSs generally fell into the following five categories:

1. Flood Mitigation Education and Outreach
2. Area-wide LWC Flood Mitigation Studies and Projects
3. Buyout Program Identification and Funding
4. Regional Flood Warning Measure Development
5. Flood Management Regulation Strengthening

5.1.2 Screening of FMPs, FMEs, and FMSs

TWDB requirements for Task 4B state that each RFPG is to develop and receive public comment on a "…proposed process to be used by the RFPG to identify and select flood management evaluations, flood mitigation strategies, and flood mitigation projects." This process, once adopted by the San Antonio RFPG, is to be documented and such documentation is to be included in the Technical Memorandum, the Initial Draft RFP, and the adopted Final RFP.

The following describes the proposed process being considered by the San Antonio RFPG and on which public comment will be taken, both during the December San Antonio RFPG meeting and via written comments submitted through the San Antonio RFPG's website. The process, as described below, was designed to conform with TWDB requirements as expressed in the rules, the scope-of-work for the regional flood planning process, and technical guidelines.

Step 1. Conduct an initial screening of FMPs, FMEs, and FMSs that were received by or developed in conjunction with floodplain management communities/project sponsors:

In this first step, screening is conducted based on minimum TWDB requirements. The screening criteria applied in this step are:

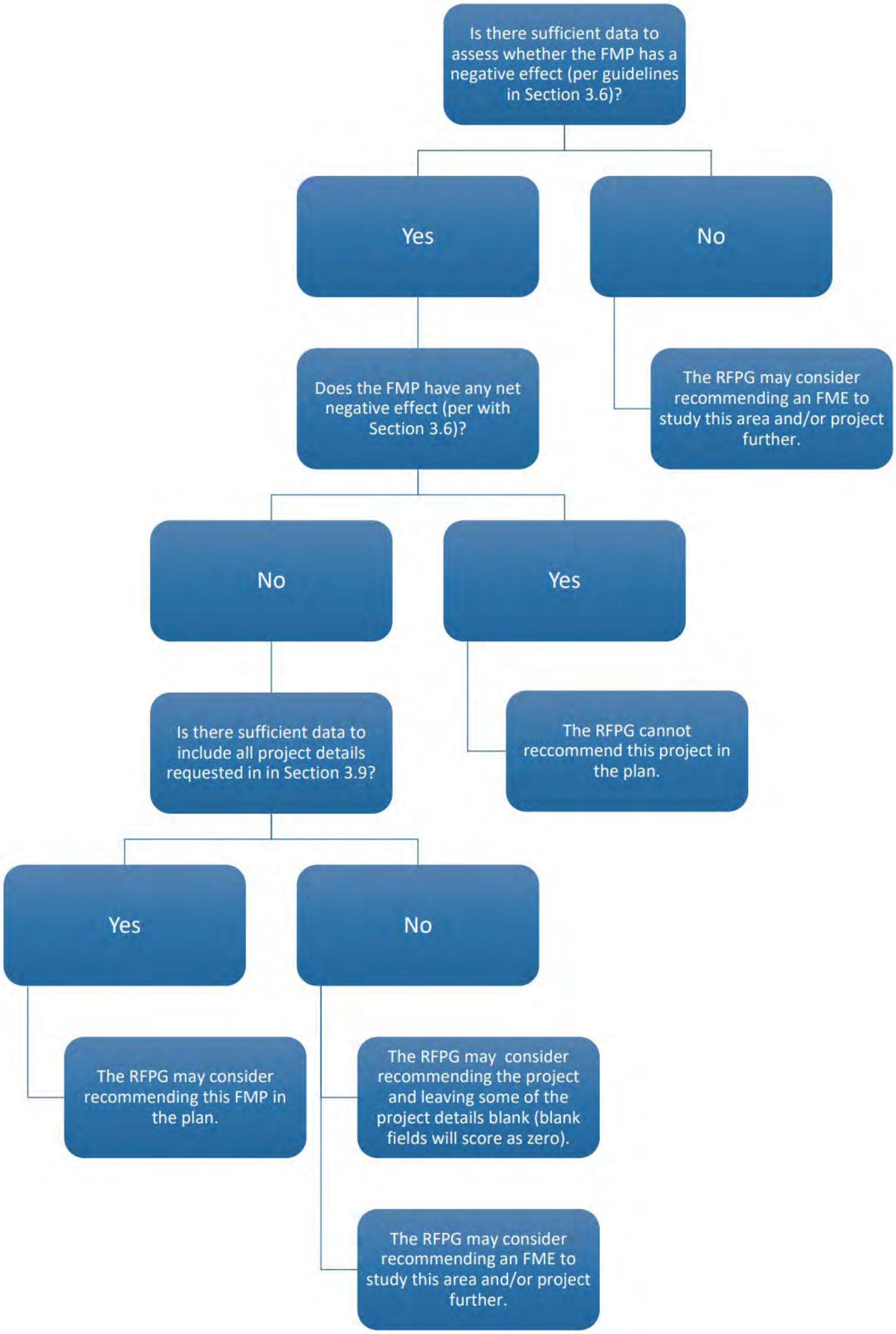
- The FMP/FME/FMS is related to a flood mitigation or floodplain management goal.
- The FMP/FME/FMS meets an emergency need.
- The FMP/FME/FMS addresses a flood problem with a drainage area of 1 square mile or greater.
- The FMP/FME/FMS reduces the flood risk for the 100-year (1 percent annual chance) flood.
- Exceptions for level of flood risk reduction or problem area size include instances of flooding of critical facilities, transportation routes, or other factors as determined by the RFPG.

Step 2-1. Screening of Projects (FMPs):

In the second step, potential FMPs are subjected to a screening-level evaluation based on the TWDB's *Technical Guidelines for Regional Flood Planning* (April 2021) and specifically Figure 5-2. If a potential FMP does not satisfy the screening criteria in this step, it will then become a potential FME. Three criteria applied in this step are: "sufficient data," "no negative effect," and "project details." These criteria are described as follows:

- **Sufficient data:** The data upon which an assessment of no negative effect has been made must be reliable and have minimal uncertainty. H&H modeling, mapping, and basis for mitigation analysis must generally meet Section 3.5 of TWDB's technical guidelines.
- **No negative effect:** The potential project must not have negative impact on the 100-year (1 percent annual chance) flood event. It must not raise the flood elevation or increase discharge of the 100-year flood event. Any of the following will disqualify the potential project in this screening step:
  - Potential project increases inundation of homes, commercial buildings, critical facilities, and other structures
  - Potential project increases inundation beyond existing or proposed ROW or easements
  - Potential project increases inundation beyond existing drainage infrastructure capacity

Figure 5-2. FMP Flowchart



TWDB *Technical Guidelines*

- **Project details:** Data used to define the potential project must include sufficient project details as described in Section 3.9 of TWDB's technical guidelines, including but not limited to the following:
    - Flood severity level metrics
    - Flood risk/damage reduction metrics
    - Estimated capital and O&M costs
    - Benefit-cost ratios (BCRs)
    - Environmental benefits/impacts
    - Potential for natural flood mitigation components
    - Implementation constraints
    - Water supply benefits

Step 2-2: Screening of Evaluations (FMEs):

FMEs may fall into one of three general categories:

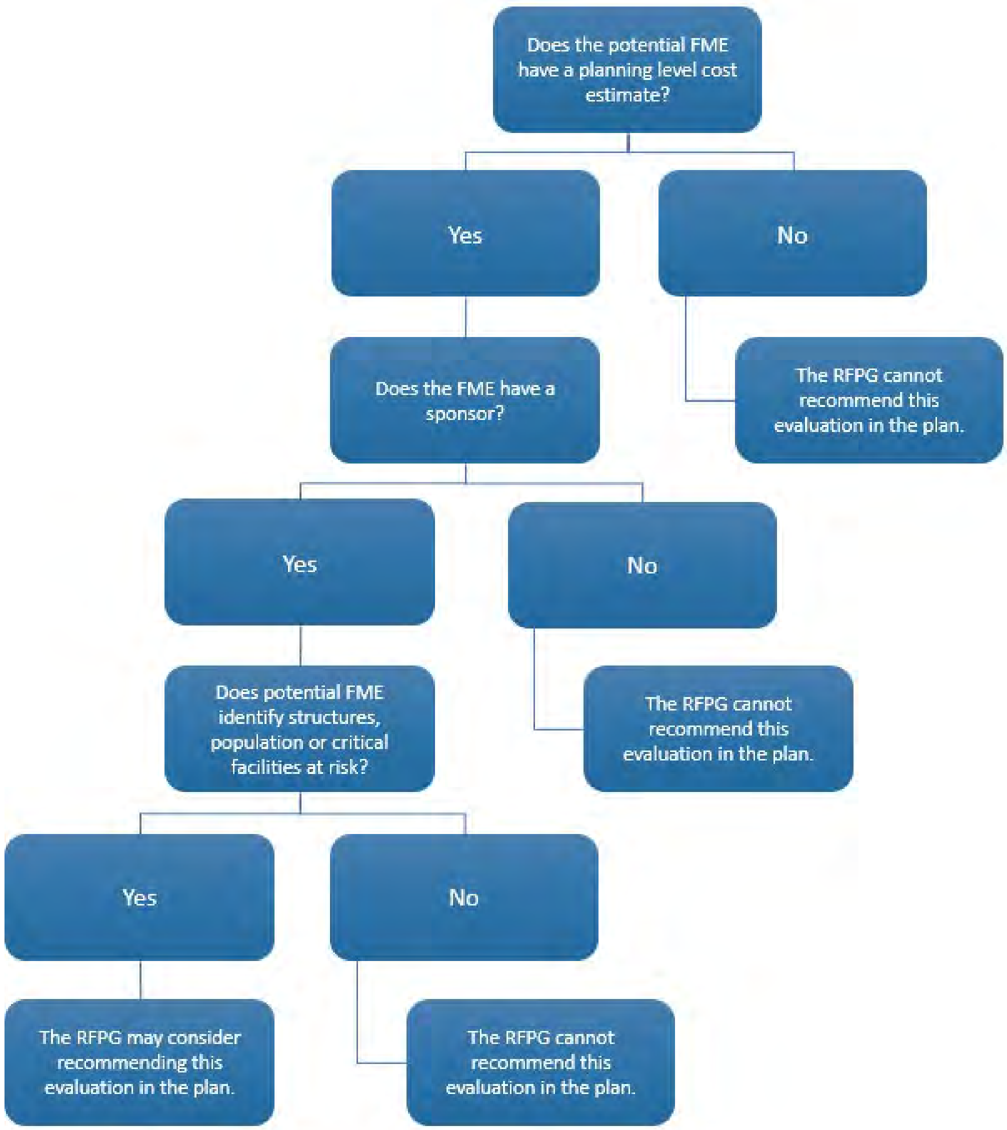
1. Potential projects (FMPs) that did not meet screening criteria Step 2-1
2. Planned flood studies or flood risk reduction alternatives analyses provided by or developed in conjunction with floodplain management communities/project sponsors
3. Potential flood studies or flood risk reduction alternatives analysis needs identified by the technical consultant in Task 4A

In this step, potential studies are screened based on the following criteria from TWDB's technical guidelines and illustrated in Figure 5-3:

- The potential FME must identify structures, population, and critical facilities at risk within the flood problem area being studied.
- The potential FME must identify roadways impacted by flooding within the flood problem area being studied, if applicable.
- The potential FME must quantify the area of agricultural land at risk within the flood problem area being studied, if applicable.
- The potential FME must have a willing sponsor(s) identified that is willing to commit resources and some level of potential cost sharing.
- The potential FME must have a reasonable planning-level cost estimate.

If the H&H and flood mitigation alternatives analyses are sufficiently detailed, then the FME may be considered as a Project (FMP) or Strategy (FMS).

Figure 5-3. FME Flowchart



Step 2-3. Screening of Strategies (FMSs):

FMSs are proposed plans or actions that reduce flood risk or mitigate flood hazards to life or property. Any proposed action that does not meet the criteria to qualify as an FME or FMP can potentially be considered as a strategy. FMSs can also be flood studies or flood risk reduction alternatives analysis needs that are identified in Task 4A. In general, the RFPG has flexibility with what qualifies as Strategies (FMSs).

In this step, FMSs are screened based on the following criteria from the TWDB's technical guidelines:

- The potential FMSs must include a planning-level cost estimate.
- The potential FMSs must have an identified sponsor(s) that is willing to commit resources and some level of potential cost sharing.
- The potential FMSs must quantify the estimated flood risk being addressed and potential level of flood risk reduction.

Step 3. Sorting of FMPs, FMEs, and FMSs by Flood Mitigation and Floodplain Management Goals:

In the third step, the FMPs, FMEs, and FMSs identified will be assigned to one or more of the goals defined in Task 3B.

Step 4. Detailed assessment of selected FMPs, FMEs, and FMSs:

In the fourth step, potential FMPs, FMEs, and FMSs that meet the criteria in the initial screening processes described in Steps 1 and 2 are to be evaluated further for potential feasibility and must meet the following:

- Potential FMPs are preferred to have an estimated BCR greater than 1.0. If less than 1.0, projects may still be considered with additional justification from the RFPG.
- Potential FMPs, FMEs, and FMSs must have a willing sponsor(s) that has been verified.
- No known insurmountable implementation constraints or hurdles may exist, such as ROW acquisitions, utility conflicts, and/or permitting issues.
- Potential FMPs, FMEs, and FMSs will be evaluated to identify maintenance requirements and their costs.
- Potential FMPs and FMSs must include a description of residual, post-project, and future risks.
- Potential FMPs and FMSs must indicate potential use of federal funds, or other sources of funding, as a component of the total funding mechanism.

Step 5: Final recommendation of FMPs, FMEs, and FMSs:

In this final step, recommended FMPs, FMEs, and FMSs are to be incorporated in the initial draft and final RFP. The RFP must also include:

- Public comments and RFPG responses on the recommended FMPs, FMEs, and FMSs
- Initial and final adoption

The RFPG conducted a targeted outreach effort to each potential sponsoring community to discuss the initial list of potential actions for potential additions, deletions, or edits to the actions and their attributes, and to verify that they are a willing sponsor. A total of 110 potential sponsors were contacted; approximately 34 responded and met via online video conferences for discussion.

5.1.3 Initial Screening Results

5.1.3.1 Potentially Feasible FMPs

Potentially feasible FMPs were identified based on responses to the survey, reviews of previous studies, and direct coordination with stakeholders. FMPs are required to be developed in a sufficient level of detail to be included in the San Antonio RFP and recommended for state funding. In most cases, this includes having recent H&H modeling data to assess project impacts and an associated project cost to develop the project's BCR. The development and use of the technical information to evaluate potentially feasible projects is described in the following subsections.

Due to multiple completed drainage master plans, the San Antonio RFPG was able to identify 28 potentially feasible FMPs, mostly within the CoSA and City of Boerne. Additional potentially feasible FMPs may be identified through continued outreach with regional stakeholders under Task 11 and through the execution of identified FMEs, either as FMEs are approved by the San Antonio RFPG to be performed under Task 12, or as other funding sources are acquired by individual stakeholders. These results can be summarized in the TWDB-required Table 13 Potentially Feasible Flood Mitigation Projects Identified by RFPG in Appendix A.

5.1.3.2 Potentially Feasible FMEs

All potential FMEs that were identified are listed with their supporting technical information in TWDB-required Table 12 Potential Flood Management Evaluations Identified by RFPG in Appendix A. In total, 163 potential FMEs were identified and evaluated. The evaluation of FMEs relied on the compilation of planning level data to gage alignment with regional strategies and flood planning guidance, potential flood risk within the SAFPR, and funding need and availability.

5.1.3.3 Potentially Feasible FMSs

The San Antonio RFPG identified 19 potentially feasible FMSs for the SAFPR; these are listed in TWDB-required Table 14 Potentially Feasible Flood Management Strategies Identified by RFPG in Appendix A. A variety of

FMS types were identified. Some strategies encourage and support communities and municipalities to actively participate within the NFIP. Other FMSs recommend the establishment and implementation of public awareness and educational programs to better inform communities of the risks associated with flood waters. Additional FMSs promote preventive maintenance programs to optimize the efficiency of existing stormwater management infrastructure, recommend the development of a stormwater management manual to encourage best management practices, or recommend the establishment of conservation easement programs. Because many projects are constrained physically and financially, the San Antonio RFPG decided it did not want to exclude flood reduction projects based on the LOS or BCR. Similarly, because many of the known flood mitigation projects were identified by local jurisdictions, the drainage areas are sometimes under 1 square mile, and the San Antonio RFPG did not want to exclude those from the RFP for this first planning cycle. The San Antonio RFPG expressed a desire to identify and group small individual projects to create larger flood mitigation actions within single jurisdictions where allowable 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 RFP anticipated to be submitted in July 2023.

5.2 Task 5 – Recommendation of FMEs and FMSs and Associated FMPs

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 San Antonio RFP. Task 5 was essentially a continuation of Task 4B. As described above, Task 4B was an initial technical evaluation and screening of potential FMEs and potentially feasible FMSs and FMPs. Task 5 and the remainder of this chapter focus on how the San Antonio RFPG used this information to further evaluate and develop its recommendations for the inclusion of flood mitigation actions in the San Antonio RFP. This chapter summarizes and documents:

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

Significant need exists across the SAFPR to improve flood risk awareness and to develop and implement actions to reduce existing and future flood risk. The San Antonio RFPG opted to take an inclusive approach to the evaluation and recommendation process. If an FMP, FME, or FMS met the TWDB requirements and was aligned with the SAFPR flood mitigation and floodplain management goals, the RFPG chose to show deference to the local communities/sponsors and leaned towards including it in the RFP.

5.2.1 Detailed Evaluation Requirements per Rules and Guidelines

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 (e.g., FMP to FME).

Figure 5-4 and Figure 5-5 expand upon the initial screening process previously described for FMPs/FMSs and FMEs, respectively. These processes were developed following the TWDB's rules and requirements that left some evaluation criteria to the RFPG's discretion. The discretionary evaluation criteria are the following:

- LOS to be provided: If a 100-year LOS is not feasible, the RFGP can recommend an FMP with a lower LOS.
- BCR for the project: TWDB recommends that proposed actions have a BCR greater than 1, but the RFPG may recommend FMPs with a BCR less than 1 with proper justification.
- Drainage Area: TWDB recommends actions with a drainage area greater than 1 square mile to encourage regional actions and cooperation, but the RFPG may recommend FMPs with a smaller drainage area and justification.

Due to some projects being physically and financially constrained, the RFPG decided it did not want to exclude good flood reduction projects based on the LOS or BCR. Similarly, because local jurisdictions identified many of the known flood mitigation projects, the drainage areas are often less than 1 square mile, and the San Antonio RFPG did not want to exclude those from the RFP.

Figure 5-4. FMP and FMS Final Screening and Recommendation Process

1. Goals	• Confirm FMPs/FMSs support an RFPG goal
2. Unfeasible	• Remove FMPs/FMSs deemed not to be feasible; for example, focuses on addressing response and recovery rather than mitigation
3. Contact Sponsors	• Determine if the FMP/FMS is still viable and/or has not been completed or funded • Request additional data • Remove FMPs/FMSs that have been completed or sponsor is not interested
4. Initial Analysis	• Populate flood risk indicators • Calculate reduction in flood risk for FMPs • Update or calculate costs
5. Full Analysis	• Verify no negative impacts • Conduct BCA (existing or can be determined)
6. Unfeasible	• Remove FMPs/FMSs deemed not to be feasible • Causes negative impacts, no quantifiable flood reduction benefits, duplicate benefits
7. Reassign	• Determine if there are any FMPs that need to be reassigned as an FME
8. Evaluate	• Quantifiable results to identify FMPs/FMSs with the most complete information and/or result in the greatest benefits • Identify FMPs/FMSs located in areas of greatest need (use Task 4A results)
9. Recommend	• Final FMP/FMS recommendations

Figure 5-5. FME Final Screening and Recommendation Process

1. Goals	• Confirm FMEs support a specific RFPG goal
2. Contact Sponsors	• Verify if study has been completed • Verify interest in potential FME • Request additional data to refine FME areas • Remove FMEs that have been completed or sponsor is not interested
3. Analysis	• Refine FME areas as needed • Populate flood risk indicators • Calculate cost for FME
4. Evaluate	• Evaluate if quantifiable • Identify FMEs that have potential to develop into FMPs for the next planning cycle • Identify FMEs that could be promoted to FMP • Identify FMEs located in areas of greatest need (use Task 4A results)
5. Goals	• Develop additional FMEs as needed to cover missing short-term goals • Identify sponsors for additional FMEs and obtain their commitment
6. Recommend	• Final FME recommendations

5.2.1.1 Costs and Benefit-Cost Ratio for Flood Mitigation Actions

FME Planning Level Cost Estimates

Planning level cost estimates are based on sponsor-provided information and verification/validation of those costs in accordance with the TWDB's *Technical Guidelines*. The process to produce cost estimates where none exist for each FME type is summarized below. Cost estimates presented are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. Sponsors were provided the opportunity to confirm or alter the costs through the Flood Infrastructure Financing survey discussed in Chapter 9 Flood Infrastructure Financing Analysis.

