Task 4B – Identification and Evaluation of Potential Flood Management Evaluations, Potentially Feasible Flood Management Strategies, and Flood Mitigation Projects

4B.1 Process to Identify Flood Management Evaluations (FME), Flood Management Strategies (FMS), and Flood Mitigation Projects (FMP)

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

- **Flood Management Evaluation (FME)**: a proposed flood study of a specific, flood-prone area that is needed to assess flood risk and/or determine whether there are potentially feasible FMSs or FMPs.
- **Flood Mitigation Project (FMP)**: a proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring cost and when implemented will reduce flood risk, mitigate flood hazards to life or property
- **Flood Management Strategy** (**FMS**): is a proposed plan to reduce or mitigate flood hazards to life or property.

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

A list of the relevant documents for the first flood plan are found in Table X and Appendix X.

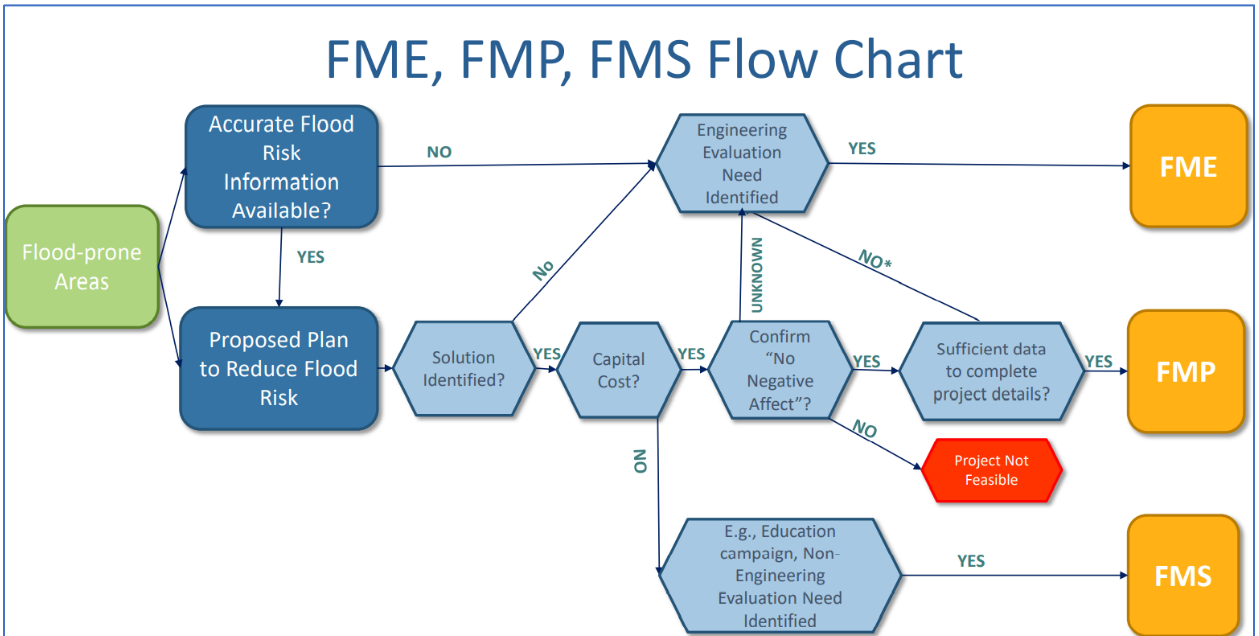
4B.2 Classification of Potential FMEs and Potentially Feasible FMSs and FMPs

The *Technical Guidance* included a summary of different general action types, listed below in **Table 4.7** After potential flood risk reduction actions were identified, a high-level screening process was used to confirm that potential actions had been sorted into their appropriate category. The screening process is shown in **Figure 4.12.**

