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

The objective of **Task 5** is for the Trinity Regional Flood Planning Group (RFPG) to use the information developed under **Task 4** to recommend flood mitigation actions, including Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) for inclusion in the Trinity Regional Flood Plan. While **Chapter 4B** discussed the technical evaluations of the potential FMEs and potentially feasible FMSs and FMPs identified by the Trinity RFPG, **Chapter 5** focuses on how the Trinity RFPG used this data to make a recommendation for a given flood mitigation action. Generally, this chapter summarizes and documents:

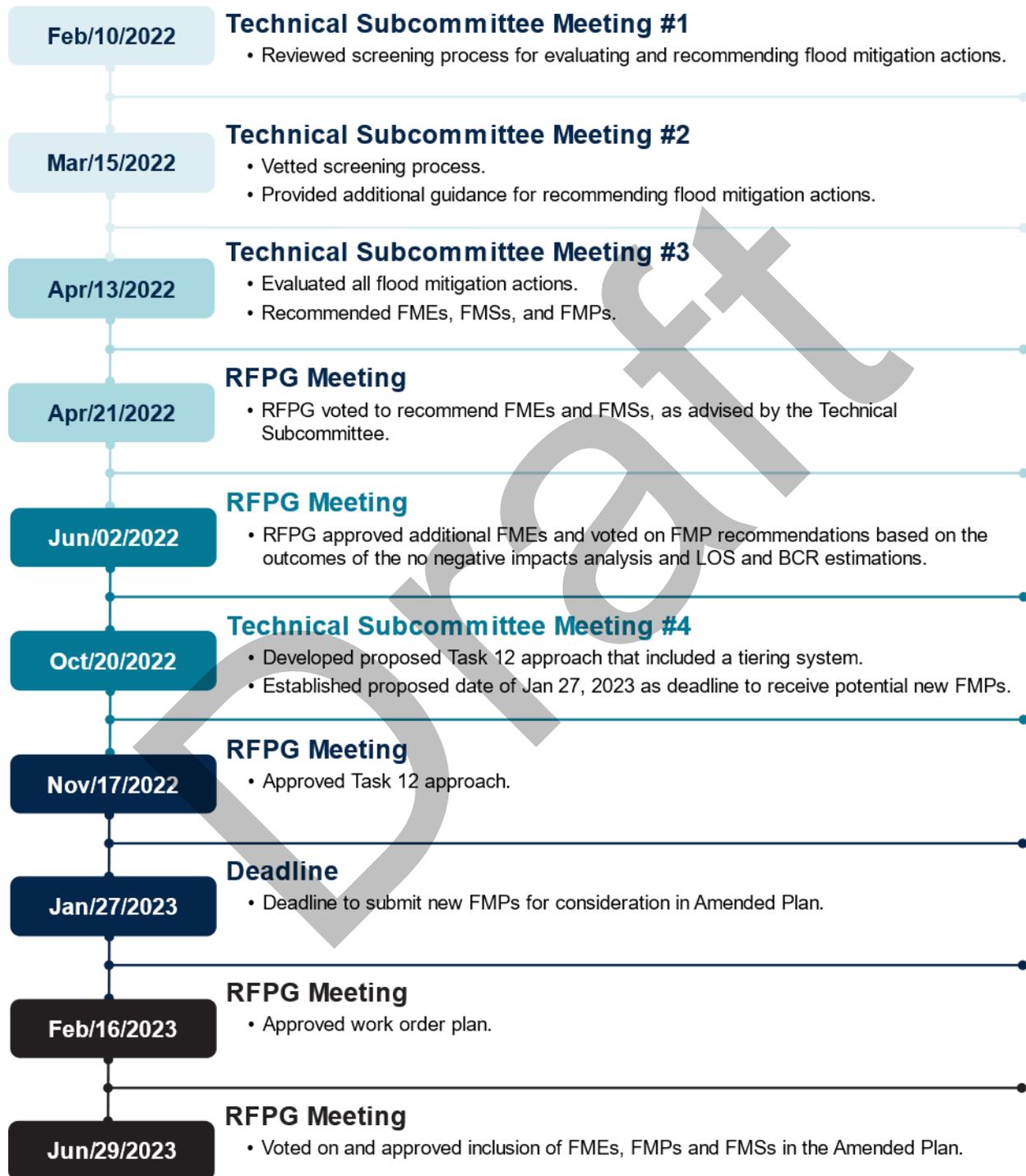
- The process undertaken by the Trinity RFPG to make final recommendations on the given flood mitigation action types
- The potential FMEs and potentially feasible FMSs and FMPs identified and evaluated under **Task 4B**, and whether these actions are recommended by the Trinity RFPG

While there is abundant need across the region and the state for better, recent, and more widely available data on flood risk, it is evident that not every conceivable flood mitigation action can be recommended in the Trinity Regional Flood Plan or included in the State Flood Plan. The Trinity RFPG evaluated the identified potential flood mitigation actions and based on the significant needs in the region, recommended those that met the Texas Water Development Board (TWDB) requirements, with the understanding that not all recommendations may be performed in the same planning cycle as they are identified. Finally, all recommendations considered alignment with Trinity RFPG-adopted flood mitigation and floodplain management goals.

Trinity Regional Flood Planning Group Evaluation and Recommendation Process

The Trinity RFPG considered recommendations on flood mitigation actions through a multi-step process. The Trinity 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 Trinity RFPG for formal approval. **Figure 5.1** provides a timeline and key decisions of the Trinity RFPG evaluation and recommendation process.

Figure 5.1 Trinity Regional Flood Planning Group Evaluation and Recommendation Process Timeline



The general methodology included a screening of all potential flood mitigation actions considering TWDB requirements for inclusion in the Regional Flood Plan and any other additional considerations established by the Technical Subcommittee. The reasons for not recommending a particular flood mitigation action were clearly documented as part of the evaluation and recommendation process.

The first Technical Subcommittee meeting was held on February 10, 2022. This meeting focused on reviewing the proposed screening process for evaluating and recommending flood mitigation actions. This process is summarized in **Figure 5.2** for FMEs and in **Figure 5.3** for FMPs and FMSs. The process was primarily developed following the TWDB rules and requirements for inclusion in the plan. However, the TWDB left some evaluation criteria to the discretion of each individual RFPG to implement in the screening process. The main discretionary evaluation criteria included the Level of Service (LOS) to be provided by an FMP and the Benefit-Cost Ratio (BCR) for the project.