Watershed Planning – Floodplain Modeling and Mapping: A unit cost per square mile was developed to generate estimates based on the size of the study area. Based on previous FEMA FIF projects, Regional or Watershed Planning Studies costs are estimated to be $2,500/square mile.

Watershed Planning – Drainage Master Plans: Depending on the size of the desired drainage master plan, a unit cost per square mile was used for the estimates. After a comparative analysis of previously completed city- and county-wide studies, unit costs were separated into three categories to capture the appropriate funds necessary to accomplish each. Table 5-3 shows the estimated ranges.

Table 5-3. Drainage Master Plan Cost Estimate Ranges

Area (square miles)	Cost Estimate (per square mile)
0–10	$40,000
10–25	$30,000
>25	$20,000

Engineering Project Planning – These studies consider two components: the evaluation of a proposed project to determine whether implementation would be feasible (conceptual design); and an initial engineering assessment, including alternative analysis. Based on an analysis of pasts projects, a range of estimated costs were estimated based on size. Table 5-4 is the criteria set for FMEs in this category.

Table 5-4. Preliminary Engineering/Site Cost Estimate Ranges

Site Size	Cost Estimate (per site)
Small	$50,000
Medium	$100,000
Large/Bridge	$150,000

Estimated Capital Cost of FMPs and FMSs

Cost estimates for each FMP and FMS 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, and to include applicable non-recurring and recurring project costs as listed on Table 22 of the TWDB's *Technical Guidance*. The cost estimates listed in the TWDB-required Table 13 Potentially Feasible Flood Mitigation Projects Identified by RFPG and Table 14 Potentially Feasible Flood Management Strategies Identified by RFPG, in Appendix A, are expressed in September 2020 dollars.

BCRs for FMPs

BCA is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The result is a BCR, which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. 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[42]. However, a BCR greater than 1.0 is not a requirement for inclusion in the RFP. 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 was used to create an FMP, the previously calculated BCR value was used for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was used in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values.

5.2.1.2 Willing Sponsors for FMEs, FMPs, and FMSs

Initial efforts to contact potential sponsors consisted of sending surveys to communities. These surveys included providing a list of 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 telephone calls to inform communities of the survey and its purpose. To supplement this outreach effort, the technical consultant leveraged existing relationships to contact communities in order to increase community participation and gather additional input.

While these efforts furthered the goal of receiving community feedback on what FMEs, FMPs, and FMSs these communities wanted to pursue, not all communities were able to be reached; accordingly, the San Antonio RFPG decided that an affirmative willingness to sponsor a given action would not be a prerequisite for inclusion in the San Antonio RFP. Therefore, all potential FMEs, FMPs, and FMSs were considered for inclusion in the RFP unless an

[42] https://www.fema.gov/grants/tools/benefit-cost-analysis

entity had specifically declined to be listed as a sponsor and no other appropriate potential sponsor was identified. This approach was adopted because:

- It provides a conservative estimate of the flood mitigation need within the region.
- 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 RFP. This effort is detailed in Chapter 9 Flood Infrastructure Financing Analysis.

5.2.1.3 Residual, Post-Project, and Future Risks of FMPs

The implementation of recommended FMPs is expected to reduce current and future levels of flood risk within the SAFPR. 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. In general, residual and future risks for FMPs could be characterized as follows:

- Flood events exceeding the LOS for which infrastructure is designed
- Potential failure or overtopping of dams and levees
- Lack of routine maintenance to maintain, repair, or replace its design capacity
- Policy changes that adversely affect budgets, prior plans, assets, and design or floodplain management standards
- Unpredictable human behavior; people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons

5.2.1.4 Insurmountable Constraints of FMPs

Potential project implementation issues include conflicts pertaining to ROWs, permitting, acquisitions, and utility or transportation relocations, among other issues that might be encountered before an FMP is able to be fully implemented. Such issues are an inherent part of flood mitigation projects, so they do not exclude actions from being considered for the San Antonio RFP.

Because a ROW is a public use on private land, it can create issues when securing access to projects for construction and maintenance. The acquisition of ROW, or other property and utility relocation located near or on property 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 and initiate the permitting process as early as practicable during final design. This will minimize significant design changes and delays in project implementation.

The terms “buyout” and “acquisition” are often used 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 most often involves the purchase of property in a floodplain to reduce repetitive flood damage. Voluntary buyout programs are a specific subset of property acquisitions in which private land is purchased, existing structures are 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 could also include other governmental agencies and program requirements. The process can also be financially burdensome and lengthy.

Utility relocations may include water and wastewater lines, existing storm drain systems, telecommunication infrastructure, 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, including necessary temporary utilities; acquiring necessary ROW; and taking any necessary safety and protective measures. Utility relocations can take significant lead time to accomplish and can be a significant portion of the total project implementation cost.

5.2.2 Recommendations Evaluation Summary of Screening Results

5.2.2.1 Overview Process

Technical Committee Formation

The San Antonio RFPG created a Technical Committee tasked with establishing a selection methodology, implementing the evaluation and selection process, and reporting its findings and recommendations back to the San Antonio RFPG for formal approval. The methodology included a screening of all potential flood mitigation actions based on the general process described in Section 5.1.1 Process to Identify FMEs, FMPs, and FMSs and any other additional considerations established by the Technical Committee.

On January 13, 2022, the Technical Committee reviewed, discussed, and approved the process and timeline for reviewing FMEs, FMSs, and FMPs as well as making recommendations to the San Antonio RFPG. The Technical Committee met over a series of meetings in 2022 to further discuss recommendations. Meetings occurred on:

- January 13, 2022
- February 10, 2022
- March 24, 2022
- April 21, 2022
- May 16, 2022
- June 23, 2022
- July 19, 2022

Technical Committee Review and Approval of Recommendations

Initial meetings of the Technical Committee focused on completion of the initial screening process to identify potentially feasible FMPs, FMEs, and FMSs. This included the discussion of how the actions were being categorized, limitations of the available data, and confirmation of how the discretionary evaluation criteria was applied to each applicable action.

On March 24, 2022, the Technical Committee established a process for reviewing, discussing, and making their recommendations. In short, the committee agreed that future batches would be reviewed prior to the meeting at which they were to be considered, and the actions would be brought forward in groups, or batches, for consideration in a manner similar to a consent agenda. This format allowed each committee member to provide comments on or to discuss any of the individual actions, and allowed the committee to make recommendations to the San Antonio RFPG for each batch. At the June 23, 2022, Technical Committee meeting, the committee reviewed and forwarded recommendations for 163 FMEs, 28 FMPs, and 19 FMSs to the full San Antonio RFPG for approval.

RFPG Review and Approval of Recommendations

On June 27, 2022, the San Antonio RFPG voted to recommend FMEs, FMPs, and FMSs as presented.

5.2.2.2 Flood Mitigation Projects

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 Floodplain Management Practices and Flood Protection Goals. The goals associated with each FMP are included in TWDB-required Table 11 Regional Flood Plan Flood Mitigation and Floodplain Management Goals in Appendix A. 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), and FMPs do not have any anticipated impacts to water supply or water availability allocations as established in the most recent adopted State Water Plan.

No Negative Impacts Determination: Each identified FMP must demonstrate that no negative impacts would occur on a neighboring area due to its implementation. No negative impact means that a project will not increase flood risk of surrounding properties. Using best available data, the increase in flood risk must be measured by the 1 percent annual chance event water surface elevation and peak discharge. It is recommended that no rise in water surface elevation or discharge should be permissible (without acquiring the effected land or obtaining permission from the affected parties), and that the analysis extent must be sufficient to prove proposed project conditions are equal to or less than the existing conditions.

For the purposes of flood planning effort, a determination of no negative impact can be established if a project does not increase inundation of infrastructure, such as residential and commercial buildings and structures. Additionally, the following requirements, per TWDB's *Technical Guidelines*, should be met to establish no negative impact, as applicable:

- Does not increase inundation in areas beyond the public ROW, project property, or easement
- Does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity
- A maximum increase of one-dimensional Water Surface Elevation must round to 0.0 feet (less than 0.05 feet) measured along the hydraulic cross section
- A maximum increase of two-dimensional Water Surface Elevation must round to 0.3 feet (less than 0.35 feet) measured at each computation cell
- Maximum increase in hydrologic peak discharge must be less than 0.5 percent measured at computation nodes (sub-basins, junctions,

reaches, reservoirs, etc.); this discharge restriction does not apply to a two-dimensional overland analysis

If negative impacts are identified, mitigation measures may be used to alleviate such impacts. Projects with design level mitigation measures already identified may be included in the RFP 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 the above requirements based on engineer’s professional judgment and analysis provided any 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 percent annual chance event (100-year flood) was performed for each potentially feasible FMP based on their reported H&H model results. Study results for floodplain boundary extents, resulting water surface elevations, and peak discharge values were reviewed to verify potential FMPs conform to the no negative impact requirements. The same studies were used to identify reported flood risk reduction.

A general description of the scope of work and a summary of the expected impacts of the proposed improvements for each potentially feasible FMP is provided in Table 5-5, at the end of this section. Figure 5-6 shows the geographic distribution of recommended FMPs.

LOS Evaluation and BCA: All the recommended FMPs provide some level of flood reduction benefits, which are included based on 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 used for the FMP analysis. For any FMP that did not already have a calculated BCR value, the TWDB BCA Input Spreadsheet was used in conjunction with the FEMA BCA Toolkit 6.0 to generate BCR values.

Most LWC improvements did not include improvements that removed structures from the 1 percent annual chance (100-year) floodplain. For these types of projects, the TWDB BCR spreadsheet does not require structure data to complete a BCR. To calculate a BCR for LWCs, traffic counts, depth of flooding over the roadway, duration of flooding, and the length of detour were needed. This data was obtained from the entities or extracted from the H&H models to incorporate into the TWDB BCA Input spreadsheet.

As stated previously, a BCR greater than 1.0 is not a requirement for inclusion in the San Antonio RFP. The RFPG can recommend a project with a lower BCR with appropriate justification. The RFPG considered the following projects in Table 5-5 (shown in Figure 5-6) and determined that recommending these FMPs is consistent with the overarching goal of the San Antonio RFP “to protect against the loss of life and property.”

Figure 5-6. Geographical Distribution of Recommended FMPs

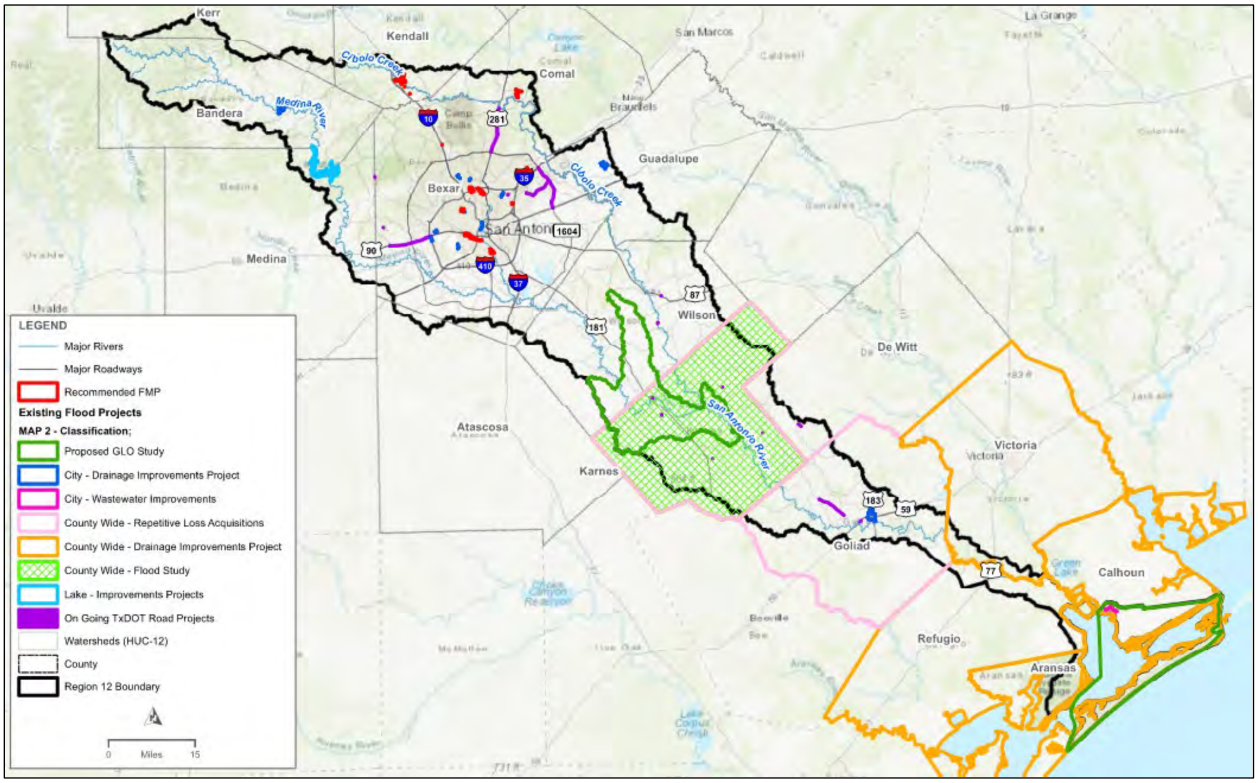


Table 5-5. Summary of FMPs Recommended by the RFPG

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Lewis Creek Alternative 1 Phase 1 & 2	Channel improvement, roadway improvement	City of Bulverde	0.11	City of Bulverde Mapping Improvements Lewis Creek Watershed Phase 2 Alternatives Analysis Drainage Report

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Lewis Creek Tributary 2 Alternative 1 & 2	Channel widening/ lowering, culvert improvement, roadway improvement	City of Bulverde	0.19	City of Bulverde Mapping Improvements Lewis Creek Watershed Phase 2 Alternatives Analysis Drainage Report
Lewis Creek Main	High water detection system, including warning signs, with flashers and automatic arm barricade	City of Bulverde	N/A[a]	City of Bulverde Mapping Improvements Lewis Creek Watershed Phase 2 Alternatives Analysis Drainage Report
Project 1A – Adler Road at Currey Creek and Unnamed Tributary A	Improve LWCs along Adler Road, channel regrading, curbs, sidewalks, street reconstruction	City of Boerne	2.5	Boerne Master Drainage Plan 2022
Project 2 – Unnamed Tributary A Regional Detention Facility	Inline detention facility with culvert improvements	City of Boerne	0.54	Boerne Master Drainage Plan 2022
Project 3 – Currey Creek Regional Detention Facility	Inline detention facility with additional storm drain improvements	City of Boerne	2.79	Boerne Master Drainage Plan 2022
Project 4 – School Street at Cibolo and Frederick Creeks	Elevated bridge, channel grading street reconstruction, curb, sidewalks, and driveways	City of Boerne	0.4	Boerne Master Drainage Plan 2022

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Project 5D – Old San Antonio Street at Menger Creek	Elevated bridge, channel grading, street reconstruction, curb, sidewalks, and driveways	City of Boerne	0.5	Boerne Master Drainage Plan 2022
Project 6 – Johns Road Near Cibolo Crossing Subdivision	Storm drain, channel, increase capacity of existing detention	City of Boerne	0.86	Boerne Master Drainage Plan 2022
Project 7 – Schweppe and Hickman Streets	Storm drain and channel improvements	City of Boerne	0.82	Boerne Master Drainage Plan 2022
Project 8 – Johns and Lohmann Streets	Storm drain and channel improvements	City of Boerne	5.46	Boerne Master Drainage Plan 2022
Project 9 – Unnamed Tributary A – Subdivision Flood Protection and Mobility Project	LWC and channel improvements	City of Boerne	0.48	Boerne Master Drainage Plan 2022
Project 10 – East Blanco Road at Unnamed Tributary A	Improve LWCs along Blanco Road, channel regrading, curbs, sidewalks, street reconstruction	City of Boerne	4.1	Boerne Master Drainage Plan 2022
Project 11 – River Road at Unnamed Tributary A	Improve LWCs along River Road, channel regrading, curbs, sidewalks, street reconstruction	City of Boerne	3.1	Boerne Master Drainage Plan 2022

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Project 12 – Plant Channel Improvement	Channel improvements	City of Boerne	0.4	Boerne Master Drainage Plan 2022
Project 13 – Herff and Esser Road Improvements at Currey and Cibolo Creeks	Bridge at Currey Creek and Esser Road, Bridge at Cibolo Creek and River Road, Channel grading, roadway reconstruction	City of Boerne	1.7	Boerne Master Drainage Plan 2022
Project 14 – East Boerne Regional LID	Proposed inline extended detention facility that provides water quality benefits to the urbanized tributary of Cibolo Creek and properties downstream of Scenic Loop Road	City of Boerne	0.6	Boerne Master Drainage Plan 2022
Project 15 – North Currey Channel Improvements	Channel regrading, curbs, sidewalks, street reconstruction; project is dependent on Projects 1A, 3, 12, and 13 being completed and Project 16 being implemented concurrently with this project to achieve the project benefits	City of Boerne	1.33	Boerne Master Drainage Plan 2022

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Project 16 – South Currey Creek Channel Improvements	LWC and channel improvements; project is dependent on Projects 1A, 3, 12, and 13 being completed and Project 15 being implemented concurrently with this project to achieve the project benefits	City of Boerne	1.33	Boerne Master Drainage Plan 2022
29010 Tivoli Way	Use existing stormwater infrastructure by regrading the roadway to slope toward existing inlets and open channels on the northern and southern sides of Windermere Drive on the eastern side of Fair Oaks Parkway; new curb installed along the western side of Fair Oaks Parkway	City of Fair Oaks Ranch	6.92	City of Fair Oaks Ranch Master Drainage Plan
Seeling Drainage Improvements	Install box culverts, grass lined channel construction	CoSA	0.62	Seeling Channel Phase IV Project Preliminary Engineering Report

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Rock Creek – Alternative 1	Reduce the height of the drop structure at the Olmos Creek outfall; bridge replacements will be required for both the railroad crossing and West Avenue	CoSA	0.1	Rock Creek HEC-RAS Model
Judson and Lookout LWC Improvement	Upgrade the LWCs and connecting/ downstream channel	CoSA	0.9	Lookout Judson LWC Improvement HEC-RAS Model
Symphony Lane Voluntary Property Acquisition	Purchase 32 properties located west of the San Antonio River Symphony Reach, and along Pyron Avenue and Symphony Lane	CoSA	0.4	Symphony Lane Project Narrative
Holbrook Road Improvements	Offset a portion of the roadway south of Woodburn Road	CoSA	0.01	Holbrook Road Preliminary Engineering Report
Barbara Drive Drainage Improvements	Upsize the boxes underneath Dellwood and Oblate Drives; improvements will also include reconstruction of the street and curb for the portion of Dellwood and Oblate Drives within the project boundary	CoSA	0.04	Barbara Drive Preliminary Engineering Report

Project Title	Project Description	Community	BCA	No Negative Impacts Designation
Thames Drainage Channel Replacements – Alternative 1	Replace the existing culverts at Blanco Road, San Pedro Avenue, Thames Drive, Private Drive, and Dorsets	CoSA	0.03	Trib A to Airport Trib HEC-RAS Model
Shady Lane Dr. Voluntary Property Acquisition	This project consist primarily of property buy-outs within the floodplain to mitigate structural flooding to those properties	CoSA	0.2	Shady Lane Project Summary
Concepcion Creek Improvements Project	Phase 1: 54-acre detention, property acquisition and 10,000 feet of storm drain systems and road reconstruction Phase 2: 1.36 miles of Concepcion Creek channel improvements Phase 3: 2,300 feet of (3)10- by 8-foot Multiple Box Culvert systems	CoSA	0.1	Concepcion Creek Improvements Drainage Report

[a] There is not a process to quantify the benefits for a high-water detection system. Flood warning systems are one of the listed types of potential FMPs described in Section 3.2 of TWDB's *Technical Guidelines*.