Table 4.7 General Flood Risk Reduction Action Types

Flood Risk Reduction Action Category	Action Types
FME	a. Watershed Planning i. H&H Modeling ii. Flood Mapping Updates iii. Regional Watershed Studies b. Engineering Project Planning i. Feasibility Assessments c. Preliminary Engineering (alternative analysis and up to 30% design) d. Studies on Flood Preparedness
FMP	**Structural** a. Low Water Crossings or Bridge Improvements b. Infrastructure (channels, ditches, ponds, stormwater pipes, etc.) c. Regional Detention d. Regional Channel Improvements e. Storm Drain Improvements f. Reservoirs g. Dam Improvements, Maintenance, and Repair h. Flood Walls/Levees i. Coastal Protections j. Nature Based Projects – living levees, increasing storage, increasing channel roughness, increasing losses, de-synchronizing peak flows, dune management, river restoration, riparian restoration, run-off pathway management, wetland restoration, low impact development, green infrastructure k. Comprehensive Regional Project – includes a combination of projects intended to work together.
	Non-Structural a. Property or Easement Acquisition b. Elevation of Individual Structures c. Flood Readiness and Resilience d. Flood Early Warning Systems, including stream gauges and monitoring stations e. Floodproofing f. Regulatory Requirements for Reduction of Flood Risk
FMS	None specified; RFPGs were instructed to include at a minimum any proposed action that the group wanted to consider for inclusion in the plan that did not qualify as either an FME or FMP.

Figure 4.12: Potential Flood Risk Reduction Action Screening Process



*Please refer to Exhibit C Figure 5: FMP flowchart.

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

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

4B.3 Evaluation of Potential FMEs

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

- Hazard Mitigation Action Plans (HMAP)
- Capital Improvement Plans
- Drainage Master Plans
- Previous Community Flood Studies

- Flood Infrastructure Fund (FIF) applications not chosen for funding
- Stakeholder input

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

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

FME Types

The definition of an FME allows for a variety of study types to help assess flood risk and potentially define future FMPs and FMSs. A general list of study types was previously summarized in **Table 4.7** above. The following section describes these project types in more detail and provides a summary of the different potential FMEs identified in Region 11.

Watershed Planning

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

- Flood Modeling and Mapping Updates
- Drainage Master Plans
- Watershed Studies

Engineering Project Planning

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

- Culvert and Low Water Crossing Improvements
- Road/Bridge Improvements
- Creek Improvements for Conveyance, Erosion Control, and Stabilization
- Storm Drain Improvements
- Detention
- Buyouts/Elevation
- Floodproofing and Hardening Critical Facilities

Flood Preparedness Studies

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

- Dam Evaluations, Breach Mapping, and Evacuation Planning
- Improving Ingress/Egress Routes for Emergency Responders

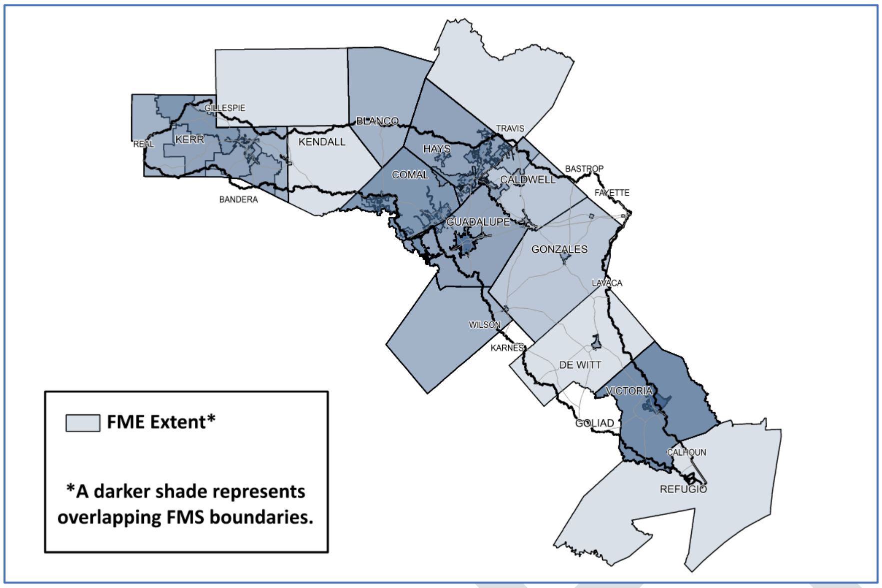
FME Classification Summary

A summary of identified FMEs is provided in **Table 4.8** and supporting technical information is presented in TWDB-Required **Table 12 (Appendix X)**. In total, 136 potential FMEs were identified and evaluated. The geographical distribution of the identified FMEs is shown in **Figure 4.13**.

