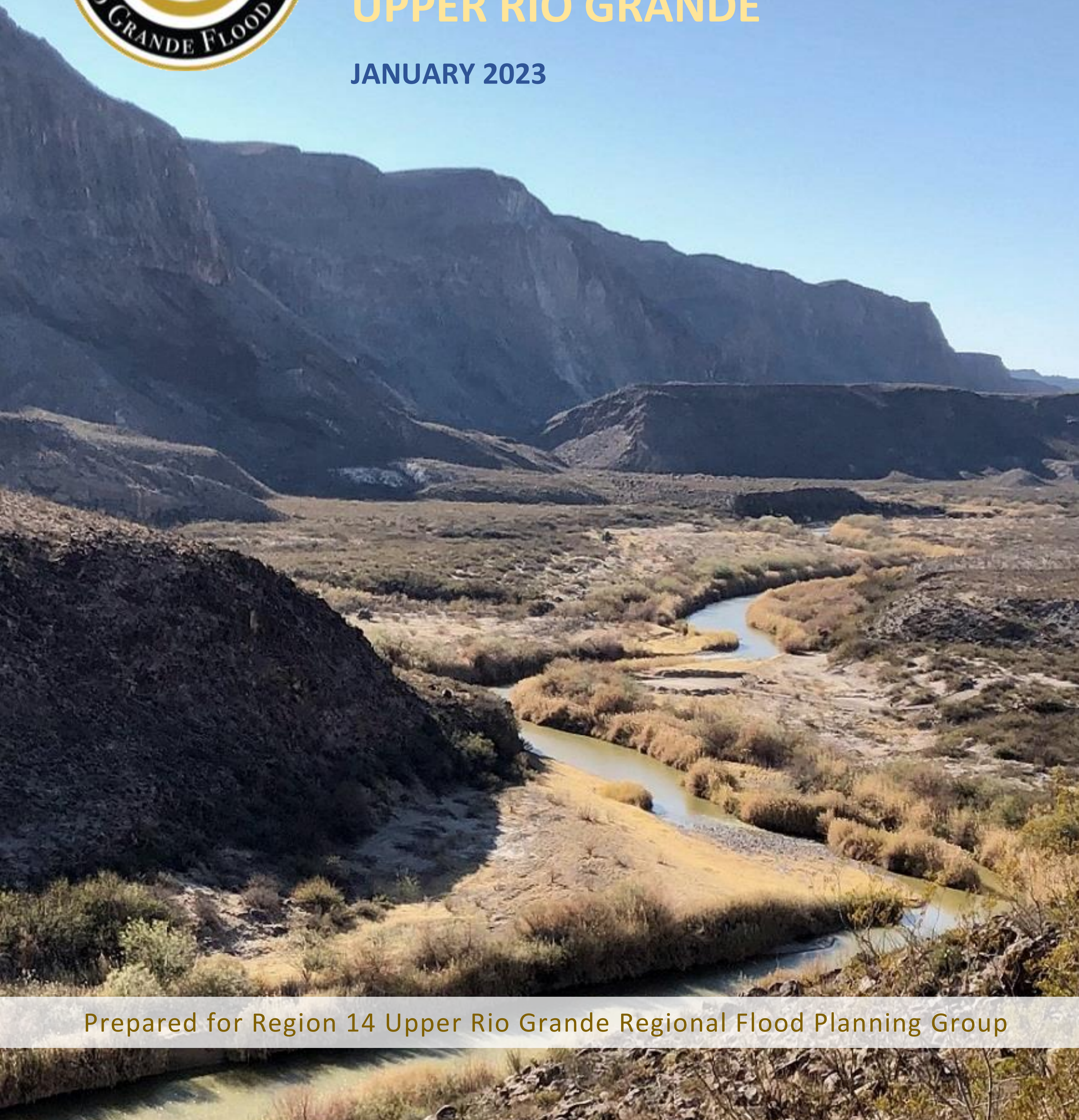
2023 REGIONAL FLOOD PLAN

REGION 14

UPPER RIO GRANDE

JANUARY 2023



Prepared for Region 14 Upper Rio Grande Regional Flood Planning Group

2023 REGIONAL FLOOD PLAN
REGION 14
UPPER RIO GRANDE

January 2023

Prepared for:

Region 14 Upper Rio Grande Regional Flood Planning Group

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2023 Regional Flood Plan – Upper Rio Grande (Region 14)

January 2023

01-10-2023

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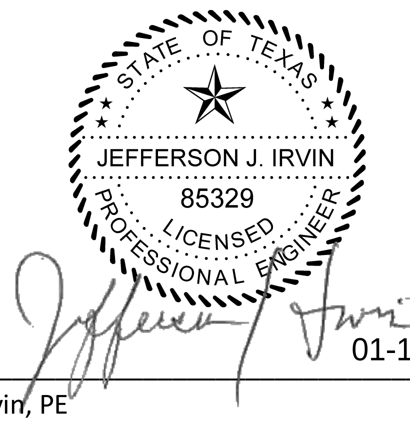

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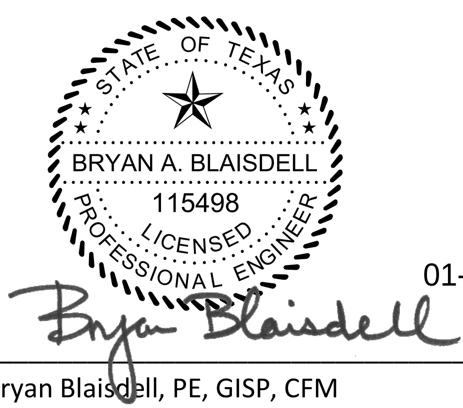

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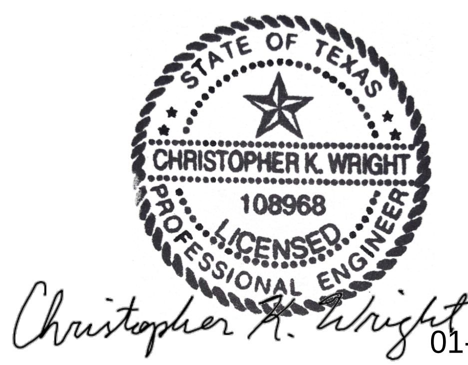

01-03-2023

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ES. Executive Summary

In response to historic flooding across the State of Texas, the 2019 Texas Legislature passed legislation to form the state's first-ever regional and state flood planning process and provide funding for investments in flood science and mapping efforts to support flood plan development. Through this legislation, a state flood planning framework was created, charging the Texas Water Development Board (TWDB) with creating flood planning regions based on river basins and administering the flood planning process.

In April 2020, the TWDB adopted rules establishing 15 regional flood planning areas across the State of Texas to develop the first planning cycle (2020-2023) Regional Flood Plans (RFPs). Information from these adopted regional plans will then be consolidated into a State Flood Plan (SFP) to be adopted by the TWDB by September 1, 2024. Following this, updated regional and state plans will be developed on a recurring cycle every five years.

The overall goal of the Regional and State Flood Plans is to identify specific flood risks and recommend potential flood solutions to address these risks at the local level, including flood studies, strategies, and projects. The effort is aimed at better managing flood risk overall to reduce loss of life and property from flooding.

ES.1 Introduction and Description of the Upper Rio Grande Flood Planning Region

The Upper Rio Grande Flood Planning Region, designated by the TWDB as "Region 14" and led by the Upper Rio Grande Flood Planning Group (URGFPG), encompasses all or part of 23 West Texas counties as listed below and shown in **Figure ES.1** (partial counties denoted with asterisks):

- Andrews*
- Brewster
- Crane
- Crockett*
- Culberson
- Ector*
- Edwards*
- El Paso
- Hudspeth
- Jeff Davis
- Loving
- Midland*
- Pecos
- Presidio
- Reagan*
- Reeves
- Schleicher*
- Sutton*
- Terrell
- Upton*
- Val Verde*
- Ward
- Winkler

The planning area for Region 14 follows the Upper Rio Grande in West Texas along the US-Mexico border from the City of El Paso to the Amistad Reservoir in Val Verde County as well as the Pecos River from the New Mexico Border to the Rio Grande. This region is the largest of the fifteen state flood planning regions by area, covering more than 43,000 square miles across three river basins – the Upper Rio Grande, the Pecos River, and the Devils River.