5.2.2.3 Flood Management Evaluation

In considering potential FMEs for recommendation, the San Antonio RFPG sought to determine which FMEs would be most likely to result in identification of potentially feasible FMSs and FMPs in future planning cycles. Recommended FMEs were also required to demonstrate alignment with at least one regional floodplain management and flood mitigation goal developed under Task 3. Finally, each recommended FME should identify and investigate at least one solution to mitigate the 1 percent annual chance flood. It is the intent that all FMEs with an H&H modeling component will evaluate multiple storm events, including the 1 percent annual chance flood. The potential solutions and LOS that will be identified are unknown; however, it is expected that analyses will evaluate potential negative impacts and potential flood risk reduction for the 1 percent annual chance flood to help inform recommended alternatives and to define potentially feasible FMPs under this planning framework. Based on these TWDB requirements, the San Antonio RFPG identified two main reasons for recommending FMEs.

The first subset of recommended FMEs would result in increased flood risk modeling and mapping coverage across the SAFPR as they are implemented. These types of FMEs have two major implications for the identification of potentially feasible FMSs and FMPs. First, a current and comprehensive understanding of flood risk across the basin is necessary to identify high-risk areas for evaluation and development of flood risk reduction alternatives. Secondly, FMPs, and in some cases FMSs, require a demonstrated potential reduction in flood risk to be recommended in the San Antonio RFP. For this metric to be assessed, H&H modeling must be available to compare existing and post-project flood risk.

The second subset of recommended FMEs were project planning type FMEs. These FMEs are generally studies or preliminary designs to address a specific, known flood need. These actions include LWC improvements, storm drain or channel projects, city- or county-wide studies, and evaluations of possible buyouts or elevation. While in many cases a specific location is known, the actions currently lack some or all the detailed technical data necessary for evaluation and recommendation as an FMP. An example would be an existing study that identifies potential drainage construction projects but does not provide a full negative impacts analysis. Completing these components as part of an FME will result in a potentially feasible FMP for consideration during future flood planning efforts.

Sponsor input was a major driver for choosing not to recommend FMEs. FMEs that were indicated by the sponsor as being in progress, completed, or lacking interest to pursue were not recommended. Additionally, some FMEs located near one another were combined into a single FME for recommendation, a process the San Antonio RFPG plans to continue as it develops the amended plan (anticipated to be completed July 2023).

Description and Summary of Recommended FMEs

A total of 163 potential FMEs were identified and evaluated by the San Antonio RFPG. Of these, all were recommended, representing a combined total of $794,400,000 of FME need across the SAFPR. The number and types of studies recommended by the San Antonio RFPG are summarized in Table 5-6 and shown in Figure 5-7. The full list of FMEs and supporting technical data is included in the TWDB-required Table 12 Potential Flood Management Evaluations Identified by RFPG in Appendix A, and Map 16 Extent of Potential Flood Management Evaluations and Existing Mapping Needs in Appendix B. Recommended FMEs are presented in the TWDB-required Table 15 Flood Management Evaluations Recommended by RFPG in Appendix A, and Map 19 Recommended Flood Management Evaluations in Appendix B. Overall, the recommended FMEs represent more than 28,600 square miles of contributing drainage area and provide comprehensive coverage of the SAFPR.

Figure 5-7. Geographical Distribution of Recommended FMEs

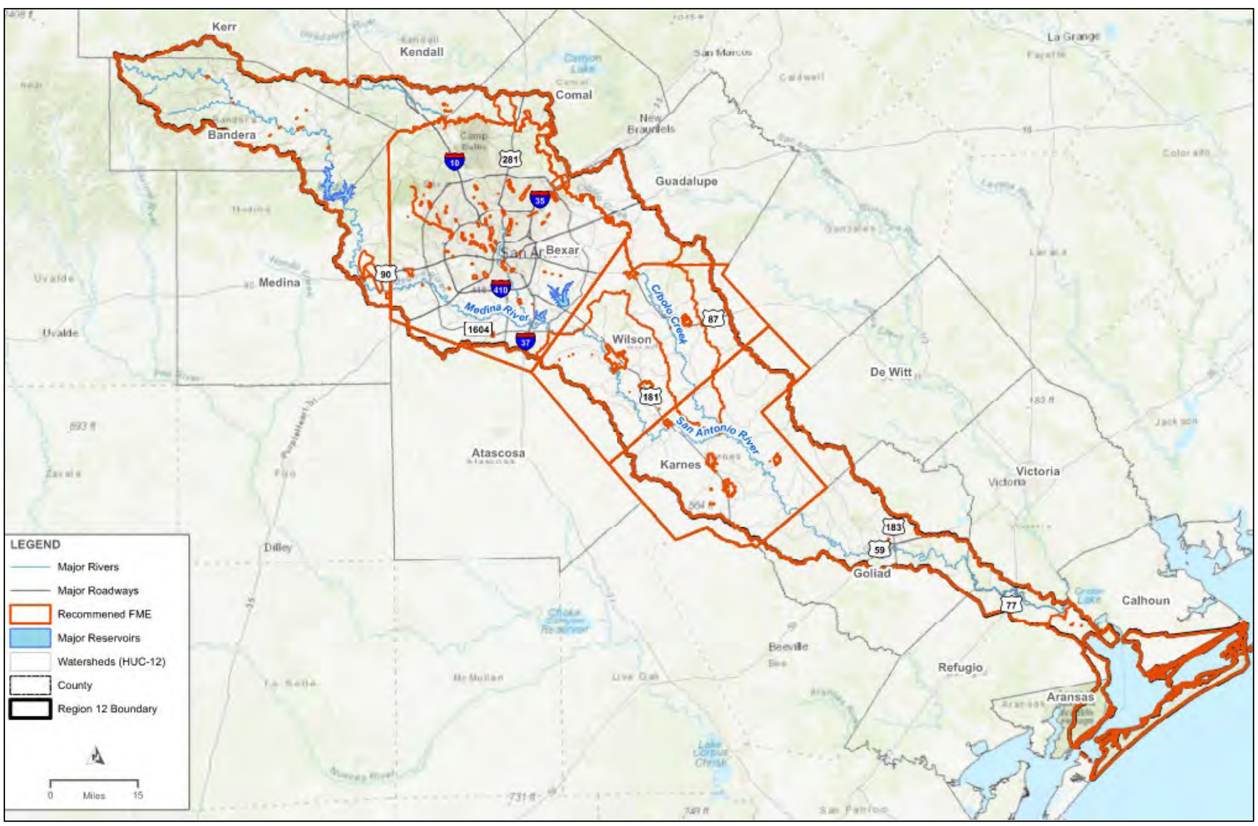


Table 5-6. Summary of FMEs Recommended by the RFPG

Type	Total
Project Planning	141
Watershed Planning	20
Flood Readiness and Resilience	2

5.2.2.4 Flood Management Strategy

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

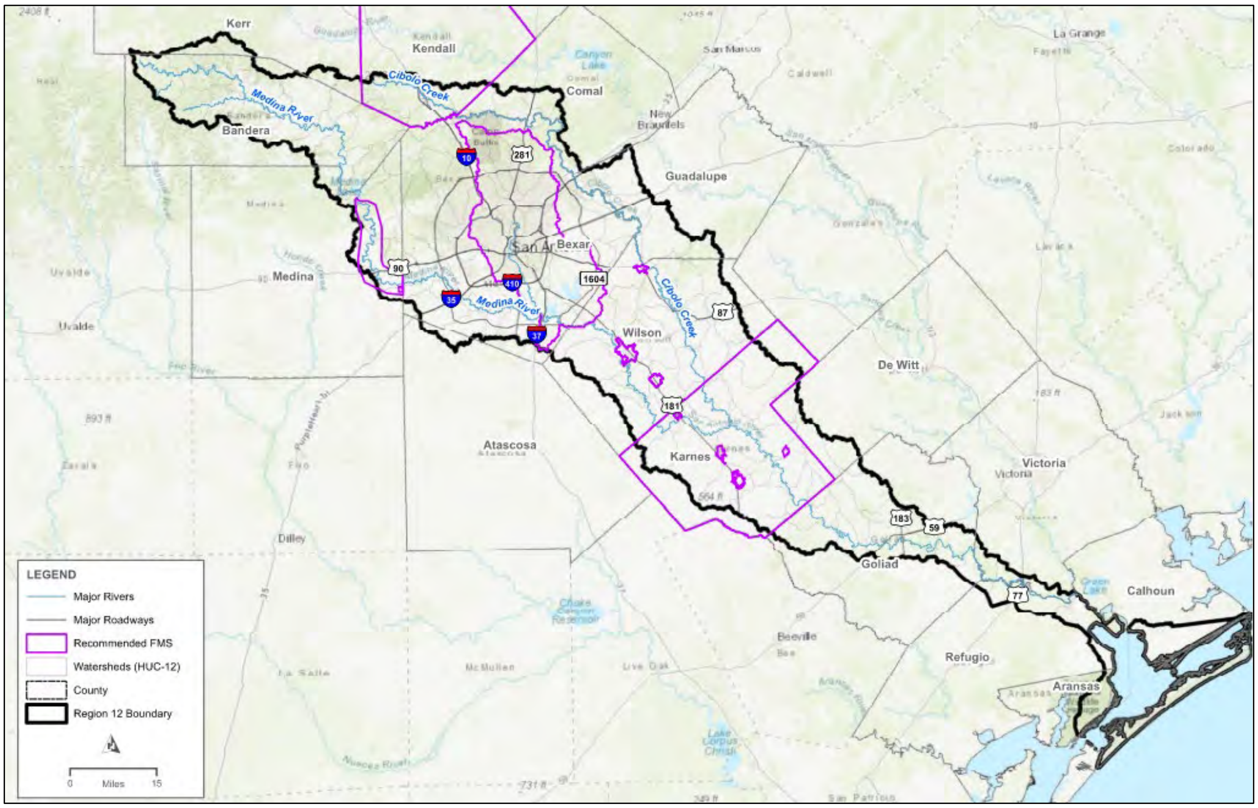
- The primary purpose of the FMS is mitigation (response and recovery projects are not eligible for inclusion in the RFP).
- The FMS supports at least one regional floodplain management and flood mitigation goal.
- Implementation of the FMS results in:
    - Quantifiable flood risk reduction benefits
    - No negative impacts to adjacent or downstream properties (a No Negative Impact certification is required)
    - No negative impacts to an entity's water supply
    - No overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan

Additionally, the TWDB recommends that, at a minimum, FMSs should mitigate flood events associated with the 1 percent annual chance flood (100-year flood) and must demonstrate no negative flood impacts would occur to a neighboring area due to its implementation. No structural FMSs were identified for this region; therefore, flood mitigation and no adverse impacts from flooding or to the water supply are anticipated. A total of 19 potential FMSs were identified and evaluated by the San Antonio RFPG. Of these, all were recommended, representing a combined total of $999,000 of FMS needs across the SAFPR. The number, types, and distribution of studies recommended by the San Antonio RFPG are summarized in Table 5-7 and shown in Figure 5-8.

Table 5-7. Summary of FMSs Recommended by the RFPG

Type	Total
Education and Outreach	11
Regulatory and Guidance	7
Flood Measurement and Warning	1

Figure 5-8. Geographical Distribution of Recommended FMSs



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6

Impact and Contribution of the Regional Flood Plan

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6 Impact and Contribution of the San Antonio Regional Flood Plan

The objective of this task is to assess and summarize the impacts and contributions, in the aggregate, associated with implementation of this San Antonio RFP. In previous chapters, existing flood hazard and exposure conditions were assessed based on the 1 and 0.2 percent annual chance flood events. Additionally, an inventory of existing infrastructure and natural features was compiled for use as a baseline. Flood risk reduction or mitigation needs were identified, leading to adoption by the San Antonio RFPG of recommendations, presented in Chapter 5 Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects, of FMPs, FMEs, and FMSs. This chapter aims to compare those identified risks with the potential estimated positive and negative benefits of implementing the San Antonio RFP. Additionally, in the second part of this chapter, potential contributions to and impacts on water supply development and the State Water Plan are assessed.

6.1 Impacts of San Antonio Regional Flood Plan

Implementation of the San Antonio RFP can be expected to provide numerous benefits to the areas served by local sponsors and will not negatively affect neighboring areas within or outside the SAFPR. More specifically, the implementation of recommended flood mitigation actions are expected to reduce the number and/or spatial extent of areas with high flood hazard and exposure. For example, implementation of recommended FMPs are expected to remove an estimated 3,582 at-risk structures from flood-prone areas. Note, however, that the benefits will vary greatly across the SAFPR due to the highly variable and local nature of most flood hazard areas as well as with the types of studies, strategies, and projects that are implemented. Further discussion of the potential benefits of implementing this San Antonio RFP is provided below.

6.1.1 Floodplain Management and Modeling

Information was compiled during the baseline development of the San Antonio RFP. As part of the compilation, data gaps were identified within the SAFPR. The information and data gaps were found in areas of low to high flood risks that lack floodplain management practices, adequate enforcement of floodplain standards and regulations, detailed H&H models, and flood inundation mapping. Combined, these areas cover approximately

1,083 square miles, or 25 percent of the SAFPR, and include an estimated population of 121,672. The lack of information hinders the ability of local entities to effectively manage activities in floodplains, adequately assess flood risks and exposure, evaluate potentially feasible flood risk reduction strategies and solutions, and select a preferred option(s) for implementation. Overall, this likely results in population and property exposed unnecessarily to flood risk. As reported in Chapter 5 Identification and Evaluation of Potential Flood Management Evaluations and Potentially Feasible Flood Management Strategies and Flood Mitigation Projects, 163 FMEs are recommended. When implemented, these FMEs will close data and information gaps and set in motion the process of developing and implementing flood risk reduction solutions to ultimately reduce exposure to flood hazards. Twenty recommended FMEs are specifically focused on watershed modeling and mapping. A total of 141 FMEs include modeling and mapping to identify flood risk, flood mitigation alternatives analysis and feasibility studies, and preliminary engineering studies, among others. The FMEs that are being proposed will cover the whole basin. One FME, in particular, will target the lower basin that has the majority of the data gap previously described. The SARA is proposing a lower basin predictive flood model that will reduce the data gap by 100 percent.

6.1.2 Reduction in Flood Impacted Areas

Existing flood hazard areas were identified and quantified for the 1 percent annual chance flood events. Table 6-1 shows the existing versus proposed flood impacted area in square miles for the recommended FMPs. By implementing the recommended FMPs, these flooded project areas will be reduced by approximately 94 percent, or a reduction in approximately 3.6 square mile, removing many structures, population, LWC, and roads.

Table 6-1. Reduction in Existing Flood-Impacted Areas

Annual Chance Event	Project Area in Floodplain (square miles)	Reduction Due to the FMP (square miles)	Change in Area (square miles)	Change in Area
1.0%	3.8	0.2	3.6	94%

6.2 Benefits to Population and Structures at Risk

With the number of square miles affected by flooding being reduced with the implementation of the FMPs in this RFP, the ultimate beneficiaries are populations residing in those areas as well as public and private assets (e.g., structures, roads, utilities). Since the land area being affected will be reduced, the subsequent population benefitting from the San Antonio RFP within the SAFPR is estimated to be 18,957. The socioeconomic benefits to the population will vary based on location. Additional descriptions of those benefits will be provided in Tables 23 through 40 Project Details Scoring Summary Table in the digital submittal. The estimated population to be removed from the floodplain if these FMPs are implemented is shown in Table 6-2. While the number of potentially avoidable injuries and deaths associated with implementation of these FMPs is not quantifiable, the expected benefits can be substantial. The benefits will be generated by changing flood characteristics to reduce flood risk to structures, roads, and property (structural flood mitigation projects) and changing the way people interact with flood risk (nonstructural flood mitigation projects and strategies) through regulatory improvements, educating people about flood risks, and implementing flood early warning and evacuation measures.

Table 6-2. Population Removed from the Floodplain

Annual Chance Risk Flood	Existing Population Impacted	Estimated Population Removed after Implementation	Decrease in Population Impacted
1.0%	18,957	7,494	60%

Implementing the San Antonio RFP provides additional benefit to the removal of existing structures located within flood hazard areas. Removing structures from flood danger benefits communities who rely on those structures for residences, work, industry, and critical facilities. These include structures that are inundated for short periods and those inundated for extended periods along the flatter topographical areas within the SAFPR. Table 6-3 shows the estimated reduction in the number of structures that will be removed by implementing the RFP.

Table 6-3. Structures Removed from the Floodplain

Annual Chance Risk Flood	Existing Structures Impacted	Estimated Structures Removed after Implementation	Decrease in Structures Impacted
1.0%	6,319	3,582	43%

Critical facilities identified generally as municipal utilities and buildings, hospitals and care facilities, and schools are of special importance and will benefit from the San Antonio RFP. No critical facilities are being removed with the implementation of the San Antonio RFP. However, multiple studies are being recommended for the San Antonio RFP that will assess floodproofing or removing critical infrastructure from the floodplain.

6.3 Low Water Crossings and Impacted Roadways

Implementing the recommended FMPs across the SAFPR will have a considerable impact on the number of existing LWCs. As projects are implemented over time, the number of LWCs will be reduced, saving life and property. The estimated number of LWCs being removed due to implementing the San Antonio RFP is shown in Table 6-4.

Table 6-4. LWCs Removed from the Floodplain

Annual Chance Risk Flood	Existing LWCs	LWCs Removed After Implementation	Decrease in LWCs
1.0%	498	22	4%

In addition to the number of LWCs being removed, flooded roadways also benefit from the San Antonio RFP being implemented. Roadways are often closed due to flooding, posing risks to life, property, and transportation in general. Table 6-5 shows the benefit to transportation infrastructure by reducing the amount of time a roadway is closed or removing it from flooding altogether.

Table 6-5. Roads Removed from Flood Risks

Annual Chance Risk Flood	Existing Roads in Floodplain (Miles)	Roadways Removed from Floodplain After Implementation	Decrease in Roads in Floodplain
1.0%	753	13	2%

6.4 Socioeconomic and Recreational Impacts

6.4.1 Socioeconomic

Implementing the San Antonio RFP, as shown in the previous sections, provides a benefit to the SAFPR. As part of this effort, socioeconomic impacts were considered to evenly distribute flood risk reduction benefits among all groups across the SAFPR as much as practical. The SAFPR has a diverse population with wide-ranging economic levels, requiring extra attention to improve conditions for everyone. Disadvantaged socioeconomic populations have limited access to resources, hindering response and recovery from flood events. Processes in developing the appropriate FMSs, FMPs, and FMEs included reducing impacts to flood events and improving the lives of all socioeconomic groups, ensuring the most disadvantaged were well represented. This can be shown in the locations of FMSs, FMPs, and FMEs identified throughout the SAFPR.

6.4.2 Recreation Impacts

Many opportunities to benefit recreation could occur through implementation of the San Antonio RFP. Many parks located along water fronts are designed to be flooded periodically with infrastructure minimally impacted. Floodplains and wetlands can support recreation and tourism. Although not specifically identified in this RFP, as FMSs and FMPs are implemented, existing floodplains are reduced, and structures are removed from the floodplain, new opportunities become available for local sponsors. These areas are often used in cities throughout the state for hiking and biking trails. The San Antonio RFPG will encourage secondary benefits such as recreational opportunities. While the San Antonio RFP will provide opportunities, it will not negatively affect existing recreation activities throughout the SAFPR.

6.5 Overall Impacts

Implementing the San Antonio RFP provides numerous benefits associated with the primary purposes of FMSs, FMPs, and FMEs. The benefits, although not readily quantifiable, will protect health and safety within the SAFPR. This will be done by reducing flooding frequency and severity, providing advanced flood warning systems, removing roads and LWCs from flooding, and providing officials the tools to properly manage flood-prone areas.

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

RFPs must include a region-wide assessment of the potential contributions and impacts that implementation of the RFP can be expected to have on water supplies and the State Water Plan. As part of this analysis, each FMS and FMP was reviewed to determine whether potential impacts to existing water supplies or the availability of water supplies could occur. Impacts include potential contributions to, as well as reductions in, water supply and availability. These impacts, as determined, would be placed in one of the following categories:

- Directly affects available water supply yield during a drought-of-record, which requires both availability and directly connecting water supply to specific water user group(s)
- Directly benefits (i.e., increases) water availability
- Indirectly benefits water availability
- Has no anticipated impact on water supply

A coordinated effort with representatives from multiple regional water planning groups occurred to identify water management strategies that could be affected. Those regional water planning groups include Region J (Plateau), Region L (South Central Texas), and Region N (Coastal Bend). The San Antonio RFPG has not identified any negative impacts to the State Water Plan. However, projects in Table 6-6 have been identified that could potentially benefit water supply.

It was determined that three FMPs have the potential to add to water supply availability. These FMPs are located over the Edward Aquifer Contributing or Recharge Zone. These FMPs would potentially contribute to the natural recharge. Table 6-6 lists those three identified FMPs and their potential impact.