The TWDB recommends that, at a minimum, FMPs should mitigate flood events associated with the 1% annual chance storm event (100-year LOS). However, if a 100-year LOS is not feasible, the Trinity RFPG can document the reasons for its infeasibility and still recommend an FMP with a lower LOS. Similarly, the TWDB recommends that proposed actions have a BCR greater than one, but the Trinity RFPG may recommend FMPs with a BCR lower than one with proper justification.

During the second Technical Subcommittee meeting held on March 15, 2022, the participants provided a series of sample evaluations to demonstrate how the screening process would be implemented and requested feedback on the discretionary evaluation criteria. The Technical Subcommittee vetted the process and provided the following additional guidance to determine whether a flood mitigation action may be recommended:

- The Trinity RFPG will not require confirmation from potential sponsors to support a flood mitigation action as a prerequisite for recommendation. (see Sponsor Outreach section)
- All potential actions should be considered for inclusion in the plan unless an entity specifically declines to be listed as a sponsor and no other appropriate potential sponsor is identified.
- If a potential flood mitigation action falls within multiple flood planning regions, the Trinity RFPG will consider recommending that action for the portion that falls within Trinity RFPG's jurisdiction.

Figure 5.2: Flood Management Evaluation Screening Process

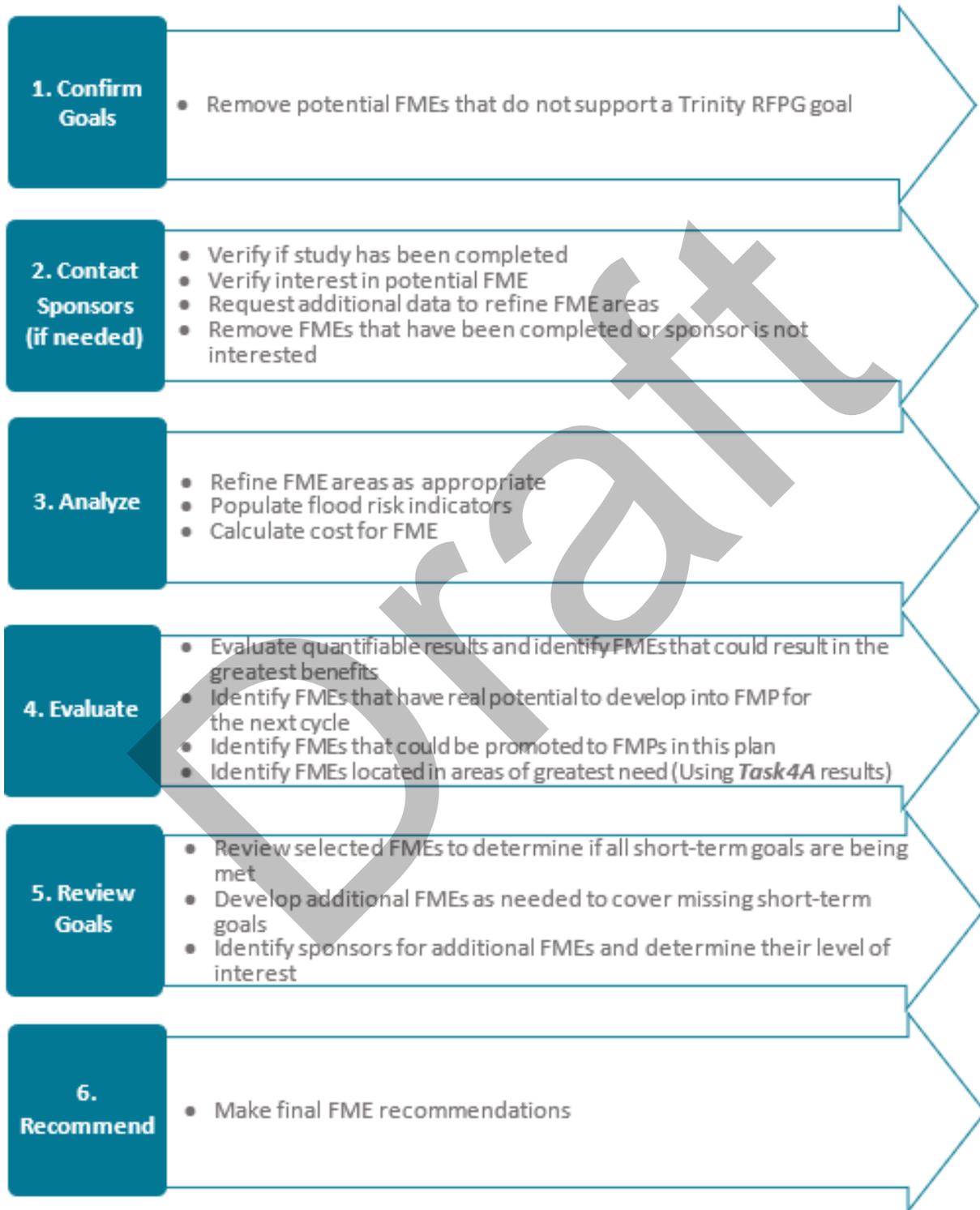
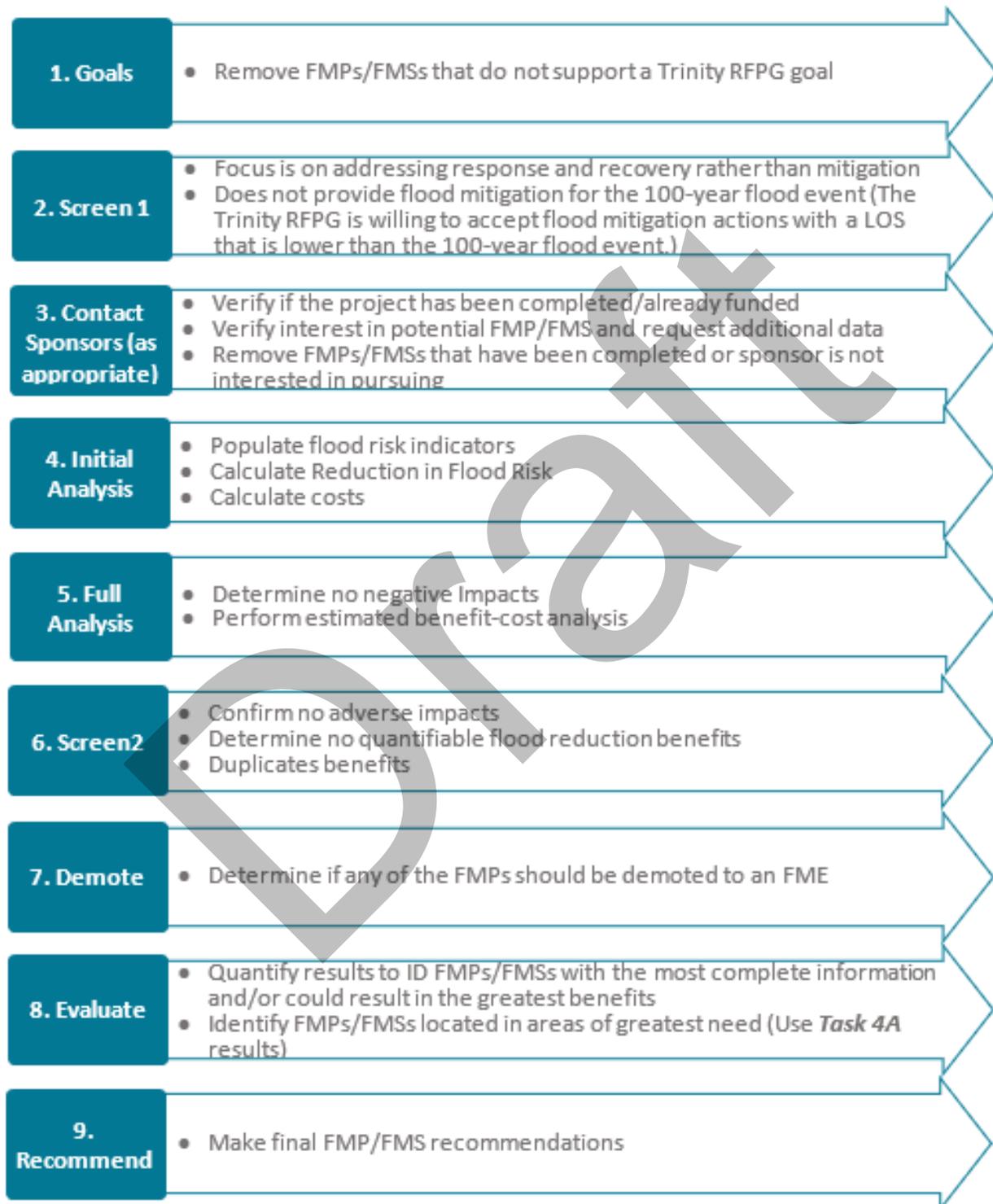