Table 4.8: FME Types and General Description

FME Type		Description	Number
Watershed Planning	Drainage Master Plans, Other Community-Scale Plans	Supports the development and analysis of hydrologic and hydraulic models to evaluate flood risk within a given jurisdiction, evaluate potential alternatives to mitigate flood risk, and develop capital improvement plans.	26
	H&H Modeling, Regional Watershed Studies	Supports the development and analysis of hydrologic and hydraulic models to define flood risk or identify flood prone areas OR Large-scale studies that are likely to benefit multiple jurisdictions.	10
	Flood Mapping Updates	Promotes the development and/or refinement of detailed flood risk maps to address data gaps and inadequate mapping. Create FEMA mapping in previously unmapped areas and update existing FEMA maps as needed.	2
Project Planning	Engineering Project Planning	Evaluation of a proposed project to determine whether implementation would be feasible OR Initial engineering assessment including conceptual design, alternative analysis, and up to 30 percent engineering design.	91
Preparedness	Studies on Flood Preparedness	Encourages preemptive evaluations and strategies to better prepare an area in the event of flood.	6

Figure 4.13: Geographical Distribution of Potential FMEs



Planning Level Cost Estimates

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

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

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

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

Sponsor-provided costs were utilized for all FMEs entailing flood mapping updates or large-scale hydrologic and hydraulic modeling, as described in **Table 4.8**. The costs provided by Sponsors were reviewed for reasonableness based on the information available and validated before inclusion as cost-level estimates in this plan.

Project Planning – Engineering Project Planning

Engineering project planning considers two important components: the evaluation of a proposed project to determine whether implementation would be feasible (conceptual design), and an initial engineering assessment including alternative analysis and up to 30 percent engineering design. Each evaluation area is project-specific and varies due to the wide range of potential improvements in channels, culverts and low water crossings, roads and bridges, storm drain systems, and stream stabilization.

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

Studies on Flood Preparedness

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

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Process to Determine Flood Risk Indicators

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

Comparison and Assessment of FMEs

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

Determination of Emergency Need

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

4B.4 Evaluation of Potentially Feasible FMPs and FMSs

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

Potentially Feasible FMPs

The RFPG identified 37 potentially feasible FMPs. The geographical distribution of each identified FMP is shown in **Figure 4.14** with technical information for each FMP summarized in **Table 13 (Appendix 4).** Each project is unique, and the specific FMPs recommended by the RFPG will be described in detail in Chapter 5. A general description of the potentially feasible FMPs is presented in **Table 4.9**.

Table 4.9: Summary of FMP Types

FMP Type	General Description	Number of FMPs Identified
Stormwater Infrastructure Improvements	Improvements to stormwater infrastructure including channels, ditches, ponds, stormwater pipes, etc.	14
Roadway Drainage Improvements	Improvements to roadway drainage infrastructure including side ditches, culvert crossings, bridge crossings, etc.	6
Regional Detention Facilities	Runoff control and management via detention facilities.	10
Property Acquisition	Voluntary acquisition of flood prone structures.	1

Flood Warning Systems	Install gauges, sensors, or barricades to monitor streams and low water crossings for potential flooding and support emergency response.	2
Emergency Generators	Purchase and install emergency generators at critical facilities	4