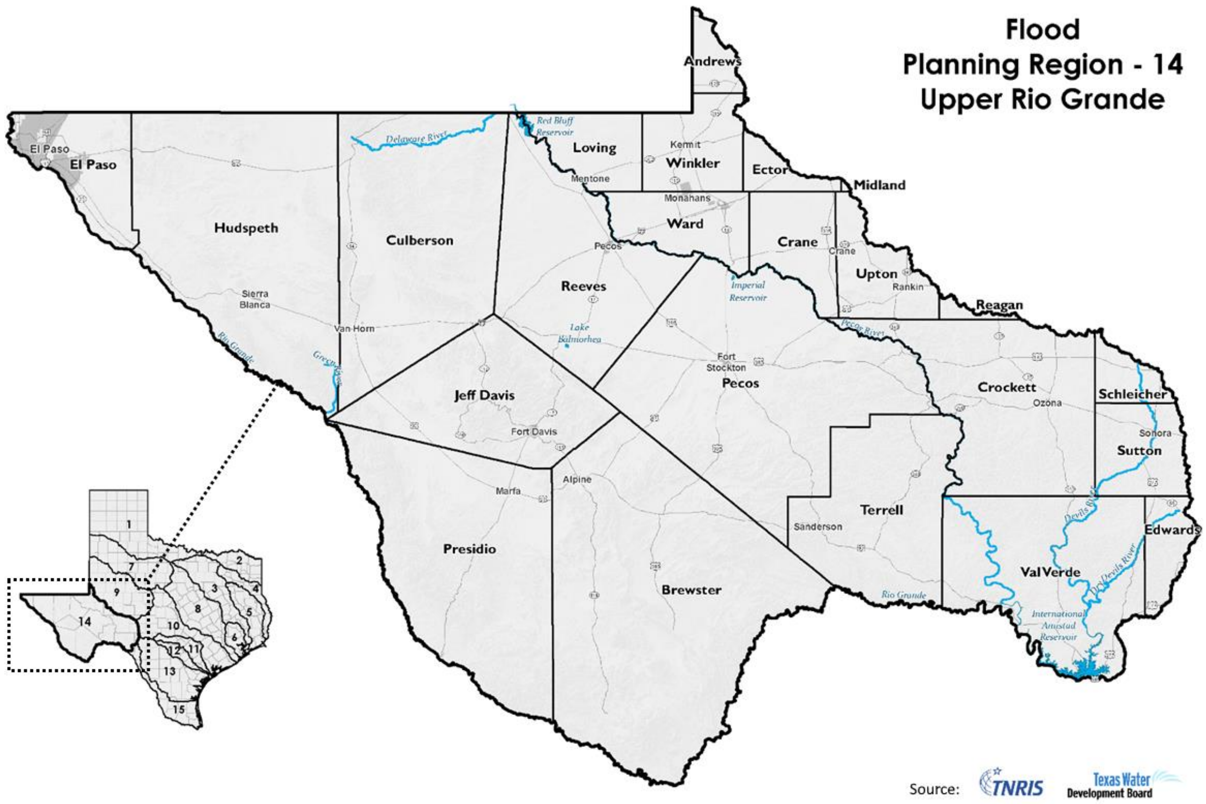

Figure ES.1 Upper Rio Grande Flood Planning Region (Region 14)

ES.1.1 Social and Economic Characteristics

The Far West Texas region is well known for its wide-open expanses and rugged landscapes. Compared to other flood planning regions across the state, Region 14 remains largely rural and less impacted by urban development.[1] The region is approximately 99% rural or undeveloped by land area, including about 2,500 square miles of grassland or pasture (6% of the total area) and 300 square miles of other agricultural property (1% of the total area). Based on population estimates from the 2020 Decennial Census, the total population in the region is estimated at approximately 1.04 million with nearly 90% of the population residing in El Paso County.