Figure 5.3: Flood Management Project and Flood Management Strategy Screening Process



- The Trinity RFPG is willing to accept flood mitigation actions with a LOS that is lower than the 100-year flood event. The Trinity RFPG team shall determine the estimated LOS for each FMP and the Trinity RFPG will make the final determination for its recommendation.
- The Trinity RFPG is willing to accept an FMP with a BCR less than one. The Trinity RFPG team shall determine the estimated BCR for each FMP based on readily available data and/or generalized assumptions. The Trinity RFPG will make the final determination regarding each FMP recommendation.

The RFPG team applied the screening process based on the technical data developed under **Task 4B** and the Technical Subcommittee guidance. An initial recommendation for each flood mitigation action was presented to the Technical Subcommittee on April 13, 2022. This working session allowed for multiple adjustments to the flood mitigation action lists, including additions of new FMEs and FMSs, merging multiple FMEs or FMSs into one action, and enhancing project descriptions. All FMEs and FMSs were reviewed, and those that met all screening criteria were selected for recommendation. All FMPs were recommended contingent upon confirmation of no negative impacts and a completion of estimated LOS and BCR estimations.

On April 21, 2022, the Trinity RFPG voted to recommend FMEs and FMSs, as advised by the Technical Subcommittee. The Trinity RFPG approved these FMEs and FMSs with the understanding that they could revisit them at a future meeting if new information warranted additional discussion and possible action.

Finally, on June 2, 2022, the Trinity RFPG approved additional FMEs received since the last Technical Subcommittee meeting and voted on FMP recommendations based on the outcomes of the no negative impacts analysis and the LOS and BCR estimations. These were included in the Draft and Final Flood Plans.

The regional flood plan was developed on an expedited schedule to meet legislative requirements. The regional flood planning groups expressed concern that the time constraint limited local jurisdiction participation. In response, the TWDB authorized **Tasks 12 and 13** to provide additional time and budget to develop an Amended Plan by July 14, 2023.

The Technical Subcommittee reconvened on October 20, 2022, to develop an approach to incorporate as many new FMPs as possible in the Amended Plan. The Technical Subcommittee provided guidance to the proposed approach, including an outreach plan, tiering criteria for FMPs, and a deadline for all potential new FMEs, FMPs, and FMSs. Although the focus was on FMPs, the Technical Subcommittee recognized that the information received may not meet the TWDB's project criteria. Therefore, a single deadline for all new potentially feasible flood mitigation actions was recommended.

On November 17, 2022, the RFPG met and approved the Technical Subcommittee’s recommendations for **Task 12**. The RFPG established January 27, 2023, as the deadline for potential new FMEs, FMPs, and FMSs to be submitted for consideration in the first Amended Plan. The RFPG subsequently approved the Work Order of FMPs at its meeting on February 16, 2023. On June 29, 2023, the RFPG held a regularly scheduled meeting at which time it approved the recommended FMEs, FMPs, and FMSs for inclusion in the first Amended Plan.

A second amendment cycle was held from October 2024 to December 2024. The Trinity RFPG solicited additional flood mitigation actions from the communities within the Trinity region. As a result, 15 communities responded with eight FMEs, 31 FMPs, and six FMSs. The RFPG met on March 12, 2025 to review, recommend, and approve the submitted actions for approval in the second Regional Flood Plan amendment.

All meetings were held in accordance with the requirements of the Trinity RFPG bylaws, the Texas Open Meetings Act, the general requirements of the Texas Water Code, and the TWDB’s flood planning process requirements. Additional details regarding the flood mitigation action evaluation process and final recommendations are provided in subsequent sections.

Sponsor Outreach

A supplemental effort to contact potential sponsors was conducted to obtain clarification on flood mitigation actions where there was significant uncertainty regarding their location and/or scope of work. Feedback from potential sponsors was requested via email. These outreach emails included a one-page summary of the potential flood mitigation action with a map showing its approximate location, allowing the potential sponsors to view the potential actions for their entity. In addition, potential sponsors were encouraged to provide any other flood mitigation action of their interest for the Trinity RFPG to consider for inclusion in the regional flood plan. Several conference call meetings were held following this outreach effort, which resulted in multiple positive outcomes for the flood planning process. Potential sponsors were able to fill in data gaps, identify actions that were already completed or had allocated funding, add new actions for consideration, and confirm interest in including the identified potential actions in the Final Trinity Regional Flood Plan.