Table 6-6. FMS/FMP Contributions to Water Supply

Name	FMS/ FMP	Volume (acre-feet)	Water Supply	Direct Water Availability	Indirect Water Availability	No Impact
Project 2 – Unnamed Tributary A Regional Detention Facility	FMP	22.6	N/A	N/A	Natural Recharge	N/A
Project 3 – Currey Creek Regional Detention Facility	FMP	154.3	N/A	N/A	Natural Recharge	N/A
Project 14 – East Boerne Regional Low Impact Development	FMP	35.5	N/A	N/A	Natural Recharge	N/A

Notes: N/A = not applicable

7

Flood Response Information and Activities

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7 Flood Response Information and Activities

[31 TAC §361.42]

7.1 Flood Response and Recovery Activities in the SAFPR

This chapter summarizes the flood response preparations using demographic, historical, projected, and statistical data from the previous chapters and further research. The TWDB specifically stated that the San Antonio 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.

7.1.1 Types of Flooding within the SAFPR

To better understand how to respond, floods are generally categorized into five types:

- **Flash Floods:** Floods caused by heavy rainfall over a short period. The flood water can occur quickly and be very powerful, making it extremely dangerous.
- **Pluvial Floods:** Floods that happen when there is flooding independent of an overflowing body of water due to extreme rain fall. The most common example of this is when an urban drainage system is overwhelmed, and the excess water floods into the streets and onto adjacent property.
- **Riverine Floods:** Floods that occur when excess rainfall causes an overtopping of the riverbank. This overtopping then spills the water onto nearby land.
- **Urban Flooding:** Floods caused by excess runoff water in developed areas where the water does not have anywhere else to go. Urban flooding can be considered a type of pluvial flooding.
- **Coastal Floods:** Floods that occur when a coastal process such as waves, tide, storm surge, or heavy rainfall from coastal storms create a flood where the sea meets land.

The SAFPR is prone to each type of flood with frequency, depending on the part of the region where it occurs. The SAFPR is separated into four subregions:

- **Upper:** North of Loop 1604 from Culebra Road to I-35

- **Mid:** South of North Loop 1604 to south of Karnes County
- **Coastal:** From south Karnes County to the sea
- **Medina:** The Medina River and its tributaries

Geography, climate, and urbanization merge to create significant flood issues for a band of counties in North Central, Central, and South Central Texas. This is one of the most flash-flood prone regions in North America and is often referred to as "Flash Flood Alley."[43] The counties that are most affected by this phenomenon are shown in Figure 7-1, with green representing the boundaries of the SAFPR. The primary feature affecting flooding within the SAFPR is the Balcones Escarpment, a geological fault zone that traps warm weather masses moving in from the coast, resulting in heavy rainfall events that runoff quickly downhill due to terrain, increasing impervious surfaces, shallow soils, and narrow river channels. The result is deep, fast, erosive floodwaters with destructive forces that have the potential to penetrate communities downstream. Increased development and impervious surfaces can exacerbate these issues, leading to water running over the banks of rivers and overwhelming drainage systems in urban and non-urban areas.

When storms fall over the CoSA area, the runoff flows into the river system and arrives in Wilson, Karnes, or Goliad Counties several days later, providing advance notice of impending flooding. When such flood events occur, it is imperative that plans are in place to combat the effects of the flooding.

[43] SARA. The River Basin Report Card Highlights. March 18, 2022. New to San Antonio? Welcome to Flash Flood Alley. Available at https://www.sariverauthority.org/whats-new/blog/new-san-antonio-welcome-flash-flood-alley#:~:text=Within%20the%20San%20Antonio%20River%20Basin%2C%20the%20City,to%20several%20factors%2C%20including%20geography%2C%20climate%2C%20and%20urbanization.

Figure 7-1. Floodplain Alley in Texas

Source: SARA, https://www.sariverauthority.org/be-river-proud/flood-risk

7.1.2 The Nature and Types of Flood Responses

Emergency management is defined by four phases:

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

For example, when a severe rain event is projected to occur, steps are taken for preparedness: disaster preparedness plans are in place, drills and exercises are performed, memorandums of understanding are enacted, an essential supply list is created, and potential vulnerabilities are assessed. During the response phase, disaster plans are implemented, search and rescue missions may occur, and LWC signs may be erected. The recovery phase includes evaluation of flood damage, rebuilding damaged structures, and removing debris. The most important step of the four phases of emergency management occurs prior to any of these: mitigation.

Hazard mitigation is defined as any sustained action taken to reduce or eliminate the lasting risk to life and property from hazard events. It is an ongoing process that occurs before, during, and after disasters, and seeks to break the cycle of damage and restoration in hazardous areas.

Flood mitigation is the primary focus of the SAFPR planning process and the San Antonio RFPG's efforts to identify and recommend FMPSs, FMEs, FMSs. The plan may also include FMEs, FMSs, and FMPs related to flood preparedness.

Examples of mitigation actions include planning and zoning, floodplain protection, property acquisition and relocation, and public outreach. Examples of preparedness actions include installing disaster warning systems, purchasing radio communications equipment, and conducting emergency response training.

Mitigation actions from Hazard Mitigation Action Plans (HMAPs) can include the following efforts:

- Buyout/Acquisition/Elevation Projects
- Drainage Control and Maintenance
- Education and 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

7.1.3 Relevant Entities within the SAFPR

The purpose of flood risk management is to help prevent or reduce flood risk by using structural and/or nonstructural means. Responsibility for flood risk management is shared between federal, state, and local government agencies; private-sector stakeholders; dam and levee owners; and the general public. The political subdivisions within the SAFPR with flood-related authority are listed in Table 7-1 through Table 7-3.

Table 7-1. Counties with Flood-Related Authority within the SAFPR

County	County	County	County
Aransas County	Calhoun County	Guadalupe County	Medina County
Atascosa County	Comal County	Karnes County	Refugio County
Bandera County	DeWitt County	Kendall County	Victoria County
Bexar County	Goliad County	Kerr County	Wilson County

Table 7-2. Cities with Flood-Related Authority within the SAFPR

City	City	City	City
City of Alamo Heights	City of Falls City	City of La Coste	City of Santa Clara
City of Austwell	City of Floresville	City of Leon Valley	City of Schertz
City of Balcones Heights	City of Garden Ridge	City of Live Oak	City of Seadrift
City of Bandera	City of Goliad	City of Marion	City of Selma
City of Boerne	City of Grey Forest	City of New Berlin	City of Shavano Park
City of Bulverde	City of Helotes	City of New Braunfels	City of Somerset
City of Castle Hills	City of Hill Country Village	City of Nordheim	City of St. Hedwig
City of Castroville	City of Hollywood Park	City of Olmos Park	City of Stockdale

City	City	City	City
City of China Grove	City of Karnes City	City of Poth	City of Terrell Hills
City of Cibolo	City of Kenedy	City of Runge	City of Universal City
City of Converse	City of Kirby	CoSA	City of Von Ormy
City of Elmendorf	City of La Vernia	City of Sandy Oaks	City of Windcrest
City of Fair Oaks Ranch	—	—	—

Table 7-3. Other Entities with Flood-Related Authority within the SAFPR

Entity	Entity	Entity
Bandera County River Authority	East Central SUD	La Salle WCID 1-B
Guadalupe-Blanco River Authority	Ecleto Creek Watershed District	Lerin Hills MUD
Nueces River Authority	Escondido Watershed District	Medina County FWSD 1
San Antonio River Authority	Espada Development District	Medina County WCID 1
Upper Guadalupe River Authority	Falcon Point WCID 1	Northeast Medina County WCID 1
Alamo Area Council of Governments	Flying L PUD	Port O'Connor MUD
Bandera County FWSD 1	Golden Crescent Regional Planning Commission	Refugio County Drainage District 1
Bexar-Medina-Atascosa Counties WCID 1	Green Valley SUD	Refugio County Navigation District
Bexar County WCID 10	Hondo Creek Watershed Improvement District	Refugio County WCID 1
Canyon Regional Water Authority	Johnson Ranch MUD	Refugio County WCID 2
Cibolo Canyon Conservation and Improvement District 1	Kendall County WCID 2	San Antonio MUD 1

Entity	Entity	Entity
Cibolo Creek Municipal Authority	Kendall County WCID 2A	Victoria County Navigation District
Coastal Bend Council of Governments	Kendall County WCID 3	West Side Calhoun County Navigation District
Comal County WCID 6	Kendall County WCID 4	Westside 211 Special Improvement District
Crosswinds at South Lake Special Improvement District	La Salle WCID 1-A	Wilson County FWSD 1 of Wilson County Texas

Notes: FWSD = Fresh Water Supply District; MUD = Municipal Utility District; PUD = Planned Unit Development; SUD = Special Utility District; WCID = Water Control and Improvement District

Various stakeholders can play a role in flood preparation and response, including agricultural entities, cities, counties, councils of government, districts (e.g., Municipal Utility Districts, Fresh Water Supply Districts, etc.), and state and federal agencies. Following are the various contributing entities and partners, with a description of their role related to flooding. These include entities listed in Table 7-1 through Table 7-3, as well as other types of entities not previously mentioned.

Agricultural Extension agents are employed by land-grant universities and serve the citizens of Texas as experts or teachers on the topic of agriculture. Every county in Texas has an Agricultural Extension office. Agricultural Extension agents can provide valuable information about preparing for and recovering from flood events specific to agricultural entities. The SAFPR contains a significant amount of agricultural land, particularly in Wilson, Bexar, Guadalupe, and Medina Counties. This type of land use has a substantial footprint, making working closely with Agricultural Extension agents crucial to preventing losses.

Cities and **municipalities** generally take responsibility for parks and recreation services, police and fire departments, housing services, emergency medical services, municipal courts, transportation services (including public transportation), and public works (streets, sewers, snow removal, signage, etc.) in addition to serving frequently as floodplain managers. A total of 49 municipalities are within the SAFPR.

The major responsibilities of the 12 SAFPR **county governments** include providing public safety and justice, holding elections at every level of government, maintaining Texans’ most important records; building and maintaining roads, bridges, and in some cases, county airports; providing emergency management services; providing health and safety services; collecting property taxes for the county and sometimes for other taxing entities; issuing vehicle registration and transfers; and registering voters. Counties have substantial unincorporated land under their jurisdiction that is outside the land use regulations of local cities. Many counties have a floodplain management authority.

The three SAFPR **Council Of Governments (COGs)** are voluntary associations that represent member local governments, mainly cities and counties, that seek to provide cooperative planning, coordination, and technical assistance on cross-jurisdictional issues of mutual concern. COGs can serve as regional resources for flood data, flood planning, and flood management.

The mission of the **TWDB** is to lead the state's efforts in ensuring a secure water future for Texas and its citizens. The TWDB provides water and flood planning, data collection and dissemination, financial assistance, and technical assistance services to the citizens of Texas.

A **flood control district** is a special purpose district created by the Texas Legislature and governed by County Commissioners Courts. It is a government agency established to provide control of rivers, streams, their tributaries, and related structures within a certain boundary to reduce the effects of flooding. Multiple flood control districts are within the SAFPR.

Dams and levees are owned and operated by individuals, private and public organizations, soil and water districts (levees), and the government. The responsibility for maintaining a safe dam rests with the owner. Two major dam owners within the SAFPR are SARA and NRCS. They work closely with the TCEQ to meet dam safety requirements. A dam failure resulting in an uncontrolled release of water can have a devastating effect on persons and property downstream. To ensure the safety of the people and infrastructure downstream from a dam, the owners must create an emergency action plan (EAP) and submit it for approval to the TCEQ. Approximately 269 dams and an estimated 1,865,900 acres within the SAFPR are at potential risk from potential inundation of at least 1 foot in depth.[44] Dam owners should play a critical role in the flood planning process to ensure collaborative and cohesive flood planning.

[44] Alamo Area Council of Governments. Regional Mitigation Action Plan Update. April 23, 2012.

The **NWS's** mission is to provide weather, water and climate data, forecasts, warnings, and impact-based decision support services for the protection of life and property as well as enhancement of the national economy. The NWS provides flash flood indicators through watches, warnings, and emergency notices.

Flash Flood WATCH is issued when conditions look favorable for flash flooding. A watch usually encompasses several counties. This is the time the public should start thinking about their plan of action and where they would go if the water begins to rise.

Flash Flood WARNING is issued when dangerous flash flooding is happening or will happen soon. A warning usually focuses on a smaller, more specific area. A warning can be issued due to excessive heavy rain or a dam/levee failure. This is when the public must act quickly because flash floods are an imminent threat to them and their family. They may only have seconds to move to higher ground.

Flash Flood EMERGENCY is issued for the exceedingly rare situations when extremely heavy rain is leading to a severe threat to human life, and catastrophic damage from a flash flood is happening or will happen soon. Typically, emergency officials are reporting life threatening water rises, resulting in water rescues/evacuations.

Daily river forecasts are issued by **River Forecast Centers (RFCs)** of the NWS using hydrologic models based on rainfall, soil characteristics, precipitation forecasts, and several other variables. Some RFCs, especially those in mountainous regions, also provide seasonal snowpack and peak flow forecasts. A wide variety of users rely on these forecasts, including those in agriculture, hydroelectric dam operation, and water supply resources. The forecasts can provide essential information regarding river levels and conditions.

NOAA is a scientific and regulatory agency within the United States Department of Commerce that forecasts weather, monitors oceanic and atmospheric conditions, charts the seas, conducts deep sea exploration, and manages fishing and protection of marine mammals and endangered species within the United States exclusive economic zone. NOAA provides historical data that can help communities determine their future probability of flood events, and is key in the planning and mitigation process. The NWS is an agency within NOAA.

River authorities or districts in Texas are public agencies established by the state legislature, and given authority to develop and manage the waters of the state. The SAFPR has four river authorities within its region that each have the power to conserve, store, control, preserve, use, and distribute the waters of a designated geographic region for the benefit of the public.

After multiple flooding events in the late 1990s and early 2000s that resulted in $1 billion in damage, government leaders united to come up with improved flood control, stormwater management, and water quality strategies for the region. The **Bexar Regional Watershed Management (BRWN) partnership** was formed between Bexar County Commissioners, San Antonio City Council, and SARA. BRWN works to prevent the impact that heavy rain and flooding has on Bexar County by coordinating planning and capital improvement programs. Technology is used to aid in analyzing flood and stormwater data to enhance flood warning, water quality, and land use planning. This collaboration makes it easier to apply for grants as a region.

The **Texas Division of Emergency Management (TDEM)**, a division of the Texas Department of Public Safety, is charged with coordinating state and local responses to natural disasters and other emergencies in Texas. TDEM is intended to ensure the state and its local governments respond to and recover from emergencies and disasters as well as implement plans and programs to help prevent or lessen the impact of emergencies and disasters. Texas has six TDEM regions and in those regions, assistant chiefs and district coordinators serve as TDEM's field response personnel stationed throughout the state. They have a dual role as they carry out emergency preparedness activities and coordinate emergency response operations. In their preparedness role, they assist local officials in carrying out emergency planning, training, and exercises, as well as developing emergency teams and facilities. They also teach a wide variety of emergency management training courses. In their response role, they deploy to incident sites to assess damages, identify urgent needs, advise local officials regarding state assistance, and coordinate deployment of state emergency resources to assist local emergency responders. The SAFPR falls within **TDEM Region 6**.

TxDOT generally is associated with the construction and maintenance of the state's immense state highway system; however, the agency is also responsible for overseeing aviation, rail, and public transportation systems within the state. TxDOT can provide real-time road closure and LWC information in the response and recovery phases of a flood event. Users can access these data through TxDOT's Drive Texas website[45]:

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[45] https://drivetexas.org

The Texas **Public Works Emergency Response Council** serves as a statewide database of assets available to respond as requested to human-made and natural disasters through mutual aid. It serves to support and promote statewide emergency preparedness, disaster response, mutual aid assistance, and training for Public Works agencies as well as seeks to provide a formalized system allowing jurisdictions affected by disaster to request assistance through a standardized process. It is a key figure in all four emergency management phases.

The **GLO** is the oldest state agency in Texas. The GLO manages state lands, operates the Alamo, helps Texans recovering from natural disasters, helps fund Texas public education through the Permanent School Fund, provides benefits to Texas veterans, and manages the vast Texas coast. The GLO, through the Community Development and Revitalization Division, aids communities in rebuilding, restoring critical infrastructure, and mitigating future damage through resilient community planning. The GLO administers both Community Development Block Grant – Disaster Recovery (CDBG-DR) and Community Development Block Grant – Mitigation (CDBG-MIT) funds from the United States Department of Housing and Urban Development (HUD) on behalf of the state of Texas.

The **Texas Association of Regional Councils** assists state and federal partners by coordinating and improving regional homeland security preparedness, planning, and response activities across jurisdictional boundaries. The TDEM works with the regional councils to ensure that all regional and local emergency plans are up-to-date and compliant with the Texas Government Code. Regional councils also work with the TDEM in the event of a disaster within their region to access state resources in a timely manner.

The **USACE** is an important part of the nation's military. The agency is responsible for a wide range of efforts within the United States, including addressing safety issues related to waterways, dams, and canals but also environmental protection, emergency relief, and hydroelectric power. The USACE is composed of several divisions, with the SAFPR located within the Southwest Division and the Galveston and Fort Worth Districts.

The **USACE Flood Risk Management Program** works across the agency to focus the USACE’s policies, programs, and expertise toward reducing overall flood risk. This includes determining the appropriate use and resiliency of structures such as levees and floodwalls, as well as promoting alternatives when other approaches (land acquisition, flood proofing, etc.) reduce the risk of loss of life, reduce long-term economic damages to the public and private sector, and improve the natural environment.

The USACE responds to disasters each year by deploying hundreds of trained personnel and providing resources nationwide. The USACE works under the direction of FEMA as a member of the federal team supporting state and local governments in responding to major disasters.

FEMA is an agency of the United States Department of Homeland Security. While on-the-ground support of disaster recovery efforts is a major part of FEMA's charter, the agency provides state and local governments with experts in specialized fields and funding for rebuilding efforts and relief for infrastructure by directing individuals to access low-interest loans in conjunction with the Small Business Administration. FEMA also manages technical efforts for floodplain mapping for communities in the NFIP. In addition to this, FEMA provides funds for training of response personnel throughout the United States and its territories as part of the agency's preparedness effort.

7.1.4 Emergency Information

7.1.4.1 Flood Warning Systems

Data can be collected and disseminated by various means during a flood event. These include gages to measure the current flood risk and communication systems to alert the public.

Two types of gages used are rain gages and stream gages. A rain gage is a meteorological instrument to measure rainfall in a given amount of time. It collects water falling on it and records the change over time in the rainfall depth. Stream gaging is a technique used to measure the discharge, or the volume of water moving through a channel per unit of time, of a stream. The height of water in the stream channel, known as a stage or gage height, can be used to determine the discharge in a stream. Within the SAFPR, 56 USGS stream gages are jointly funded under a cooperative program between the USGS and local cooperators such as river authorities, cities, and the TWDB.

Rain and stream gages are useful for a variety of flood warning systems that cities, counties, and the region employ to keep citizens informed. SARA’s Predictive Flood Model (PFM) is a continuous simulation software that ingests Next Generation Weather Radar rainfall estimates, gaged rainfall, and gaged stream level, as well as runs VFlo model hydrology and hydraulics to estimate stream flow, depth, velocity, maximum flood inundation, swift-water rescue risk as well as produce short-term stream forecasts at selected warning points anywhere within the inundation grid.

The recently expanded warning system covers all of Bexar County with stream-related products. The PFM also provides gage-adjusted radar rainfall totals and forecasts for the entire San Antonio River basin. The PFM dynamic hydraulic models produce alerts and flood inundation maps every 15 minutes. Results are accessible through the Vieux & Associates' web-based Vieux Information Platform. Critical information about depth, flow velocity, and whether creeks are continuing to rise or have peaked is transmitted to the CoSA's Swift Water Rescue Teams in mobile device formats so they can enhance their situational planning.

SARA performs flood risk studies and uses the results to map flood risk and provide this information to property owners and local governments for planning mitigation action through watershed master planning, and to improve their flood warning systems. As part of their flood warning, the CoSA also developed a public education and flood preparedness program called SAFE. The goals of this program are: educate the public on flood awareness, preparedness, and safety; develop a multi-media approach to public education training; and work with first responders, the NWS, school districts, businesses, media, and neighborhood and apartment organizations to reach a wide range of individuals.