Among the Upper Rio Grande Region's most defining characteristics are the many small towns and unincorporated communities dispersed throughout the region. The region encompasses 61 incorporated and unincorporated communities, all with populations less than 10,000 except for six (El Paso, Socorro, Horizon City, Pecos, Fort Bliss, and San Elizario). In addition, only four of the 23 counties have populations exceeding 10,000, including the Counties of El Paso, Pecos, Reeves, and Ward.

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[1] Texas A&M Natural Resources Institute (NRI). *West Texas Landowner Report: Energy and Growth Trends.* December 2019. *https://nri.tamu.edu/media/2786/west-texas-landowner-report-final-20200115.pdf*

As of 2021, the region employs an estimated 590,000 jobs across its 23 counties, with about 91,000 of these jobs added since 2010. In the past decade, jobs in the region have grown at an annual rate of 1.5%, faster than the U.S. average (0.9%) and similar to the Texas average (1.7%). By total employment, the region's top five industries (representing approximately 45% of total jobs) include healthcare, food services, education, oil and gas upstream, and non-food retail.

ES.1.2 Historical Flooding

Flooding in Texas is principally associated with hurricanes, tropical storms, and high intensity storms. Flooding is usually caused by high precipitation volumes, long precipitation duration, and high precipitation intensity. Hurricanes and tropical storms have the potential for each dangerous mode of precipitation as they are large storms fed from warm oceans and can linger over a location.

El Paso County has experienced long duration/low intensity rain events (e.g., 7.95 inches over four days in 2006) and short duration/high intensity rain events (e.g., 3.18 inches over one hour in 2021) which result in various flood hazards and require different mitigation strategies. Both of these storm events had an extremely low Annual Exceedance Probability (AEP) of approximately 0.4% (or the 250-year return period). Both of these storms covered the streets in debris and caused significant damage.

ES.1.3 Agricultural & Natural Resources

More than 30 types of crops are grown in the Upper Rio Grande Region, with the top seven crops most at risk to flooding including grassland/pasture, cotton, alfalfa, pecans, winter wheat, oats, and sorghum. The top five counties for agricultural production include the Counties of Hudspeth (notably Dell City), El Paso, Jeff Davis, Pecos, and Presidio.

Approximately 50 federal- and state-listed threatened and endangered species have been identified in the region, including most notably the western yellow-billed cuckoo, for which the U.S. Fish and Wildlife Services has designated critical habitat along much of the Rio Grande in Brewster County and which may potentially live in many other counties across the region. Other prominent protected species may include the federally endangered southwestern willow flycatcher bird species and the Texas hornshell freshwater mussell.

ES.1.4 Constructed Major Flood Infrastructure

Region 14 includes the following existing stormwater infrastructure: stream crossings; levees; flood protection dams; detention and retention ponds; storm drain systems; stormwater canals; pump stations; and weirs. While statewide and nationwide data sets for dams and levees are available throughout the region, there was generally a lack of digital data for stormwater infrastructure in all Region 14 counties other than El Paso County. The RFP incorporates available digital infrastructure data for constructed flood mitigation features into the "Existing Flood Infrastructure" dataset, summarizing the existing flood infrastructure geodatabase and identifying both constructed and natural features.

ES.2 Flood Risk Analyses

The RFP included an evaluation of flood risks and flood hazard data gaps across the region for existing and future conditions.

Flood risks can be defined in terms of *flood hazards* (i.e., the location, magnitude, and frequency of flooding), *flood exposure* (i.e., who and what might be harmed within the region), and *vulnerabilities* (i.e., areas of exposure including communities and critical facilities which may be particularly susceptible to flood impacts). Flood risk may also be evaluated based on *existing conditions*, accounting for present-day land use and impervious cover, as well as based on *future conditions*, accounting for future land use and impervious cover trends as well as overall climate and precipitation trends.

Existing and future condition flood risk analyses for the 1% annual chance (1% AC) and 0.2% annual chance (0.2% AC) flood events were performed for the Upper Rio Grande region using the best available hydrologic and hydraulic modeling data within the region, including models developed specifically for the RFP.

The results of the flood risk analyses are intended for use by the RFPG to establish priorities in subsequent planning tasks and to identify areas for potential flood solutions. The flood risk maps presented in this RFP do not reflect the effective regulatory floodplains and do not supersede or change federal flood insurance requirements.