Due to schedule limitations, this outreach effort targeted potential flood mitigation actions with the greatest data gaps. Because flood mitigation actions must be included in the regional flood plan to be eligible for future state funding from the TWDB, the Trinity RFPG decided that an affirmative willingness to sponsor a given action would not be a prerequisite for inclusion in the plan. As a result, all potential actions were considered for inclusion unless an entity had specifically declined to be listed as a sponsor and no other appropriate potential sponsor was identified. This approach was adopted because:

- It provides a conservative estimate of the flood mitigation needs in the region.

- It does not obligate an entity to sponsorship; it simply allows an entity to be eligible for funding if interest in and capacity to sponsor an action becomes evident before the next regional flood plan is adopted.

The RFPG implemented an outreach program between November 2022 and January 2023 soliciting new FMPs, FMEs, and FMSs for potential inclusion in the first Amended Plan. The outreach program included multiple emails, a website notification posting, and meetings with the consultant team as requested by potential sponsors.

It is important to note that all sponsors associated with recommended actions subsequently received a survey to communicate that they were identified as a sponsor and were asked to provide information for potential funding sources for the actions listed in the plan. This effort is detailed in **Chapter 9**.

An outreach effort was also initiated to support the second amendment to the Regional Flood Plan. The RFPG distributed e-blasts requesting flood mitigation actions for inclusion and followed up with any interested entities with additional email communications and phone calls. In all, 15 communities responded to the second amendment cycle. The opportunity was also posed on the RFPG website and social media platforms.

Flood Management Evaluations

Summary of Approach in Recommending Flood Management Evaluations

The Trinity RFPG evaluated the identified potential FMEs and based on the significant needs in the region, recommended all FMEs that met the TWDB requirements, with the understanding that not all FMEs may be performed during the same planning cycle as they are identified. Recommended FMEs were also required to demonstrate alignment with at least one regional floodplain management and flood mitigation goal developed in **Chapter 3**. Finally, each recommended FME should identify and investigate at least one solution to mitigate the 1% annual chance storm event. It is the intent that all FMEs with a Hydrologic and Hydraulic (H&H) modeling component will evaluate multiple storm events, including the 1% annual chance storm event. The exact solutions identified through performing these FMEs cannot be defined at this time. However, it is anticipated that an impact analysis will be performed for all alternatives and project benefits will be tabulated for the 100-year storm to inform any recommended alternatives and to define potentially feasible FMPs under this planning framework. Based on these TWDB requirements, the Trinity RFPG identified and recommended two main types of FMEs:

1. **FMEs that would result in increased flood risk modeling and mapping coverage across the region 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. Second, FMPs, and in some cases, FMSs, require a demonstrated potential reduction in flood risk to be recommended in the regional flood plan. For this metric to be assessed, H&H modeling must be available to compare existing and post-project floodplain boundaries to determine the flood risk reduction potential of a given project.

2. **FMEs classified as project planning** – These FMEs are generally studies or preliminary designs to address a specific, known flood need. However, these flood mitigation actions currently lack some or all of 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 impacts analysis. Completing these components as part of an FME will result in a potentially feasible FMP for consideration during future flood planning efforts.

The primary reason for not recommending an FME was based on sponsor input. An FME was not recommended if a sponsor indicated that the proposed study was already in progress, had been completed, or was no longer a priority they intended to pursue. In some cases, multiple FMEs were combined into a single FME for recommendation due to the proximity of the study areas.

Multiple requests for new FMEs were received and were included in the Amended Plan as potentially feasible FMEs. All FME requests required a short description of the desired study and a shapefile or graphic showing the area that would benefit from the study. These two pieces of information allowed the RFPG to populate the TWDB-required tables and maps for FMEs.

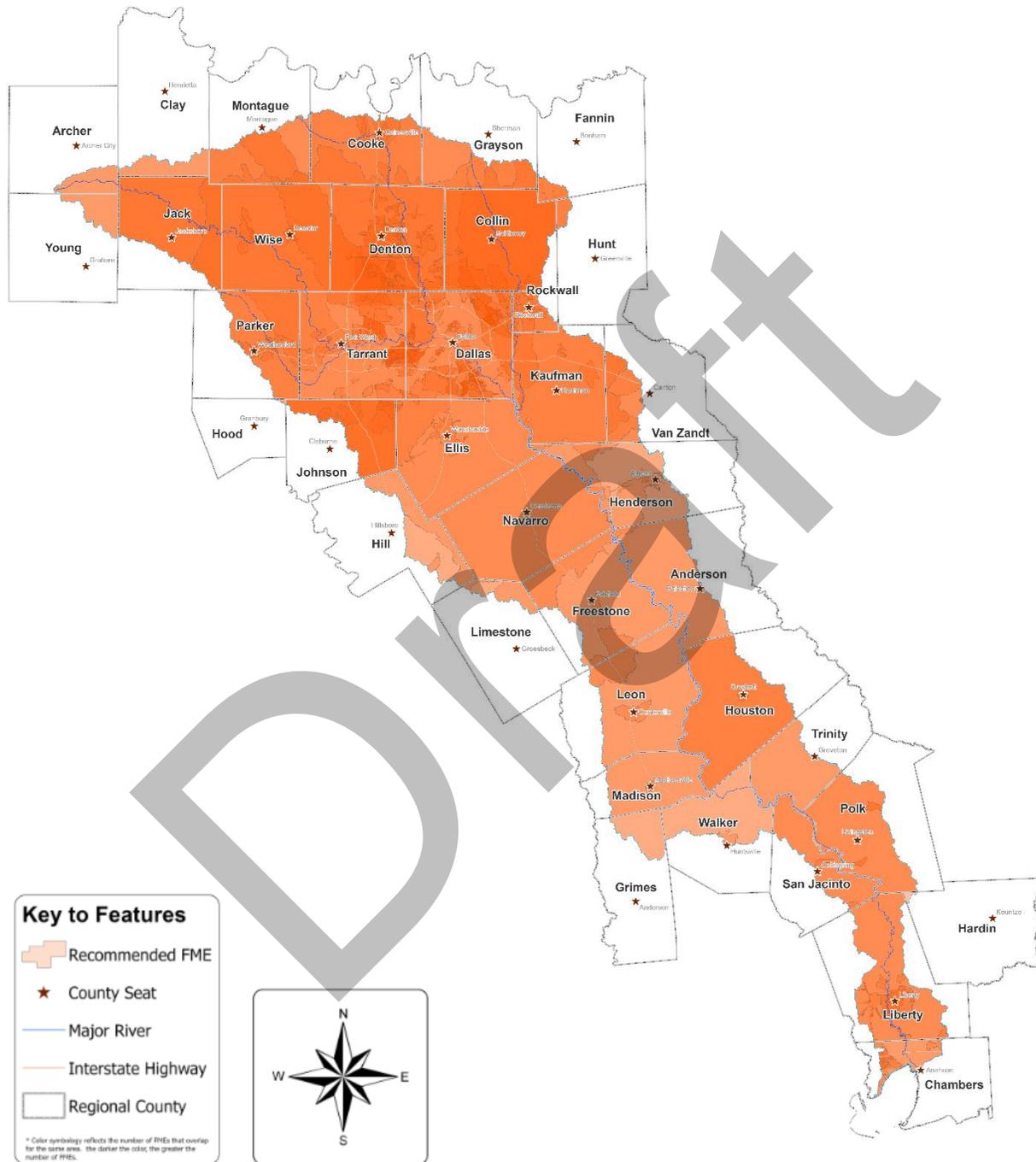
Description and Summary of Recommended Flood Management Evaluations