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

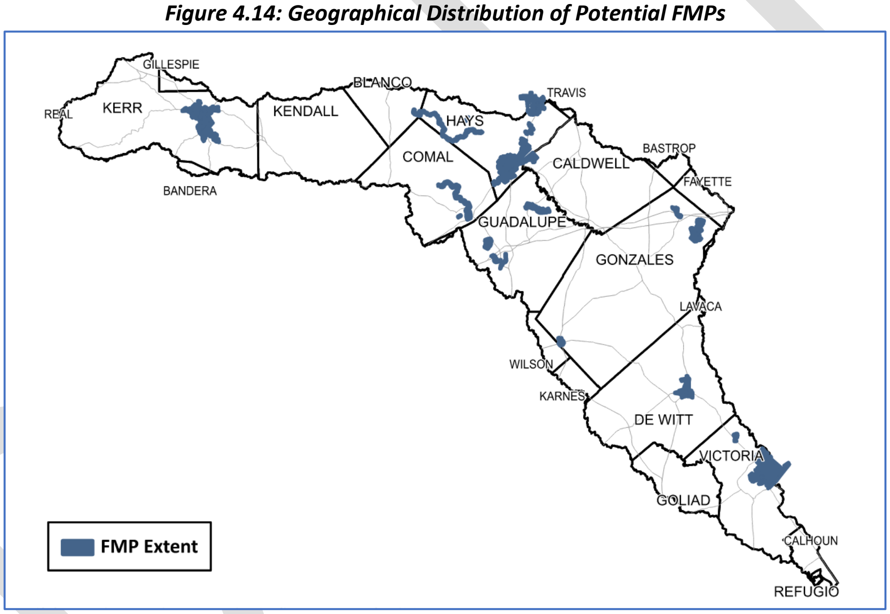
Table 4.10 Potentially Feasible FMPs

FMP ID Number	Name	Sponsor
113000001	Detention on the Blanco River	Blanco County
113000006	Plum Creek Tributary 3 Arbor Knot Dr. Improvement	City of Kyle
113000007	Plum Creek Tributary 4 Sledge Rd. Improvement	City of Kyle
113000008	Plum Creek Tributary 4 FM 150 Improvement	City of Kyle
113000009	80ft Channel Modification and Additional Culvert	City of Kyle
113000010	65ft Channel Modification and Additional Culvert	City of Kyle
113000011	Plum Creek Detention Pond Upstream of IH35	City of Kyle
113000013	Wood Road/Landa Street Drainage Improvement	City of New Braunfels
113000015	Improve Flood Warning Systems	City of San Marcos
113000026	Purgatory Creek Channel Improvement	City of San Marcos
113000027	Sherwood/Kingwood Drainage Improvements	City of San Marcos
113000035	Guadalupe Street Automatic Flood Gates	City of Seguin
113000036	Baldridge Creek Regional Detention Pond	City of Waelder
113000037	Baldridge Creek Channel and Culvert Improvement	City of Waelder
113000039	Wilson Creek - Green Acres Dr. Improvement	City of Wimberley
113000040	Regional Detention South of Mountain Crest Drive	City of Woodcreek
113000041	Improvements to Brookside Drive Culvert Crossing	City of Woodcreek
113000042	Brookmeadow Drive Drainage Improvements	City of Woodcreek
113000044	Regional Detention on Bear Creek	Comal County
113000046	Flood Warning System & Stream Gage Network	DeWitt County Drainage District #1
113000047	Regional Detention on Peach Creek	Gonzales County
113000049	Lake McQueeney Spillgate Replacement and Dam Armoring	Guadalupe Blanco RA
113000050	Lake Placid Spillgate Replacement and Dam Armoring	Guadalupe Blanco RA
113000052	Kerr County Back-up Power Generators	Kerr County
113000057	Spring Street Erosion at Outfall Project	City of Kerrville
113000058	Clay Street Drainage and Kroc Center Detention Pond Spillway	City of Kerrville
113000059	Coronado Drive and Junction Highway Drainage Improvements	City of Kerrville
113000060	City of Victoria Back-up Power Generators	City of Victoria