Similarly, these regionwide flood risk analyses are intended to establish baseline flood risk levels as currently recognized by the Federal Emergency Management Agency (FEMA) and other best available modeling. As a result, and in accordance with State RFP requirements, any existing levees in the region that do not meet FEMA accreditation are excluded from the baseline flood risk analysis. This consideration is especially applicable to El Paso County, where unaccredited levees are present along the Upper Rio Grande.

In addition to the overview of flood risk analyses process and results described below, *Chapter 2 ("Flood Risk Analyses")* provides additional details regarding potential flood exposure, vulnerabilities, and anticipated loss of function for different types of critical facilities.

ES.2.1 Existing Conditions Analysis

Existing condition flood hazard data sources used for the risk analysis included FEMA National Flood Hazard Layer Preliminary data (for El Paso County only), NFHL Approximate Effective data (for Ector and Val Verde Counties), the First American Flood Data Services (FAFDS) layer (outside of El Paso County), and the Fathom Cursory Floodplain dataset.

While recent flood hazard mapping information is available for El Paso County, Ector County, and Val Verde County, the availability of recent flood hazard data across the rest of the region is much more limited. Two types of existing condition flood hazard data gaps were identified across the region based on data availability and reliability.

The first type of existing condition data gap includes counties which do not have a broad coverage of available FAFDS information or any other available flood hazard data apart from the

Fathom dataset. It also includes counties with limited FAFDS coverage (e.g., for small areas within selected municipalities) that do not have broad countywide coverage of flood hazard data. This first group is made up of five counties with no FAFDS coverage (including the Counties of Andrews, Crane, Loving, Reagan, and Schleicher) and four counties with limited FAFDS coverage (including the Counties of Pecos, Reeves, Upton, and Winkler).

The second type of existing condition data gap includes counties which do have broad coverage of FAFDS information in addition to the Fathom dataset but are in need of updated flood hazard information due to the age of the FAFDS floodplains. This second group is made up of 11 counties, including the Counties of Brewster, Crockett, Culberson, Edwards, Hudspeth, Jeff Davis, Midland, Presidio, Sutton, Terrell, and Ward.

Maps showing the results of the existing condition flood risk and flood hazard data gaps analyses are provided in **Map Exhibits 4-7**, and a summary of the existing condition flood exposure results is provided in **Table ES.1**.

Table ES.1 Existing Flood Exposure Summary

Exposure Type	Number of features		
	1% AC	0.2% AC*	Possible Flood Prone Areas
Floodplain Area (sq. mi.)	9,285	1,755	161
Structures (#)	40,121	14,290	12,393
Population (#)	115,530	47,985	71,036
Critical Facilities (#)	94	41	19
Roadway Segments (mi.)	3,047	548	353
Roadway Stream Crossings (#)	1,377	548	147
Agricultural Areas (sq. mi.)	615	135	39

*0.2% AC flood exposure results are reported separately from the 1% AC results and do not include cumulative flood hazard areas or property impacts from 1% AC flood hazard areas.

ES.2.2 Future Conditions Analysis

Future condition flood hazards were estimated to account for future projections in land use and precipitation over the next 30 years.

According to population projections from the 2021 Regional Water Plan, the Upper Rio Grande Region is projected to grow in population between 2020-2050 by approximately 400,000, which is equivalent to a 38% increase over 30 years with an average annual growth rate of 1.08%. El Paso County is projected to see the highest future population growth compared to other counties in the region with an increase of approximately 370,000 by 2050 or 93% of the region’s total growth.

To account for these population growth trends in El Paso County, the El Paso County FEMA Preliminary 2D models were updated based on future condition hydrologic data derived from local population projections. Outside of El Paso County, existing condition 0.2% and 0.1% AC flood hazard areas were utilized as a proxy for future condition 1% and 0.2% AC flood hazard areas, respectively, with changes limited to areas of anticipated future development.