Between the Final Plan in January 2023 and both Amended Plans, a total of 529 potential FMEs were identified and evaluated by the Trinity RFPG. Of these projects, 510 were recommended, representing a combined total of approximately \$222.5 million dollars of FME needs across the region. The number and types of projects recommended by the Trinity RFPG are summarized in **Table 5.1**. The full list of FMEs and supporting technical data is included as **TWDB-Required Table 15 in Appendix A**. A map of recommended FMEs is presented as **Figure 5.4**. Color gradations in **Figure 5.4** reflect the number of FMEs that overlap for the same area - the darker the color, the greater the number of FMEs. A one-page report summary for each recommended FME is included in **Appendix E**. Overall, the recommended FMEs provide extensive coverage of the Trinity Region.

Table 5.1: Summary of Recommended Flood Management Evaluations

FME Type	FME Description	# of Potential FMEs Identified	# of FMEs Recommended	Total Cost of Recommended FMEs
Watershed Planning	Flood Mapping Updates, Drainage Master Plans, H&H Modeling, Dam, and Levee Failure Analysis	167	164	\$92,434,000
Project Planning	Feasibility Assessments and Preliminary Engineering Studies (alternative analysis and up to 30% design)	335	319	\$117,171,000
Preparedness	Studies on Flood Preparedness	5	5	\$3,150,000
Other	Dam Studies	24	24	\$9,710,000
Total		531	512	\$222,465,000

Figure 5.4: Map of Recommended Flood Management Evaluations



Flood Management Projects

Summary of Approach in Recommending Flood Management Projects

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

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

In addition, the TWDB recommends that, at a minimum, FMPs should mitigate flood events associated with the 1% annual chance storm event (100-year LOS). However, if a 100-year LOS is not feasible, the Trinity RFPG can document the reasons for its infeasibility and may recommend an FMP with a lower LOS.

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

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

Flood Management Project Evaluation

Initial Evaluation

Each FMP was evaluated to verify that it would support at least one of the regional floodplain management and flood mitigation goals established in **Chapter 3**. The goal(s) associated with

each FMP are included in **TWDB-Required Table 16** in **Appendix A**. Based on a review of the supporting studies and H&H models, the region determined that the primary purpose for each FMP is mitigation (rather than a response or recovery project), is a discrete project, and does not have any anticipated impacts to water supply or water availability allocations as established in the most recently adopted State Water Plan.

No Negative Impacts Determination

Each identified FMP must demonstrate no negative impacts on a neighboring area would result from its implementation. No negative impacts means that a project will not increase flood risk of surrounding properties. Using best available data, the increase in flood risk is measured by the 1% annual chance storm event Water Surface Elevation (WSE) and peak discharge. According to TWDB’s Technical Guidelines, it is recommended that no rise in WSE or discharge should be permissible, and that the analysis extent must be sufficient to prove proposed project conditions are equal to or less than the existing conditions. These conditions were evaluated for each potentially feasible FMP based on currently available regional planning level data. However, the local sponsor will be ultimately responsible for proving the final project design has no negative impacts prior to initiating construction.

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

1. Stormwater does not increase inundation in areas beyond the public right of way, project property, or easement
2. Stormwater does not increase inundation of storm drainage networks, channels, and roadways beyond design capacity
3. Maximum increase of one-dimensional (1D) WSE must round to 0.0 feet (<0.05 feet) measured along the hydraulic cross-section
4. Maximum increase of two-dimensional (2D) WSE must round to 0.3 feet (<0.35 feet) measured at each computation cell
5. 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 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 Trinity RFPG has flexibility to consider and accept additional “negative impact” for requirements one

through five based on the RFPG team’s professional judgment and analysis given any affected communities are informed and accept the impacts. This should be well-documented and consistent across the entire region. Flexibility regarding negative impact remains subject to Trinity RFPG review.

A comparative assessment of pre- and post-project conditions for the 1% annual chance storm event (100-year storm) was performed for each potentially feasible FMP based on their associated H&H models. The floodplain boundary extents, resulting WSE, and peak discharge values were compared at pertinent locations to determine if the FMP conforms to the no negative impacts requirements. This comparative assessment was performed for the entire zone of influence of the FMP.

A general description of the scope of work and a summary of the expected benefits and impacts of the proposed improvements for each potentially feasible FMP is provided in **Appendix F**. This appendix also provides a summary of the comparative assessment of H&H parameters and the final determination of no negative impacts for each FMP. Based on this evaluation, it was determined that 100 potentially feasible FMPs conform to the no negative impact requirements (see **Appendix F**). However, 17 FMPs that do not strictly comply with these requirements were still considered by the Trinity RFPG as not having adverse impacts due to various justified conditions and based on RFPG team’s professional judgment. These particular cases are explained as appropriate in the project descriptions included in **Appendix F** and are identified in **Table F.1**.

Benefit Cost Analysis

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 end 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 one or greater, indicating the benefits of a prospective hazard mitigation project are sufficient to justify the costs (FEMA, 2009). However, a BCR greater than one is not a requirement for inclusion in the Trinity Regional Flood Plan. The Trinity 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 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. BCR calculations are included in **TWDB-Required Table 16** in **Appendix A**).

FMP Tiers System

For the first Amended Plan, the RFPG approved a tiering system shown in **Figure 5.5** that categorized potential FMPs according to the data received.