113000061	City of Buda-Lifschutz Headwaters Voluntary Buyout	City of Buda
113000062	City of Nixon-Wastewater System Flood Improvments	City of Nixon
113000063	City of San Marcos-Emergency Generators	City of San Marcos
113000064	Victoria County-Emergency Generators	Victoria County
113000065	City of Seguin Regional Detention Southwest of Seguin City Limits	City of Seguin
113000066	City of Seguin - Culvert Improvements at Guadalupe River Drive	City of Seguin
113000067	City of Victoria Channel and Bridge Modifications on Highway 87	City of Victoria
113000068	City of Victoria Detention Upstream of State Highway 87	City of Victoria
113000069	Guadalupe County Detention on York Creek Project	Guadalupe County

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

Figure 4.14: Geographical Distribution of Potential FMPs



Potentially Feasible FMSs

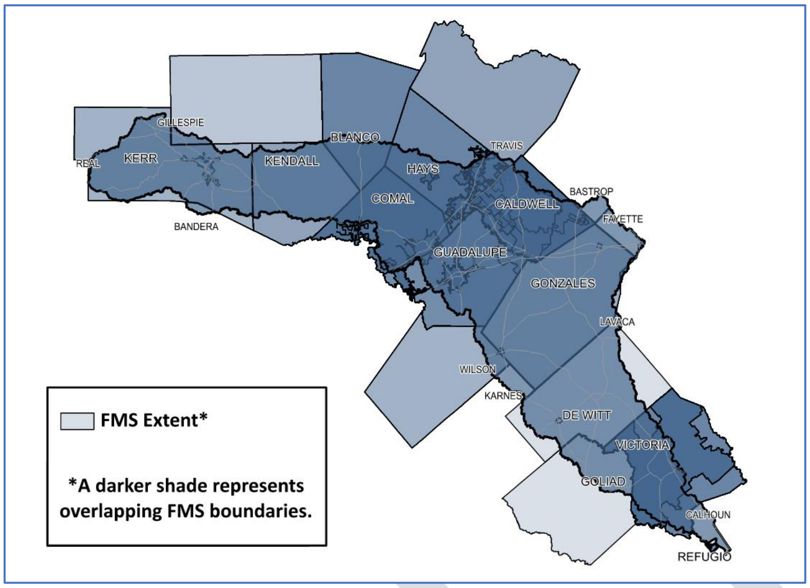
The RFPG identified approximately 185 potentially feasible FMSs and the geographical distribution of each identified FMS is shown in **Figure 4.16**. with technical information for each FMS summarized in TWDB-required **Table 14 (Appendix 4).**

A variety of FMS types were identified. Some establish and implement public awareness and educational programs to better inform communities of the risks associated with flood waters. Other FMSs improve preventative maintenance programs to maximize operational efficiency of existing stormwater management infrastructure, develop stormwater management manuals to encourage best management practices, or setup programs to establish community-wide flood warning systems. A few property acquisition programs were also identified. These programs include a variety of purposes such as acquiring floodplain and environmentally sensitive areas to convert them into open space land and acquisition of repetitive loss structures. A summary listing of FMS types is provided in **Table 4.11**.

Table 4.11: Summary of FMS Types

FMS Type	General Description	Number of FMSs Identified
Education and Outreach	Develop a coordinated education, outreach, and training program to inform and educate the public about the dangers of flooding, flood insurance, how to prevent flood damages to property, and training..	61
Flood Measurement and Warning	Install gauges, barricades, signage and improvements to increase low water crossing safety; create or enhance evacuation plans; improve community preparedness.	45
Infrastructure Projects	General city- and countywide Programs to develop and implement flood reduction projects.	16
Property Acquisition and Structural Elevation	Acquire, relocate, and/or elevate flood-prone structures. Acquire floodplain and protect environmentally sensitive areas by converting floodplain encroachments into open space land.	31
Regulatory and Guidance	Review, updates, enhance Flood Damage Prevention Ordinances and development practicies. Consider incorporating higher standards..	31
	Develop and adopt “green infrastructure” programs and incorporate regulatory standards to protect open space in flood prone areas.	
	Join the FEMA Cooperating Technical Partners (CTP) program to lower flood insurance rates for residents	

Figure 4.16: Geographical Distribution of Potential FMSs



Potentially Feasible FMS Comparison and Assessment

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

Thirty-six sponsors requested flood awareness and safety education support. These FMSs range from implementing the National Weather Service’s “StormReady” campaign to general education in regards the NFIP, flood insurance campaigns, and training.