In addition, future precipitation projections influenced by present changes in climate show the potential for increases in the magnitude of extreme precipitation events. In an April 2021 report, the Office of Texas State Climatologist recommended applying a 20% increase to precipitation totals to estimate future rainfall. This adjustment was applied to the El Paso County FEMA Preliminary 2D models for the future condition analysis. Outside of El Paso County, no modifications were made for precipitation in the future condition analysis due to inconclusive precipitation trends shown for a majority of the region east of El Paso County in the Texas State Climatologist report.

Due to the limited availability of future condition flood hazard information across the region (such as detailed future land use data or future conditions flood studies), future flood hazard data gaps were identified for the entire region except for the watersheds of El Paso County and western Hudspeth County. These areas were analyzed as part of the RFP future flood hazard analysis described in Chapter 2.

Maps showing the results of the flood hazard data gaps analysis are provided in **Map Exhibits 5 and 9**, and a summary of the future condition flood exposure results is provided in **Table ES.2**.

Table ES.2 Future Flood Exposure Summary

Exposure Type	Number of features		
	1% AC	0.2% AC	Possible Flood Prone Areas
Floodplain Area (sq. mi.)	9,543	1,807	161
Structures (#)	67,134	35,167	12,393
Population (#)	253,678	110,302	71,036
Critical Facilities (#)	178	56	19
Roadway Segments (mi.)	3,846	1,035	353
Roadway Stream Crossings (#)	1,467	585	147
Agricultural Areas (sq. mi.)	678	149	39

*0.2% AC flood exposure results are reported separately from the 1% AC results and do not include cumulative flood hazard areas or property impacts from 1% AC flood hazard areas.

ES.3 Floodplain Management Practices and Goals

The RFP included an evaluation of floodplain management practices across the region as well as recommendations for floodplain management standards and both short-term (10-year) and long-term (30-year) flood mitigation and floodplain management goals.

ES.3.1 Evaluation of Floodplain Management Practices

In the Upper Rio Grande Region, 75% of all eligible communities participate in the NFIP (40 out of 53), including 78% of counties (18 out of 23 counties representing 31 unincorporated communities) and 73% of incorporated places (22 out of 30). All county and incorporated entities in the region are encouraged to enact ordinances that meet minimum requirements for NFIP Participation and remain active NFIP participants in good standing.

Higher floodplain management standards are recognized through the Texas Floodplain Management Association (TFMA) Higher Standards Survey and the FEMA Community Rating System (CRS). The City of El Paso is presently the only entity in the region with higher standards recognized by the TFMA Higher Standards Survey and an enrollment in the CRS Program (earning an entry-level rating of 9).[2] Applications for CRS participation have also been submitted by El Paso County and City of Sonora and are under review with an expected rating date by the end of 2022.

Communities not participating in the NFIP include seven incorporated places (Barstow, Kermit, Rankin, Thorntonville, Valentine, Wickett, and Wink) and five counties (Andrews, Edwards, Pecos, Reeves, and Winkler). All non-participating communities in the region are located in a Zone A FEMA flood hazard area or are unmapped.

ES.3.2 Recommendations for Minimum Standards and Best Practices

The Upper Rio Grande RFPG is required to consider whether to recommend or adopt region-wide minimum floodplain management standards and land use practices. *Recommending* minimum practices by the RFPG encourages entities to adopt similar floodplain management practices within their communities. On the other hand, a*dopting* minimum practices by the RFPG requires potential sponsoring entities to adopt these minimum standards before their flood needs (FMEs, FMSs, and FMPs) may be considered for inclusion in the RFP and be eligible for potential state funding.

During the course of this first planning cycle of the 2023 Region/2024 State Flood Plan, the **Upper Rio Grande RFPG voted to recommend but not adopt** the following minimum standards for the region. <u>In future planning cycles, the RFPG may reconsider whether to adopt these recommendations as minimum standards requirements.</u>

- Participate (and maintain active status) in the National Flood Insurance Program (NFIP)
- Require development permits for all proposed construction to determine whether such construction is proposed within flood-prone areas and will be reasonably safe from flooding (44 CFR § 60.3a[1-4])

[2] CRS Rating classes range from 9 to 1 where CRS Class 1 is the highest possible classification. Most communities enter the program at a CRS Class 9 or Class 8 rating.