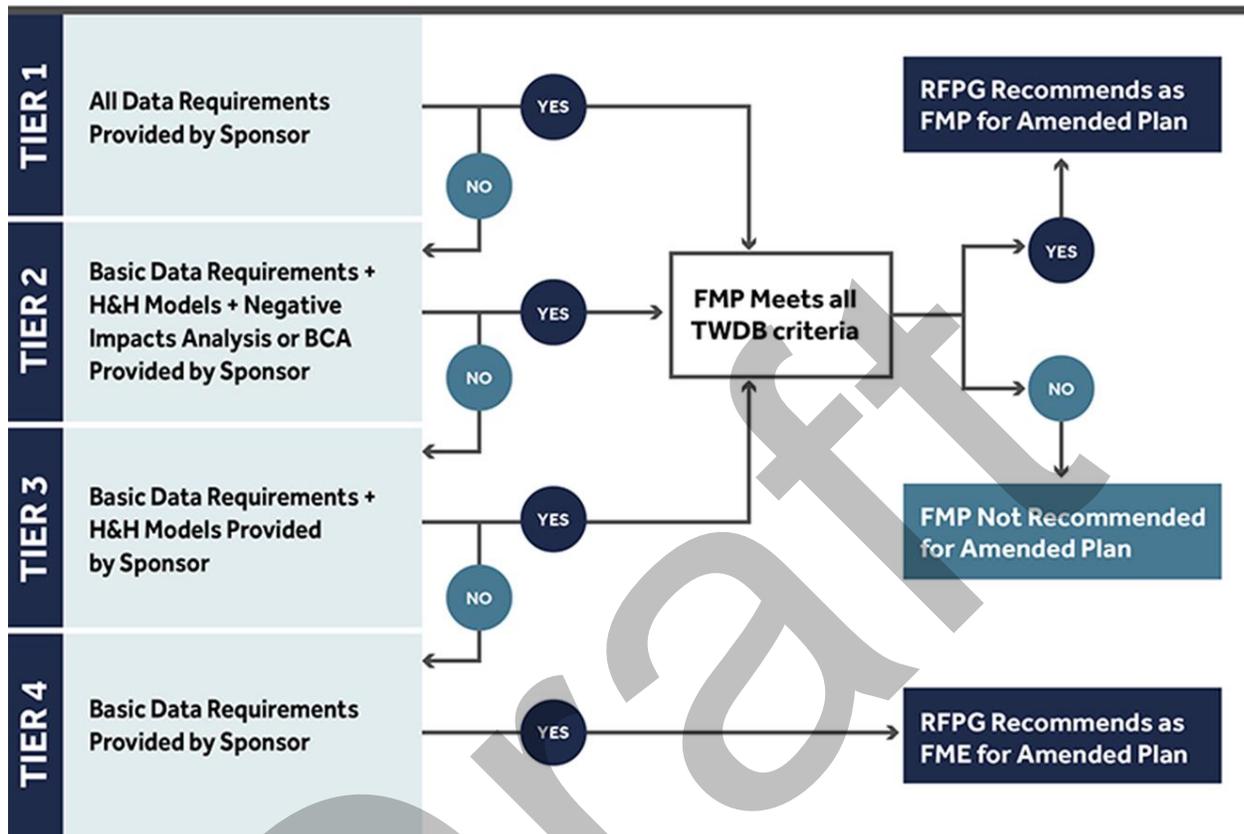
- Tier 1 FMPs included all TWDB-required data and documentation, including the confirmation of no negative impacts (NNI) and benefit cost analyses. Tier 1 required little effort to review and confirm the TWDB criteria had been met. Thus, Tier 1 FMPs would be included in the Amended Plan.
- Tier 2 FMPs were received with the basic data requirements, H&H models, and either a NNI analysis or BCA provided by the sponsor. Tier 2 FMPs required some time for the RFPG to review the documentation and complete the missing TWDB-required documentation.
- Tier 3 FMPs included the basic data requirements and H&H models provided by the sponsor. Tier 3 FMPs required significantly more time for the RFPG to review the documentation received and complete the remaining TWDB-required criteria.
- Tier 4 FMPs were submitted to the RFPG with basic data requirements provided by the sponsor. All Tier 4 FMPs were reclassified as FMEs.

The RFPG wanted to include at least one FMP per sponsor in the Amended Plan as time permitted. Therefore, the RFPG asked each sponsor to prioritize the order of their requested FMPs for inclusion in the Amended Plan. The RFPG reviewed each of the submittals to confirm if the required documentation had been provided for each tier.

If a sponsor submitted multiple projects that fell in a particular tier, then the sponsor's highest priority FMP would be evaluated and completed. Then, another sponsor's highest priority FMP within that tier would be evaluated and completed. The RFPG applied this process until it reached the end of the first projects within the tier before looking at the next requested FMP by the same sponsor.

This process framed the work order plan that the RFPG approved during the February 2023 meeting with the caveat that if information was found to be missing, and the sponsor was slow to respond or unable to provide the missing data, the RFPG would move to the next FMP on the list to minimize delays and to evaluate as many FMPs as possible for potential inclusion in the plan. Some FMPs were reclassified in the event that TWDB-required documentation was unable to be met. The RFPG was unable to evaluate all Tier 3 FMPs, which were then reclassified and considered as FMEs for potential inclusion in the Amended Plan.

Figure 5.5: Trinity Tiers Flow Chart



For the second Amended Plan, all projects that were submitted were included in the plan as potentially feasible and all FMPs were recommended for inclusion in the amended plan.

Description and Summary of Recommended Flood Management Projects

After the evaluation of 100 potentially feasible FMPs, the Trinity RFGP determined that 83 met all the TWDB requirements for inclusion in the Trinity Regional Flood Plan. The Trinity RFGP recommendations also considered the LOS and BCR of each FMP as discretionary evaluation criteria. Some FMPs do not provide a 100-year LOS and/or their BCR is less than one.

- Physical, environmental, or other constraints may impact the ability of a recommended FMP regarding the LOS to which it can provide. The Trinity RFGP considered these results and determined that recommending these FMPs would still be consistent with the overarching goal of the regional flood plan, which is “to protect against the loss of life and property” (TWDB, 2021), even if that protection can only be provided against smaller storm events.
- The costs and benefits of the FMPs are developed at a high level or regional scale. A sponsor will need to refine the BCR according to the funding program BCA requirements

if and when the sponsor decides to pursue funding to move forward with the implementation of an FMP. Every funding program has its own BCA tool that is required for its specific funding application. Therefore, the Trinity RFPG considered potential non-quantifiable secondary benefits, such as improving water quality, expanding recreational opportunities, and improvements in community livability, as a justification for recommending FMPs with BCRs less than one.