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

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

Effects on Neighboring Areas of FMSs or FMPs

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

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

1. Stormwater does not increase inundation in areas beyond the public right-of-way, project property, or easement.
2. Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity.
3. Maximum increase of 1D Water Surface Elevation must round to 0.0 feet (< 0.05ft) measured along the hydraulic cross-section.
4. Maximum increase of 2D Water Surface Elevations must round to 0.3 feet (< 0.35ft) measured at each computational cell.
5. Maximum increase in hydrologic peak discharge must be < 0.5 percent measured at computational nodes (sub-basins, junctions, reaches, reservoirs, etc.). This discharge restriction does not apply to a 2D overland analysis.

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

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

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

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

Estimated Benefits of FMP or FMS

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

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

These estimated benefits were produced from geospatial data (where available) by analyzing the existing 1% and 0.2% annual chance floodplain boundaries with the proposed post-project floodplain boundaries. These proposed flood risk conditions were compared to the existing conditions flood risk indicators for a given area to quantify the reduction of flood risk achieved by implementation of an FMP or FMS. Where geospatial data was not available, data was extracted from the available studies and reports. The results of the analysis are shown for each FMP or FMS in **Table 13** and **Table 14**, respectively.

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

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

Environmental

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

1. What is the quantity of water required by the state's rivers/estuaries to sustain a sound ecological environment?
2. How can this water be protected?

3. What is the appropriate balance between water needed to sustain a sound ecological environment and water needed for human or other uses?

FMSs or FMPs in the region should consider potential impacts as it relates to the ecological flows established under the directive of SB3. Because none of the proposed FMSs or FMPs involved permanent detention or retention therefore, there are no anticipated impacts to base or environmental flows. In fact, short-term detention for peak flood attenuation may improve base flow slightly.
Several of the proposed actions involve protecting or improving riparian corridors through regulation, acquisition, and erosion prevention/repair. These types of actions would have direct and indirect environmental benefits by minimizing erosion and restoring natural stream function.

Agricultural

According to the Texas A&M AgriLife Extension Service economists, Hurricane Harvey caused more than $200 million in crop and livestock losses in Texas. Flood waters have the potential to destroy standing crops, create water-logged conditions that delay planting or harvesting, wash away productive topsoil, and damage farm equipment and infrastructure. FMS or FMP potentially reduce extremely high flows in rivers and streams thereby preventing flood waters from inundating areas outside of the floodway including agricultural areas. Structural FMS or FMP like small flood control ponds also have the potential to assist in agricultural production by serving dual purpose of flood mitigation and water supply. Non- structural FMS or FMP have similar impacts on flood peak flow reduction and flooding including agricultural conservation practices such as such as conservation tillage, residue management, cover crops and furrow dikes. These practices not only reduce downstream flooding by reducing surface runoff and increasing infiltration on agricultural lands but also sediment and nutrient losses thereby improving downstream water quality.

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

Recreational Resources

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

Navigation

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

Water Quality, Erosion, and Sedimentation

Water quality, erosion, and sedimentation are complex and interrelated issues. Water quality usually relates to nutrient and bacterial loading, but also includes turbidity, which relates to sediment load. Most water quality issues are influenced by upland portions of the watershed, while sedimentation and erosion are impacted by channel dynamics. These issues have been of significant concern to the region in part due to the topography and geology of the basin which transitions from generally steep and rocky in the mid- to upper basin to flatter alluvial soils in the lower basin.