In collaboration with the USGS, the Bandera County River Authority and Ground Water District (BCRAGD) developed a tool set in 2018 that provides a flood warning system for Bandera County. The tool consists of a streamflow-gage monitoring network, a HEC-RAS that creates a well-calibrated hydraulic model of the Medina River. It has the ability to generate flood inundation maps in the USGS Flood Inundation Mapping Program (FIMP) website[46] and a Decision Support System. The hydraulic model of Medina River at and near Bandera was created using high-resolution digital elevation data, aerial photographs, field surveys on structure and channel cross sections, and the stage-discharge rating curve that was established at the Bandera Station. This information was used to develop 29 flood inundation maps showing potential inundation areas and depths for stages ranging from 10 to 38 feet. The river is continuously measured at all gages every 15 minutes and transmitted every hour to a satellite. This information is publicly accessible through the USGS FIMP[47], seen in Figure 7-2.

[46] https://webapps.usgs.gov/infrm/fdst/

[47] https://webapps.usgs.gov/infrm/fdst/

Figure 7-2. USGS InFRM Website Interface

Source: USGS InFRM website, https://webapps.usgs.gov/infrm/fdst/

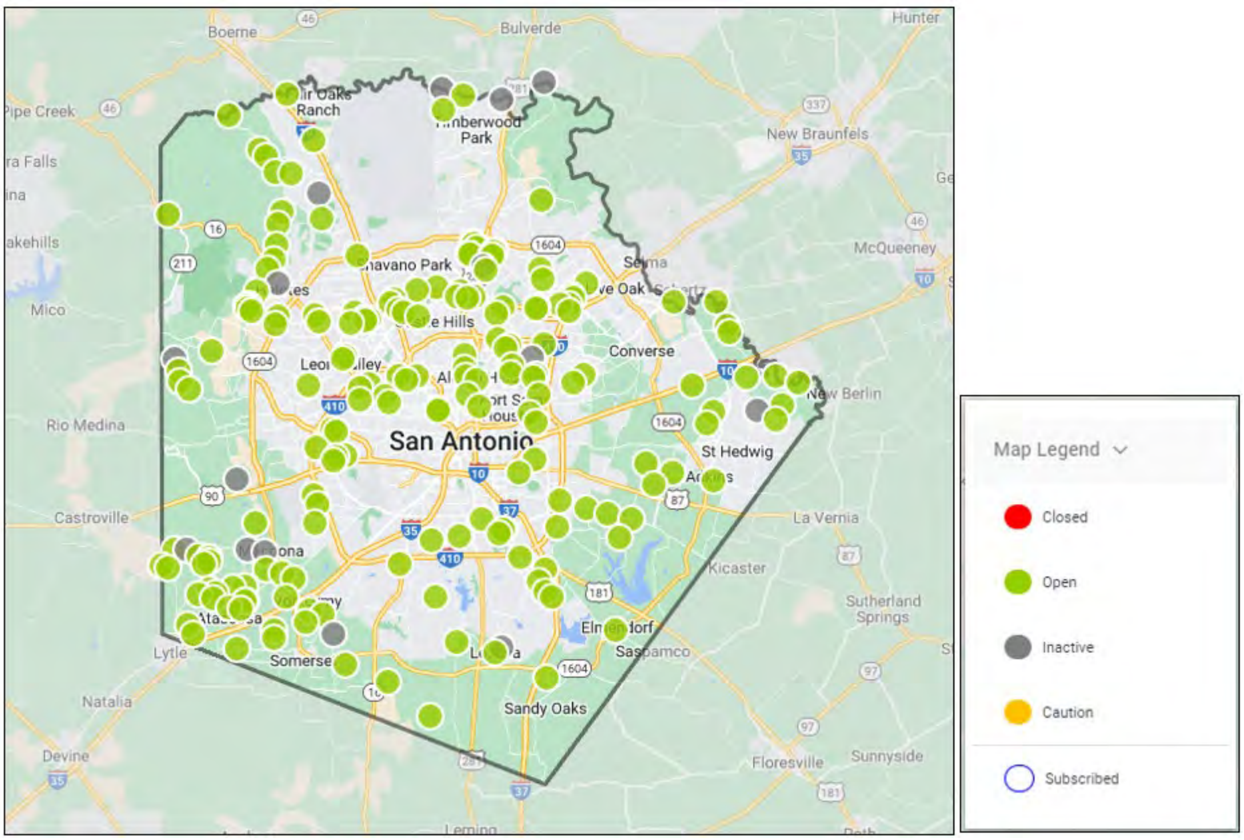
Across the region, several jurisdictions have shown an interest in installing more flood warning and readiness systems (gages, gates, LWC barriers, etc.) that provide localized data. The SAFPR is a site where Hill Country rocky terrain and the Gulf Coastal Plain converge. These topographic changes cause intense, localized floods. The current system of rain and stream gages is not able to convey data on a granular level to better inform downstream entities so they can act accordingly to protect from the loss of life.

7.1.4.2 Alert Systems

In addition to the NWS, local news stations or radio stations are vital components in relaying real-time information to residents of inclement weather and flooding. They can also alert residents to LWC closings, dam or levee breaches, and other potential dangers as well as issue flood watches, warnings, and emergency notifications. Various entities within the SAFPR maintain websites to provide the public with real-time information about flooded streets and areas to avoid.

Bexar County has implemented a new system known as HALT to warn drivers about too much water over the road, creating unsafe conditions. A sensor detects rising water depth, initiating flashing lights or a combination of gates and lights once a certain depth is reached. The county has installed more than 150 HALT systems in the community, monitoring road conditions 24 hours per day, 7 days per week. In addition to lights and gates, the county has set up an interactive website[48] with information and a map displaying the status of all the county's LWCs at any given time. Each dot on the map indicates a location of a Bexar County HALT sensor. The sensors detect rising water and send real-time information to this website: green means the road is safe, yellow means the water is rising, and red means the road is closed. Figure 7-34 shows an example of HALT locations and their conditions.

Figure 7-3. Bexar County HALT Sensor Locations



Source: Bexar County Flood website, https://www.bexarflood.org/#!/main/map

The CoSA has a similar system called SAFE ROUTE[49], which monitors LWCs and provides alternative routes to local drivers.

An Emergency Alert System is software that provides alert messages during an emergency. Messages can interrupt radio and television programming to broadcast emergency alert information. Messages cover a large geographic footprint. Emergency message audio/text may be repeated twice, but

48 https://www.bexarflood.org/#!/main/map

49 https://gis.sanantonio.gov/OEM/SAFE/index.html

Emergency Alert System activation interrupts programming only once, then regular programming continues.

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. AlertSA is a program that residents can sign up for to receive alerts about disasters to their home, business, and/or cell phone. The system is also Americans with Disabilities Act-compliant with options for those that are hearing and/or sight impaired to receive alerts tailored to their needs. Bexar, Comal, and Guadalupe Counties are all included in the geographical scope. Many counties within the SAFPR have county-wide organized alert systems that residents can sign up for on county websites.

School emergency alert systems allow schools to communicate quickly with staff, students, first responders, and others so 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 kindergarten through 12th grade, as well as universities.

7.1.4.3 Local Emergency Operations

The four phases of emergency management—mitigation, preparedness, response, and recovery—are used as guides for action. Community outreach, proper staff training, agreement development with other municipalities, and proper equipment acquisition are completed during the mitigation and preparedness phase. Response activities include warning, emergency medical services, law enforcement operations, evacuation, shelter and mass care, emergency public information, and search and rescue. Short term recovery focuses on restoring vital services and addressing public needs. Long-term recovery includes applying for funds to upgrade and/or fix damaged infrastructure and homes, debris removal, utilities restoration, mental health services, and business support for those affected.

CoSA outlines emergency operations in their recently updated Basic Plan.[50] CoSA's emergency management program is comprehensive and integrated with resources from government, organized volunteer groups, and businesses. CoSA employs the Incident Command System to manage emergencies. The major organizational activities include managing the incident as well as operations, planning, logistics, and finance/administration.

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[50] City of San Antonio. Basic Plan. Updated September 7, 2021. Available at https://www.saoemprepare.com/Portals/16/Files/Plans/BasicPlan.pdf

During major emergencies and disasters, the Emergency Operations Center is activated along with the Incident Command System. Responsibilities of informing the public, controlling the scene of the event, making informed decisions about whether to evacuate the public or shelter in-place, implementing traffic controls, and requesting assistance if local capacity is overwhelmed are delegated to various staff. Leadership includes the Mayor, City Manager, and Emergency Management Coordinator, who is usually a Judge or Emergency Manager. These individuals are endowed with the authority to provide guidance and direction for the CoSA emergency management programs. A county judge or city mayor has the authority to order evacuation of the population from a threatened area. Cities are required to request assistance from the county before requesting assistance from the state. The Disaster District Committee Chairperson located at the Department of Public Safety District Office in San Antonio makes the request. If a Presidential declaration is made, federal agencies such as FEMA may be employed to the scene.

Bexar County uses a very similar plan structure as CoSA. The county employs the six components of FEMA National Incident Management System, a standardized framework that guides the county in all phases of emergency management. This includes effectively integrating resources from different agencies into a temporary emergency organization at an incident site, referred to as the Incidence Command System. Just as with the CoSA, the county will activate the Emergency Operations Center for major emergencies and disasters. Division of responsibilities is established and delegated. The site(s) of the emergency or disaster is assessed and managed, warnings are put out to the surrounding residents, the decision of whether to order an evacuation is decided, and traffic control is arranged. If local capacity is overwhelmed, either the county judge or city mayor make the request for state aid to the Disaster District 17 Committee Chairperson, located in the CoSA.

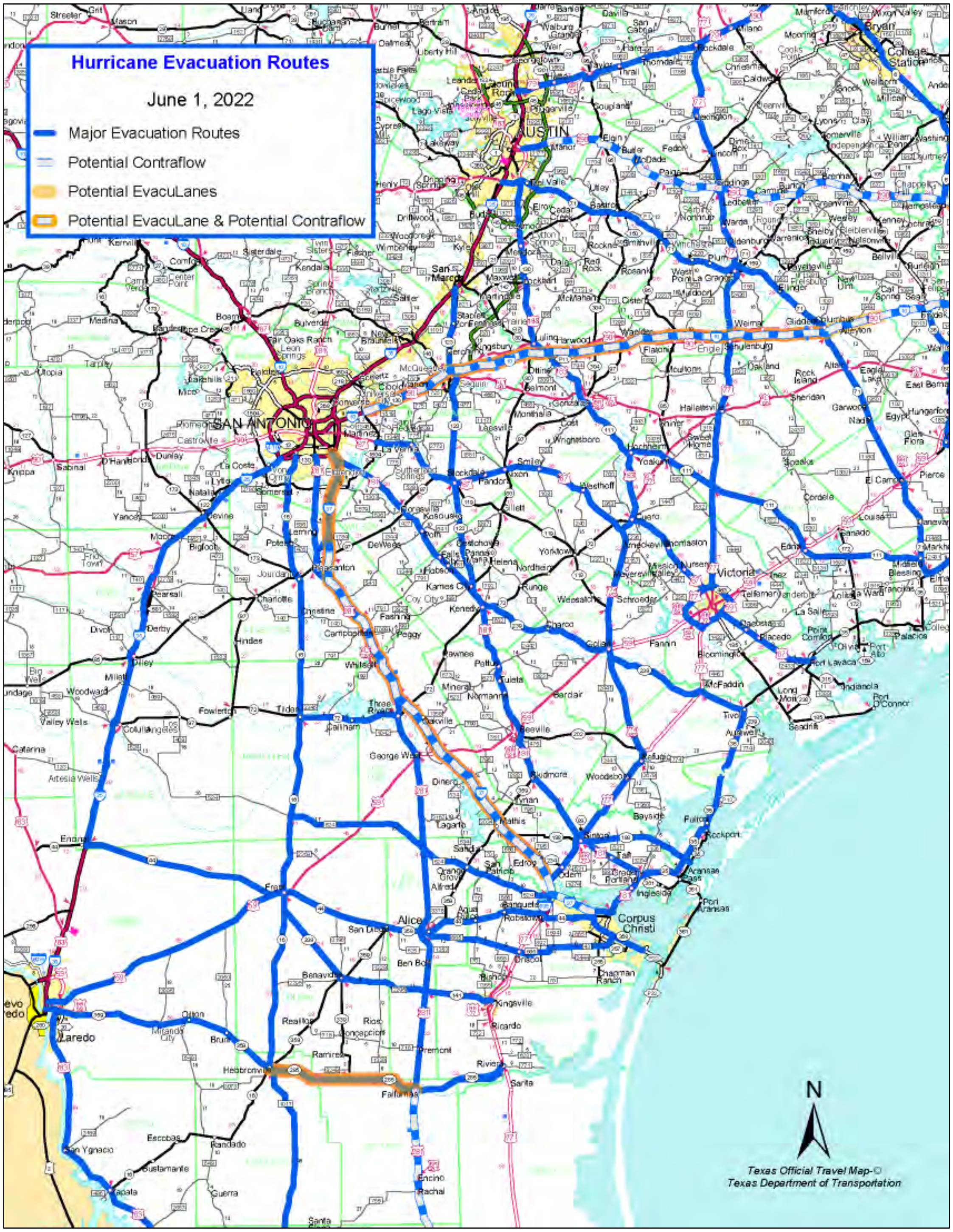
7.1.4.4 Hurricane Tracking and Evacuation

The NOAA Hurricane Center (NHC) is a component of the National Centers for Environmental Prediction located at Florida International University. The NHC issues watches, warnings, forecasts, and analyses of hazardous tropical weather. The NHC is composed of several units with the goal of understanding tropical storms so they can better inform governments and residents of risk. The SAFPR has multiple counties within the coastal zone that are at risk of damaging effects from tropical storms, strong winds, and storm surges. Few hurricanes have reached as far inland as Bexar County to cause devastating flooding conditions for residents.

Evacuation routes designated to provide the safest and most timely evacuation of the coastal areas are established by the TxDOT. During an evacuation, two options may be used to help speed up the process: contraflow and evaculanes. Contraflow reverses some or all inbound lanes into outbound lanes on a designated roadway. Evaculanes allow drivers to use the road shoulders as transportation lanes. Maps of evacuation routes are available on TxDOT's website[51] as well as city and county websites. Figure 7-4 shows hurricane evacuation routes for the region. The northern region of the river basin is typically the location where hurricane refuges go to escape an incoming tropical storm.

[51] https://www.txdot.gov/safety/severe-weather/hurricane-preparation.html

Figure 7-4. Hurricane Evacuation Routes



Source: TxDOT, https://protect-us.mimecast.com/s/JKMFC68mq2cG6PzwIpRClP?domain=ftp.txdot.gov

7.1.5 Plans to be Considered

7.1.5.1 State and Regional Plans

The State Hazard Mitigation Plan is an assessment developed by the TDEM[52]. It is an effective instrument to reduce losses by reducing the impact of disasters on people and property. Although mitigation efforts cannot completely eliminate impacts of disastrous events, the plan aims 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 and climate adaption capabilities, and develops strategies and identifies state agency (and other entities) potential actions to address needs.

The Regional Emergency Preparedness Program[53] is one of the largest and most effective programs of its kind nationwide. Bringing together urban, suburban, and rural jurisdictions, the program uses the guidance of the Homeland Security Exercise and Evaluation Program to facilitate information sharing, training collaboration, and cooperation between jurisdictions in a politically neutral and supportive environment. The Regional Emergency Preparedness Program accomplishes this through networking, standardizing policy and procedures, and coordinating efforts with stakeholders. Increased participation in this program is beneficial for the safety of the region.

7.1.5.2 Local Plans

To examine the state of its flood preparedness, the San Antonio RFPG obtained emergency management plans, hazard mitigation plans, and other regional and local flood planning studies from county and local jurisdictions.

An emergency management plan is a course of action developed to mitigate the damage of potential events that could endanger an organization's ability to function. Such a plan should include measures that provide for the safety of personnel and, if possible, property and facilities.

The SAFPR has several plans and regulations in place that provide the framework that describes a community's capabilities in implementing mitigation and preparedness actions. These include HMAPs, EAPs,

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[52] https://www.tdem.texas.gov/mitigation/hazard-mitigation-section

[53] https://www.nctcog.org/getattachment/ep/members/Member-Services-2020.pdf.aspx?lang=en-US

emergency management plans (EMPs), floodplain management plans, and watershed master plans. Table 7-4 summarizes existing HMAPs and EMPs adopted within the SAFPR and Table 7-5 lists floodplain management plans and drainage master plans developed within the SAFPR. Figure 7-5 shows counties with Flood Hazard Mitigation Plans within the SAFPR.

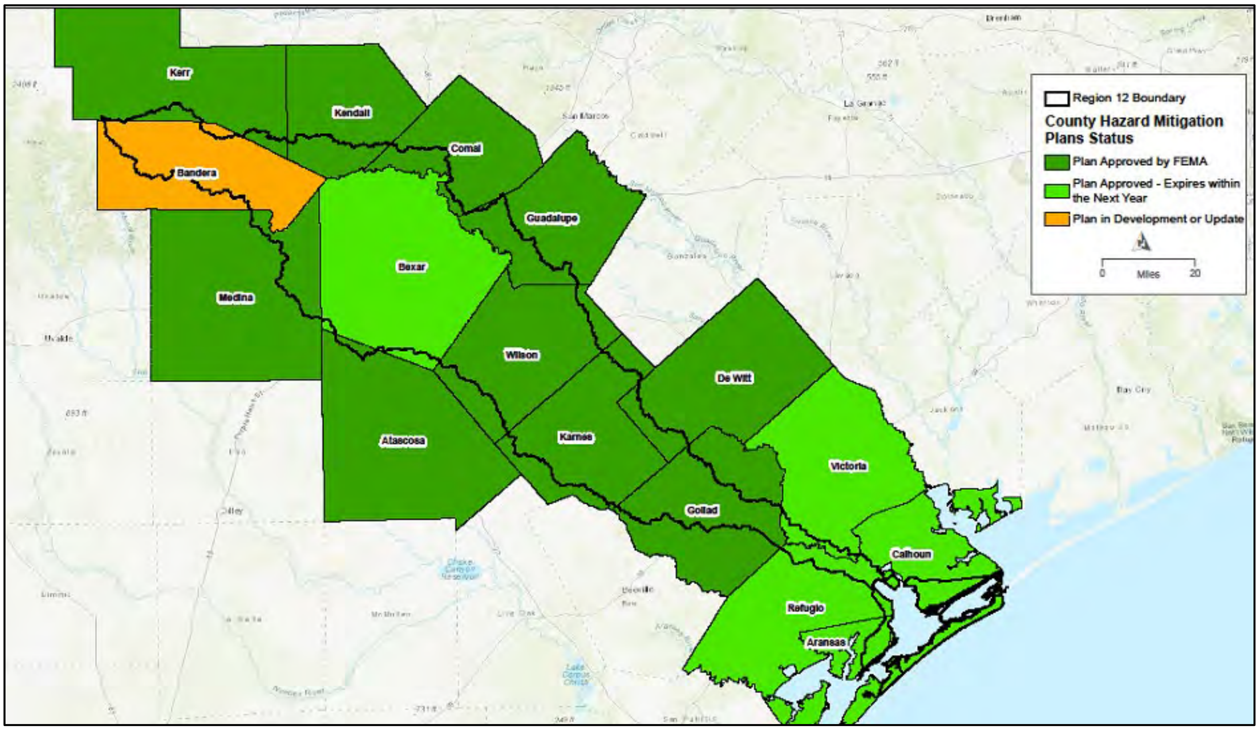
Table 7-4. HMAPs and EMPs Adopted within the SAFPR

Jurisdiction	Adoption Date	Status
Aransas County HMAP	2019	Needs updating
Victoria County HMAP	2022	Recently updated
Refugio County HMAP	2021	Recently updated
DeWitt HMAP	2016	Needs updating
Calhoun County HMAP	2020	Recently updated
Karnes and Wilson Counties Multi-jurisdictional HMAP	2020	Recently updated
Guadalupe County	2020	Recently updated
Comal County HMAP	2018	Needs updating (anticipated 2023)
Bexar County EMP	2017	Needs updating
Kendall County HMAP	2022	Pending FEMA Approval
Kerr County EMP	2015	Needs updating
Medina County HMAP	2020	Recently updated
CoSA HMAP	2021	Recently updated

Table 7-5. Floodplain Management and Drainage Master Plans within the SAFPR

Jurisdiction	Plan Type	Year
City of Boerne	Drainage Master Plan	2021
Aransas County	Multi-Jurisdictional Floodplain Management Plan	2017
Bandera County	River Authority and Groundwater District Flood Plan	2019
San Antonio	Local Drainage Master Plan	Annual Updates

Figure 7-5. County HMAPs within the SAFPR



SARA has worked with partner agencies to complete Watershed Master Plans since 2009 for watersheds within the San Antonio River basin. The master plans have two primary objectives:

1. Identify needs and opportunities related to flood risk, water quality issues, LID, stream restoration, nature-based park planning, mitigation banking, and conservation easements
2. Develop and assess proposed projects to address the identified needs and preserve identified opportunities

Watershed master plans encourage all sectors of the community to work together to create a flood hazard-resilient community. These plans address existing flooding, erosion, and water quality problems and can be useful in preparing for future challenges. Watershed master plans provide recommendations, help educate the public and influence decision makers regarding land use changes, encourage investment in capital projects, and encourage modifications to development regulations within a watershed. The developed watershed master plans within the SAFPR are shown in Table 7-6; these plans are living documents that are updated as needed.