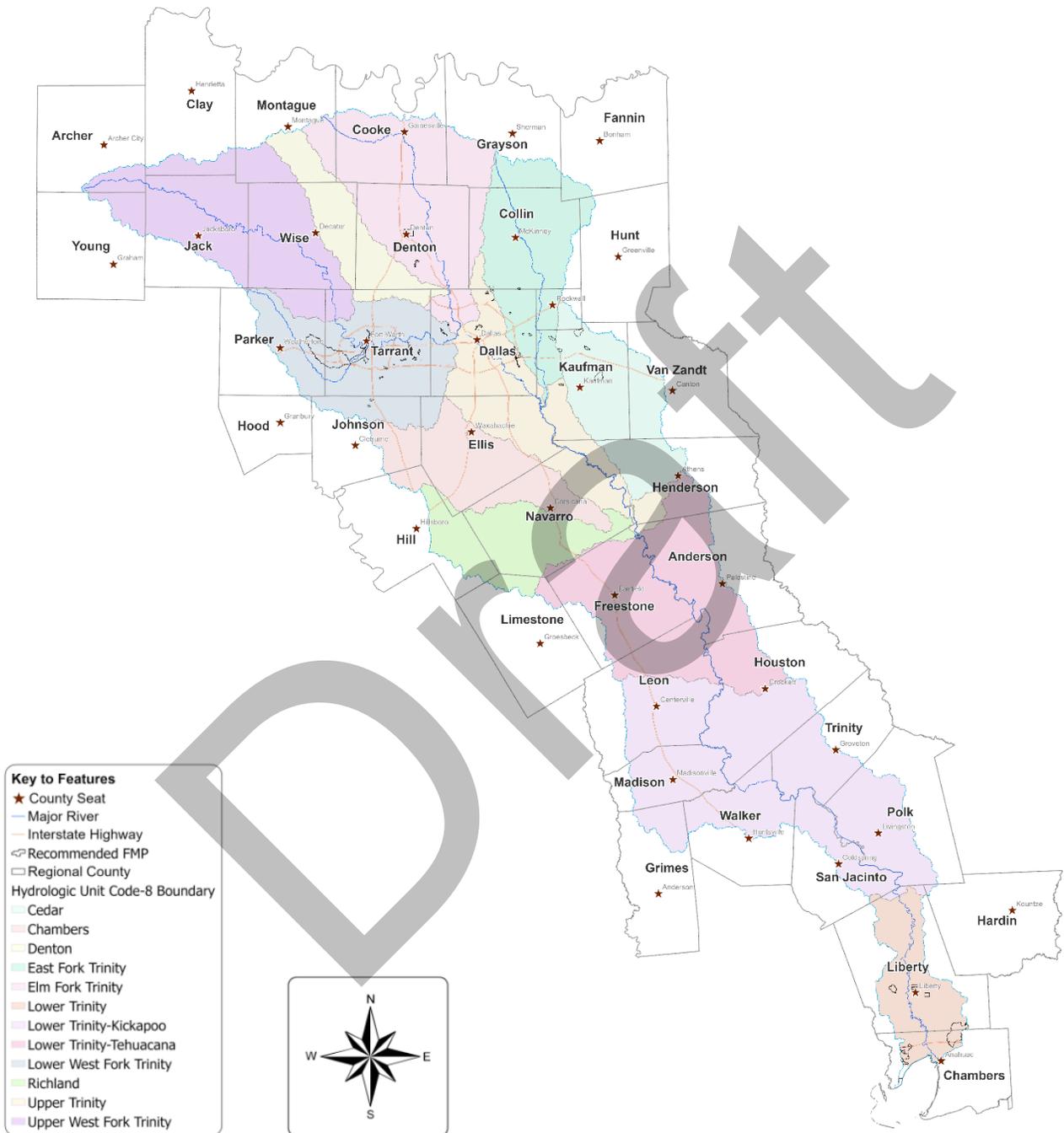
A summary of the recommended FMPs for inclusion in the Trinity Regional Flood Plan is presented in **Table 5.2**. These projects are primarily located within the Upper Subregion, and they represent a combined total construction cost of more than \$2.3 billion. Supporting technical data for each FMP, including their flood risk reduction benefits, is included as **TWDB-Required Table 16** in **Appendix A**. A map of project areas for the recommended FMPs is provided as **Figure 5.6**. A one-page report summary for each recommended FMP is included in **Appendix F**. Additionally, **Appendix G** provides a detailed breakdown of the estimated planning level costs for each FMP following the TWDB Technical Guidelines.

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Table 5.2: Summary of Recommended Flood Management Projects

FMP Type	FMP Description	# of Potential FMPs Identified	# of FMPs Recommended	Total Cost of Recommended FMPs
Infrastructure	Improvements to stormwater infrastructure including channels, ditches, ponds, stormwater pipes, etc.	55	42	\$1,683,992,000
Storm Drain Improvements	Improvements exclusively to underground urban stormwater infrastructure	14	11	\$38,700,000
Comprehensive Regional Projects	Multi-faceted projects that involve several components or phases	14	14	\$221,113,000
Regional Detention Facilities	Runoff control and management via detention facilities	6	5	\$316,658,000
Property or Easement Acquisition	Acquisition of properties located in the floodplain	5	5	\$61,953,000
Dam Improvements, Maintenance and Repair	Dam upgrades to meet TCEQ dam safety requirements	2	2	\$5,565,000
Flood Early Warning Systems	Installation of safety improvements at hazardous stream crossings	2	2	\$640,000
Low Water Crossing or Bridge Improvement	Low water crossing replaced by a bridge crossing	2	2	\$4,819,000
Total		100	83	\$2,333,440,000

Figure 5.6: Map of Recommended Flood Management Projects



Flood Management Strategies

Summary of Approach in Recommending Flood Management Strategies

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 utilization 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:

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

In addition, the TWDB recommends that, at a minimum, FMSs should mitigate flood events associated with the 1% annual chance storm event (or 100-year LOS). However, if a 100-year LOS is not feasible, the Trinity RFPG may document the reasons for its infeasibility and recommend an FMS with a lower LOS.

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

In addition to the above requirements, some FMSs were not recommended if they were redundant with another recommended FMS or if their purpose was primarily related to stormwater quality. In some cases, multiple FMSs were combined into a single FMS for recommendation. These merged FMSs included the development of county-wide educational programs and updates to land use planning and zoning regulations. Only two additional FMSs were submitted for the first Amended Plan. Both FMSs were submitted with sufficient information to complete the required analyses. Six FMSs were submitted for the second Amended Plan and were recommended for inclusion.