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

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

Estimated Capital Cost of FMPs and FMSs

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

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

Cost estimates presented in this section are for planning purposes only and are not supported by detailed scopes of work or workhour estimates. The RFPG anticipates that the local sponsor will develop detailed scopes of work and associated cost estimates prior to submitting any future funding application through TWDB or other sources.

Benefit-Cost Ratio for FMPs

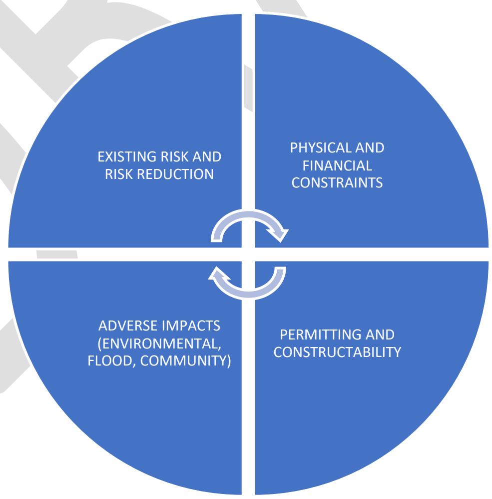
Benefit-Cost Analysis (BCA) is the method by which the future benefits of a hazard mitigation project are determined and compared to its costs. The result is a Benefit-Cost Ratio (BCR), which is calculated by dividing the project's total benefits, quantified as a dollar amount, by its total costs. The 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 (Federal Emergency Management Agency, 2009). However, a BCR greater than 1.0 is not a requirement for inclusion in the Regional Flood Plan. The RFPG can recommend a project with a lower BCR with appropriate justification.

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

Residual, Post-Project, and Future Risks of FMPs

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

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



As a result of finding the right balance, it is not uncommon for flood control projects to be designed to a storm smaller than the 100-year event. This does not mean projects should not evaluate the 100-year storm nor does it mean they will not provide risk reduction for the larger storms, rather it means the community needs to understand what the residual risk will be. Common examples include flooding in developed areas where limited right-of-way and utility conflicts can limit the size or impart a significant financial burden, or creek crossings where construction of a bridge is not practicable due to topography, right-of-way, and costs.

In general, residual and future risks for FMPs could be characterized as follows:

1) Flood events may exceed the level of service for which infrastructure is designed.
2) Potential failure or overtopping of dams and levees.
3) Lack of routine maintenance to maintain, repair, or replace design capacity (storage, conveyance, etc.).
4) Policy changes that adversely impact budgets, prior plans, assets, and design or floodplain management standards.
5) Human behavior is unpredictable, and people may choose to ignore flood warning systems or cross over flooded roadways for a variety of reasons.

Implementation Issues of FMPs

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

Because a right-of-way is a public use on private land, it can create issues when securing access to projects for construction and maintenance. The acquisition of right-of-way or other property and utility relocation located near or on property impacted by a project requires close coordination between government agencies, private entities, and landowners. Coordination and early engagement with the appropriate entities is key to facilitating projects.

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

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

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

4B.5 Potential Funding Sources

A wide variety of funding opportunities could be utilized to fund the identified actions. Traditionally, stormwater and flood mitigation project funding sources have either been locally sourced user fees, ad valorem taxes, and bonds; or externally by state and federal loans or grants. For most communities the loan programs usually can offer low-interest rates than the communities can obtain on their own, regardless of that entities credit rating. Regardless of the interest rates many small and financially stressed communities find it difficult to cover the debt service. Therefore, many communities struggle to implements flood mitigation through a “pay-as-you-go” method of funding and, in the event of a disaster, applying for state and federal disaster recovery grants.

Today, communities have a broader range of funding sources and programs available than anytime in past including the FEMA Building Resilient Infrastructure and Communities (BRIC) and the TWDB Flood Infrastructure Fund (FIF) but funding flood mitigation is still a significant challenge. The potential funding sources for the identified FME, FMP and FMS are listed in **Tables 12**, **13** and **14**, respectively (see **Appendix X**). Further details on funding opportunities and the anticipated funding sources for the recommended actions are included in **Chapter 9**.