Table 7-6. Watershed Master Plans Developed by SARA and Participating Local Entities

Watershed	Status
Upper San Antonio River	Revised November 2013
Leon Creek	Completed January 2011
Salado Creek	Completed December 2011
Medina River	Completed November 2015
Lower San Antonio River	Completed September 2015
Cibolo Creek	Revised July 2018

Hazard mitigation planning reduces loss of life and property by implementing strategies to minimize the impact of disasters. It begins with state, tribal, and local governments identifying natural disaster risks and vulnerabilities that are common in their area. Table 7-7 illustrates how the Alamo Area Council of Governments assessed risk by hazard type in their HMAP. After identifying risks, plans often locate and assess the level of risk that critical infrastructure and social systems have regarding a certain hazard. They develop long-term strategies for protecting people and property from similar events. Having an up-to-date HMAP is key in assessing risk and developing mitigation actions. Systems are interconnected, and it is also important to incorporate hazard mitigation information into other jurisdictional plans such as master and comprehensive plans.

The purpose of EAPs is to facilitate and organize employer and employee actions during workplace emergencies. They are an essential element in emergency management for critical facilities. In the private sector, an EAP is a document required by Occupational Safety and Health Administration standards.

Table 7-7. Qualitative Risk Assessment Terminology Used in the Alamo Area Council of Governments HMAP

Term	Potential Impact to People (Life/ Safety/Livelihood)	Potential Impact to Buildings/ Critical Facilities	Potential Impact to Infrastructure
Low	Some injuries possible but unlikely	Cosmetic damages to structures; loss of function for less than 1 day	Some roads/bridges temporarily blocked; temporary power loss
Moderate	Injuries expected, some deaths possible	Some structural damages; loss of function for 1 to 2 days	Road/bridge closures; power and utility loss
High	Several deaths expected	Some structures irreparably damaged; loss of function for 3 to 5 days	Long-term road/ bridge closures; long-term power and utilities loss

Source: Alamo Area Council of Governments

As part of the TCEQ Dam Safety Program, owners of significant- and high-hazard dams are required to submit an EAP to the TCEQ. Dam EAPs document responsibilities during flood response and identify the flood inundation area. Of the 162 dams within the SAFPR, 71 have EAPs, which are listed in Table 7-8.

Table 7-8. Dams with EAPs within the SAFPR

Dam Name	Dam Name	Dam Name
Alkek Lake No. 1 Dam	Escondido Creek WS SCS Site 2 Dam	Salado Creek WS SCS Site 1 Dam
Alkek Lake No. 2 Dam	Escondido Creek WS SCS Site 3 Dam	Salado Creek WS SCS Site 10 Dam
Armstrong Lake Dam	Escondido Creek WS SCS Site 4 Dam	Salado Creek WS SCS Site 11 Dam
Army Residence Community Dam	Escondido Creek WS SCS Site 5 Dam	Salado Creek WS SCS Site 12 Dam
Brooklyn Street Lock And Dam	Escondido Creek WS SCS Site 6 Dam	Salado Creek WS SCS Site 13a Dam

Dam Name	Dam Name	Dam Name
Calaveras Creek Dam	Escondido Creek WS SCS Site 7 Dam	Salado Creek WS SCS Site 13b Dam
Calaveras Creek WS SCS Site 3 Dam	Escondido Creek WS SCS Site 8 Dam	Salado Creek WS SCS Site 2 Dam
Calaveras Creek WS SCS Site 5 Dam	Escondido Creek WS SCS Site 9 Dam	Salado Creek WS SCS Site 4 Dam
Calaveras Creek WS SCS Site 6 Dam	Garrison Ranch Lake Dam	Salado Creek WS SCS Site 5 Dam
Calaveras Creek WS SCS Site 7 Dam	Love Creek Dam	Salado Creek WS SCS Site 6 Dam
Calaveras Creek WS SCS Site 8 Dam	Martinez Creek WS SCS Site 1 Dam	Salado Creek WS SCS Site 7 Dam
Calaveras Creek WS SCS Site 9 Dam	Martinez Creek WS SCS Site 2 Dam	Salado Creek WS SCS Site 8 Dam
Calaveras Creek WS SCS Site 10 Dam	Martinez Creek WS SCS Site 3 Dam	Salado Creek WS SCS Site 9 Dam
Circle Dot Dam	Martinez Creek WS SCS Site 4 Dam	Singing Hills Unit 1 Detention Dam
Dawson Ranch Dam No. 2	Martinez Creek WS SCS Site 5 Dam	Thompson Lake Dam
Dawson Ranch Dam No. 4	Martinez Creek WS SCS Site 6a Dam	Upper Cibolo Creek WS SCS Site 1 Dam
Dawson Ranch Dam No. 1	Medina Diversion Lake Dam	Upper Cibolo Creek WS SCS Site 2 Dam
Denman Park Dam	Medina Lake Dam	Upper Cibolo Creek WS SCS Site 3 Dam
Elmendorf Lake Dam	Montague Lake Dam	Upper Cibolo WS SCS Site 4 Dam
Escondido Creek WS SCS Site 1 Dam	New Langford Lake Dam	Victor Braunig Dam
Escondido Creek WS SCS Site 10 Dam	Olmos Dam	White Lake Dam
Escondido Creek WS SCS Site 11 Dam	Purple Sage Ranch Lake	Wildlake Dam

Dam Name	Dam Name	Dam Name
Escondido Creek WS SCS Site 12 Dam	Rock Cliff Dam	Woodlawn Lake Dam
Escondido Creek WS SCS Site 13 Dam	Salado Creek WS NRCS Site 15r Dam	—

A high hazard classification indicates that if the dam were to fail, there would be significant consequences (e.g., loss of life), and the dam is in a condition that is more likely to fail. As shown in Table 7-9, numerous dams are within the SAFPR. While these dams provide major flood mitigation for the region, they also introduce a secondary risk the population if they were to fail.

Table 7-9. Number of Dams by County within the SAFPR

County	Number of Dams	County	Number of Dams
Atascosa	19	Wilson	14
Bandera	32	Kendall	15
Bexar	58	De Witt	16
Comal	12	Goliad	6
Guadalupe	16	Aransas	0
Karnes	19	Calhoun	8
Kerr	18	Victoria	4
Medina	28	Refugio	4

The SAFPR'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 SAFPR will be better equipped to implement sound measures for flood mitigation and preparedness.

8

Administrative, Regulatory, and Legislative Recommendations

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8 Administrative, Regulatory and Legislative Recommendations

[31 TAC §361.43]

Part of the San Antonio RFP effort includes proposing changes to administrative practices and existing statutes in order to make floodplain management and flood mitigation planning and implementation throughout the state of Texas more efficient or logical. As set forth in the TWDB's rules and guidelines for regional flood planning, the RFPGs may adopt recommendations on policy issues related to floodplain management and flood mitigation planning and implementation. Specifically, the RFPGs may adopt:

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

Legislative, regulatory, and administrative recommendations adopted by the San Antonio RFPG are detailed in this chapter.

8.1 Regulatory and Administrative Recommendations

The San Antonio RFPG has also developed recommendations of an administrative or regulatory nature concerning existing procedures, state entities, or state/regional regulations. Alterations to these procedures could also be proposed to the TWDB for consideration.

Recommendations in Table 8-1 are suggested changes to existing standards, state-controlled entities, or procedures.

Table 8-1. Regulatory and Administrative Recommendations

ID	Recommendation	Rationale for Recommendation
8.1.2	Review and revise as necessary all state infrastructure entities’ (i.e., TxDOT) standards and practices for legislative and regulatory compliance with stormwater best practices.	State entities should be aware of the drainage and stormwater standards within the areas where they are active. State entities should be required to comply with local regulations when local regulations are higher than state minimum criteria or entity-specific criteria.
8.1.3	TxDOT should employ roadway design criteria to require all new and reconstructed state roadways to be designed and constructed, to the extent practicable, at elevations at or above the 1% annual chance event water surface elevation. TxDOT should also consider future conditions, such as urbanization and changing rainfall, in its roadway design criteria for drainage and flood risk reduction.	TxDOT is not a participant in the NFIP and does not, in all cases, design roadways in a manner consistent with minimum NFIP requirements. It is recognized that, by their nature, it is often not feasible or practicable to design and construct roadways to provide a level of flood protection equivalent to or greater than the 1% annual chance storm (100-year) event. However, concerning policy and practice, TxDOT should strive to meet this standard.
8.1.4	Establish programs and funding to evaluate and update development code, and educate local and regional officials to the floodplain management tools they have available along with NBSs.	Local and regional officials are often unaware of their authority to establish and enforce stormwater regulations (Texas Local Government Code Title 7, Subtitle B; Texas Water Code Chapter 16, Section 16.315). Flooding and drainage components of local and regional officials’ training is often inadequate for their level of responsibility.
8.1.5	Provide measures to allow and encourage jurisdictions to work together toward regional flood mitigation solutions.	Flooding does not recognize jurisdictional boundaries. Allowing and encouraging entities to work together towards common flood mitigation goals would be beneficial to all involved. This should also include state agencies.

ID	Recommendation	Rationale for Recommendation
8.1.6	Develop a publicly available, statewide database and tracking system to document flood-related fatalities and injuries.	In order to more accurately address the health, safety, and welfare of the public, high flood-risk areas should be tracked and reported. Doing so would increase awareness of the area, both so the public could be aware of the risks, and elected officials and decision makers could institute solutions to reduce the risk in those areas.
8.1.7	Revise the scoring criteria for funding associated with stormwater- and flood-related projects that benefit NBSs and agricultural activities.	The traditional BCA tools prevent agricultural projects from competing with municipal BCRs.
8.1.8	Provide financial or technical assistance and training to smaller/rural jurisdictions to help educate them on implementing flood mitigation policy, practices, and funding opportunities.	The former Office of Rural Affairs/Texas Department of Rural Affairs was intended to assist and work with rural entities. However, the department was disbanded. Actions such as maintaining a department specifically for smaller/rural entities, incentivizing consultants to pursue work for smaller or rural entities, or adjusting BCRs to rank small/rural entities equally are all ideas toward accomplishing this goal.
8.1.9	Develop a process for state flood planning goal tracking.	A process is needed to document the progress of the short-/long-term region goals. This process could be similar to the MS4 program and include interim milestones to track progress. Funding also needs to be made available for the regions.
8.1.10	Develop a set of minimum standards for regional flood warning and emergency response programs, and provide funding and resources for communities to establish these systems.	Timely warnings for flood threats and impending danger will aid in the reduction of additional flood risk and flood-related deaths. River authorities could serve as the state-level agency to implement these efforts.
8.1.11	Encourage each entity to adopt a dedicated funding mechanism for floodplain management purposes.	A dedicated funding mechanism will allow entities to study, plan for, and construction flood mitigation programs and projects.

8.2 Legislative Recommendations

The San Antonio RFPG, sponsors, and technical consultants have interacted with a wide variety of entities during the flood planning efforts. There are trends and occurrences throughout a large portion of the state. Some of these trends and occurrences are positive and should be encouraged, while others may be detrimental to the entities' floodplain and stormwater management within the SAFPR and/or state.

The San Antonio RFPG understands that flooding does not recognize jurisdictional boundaries. As Texas continues to experience rapid growth in unincorporated areas of counties throughout the state, the San Antonio RFPG encourages the Texas Legislature to clarify land use authority under the Texas Water Code to address the impacts increased development in unincorporated areas has on flooding. The San Antonio RFPG also recommends the state evaluate strategies to help communities become more competitive in acquiring federal funds.

During the flood planning process, the San Antonio RFPG, technical consultants, entities, and members of the public have provided input on the function and usefulness of existing legislation related to floodplain and stormwater management.

Table 8-2 presents recommendations related to flood planning, flood risk mitigation, and funding adopted by the San Antonio RFPG that will require legislative action and looking at options (providing entities with more options in unincorporated areas).

Table 8-2. Legislative Recommendations

ID	Recommendation	Rationale for Recommendation
8.2.1	Direct state funding to counties to maintain drainage and stormwater infrastructure in unincorporated areas.	Counties have floodplain- and drainage-related responsibilities in Texas without a consistent way to fund projects.
8.2.2	Provide funding and/or technical assistance to develop regulatory floodplain maps.	Several entities who have outdated maps or no mapping at all are not able to fund the projects necessary to update or create accurate depictions of flood risk.

ID	Recommendation	Rationale for Recommendation
8.2.3	Provide funding and/or technical assistance to update drainage criteria and development standards that prevent development in or impacts to the effective FEMA floodplain.	Up-to-date drainage criteria and development standards at the county level improve resiliency and prevent additional flood risk. However, many entities do not have the funding to update criteria and standards.
8.2.4	Provide funding and/or technical assistance to update or perform flood planning and/or master drainage planning studies.	Many communities and entities do not have up-to-date studies or plans that reflect growth or updated rainfall data.
8.2.5	Expand eligibility for and use of funding for stormwater and flood mitigation solutions (local, state, federal, public/private partnerships, etc.)	Flood mitigation studies/projects do not generate revenue, which makes them more challenging to fund at the local level. Funding sources could use different financial/economic benefit metrics for projects that do not generate revenue.
8.2.6	Provide additional funding to enable the continued function of RFPGs during the time between planning cycles.	In the time between planning cycles, not only could the RFPGs continue adding FMEs, FMSs, and FMPs to the RFP, but they could also implement planning group-sponsored flood management activities and outreach, and stay informed on regional flood-related events.
8.2.7	Establish and fund a state program to assist counties and cities with the assessment and prioritization of LWCs. Funding should also be provided on a cost-sharing basis for implementation of structural and/or nonstructural flood risk reduction measures at high-risk LWCs.	Many LWCs experience frequent flooding but may have relatively minor flood risk in terms of public safety and/or the integrity of the roadway. Others, however, are at high risk and experience flood depths and velocities that pose a significant risk. The cost to mitigate flood risk at high-risk LWCs with structural solutions (e.g., bridges) is typically cost prohibitive. Flood risk at LWCs should be systematically and fully evaluated to prioritize those crossings in need of mitigation, either through structural or nonstructural (e.g., closures, reverse 911 notifications, etc.) measures.

ID	Recommendation	Rationale for Recommendation
8.2.8	Encourage dedicated funding provided to TxDOT for upgrading critical LWCs on TxDOT facilities that are identified as critical in the RFP.	LWCs can be expensive and complicated projects. A dedicated funding source for TxDOT to upgrade critical crossings provides a mechanism for rural counties and/or small cities to implement these projects without having to apply for a grant, add staff, or hire consultants.
8.2.9	Establish perpetual and dedicated funding to implement projects identified in the SFP.	A reliable funding source is needed to implement the legislative recommendations across the states. Funding needs to be made available to the state agencies that will be required to implement the adopted recommendations.
8.2.10	Provide financial assistance to increase the amount of stream gages and flood warning systems within the region.	An increase in stream gages and flood warning systems throughout the region will reduce flood risk.

8.3 Flood Planning Recommendations

The San Antonio RFPG has identified several improvements to streamline the planning process and make it more effective. Recommendations in Table 8-3 should be considered to improve the regional flood planning process for future planning cycles.

Table 8-3. Regional Flood Planning Process Recommendations

ID	Recommendation	Rationale for Recommendation
8.3.1	Update the scope of work, guidance documents, rules, checklists, and others guidance based on the adjustments and lessons learned made to these planning documents during the first cycle of planning.	During the first cycle of regional flood planning, multiple amendments and additions to the TWDB documents and the TWDB's interpretation of its documents occurred. Moving forward, the TWDB documents provided at the onset of each new planning cycle should reflect what is ultimately required of the San Antonio RFPG.
8.3.2	Develop a fact sheet and/or other publicity measures to encourage entities to participate in the SAFPR effort.	Many entities were unaware of the regional and state flood planning efforts despite the San Antonio RFPG's outreach efforts.

ID	Recommendation	Rationale for Recommendation
8.3.3	Host "lessons learned" discussions with TWDB staff, San Antonio RFPG members, sponsors, and technical consultants following the submittal of the final RFPs.	Opening dialogue among these participants to discuss proposed improvements to the regional flood planning process will streamline and improve future regional flood planning efforts.
8.3.4	Develop a process to efficiently amend approve RFPs to incorporate additional recommended FMEs, FMSs, and FMPs, and to allow the San Antonio RFPG to advance the recommended FMEs to FMPs.	Amending the San Antonio RFP is anticipated to be an intensive process. Amendments to move FMEs to FMPs and incorporate new FMSs should have a quick turn-around time to efficiently include them in the adopted Final RFP.
8.3.5	Reduce the amount of information required to escalate potentially feasible FMEs to FMPs. Align required information to be similar to what is required for design/construction funding.	Some of the data currently requested for FMPs is more detailed than traditional planning level data. Therefore, certain FMPs had to be submitted as FMEs or FMSs despite having sufficient data to produce a project. The RFPs should focus on meeting the minimum requirement to produce funding, rather than spending time and money more appropriately spent during a project's design phase.
8.3.6	Revise the criteria for the "No Adverse Impact" certification required for FMPs.	The current criteria give thresholds for increases in flow, water surface elevation, and inundation extents. Though useful, the current criteria do not allow for consideration of projects that exceed these thresholds but address the impact during final design or downstream accommodations.

ID	Recommendation	Rationale for Recommendation
8.3.7	Streamline the data collection requirements, specifically those identified in Task 1. Focus on collecting the data that was most useful to the RFP development.	This first round of regional flood planning revealed that very few local entities collect and maintain data and information prescribed by TWDB for use in the planning process. This is particularly the case with data available in a digital geospatial format. Also, some required data (e.g., drainage infrastructure) is of questionable value in the planning process and is generally unavailable. As noted in the previous recommendation, most problems associated with drainage infrastructure do not present significant flood risk and are best characterized as nuisance flooding.
8.3.8	Provide statewide data and a methodology to determine infrastructure functionality and deficiencies in the next cycle of the flood planning process. Consider the lack of readily available local data when developing the methodology.	Most entities do not have information regarding the functionality and deficiency of their infrastructure. Some fields required by the TWDB-required tables in the San Antonio RFP are based on data that are not available to entities without extensive fieldwork. A statewide database with this information would be useful to all entities.
8.3.9	Review and revise the geodatabase submittal attributes and elements.	Normalizing the geodatabase with relationships would allow for cross-referencing of data elements and attributes. More domains for attributes need to be developed.
8.3.10	Use the FEMA SVI when available instead of the CDC's SVI in future planning cycles.	FEMA's SVI is considered to be more relevant to flood resiliency and risk than the CDC's SVI.
8.3.11	Use consistent HUC reporting requirements throughout the TWDB-required tables.	The RFPG guidance requires HUC-8 in some tables and HUC-10 or HC-12 in other tables. Some tables require multiple HUCs to be provided. The RFPG recommends that the TWDB require HUC-8 in all TWDB-required tables for consistency and to correspond to FEMA's base level watershed planning granularity.

ID	Recommendation	Rationale for Recommendation
8.3.12	Improve upon the flood risk identification and exposure process with regards to building footprints and population at risk by including first-floor elevations of structures.	While the building footprints are helpful, without the first-floor elevations of each structure, it is difficult to determine the actual flood risk to each structure. If a structure is sufficiently elevated above the BFE, for example, the footprint still shows the structure in the floodplain and the corresponding population is considered “at risk” even though the structure meets NFIP standards. This likely overestimates the population at risk.
8.3.13	Clarify the distinction between flood mitigation and flood infrastructure, and what is more commonly considered drainage infrastructure.	Many local entities, for example, municipal utility districts, have drainage responsibilities, particularly with respect to the development of land and maintenance of drainage infrastructure within their jurisdictions. These entities could also develop what might be considered flood risk reduction infrastructure. Also, most local drainage problems and deficiencies in local drainage infrastructure are localized and sometimes cause “nuisance” flooding rather than posing significant risk and exposure to people and property. It would be helpful to delineate this distinction as best as possible. For example, the TWDB guidance regarding flood exposure and vulnerability could be refined to better emphasize identifying and mitigating significant risks to public safety, property, and public infrastructure.
8.3.14	Develop guidance and a standardized evaluation criteria for the benefits of NBSs.	Including multi-benefit improvements for NBS criteria for entities within the SAFPR will allow a full life-cycle analysis and holistic cost-benefit comparisons between alternatives.