Description and Summary of Recommended Flood Management Strategies

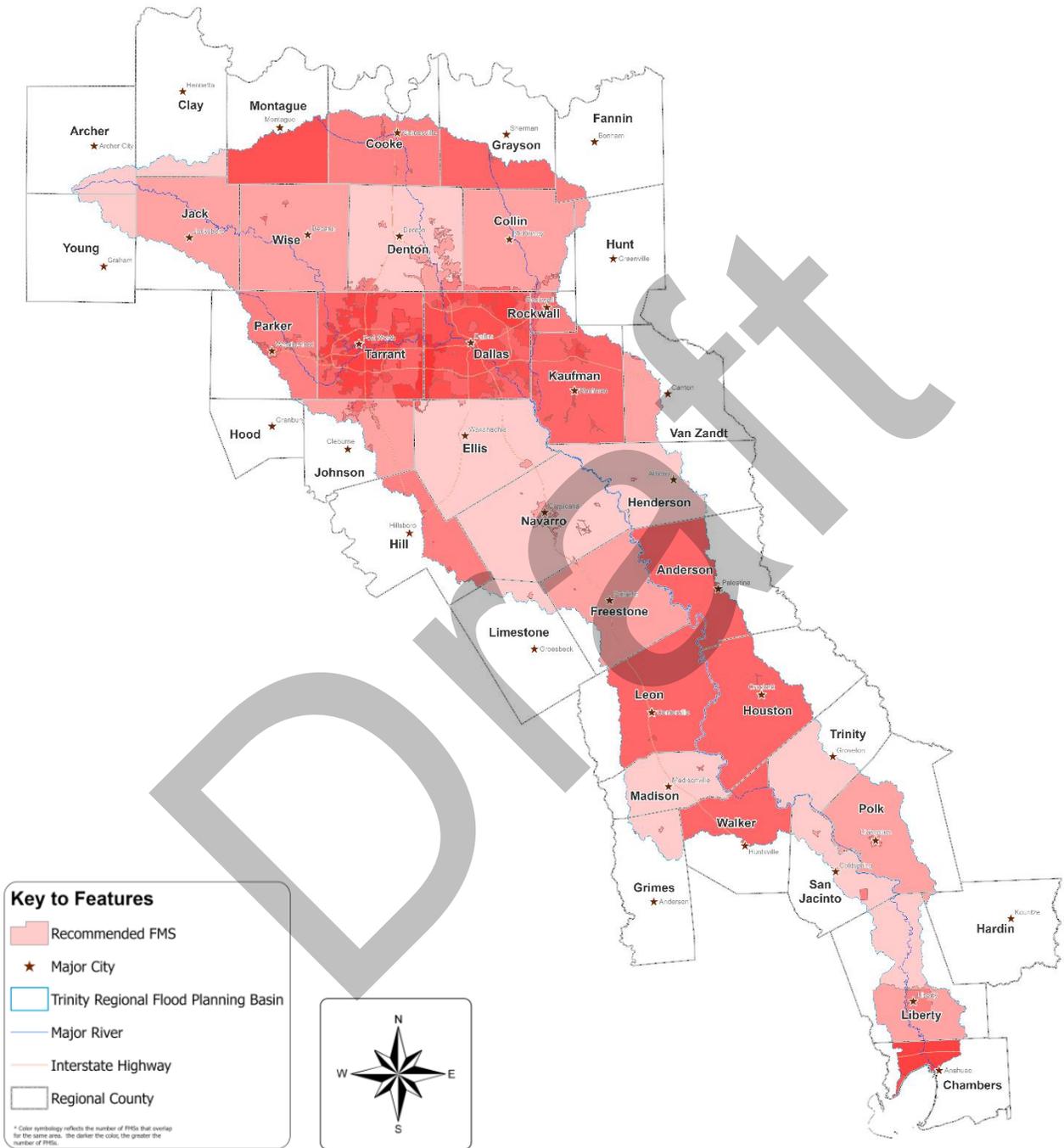
A wide variety of FMS types were identified and evaluated for the Trinity Region. A total of 151 potentially feasible FMSs were considered by the Trinity RFPG and 144 were recommended for inclusion in the Trinity Regional Flood Plan. Generally, these FMSs recommend city-wide, county-wide, and region-wide strategies and initiatives that represent a combined total cost of approximately \$747 million. Some projects did not meet FMP requirements and therefore were listed individually as FMEs or collectively as city-wide FMSs to capture the anticipated construction costs. These FMSs support several of the regional floodplain management and flood mitigation goals established in **Chapter 3**.

The number and types of projects recommended by the Trinity RFPG are summarized in **Table 5.3**. The full list of FMSs and supporting technical data, including their flood risk reduction benefits as applicable, is included in **TWDB-Required Table 17** in **Appendix A**. A map of recommended FMSs is presented as **Figure 5.7**. Color gradations in **Figure 5.7** reflect the number of FMSs that overlap for the same area; the darker the color is, the greater the number of FMSs. A one-page report summary for each recommended FMS is included in **Appendix E**.

Table 5.3: Summary of Recommended Flood Management Strategies

FMS Type	FMS Description	# of Potential FMSs Identified	# of FMSs Recommended	Total Cost of Recommended FMSs
Education and Outreach	Turn Around, Don't Drown Campaigns; NFIP Education; Flood Education; Dam Safety Education; Floodplain Regulatory Awareness	22	19	\$975,000
Flood Measurement and Warning	Flood Warning Systems; Rain/Stream Gauges and Weather Stations; Low Water Crossings (LWCs)	22	22	\$5,645,000
Property Acquisition and Structural Elevation	Acquire High Risk and Repetitive Loss Properties; Acquire and Preserve Open Spaces; Flood-Proofing Facilities	28	28	\$262,569,000
Regulatory and Guidance	City Floodplain Ordinance Creation/Updates; Zoning Regulations; Land Use Programs; Open Space Regulations	58	55	\$6,848,000
Infrastructure Projects	Hazardous Roadway Overtopping Mitigation Program; Citywide Drainage Improvement	5	5	\$430,000,000
Floodproofing	Structural and nonstructural measures to reduce a structure's risk of flooding; weather hardening.	2	2	\$30,500,000
Other	Debris Clearing Maintenance; Channel Maintenance and Erosion Control; Dam Inspections; Levee Inspections; City Parks; Green Infrastructure; Open Space Programs; Nature-Based Solution Planning Studies	14	13	\$10,489,000
Total		151	144	\$747,026,000

Figure 5.7: Map of Recommended Flood Management Strategies



Bibliography

FEMA. (2009, June). *Final BCA Reference Guide*. Retrieved from https://www.fema.gov/sites/default/files/2020-04/fema_bca_reference-guide.pdf

TWDB. (2021, April). Exhibit C: Technical Guidelines for Regional Flood Planning.

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