ID	Recommendation	Rationale for Recommendation
8.3.15	Define the phrase "flood-related authorities or entities," to clarify which local and regional governmental entities are included and which are not.	The phrase is used in the TWDB planning documents multiple times and is a central part of Tasks 1 and 10. The TWDB originally provided the San Antonio RFPG with a list of entities that were thought to have flood-related responsibilities. During the outreach efforts, many of those entities communicated they did not have flood responsibilities and did not believe they should be included in the regional flood planning effort. Clarification is requested regarding the intent of this phrase. Note, however, that some political subdivisions of the state such as water control and improvement districts or municipal utility districts, do have authority to develop and maintain drainage and other related infrastructure, such as stormwater conveyance systems and detention facilities, but not all exercise that authority.
8.3.16	Provide more flexibility to the RFPG in making recommendations for the RFP.	The San Antonio RFPG believes that more flexibility would allow the RFPG to create a more tailored RFP that best reduces risk within the SAFPR.
8.3.17	Provide additional knowledge to the planning groups about scoring and ranking prior to development of the plans.	Additional knowledge of the scoring and ranking allows the RFPGs to make better informed decisions when making recommendations.

8.4 Summary of Recommendations

The administrative, regulatory, legislative, and flood planning recommendations have been selected and proposed by the San Antonio RFPG to make floodplain management and flood mitigation planning and implementation throughout Texas more efficient and logical. From a legislative perspective, funding is one of the greatest challenges. Providing more state legislature-backed funding will allow entities to minimize additional flood risks and protect life and property. The administrative recommendations have been proposed to aid entities in their floodplain and stormwater management practices. Many communities are hesitant to enact higher standards due to their concern that future legislative acts will limit their ability to regulate. For future flood planning, recommendations were made to improve future SAFPR efforts. Clarifying and editing current requirements will improve the overall flood planning process and reduce future costs to taxpayers. These recommendations will aid in fulfilling the SAFPR goals discussed in Chapter 3 Floodplain Management Practices and Flood Protection Goals.

Additionally, during the 2023 Draft RFP public comment response period, various organizations submitted letters as their public comment. These groups include; Texas Parks and Wildlife Department, Camp Bullis Sentinel Landscape Partnership, Greater Edwards Aquifer Alliance, National Wildlife Federation, and Great Springs Project. These letters contain recommendations for the TWDB regarding the flood planning process, SFP, and other considerations. The comments received on the Draft *2023 San Antonio Regional Flood Plan* with responses are included in Appendix D.

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9

Flood Infrastructure Financing Analysis

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9 Flood Infrastructure Financing Analysis

[31 TAC §361.44]

The TWDB requires that each RFPG assess and report on how sponsors propose to finance recommended FMPs, FMEs, and FMSs. 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 FMPs, FMEs, and FMSs.

This chapter is an analysis of the funding for flood-related issues within the SAFPR. Communities within the SAFPR were surveyed to determine the needs, costs, and proposed methods of funding to address current flood-related issues. Section 9.1 Sources of Funding for Flood Management Activities presents an overview of common sources of funding for flood mitigation, planning, projects, and other flood management efforts. The methodology, results of the financing survey, and comments regarding the state's role in financing are presented in Sections 9.2 Barriers to Funding through 9.5 Proposed Role for the State in Funding Needs.

9.1 Sources of Funding for Flood Management Activities

Communities across the state use 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 summarizes the local, state, and federal sources discussed in this chapter, and characterizes each by the following three key parameters: (1) which state and federal agencies are involved, if applicable; (2) whether they offer grants, loans, or both; and (3) whether they are classified as regularly occurring opportunities or are only available after a disaster.

A combination of increased local capabilities as well as increased funding amounts and opportunities from the state and federal government will be required to meet the flood risk study and mitigation needs identified through this planning process. State funding, particularly, will be needed to provide access to funding for small, rural communities; incentivizing high-priority projects and project types; and improving access to and leveraging federal funding sources.

Table 9-1. Common Sources of Flood Funding in Texas

Federal Agency	State Agency	Program Name	Grant (G)	Loan (L)	Post-Disaster (D)
Federal					
FEMA	TWDB	Flood Mitigation Assistance	G	—	—
FEMA	TDEM	Building Resilient Infrastructure and Communities	G	—	—
FEMA	TCEQ	Rehabilitation of High Hazard Potential Dam Grant Program	G	—	—
FEMA	TBD	Safeguarding Tomorrow through Ongoing Risk Mitigation	—	L	—
FEMA	TDEM	Hazard Mitigation Grant Program	G	—	D
FEMA	TDEM	Public Assistance	G	—	D
HUD	GLO	CDBG-MIT	G	—	D
HUD	GLO	CDBG-DR	G	—	D
HUD	GLO	HUD GLO Resilient Communities Program	G	—	—
HUD	GLO	HUD GLO CDBG-MIT Local Hazard Mitigation Plans Program	G	—	—
HUD	TDA	Community Development Block Grant Program for Rural Texas	G	—	—
USACE	—	Partnerships with USACE, funded through Continuing Authorities Program, Water Resources Development Acts, or other legislative vehicles[a]	—	—	—

Federal Agency	State Agency	Program Name	Grant (G)	Loan (L)	Post-Disaster (D)
EPA	TWDB	CWSRF	G[b]	L	—
		State			
—	TWDB	FIF	G	L	—
—	TWDB	Texas Water Development Fund	—	L	—
—	TSSWCB	Structural Dam Repair Grant Program	G	—	—
—	TSSWCB	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	—	—	—

[a] Opportunities to partner with the USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction.
[b] The CWSRF program offers principal forgiveness, which is similar to grant funding.
Notes: CWSRF = Clean Water State Revolving Fund; EPA = United States Environmental Protection Agency; TBD = to be determined; TDA = Texas Department of Agriculture

9.1.1 Local Funding

Overall, larger urban communities typically bear a greater percentage of the burden for funding flood and stormwater-related activities in their jurisdictions than the smaller, more resource-limited communities that are often unable to generate a significant amount of funding for these activities.

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 because opportunities may be available to create more of these types of districts within the SAFPR.

A community's general fund revenue (for cities[54] or counties[55]) 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 the general fund for many local needs, a significant amount of funds are often not available for funding flood projects.

Many entities may be able to receive funding from the various programs listed in Table 9-1. But each entity and program must be closely evaluated to determine applicability, available financing, and ability to collect revenue to support debt and infrastructure.

As noted in the Texas Flood Information Clearinghouse information included in the TWDB's *Community Official Flood Resource Guide, Volume 1: February 2022*, some of the entity types include:

> City, council of government, county, drainage district, groundwater conservation district, hospital district ,irrigation district, levee Improvement district, local government corporation, municipal management district, municipal utility district, navigation district, private entities, regional district, school district, soil conservation district, special law district, state agency, stormwater control district, tribal organizations, water control and improvement district, water improvement district, and non-profit water supply corporation

Dedicated fees such as stormwater or drainage fees are an increasingly popular tool for local flood-related funding, primarily in more urban areas. 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 can be collected from developers to cover a portion of the expense to expand stormwater systems necessitated by new development.

Another source for local funding to support flood management efforts includes special districts. A special district is a political subdivision established to

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[54] https://comptroller.texas.gov/transparency/local/cities.php

[55] https://comptroller.texas.gov/transparency/local/counties.php

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, Municipal Utility Districts, Drainage Districts, and Flood Control Districts. 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, including the Texas Legislature, the TCEQ, county commissioners' courts, and city councils. Depending on the type of district, it may have the ability to raise revenue through taxes, fees, or issuing bonds to fund flood- and drainage-related improvements within the district's area.

Lastly, municipalities and counties have the option to issue debt[56] through general obligation bonds, revenue bonds, or certificates of obligation[57], which are typically paid back using any of the previously mentioned local revenue-raising mechanisms.

The communities within the SAFPR are impacted by flooding issues and have been proactively addressing many of these issues to the best of their funding ability. Flood studies and projects have been typically funded by individual communities as they apply for the available funding through the various state and federal programs (see Sections 9.1.2 State Funding and 9.1.3 Federal Funding) and through their own financial resources via fees, taxes, and bonds. These efforts are intended to address local flooding issues on a smaller scale, typically for smaller communities; and on a larger scale, typically for larger communities.

For example, smaller communities such as Castroville, La Vernia, and Floresville have been diligently funding projects with their own funds and with as much state and federal funding that can be obtained. The City of San Antonio's Proposition B in May 2022 was passed to apply $169,873,000 in bonds toward flood control and drainage projects. This was preceded in the city's 2017–2022 Bond Program by an investment that was approximately equal to that amount for flood control and drainage projects. In 2007, Bexar County embarked on a 10-year $500 million Flood Control Program that constructed more than 50 flood mitigation projects to alleviate some of the area's most pressing flood concerns. Wilson and Karnes Counties received a FEMA Hazard Mitigation Multi-Jurisdictional Assistance grant for planning to reduce long-term risk from natural hazards and disasters. Participants included Falls City, Karnes City, Kenedy, Runge, Floresville, La Vernia, Poth,

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[56] https://www.county.org/TAC/media/TACMedia/Legal/Legal%20Publications%20Documents/2017_Public__Finance_Final.pdf

[57] https://comptroller.texas.gov/economy/fiscal-notes/2017/january/co.php

Stockdale, various school districts, SARA, water districts, and local stakeholders. As a final example, SARA has provided funding for studies through grants and its own general fund investments for flood issues throughout the San Antonio River basin, such as the 2019 United States Department of Homeland Security's FEMA Cooperative Technical Partnership (CTP) Program Cooperative Agreement grant for $1,365,400 for flood prevention, mitigation, and protection through mapping updates throughout the basin. Also, SARA was cited by the TWDB in its *Community Official Flood Resource Guide, Volume 1: February 2022* as an example of best practice for flood outreach and education.

These examples show some of the ways the communities within the SAFPR have proactively and cooperatively pursued solutions to their flooding needs. The SARA should be viewed as a leader and applauded for its efforts. The survey discussed in this chapter shows that much more funding is needed in the San Antonio River basin, and clearly much more will be needed in the future as Texas and the SAFPR grow.

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

Communities currently have a broader range of state funding sources and programs available due to new grant and loan programs that did not exist as recently as 5 years ago. It is important to note that state 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 FIF[58] 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,

[58] http://www.twdb.texas.gov/financial/programs/FIF/index.asp

planning studies, and preparedness efforts such as flood early warning systems. After the first SFP is adopted, only projects included in the most recently adopted state plan will be eligible for funding from the FIF. FMPs, FMEs, and FMSs recommended in this RFP will be included in the overall SFP and will therefore be eligible for this funding source.

The TWDB also manages the Texas Water Development Fund (Dfund)[59] program, which is a state-funded, streamlined, loan program that provides financing for several types of infrastructure projects to eligible political subdivisions. This program enables the TWDB to fund projects with multiple eligible components (water supply, wastewater, or flood control) in one loan at low market rates. Financial assistance for flood control may include structural and nonstructural projects, planning efforts, and flood warning systems. The TWDB Clean Water State Revolving Fund (CWSRF)[60] program can also be used to fund flood improvements that may be related to wastewater infrastructure, which is the focus of the program.

The TSSWCB[61] has three state-funded programs specifically for flood control dams: the 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 O&M 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 as well as 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 NRCS, including match funding for federal projects through the Dam Rehabilitation Program and the Emergency Watershed Protection (EWP) Program of the Texas section of the NRCS.

59 http://www.twdb.texas.gov/financial/programs/TWDF/index.asp

60 https://www.twdb.texas.gov/financial/programs/CWSRF/index.asp

61 https://www.tsswcb.texas.gov/index.php/programs/flood-control-program

9.1.3 Federal Funding

The federal government plays an important, sometimes critical, role, particularly in the financing of large-scale flood mitigation projects and studies that would otherwise be beyond the capabilities of state and local governments. Commonly used 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 NFIP, requiring recipients to have an approved HMAP, or requiring a project to have a BCR 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.

9.1.3.1 Federal Emergency Management Agency

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 Grant Program (HHPD), Hazard Mitigation Grant Program (HMGP), Public Assistance (PA) program, and CTP Program.

FMA[62] 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 the TWDB[63]. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the NFIP. 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.

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[62] https://www.fema.gov/grants/mitigation/floods

[63] https://www.twdb.texas.gov/flood/grant/fma.asp

The BRIC[64] 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 TDEM[65]. Funding is typically a 75 percent federal grant with a 25 percent local match. Small, impoverished communities may be funded through grants ranging from 90 to 100 percent. Texas communities are at a disadvantage competing for these funds because points are awarded to communities for state-wide building codes, which are not adopted in Texas.

STORM[66] 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 RFP, the program does not yet appear to be operational and has not yet been implemented in Texas.

FEMA's HHPD[67], administered in Texas by the 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 HMGP[68], 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 the TDEM[69]. 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

[64] https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

[65] https://www.tdem.texas.gov/bric

[66] https://www.congress.gov/bill/116th-congress/senate-bill/3418/all-info

[67] https://www.fema.gov/emergency-managers/risk-management/dam-safety/rehabilitation-high-hazard-potential-dams

[68] https://www.fema.gov/emergency-managers/risk-management/dam-safety/rehabilitation-high-hazard-potential-dams

[69] https://www.tdem.texas.gov/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 PA[70] program provides supplemental grants to state, tribal, territorial, and local governments as well as certain types of private non-profit organizations 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 public infrastructure restoration. 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, the FEMA PA program is administered by the 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 CTP[71] Program is an effort launched by FEMA in 1999 to increase local involvement in developing and updating FIRMs, FISs, and associated geospatial data in support of FEMA's Risk Mapping, Assessment, and Planning (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.

9.1.3.2 Housing and Urban Development

HUD administers the following federal funding programs: CDBG-DR, CDBG-MIT, the Resilient Communities Program (RCP), the CDBG-MIT Local Hazard Mitigation Plans Program (LHMPP), and Community Development Block Grant (TxCDBG) for rural Texas.

Following a major disaster, Congress may appropriate funds to HUD under the CDBG-DR[72] 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

[70] https://www.fema.gov/assistance/public

[71] https://www.fema.gov/flood-maps/cooperating-technical-partners

[72] https://www.hudexchange.info/programs/cdbg-dr/

administered in Texas by the Texas GLO[73]. The special appropriation provides funds to the most impacted and distressed areas for disaster relief, long term-recovery, restoration of infrastructure and housing, and economic revitalization.

The CDBG-MIT[74] is administered in Texas by the Texas GLO. Eligible grantees can use CDBG-MIT assistance in areas affected by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks with typically 100 percent grants. The primary feature differentiating CDBG-MIT from CDBG-DR is that unlike CDBG-DR, which funds recovery from a recent disaster to restore damaged services, systems, and infrastructure, CDBG-MIT funds are intended to support mitigation efforts to rebuild in a way that will lessen the impact of future disasters.

The RCP[75] provides grant funding for the development, adoptions, and implementation of modern and resilient building codes and flood damage prevention ordinances to ensure that structures built within the community can withstand future hazards. This is a new program that began taking applications starting June 1, 2022, on a first-come, first serve basis.

The CDBG-MIT LHMPP[76] assists eligible entities through providing grants to develop or update local hazard mitigation plans, or to provide cost share for hazard mitigation planning activities funded through other federal sources.

The TxCDBG[77] program provides annual grants on a formula basis to small, rural cities and counties to develop viable communities by providing decent housing and suitable living environments, and expand economic opportunities principally for persons of low to moderate income. Funds can be used for public facilities such as water and wastewater infrastructure, street and drainage improvements, and housing. In Texas, the CDBG program is administered by the Texas Department of Agriculture (TDA)[78].

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[73] https://recovery.texas.gov/disasters/index.html

[74] https://www.hudexchange.info/programs/cdbg-mit/overview/

[75] https://recovery.texas.gov/mitigation/programs/resilient-communities-program/index.html

[76] https://recovery.texas.gov/mitigation/programs/local-hazard-mitigation-plans/index.html

[77] https://www.hud.gov/program_offices/comm_planning/cdbg

[78] https://texasagriculture.gov/GrantsServices/RuralEconomicDevelopment/RuralCommunityDevelopment BlockGrant(CDBG)/About.aspx

9.1.3.3 United States Army Corps of Engineers

The USACE[79] works with nonfederal 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 nonfederal 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, the USACE determines whether there is an existing authority under which the project could be considered, such as the USACE Continuing Authorities Program[80], 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 or 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 the 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 USACE also has technical assistance opportunities, including Floodplain Management Services and the Planning Assistance to States program, available to local communities.

9.1.3.4 United States Environmental Protection Agency

The CWSRF[81], administered by the United States Environmental Protection Agency (EPA) 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 nonstructural. LID projects are also eligible. The CWSRF is administered in Texas by the TWDB.

[79] https://planning.erdc.dren.mil/toolbox/library/IWRServer/2019-R-02.pdf

[80] https://www.swd.usace.army.mil/About/Directorates-Offices/Programs-Directorate/Planning-Division/CAP/

[81] http://www.twdb.texas.gov/financial/programs/CWSRF/index.asp

9.1.3.5 United States Department of Agriculture

The USDA's NRCS provides technical and financial assistance to local government agencies through the following programs: EWP Program, Watershed Protection and Flood Prevention Program, Watershed Surveys and Planning, and Watershed Rehabilitation. The EWP[82] 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[83] helps federal, state, local and tribal governments protect and restore watersheds; prevent erosion, floodwater, and sediment damage; further the conservation development, use, and disposal of water; and further the conservation and proper use of land in authorized watersheds. The focus of the Watershed Surveys and Planning[84] 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[85] helps project sponsors rehabilitate aging dams that are reaching the end of their design lives. This rehabilitation addresses critical public health and safety concerns. The USDA also offers various Water and Environmental grant and loan funding programs[86], which can be used for water and waste facilities, including stormwater facilities, in rural communities.

9.1.3.6 Special Appropriations

On occasion and when the need is large enough, Congress may appropriate funds for special circumstances such as natural disasters or pandemics (e.g., 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

[82] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

[83] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wfpo/

[84] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wsp/

[85] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/wr/

[86] https://www.rd.usda.gov/programs-services/water-environmental-programs

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. Eligible entities may request their allocation of Coronavirus SLFRF directly from the United States Department of Treasury.

Although not a direct appropriation to local governments like ARPA, the 2021 Infrastructure Investment and Jobs Act, also called the Bipartisan Infrastructure Law, authorizes more than $1 trillion for infrastructure spending across the United States 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 in this chapter, as well as creating new programs.

9.2 Barriers to Funding

Local communities encounter barriers to accessing or seeking funding for flood management activities, including lack of knowledge of funding sources, lack of expertise and staff time to apply for funding, and limited local funds available for local match requirements. The available funding programs operate independently, each with its own requirements, schedules, and financial offers. This alone constitutes a barrier to funding.

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 Local Funding. 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 federal 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.

9.3 Flood Infrastructure Financing Survey

The San Antonio RFPG surveyed sponsors of the recommended FMPs, FMEs, and FMSs that have capital costs 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

FMPs, FMEs, and FMSs**.** For the SAFPR, a first round of targeted outreach via in-person meetings, telephone calls, and emails to sponsors was used to gather preliminary information regarding funding needs for recommended FMPs, FMEs, and FMSs. If the entity did not meet to discuss the project, further contact was made via meetings, telephone calls, and emails to gather information.

To gather specific results related to financing, follow-up telephone calls were made to sponsors to clarify questions such as:

- How much funding is needed for the listed FMPs, FMEs, and FMSs?
- How much of this funding by percentage will be sought as a grant and how much will be sought as a loan?
- Have you ever received a designation from a state or local funding program that recognized some or all of your community as having fewer financial resources (such as “low to mod” from the TxCDBG program or “Disadvantaged” from the TWDB)?
- How will the loan portion of any proposed funding package be supported (fees and/or taxes)?

In general, sponsors that were smaller and/or considered to have fewer financial resources were noted as needing a 75 percent or greater grant. Conversely, sponsors that were larger and/or considered to have more financial resources were noted as needing a 50 percent or smaller grant.

9.4 Summary of Survey Results and Funding Needs

A total of 28 entities within the SAFPR sponsored the FMPs, FMEs, and FMSs that are recommended by the San Antonio RFPG. These 28 sponsors were contacted about funding needs to implement these projects, and to date, 15 have responded, which represents a response rate of 54 percent. TWDB-required Table 19 FMS, FMP, FME Funding Survey in Appendix A presents the results of the survey for each FMP, FME, and FMS. A 25/75 percent split was entered for those entities that did not respond.

The total cost for all the FMP, FME, and FMS projects recommended in the RFP is $1,260,123,000. Based on the funding split specified by each sponsor for each project, of this $1,260,123,000, it is projected that $1,061,702,322 in state and federal grant funding is needed for implementation of these projects**.**

The basic three sources of funding included federal and state grants, federal and state loans with favorable loan terms, and local financing through private sources of funds and bond issues. As noted in Section 9.1.1 Local Funding, smaller communities are often resource-limited and unable to generate funding for flood-related projects and activities. Discussions with stakeholders during outreach efforts confirmed that many communities, particularly smaller and more rural communities, do not have local funding available for flood management activities; larger communities that reported having local funding indicated relatively little local funding available in relation to overall need.

Since most federal funding programs are dependent on availability or 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 within the SAFPR 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 within the SAFPR.

9.5 Proposed Role for the State in Funding Needs

As noted in Section 9.1.1 Local Funding, the state currently provides some of the existing funding programs that sponsors are using to finance FMPs, FMEs, and FMSs. This is a critical source of funding to communities given the limited local financial resources. The large demand for funding and limited local resources, however, necessitate a critical look at the available federal and state funding programs. Questions that should be asked include:

- What improvements need to be made to the programs?
- How can an increase in funding be provided?
- How can grant funding be increased?
- How can favorable loan terms and conditions be used?
- What new funding mechanisms should be developed?

The following state agencies provide funding for flood needs:

- TWDB
- TDEM
- GLO
- TDA
- TSSWCB

- TCEQ

The sources of funding for these programs are eclectic. The state agencies receive some state money for these programs, but they also receive federal funds from agencies, including FEMA, HUD, EPA, USDA, NRCS, and USACE, as well as federal special appropriations. Each of these state and federal programs come with individual program requirements and specific funding terms, limits, and applicability. Addition, there is a large list of entities that may be able to access funding for flood-related purposes. The San Antonio RFPG offers suggestions in the following subsections regarding funding for flood-related projects. These suggestions are closely related to several of the administrative, regulatory, and legislative recommendations described in Chapter 8 Administrative, Regulatory and Legislative Recommendations.

9.5.1 Suggestion #1

The state should establish a perpetual source of funding that is dedicated to the implementation of recommendations in the RFP.

The intent is to provide a constant, sustainable source of funding for flood issues tailored to addressing flood issues.

9.5.2 Suggestion #2

The state should simplify access to its funding programs.

Items to consider would be to develop a common application for all state funding programs, consolidate state funding programs, reduce programmatic requirements, and accept studies and reports already performed to meet federal program requirements (particularly applicable to the use of state funding programs that are not solely targeted for flood needs, such as CWSRF, Dfund, and TxCDBG).

9.5.3 Suggestion #3

The state should increase grant funding and establish favorable loan terms for any loan share in its funding program.

The survey demonstrated a need for an increase in grant funding. Additionally, favorable loan terms can be equated as a means of providing a subsidy to borrowers.

Items to consider related to grants would be to increase the total amount of grant money provided by the state, increase the grant portion that is offered by the state in the funding packages, limit restrictions on the use of grant funding, and allow the RFPG to establish criteria for its own basin.

Items to consider related to loans would be to provide principal forgiveness; defer principal and interest in the debt/service schedule; offer longer loan terms; reduce required debt coverage ratios where possible; accept inferior lien positions to enable coordination with other funding programs; and offer guaranteed, subsidized, low-interest rates that are not tied to the market.

9.5.4 Suggestion #4

The state should allow the RFPG to establish funding priorities in its basin.

RFPGs should be allowed to identify priority FMPs, FMEs, and FMSs in its basin. This would enable the implementation of the grassroots, “bottom-up” planning that was established for the statewide flood planning process.

Items to consider would be to allow RFPGs to develop funding studies and projects, guide the development of cooperative agreements in the basin, facilitate basin-wide efforts, equip the region to develop funding packages between the available funding programs, apply for federal funding, and apply funding to special financial needs within the region.

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Public Participation and Adoption of Plan

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10 Public Participation and Adoption of Plan

[31 TAC §361.30–32]

10.1 Introduction

The objective of this chapter is to address how the San Antonio RFPG encouraged public participation through public meetings and online tools throughout the flood planning process, completed all activities necessary to complete and submit the Draft and Final San Antonio RFP, and obtained TWDB approval of the RFP. The San Antonio RFP satisfies the requirements of each of the 39 guidance principles identified in 31 TAC §362.3, as shown in Table 10-1.The San Antonio RFPG also certifies that the RFP will not negatively affect a neighboring area. Furthermore, the San Antonio RFP was developed based on TWDB guidance. Appendix A includes full data tables requested by TWDB, which are included in Exhibit C in the digital submission.

Table 10-1. Title 31 TAC §362.3 Guidance Principles and the Means by which Each Requirement is Met in the SARFP

Guidance Principle	Means by which Requirement is Met in RFP
(1) shall be a guide to state, regional, and local flood risk management policy;	The RFP is a guide with management goals in Chapter 3, management strategies in Chapter 5, and management and policy recommendations in Chapter 8.
(2) shall be based on the best available science, data, models, and flood risk mapping;	Best available information from a quality, coverage, and contemporary perspective were used in this RFP, for example in the Chapter 2 analyses.
(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;	The RFP examines current and future flood risk in Chapter 2, mitigation goals in Chapter 3, and strategies in Chapter 5. Maps in Appendix B show the areas of flood risks.

Guidance Principle	Means by which Requirement is Met in RFP
(4) shall, at a minimum, evaluate flood hazard exposure to life and property associated with the 0.2 percent annual chance flood event (500-year flood) and, in these efforts, shall not be limited to consideration of historic flood events;	Flood hazard exposure is evaluated and presented in Chapter 2. Maps in Appendix B show the areas of flood risks associated with different percent annual chance flood event.
(5) shall, when possible and at a minimum, evaluate flood risk to life and property associated with the 1 percent annual chance flood event (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 (100-year flood); and, in these efforts, shall not be limited to consideration of historic flood events;	Flood risks are evaluated and presented in Chapter 2, with recommended strategies and projects provided in Chapters 7 and 8.
(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;	Floodplain management practices throughout the SAFPR are mostly moderate and could be expanded as described in Chapter 3. Increased recognition of floodplains and flood risk is needed for most of the SAFPR.
(7) shall consider future development within the SAFPR and its potential to impact the benefits of flood management strategies (and associated projects) recommended in the plan;	Future development is considered in Chapters 2 and 3.
(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;	Various types of flooding risks pose a threat to life and property, including, but not limited to, riverine flooding, pluvial flooding, coastal flooding, and playa flooding, which are considered in Chapter 2.

Guidance Principle	Means by which Requirement is Met in RFP
(9) shall focus primarily on flood management strategies and projects with a contributing drainage area greater than or equal to 1 square mile 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;	Chapters 4 and 5 focus on flood management strategies and projects.
(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;	Consideration of neighboring areas is described in Chapters 4 and 5. Strategies and projects are assessed to confirm negative impacts to surrounding areas would not occur.
(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;	Infrastructure is evaluated in Chapters 4 and 5. The strategies and projects include many related to infrastructure. Chapter 9 examines the financing aspects.
(12) shall include the estimate of costs and benefits at a level of detail sufficient for RFPGs and sponsors of flood mitigation projects to understand project benefits and, when applicable, compare the relative benefits and costs, including environmental and social benefits and costs, between feasible options;	Costs drive most decision making and are discussed in most chapters, although Chapters 4, 5, and 9 present the most information regarding costs.
(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;	Flood preparation and response are described in Chapter 7.

Guidance Principle	Means by which Requirement is Met in RFP
(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;	Like costs and benefits in Chapters 4 and 5, reasonable costs to achieve reduction in flood risk are considered.
(15) shall be supported by state agencies, including the TWDB, GLO, TCEQ, TSSWCB, Texas Parks and Wildlife Department, and TDA, working cooperatively to avoid duplication of effort and to make the best and most efficient use of state and federal resources;	Agency representation is addressed in 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 5 includes recommended strategies and projects.
(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;	Chapters 4 and 5 include strategies and projects that are labeled as other, which includes NBSs. A variety of strategies and projects are included, but balance could be improved in future planning.
(18) shall contribute to water supply development where possible;	Contributions and impacts to water supply development are assessed in 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;	Contributions and impacts to water supply development are assessed in 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;	The RFP is based on the requirements of the TAC and the associated TWDB technical guidance documents.

Guidance Principle	Means by which Requirement is Met in RFP
(21) shall be based on established terms of participation that shall be equitable and shall not unduly hinder participation;	The RFP is based on the requirements of the TAC and the associated TWDB technical guidance documents. Chapter 10 directly addresses public participation.
(22) shall include flood management strategies and projects recommended by the RFPGs that are based on identification, analysis, and comparison of all flood management strategies the RFPGs determine to be potentially feasible to meet flood mitigation and floodplain management goals;	The RFPGs worked directly with the technical consultant in the development of the RFP as described in Chapter 1.
(23) shall consider land-use and floodplain management policies and approaches that support short- and long-term flood mitigation and floodplain management goals;	Land use and floodplain management policies and approaches that support short- and long-term flood mitigation and floodplain management goals are addressed in Chapter 3.
(24) shall consider natural systems and beneficial functions of floodplains, including flood peak attenuation and ecosystem services;	Chapter 3 includes natured-based goals such as attenuation and ecosystem services within the category of environmental stewardship.
(25) shall be consistent with the NFIP and shall not undermine participation in nor the incentives or benefits associated with the NFIP;	This is a primary aspect of the goals and purpose of the RFP, as stated in Chapter 1. The RFP is consistent with the NFIP.
(26) shall emphasize the fundamental importance of floodplain management policies that reduce flood risk;	Policies that reduce flood risk are a fundamental importance of the RFP and are specifically emphasize in Chapter 2.
(27) shall encourage flood mitigation design approaches that work with, rather than against, natural patterns and conditions of floodplains;	Chapter 3 includes natured-based goals to work with natural patterns and conditions within the category of environmental stewardship.
(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;	The conclusion of Chapter 6 states there are no anticipated impacts to the State Water Quality Management Plan.

Guidance Principle	Means by which Requirement is Met in RFP
(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;	These are part of the process for identifying the FMPs, FMEs, and FMSs as described in Chapter 5.
(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 5 includes recommended strategies and projects.
(31) shall include ongoing flood projects that are in the planning stage, have been permitted, or are under construction;	Chapter 1 includes discussion about proposed and ongoing flood mitigation projects.
(32) shall include legislative recommendations that are considered necessary and desirable to facilitate flood management planning and implementation to protect life and property;	Legislative recommendations along with rationale are provided in 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;	These are part of the process for identifying the FMPs, FMEs, and FMSs with the San Antonio RFPG providing the coordination, as described in Chapter 5.
(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;	The conclusion of Chapter 6 states there are no anticipated impacts to water rights.
(35) shall consider protection of vulnerable populations;	Flood risks to vulnerable populations are evaluated in Chapter 2 using the SVI. Vulnerability was then carried forward to the process for identifying FMPs, FMEs, and FMSs in Chapter 5.

Guidance Principle	Means by which Requirement is Met in RFP
(36) shall consider benefits of flood management strategies to water quality, fish and wildlife, ecosystem function, and recreation, as appropriate;	Chapter 4 recognizes the consideration of these additional benefits alongside the needs analysis results for developing strategies and projects.
(37) shall minimize adverse environmental impacts and be in accordance with adopted environmental flow standards;	Chapter 6 addresses minimizing adverse environmental impacts and meeting adopted environmental flow standards in the recommendations.
(38) shall consider how long-term maintenance and operation of flood strategies will be conducted and funded; and	Chapter 9 includes the consideration of conducting and funding O&M.
(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 recognizes the consideration of these additional opportunities alongside the needs analysis results for developing strategies and projects.

10.2 Public Participation

Stakeholder outreach and public participation are an important part of any planning process. Stakeholder participation has aided every aspect of the San Antonio RFP development, from the identification of flood risks and management and mitigation project needs to the formation of legislative and policy recommendations specific to the SAFPR.

The San Antonio RFPG provided opportunity for the public to participate in the regional flood planning process and met all requirements under the Texas Open Meetings Act and Public Information Act in accordance with 31 TAC Chapters 357.12, 357.21, and 357.50(f) during development of the *Final* 2023 *San Antonio Regional Flood Plan*. San Antonio RFPG meeting agendas and other meeting materials were posted on the SAFPR website[87] prior to each meeting. The public was invited to speak during public comment periods during each meeting.

Non-voting members of the San Antonio RFPG included representatives from the following state agencies: Texas Parks and Wildlife Department, TDEM,

[87] https://www.region12texas.org/

TDA, TSSWCB, GLO, TWDB, and TCEQ. The representatives provided input to the San Antonio RFPG and worked cooperatively to avoid duplication of effort as well as make the best and most efficient use of state and federal resources.

The San Antonio RFPG presented on “Pre-Planning Input” at the April 20 and May 14, 2021, meetings to obtain input on development of the San Antonio RFP, determine flood mitigation and floodplain management goals, and develop the process for identifying potential FMPs), FMEs, and FMSs. In compliance with the TWDB Regional Flood Planning Rules (31 TAC §361.21(h)(2)), written comments from the public were accepted for a period of 14 days prior to and 14 days after the pre-planning meeting. Public comments were also accepted at the January 4, 2022, meeting and the March 3, 2022, meeting where the San Antonio RFPG considered approval of the Technical Memorandum, which was an interim deliverable requirement. After the Draft RFP submittal on August 1, 2022, the public was allowed 30 days to comment on the Plan.

10.2.1 Public and Stakeholder Meetings

Per TWDB guidelines, two public meetings were required as part of the regional flood planning process. The first group of meetings held were to identify flood risk within the region. This was done once identification of existing information on flood risk was complete and summarized on a map. The flood risk map was shared at these public meetings to allow members of the public to identify flood risk that was not captured. This meeting was also used to receive preliminary feedback as well as gather general suggestions and recommendations that should be considered and potentially included during that regional flood planning cycle. Detailed information regarding the meeting content and data collected can be found in the public meeting summary reports, included in Appendix C. The dates and locations of the first group of meetings are:

- December 9, 2021 – Bandera, Texas
- January 11, 2022 – St. Hedwig, Texas
- February 7, 2022 – Virtual Meeting

The second group of meetings were held to receive feedback and to gather general suggestions and recommendations from the public regarding issues, provisions, and types of FMPs, FMEs, and FMSs that should be considered or addressed during that regional flood planning cycle. Detailed information regarding the meeting content and data collected can be found in the public meeting summary reports, included in Appendix C. The dates and locations of the first group of meetings are:

- June 6, 2022 – San Antonio, Texas
- June 7, 2022 – Schertz, Texas
- June 16, 2022 – Floresville, Texas

Entities with floodplain management responsibilities within the SAFPR provided information throughout development of the San Antonio RFP. Three surveys were sent out to stakeholders during a period from November 2021 through April 2022 to gather input on local flood plans, ongoing flood projects, flood mitigation needs, and other information. An online interactive map was made available from November 2021 through July 2022 on the FPR 12 website to gather public and stakeholder input regarding flood-prone areas. Individual interviews were set up with entities that were able to be successfully contacted to discuss specific flooding concerns. Representatives of flood planning entities within the SAFPR were also regularly notified of San Antonio RFPG meetings and subregional public informational meetings.

10.3 San Antonio RFPG Communications

10.3.1 Regional Website and Email Address

To communicate the activities of the San Antonio RFPG and receive input from the public and stakeholders, the San Antonio RFPG created a website[88] for the public to access. The website has been used to convey the following information.

- General SAFPR information;
- Contact information for members of the San Antonio RFPG;
- Notifications of upcoming San Antonio RFPG meetings, including a virtual meeting option using GoToMeeting software;
- Meeting archives containing past meeting agendas, supporting documentation, and meeting minutes;
- A link to a community survey to poll the level of community support for the goal statements of the San Antonio RFPG;
- Links to additional flood planning resources, including the TNRIS Flood Planning Regions Map Collection;

[88] https://www.region12texas.org

- The phone number and address to submit public comments for a particular agenda item and/or submit questions to the San Antonio RFPG;
- A link to an interactive map, which citizens used to confirm the benefitted area of proposed projects as well as indicate areas with flooding issues;
- The *Draft 2023 San Antonio Regional Flood Plan* for the public to review and provide comments; and
- The *Final 2023 San Antonio Regional Flood Plan* for the public to review.

10.3.2 ArcGIS StoryMap

An ArcGIS StoryMap[89] was created to help the citizens of the SAFPR visually understand the purpose of the San Antonio RFP and the work being completed by the technical consultants.

10.4 Coordination with Other Planning Regions

Coordination with other planning regions was accomplished primarily through the technical consultants, who coordinated data and shared information that were then reported to the RFPGs. Coordination was accomplished with adjacent RFPGs, including FPRs 10, 11, and 13. Other coordination was accomplished through the participation of San Antonio RFPG members and liaisons with adjacent RFPGs.

10.5 San Antonio Regional Flood Planning Group Meetings

The San Antonio RFPG and Outreach Committee met regularly in accordance with TWDB requirements and the approved bylaws. The purpose of the Outreach Committee was to facilitate public involvement in the planning process. The San Antonio RFPG and Outreach Committee met on a more frequent basis as needed in order to facilitate and direct the flood planning of the SAFPR. The following summarizes meeting dates for each entity:

- San Antonio RFPG meetings:
    - December 19, 2022
    - November 17, 2022
    - October 13, 2022
    - September 15, 2022

[89] As of March 2022, the StoryMap was located at: https://hdr.maps.arcgis.com/apps/MapSeries/index.html?appid=4bf56a7abed44fe9b07a450d1f95404b

  - July 25, 2022
  - June 27, 2022
  - May 26, 2022
  - April 7, 2022
  - March 3, 2022
  - January 4, 2022
  - December 16, 2021
  - November 16, 2021
  - October 26, 2021
  - September 21, 2021
  - August 17, 2021
  - June 15, 2021
  - May 14, 2021
  - April 20, 2021
  - February 9, 2021
  - December 1, 2020
  - November 2, 2020
- Outreach Committee meetings:
  - July 14, 2022
  - June 22, 2022
  - May 19, 2022
  - April 22, 2022
  - March 25, 2022
  - January 14, 2022
  - November 3, 2021
  - October 13, 2021

10.6 Public Hearing and Responses to Public Comments on the Draft Plan

The San Antonio RFPG approved the *Draft 2023 San Antonio Regional Flood Plan* for submittal to the TWDB on July 25, 2022. The *Draft 2023 San Antonio Regional Flood Plan* was submitted to the TWDB on August 1, 2022. Following the draft submittal, two meetings were held at the request of individual stakeholders to inform the public of the RFP and notify them of the comment period:

- August 17, 2022 – Leon Valley, Texas
- August 23, 2022 – Goliad, Texas

Abiding by the TWDB's rules, the Draft RFP comment period opened 30 days after the Draft RFP submittal, providing sufficient time to accept public comments according to statute to meet the January 10, 2023, deadline for submission of the adopted *Final 2023 San Antonio Regional Flood Plan.* A public hearing was held on September 15, 2022, to receive comments on the *Draft 2023 San Antonio Regional Flood Plan.* Hard copies of the *Draft 2023 San Antonio Regional Flood Plan* were provided as required and the RFP was posted on the SAFPR website for public review and comment.

During the comment period, a total of 13 comments were received, 5 from organizations within the SAFPR, including Texas Parks and Wildlife Department, Camp Bullis Sentinel Landscape Partnership, Greater Edwards Aquifer Alliance, National Wildlife Federation, and Great Springs Project. These organizations submitted letters as their public comments. The letters contain recommendations for the TWDB regarding the flood planning process, SFP, and other considerations. Additionally, on October 21, 2022, the TWDB provided their own comments on the Draft RFP. All comments received on the *Draft 2023 San Antonio Regional Flood Plan* and associated responses are included in Appendix D and were incorporated into the *Final 2023 San Antonio Regional Flood Plan*.

10.7 Plan Adoption

The *Draft 2023 San Antonio Regional Flood Plan* was developed and adopted in accordance with 31 TAC §361.50 and §361.60–361.61. The San Antonio RFPG approved and adopted the *Final 2023 San Antonio Regional Flood Plan* on December 19, 2022, and directed the SARA and technical consultant to submit the *Final 2023 San Antonio Regional Flood Plan* to the TWDB on January 10, 2023.