- Require new and replacement sanitary sewage and water supply systems within flood prone areas to be designed to minimize or eliminate infiltration of flood waters into the systems (44 CFR § 60.3a[1-5])
- Require additional minimum standards for flood-prone areas associated with designated special flood hazard areas (Zone A and AE) (44 CFR § 60.3b-d)
- Require additional minimum standards associated with mudslide (i.e.mudflow)-prone areas (44 CFR § 60.4)
- Require additional minimum standards associated with flood-related erosion-prone areas (44 CFR § 60.5)

The following general recommendations for best practices were recommended by the RFPG during the first planning cycle. While these general recommendations are strongly encouraged, the RFPG does not anticipate adopting them as minimum standards in future planning cycles at this time.

- Establish local flood outreach and awareness programs (addressing flood risk, resiliency, and mitigation), including providing access to FEMA informational resources
- Coordinate with TxDOT and NWS to use flood warning signs, traffic message boards, and other media (TV, radio, social media) to communicate flood warnings
- Conduct public outreach to identify ongoing flood needs (data gaps, flood management strategies, and flood mitigation projects)
- Develop and maintain local stormwater asset management plans
- Adopt higher-than-NFIP-minimum standards (e.g., higher freeboard) and participate in the TFMA Higher Standards Survey
- Enroll in CRS Program for reduction in flood insurance premiums and flood risk
- Consider and incorporate nature-based practices in flood mitigation projects where possible

ES.3.3 Flood Mitigation and Floodplain Management Goals

The Upper Rio Grande RFPG adopted both Short-Term (10-year) and Long-Term (30-year) flood mitigation and floodplain management goals. These goals help to establish the RFPG's objectives and priorities for the first-cycle flood plan and are presented in **Table ES.3**.

Table ES.3 Flood Mitigation and Floodplain Management Goals

Short Term (10 year)	Long Term (30 year)
Increase NFIP participation or adoption of equivalent standards with 90% of communities meeting qualifying standards	Enroll all current non-participating communities into the NFIP and maintain 100% community enrollment with no suspensions or sanctions
Increase number of communities that have adopted higher-than-NFIP-minimum standards	n/a

Short Term (10 year)	Long Term (30 year)
Increase number of communities enrolled in CRS Program	n/a
Improve CRS rating for the City of El Paso (which has a current CRS Rating of 9)	n/a
Adopt recommended minimum stormwater infrastructure design standards applicable across the region	n/a
Increase flood protection of unaccredited levees in El Paso County watersheds to meet FEMA levee accreditation requirements and update flood mapping to account for any changes in levee accreditation status	Increase flood protection of unaccredited levees in the region outside of El Paso County watersheds to meet FEMA levee accreditation requirements and update flood mapping to account for any changes in levee accreditation status
Increase the number of flood gages (rainfall and/or stream gages) in the region	n/a
Develop and implement region-wide flood warning and emergency response program	n/a
Increase the number of entities that use flood warning signs, traffic message boards, and other media (TV, radio, social media) to communicate flood warnings	n/a
Establish community-led flood outreach and awareness programs (addressing risk, resiliency, and mitigation) in 30% of communities in the region	Establish community-led flood outreach and awareness programs (addressing risk, resiliency, and mitigation) in 90% of communities in the region
Increase entity and public stakeholder participation in the regional flood planning process	n/a
Increase the coverage of flood hazard data across the region by completing studies in 40% of the areas identified as having current gaps in flood mapping in the first cycle Flood Plan	Have complete coverage of flood hazard data across the region by completing studies in 100% of the areas identified as having current gaps in flood mapping in the first cycle Flood Plan and have an ongoing, funded maintenance plan for updates
Remove 10% of the existing structures in El Paso County watersheds from 1% annual chance floodplain in the region (either by remapping or flood risk reduction)	Remove 20% of the existing structures in El Paso County watersheds from 1% annual chance floodplain in the region (either by remapping or flood risk reduction)
Remove 25% of the existing structures outside of El Paso County watersheds from 1% annual chance floodplain in the region (either by remapping or flood risk reduction)	Remove 50% of the existing structures outside of El Paso County watersheds from 1% annual chance floodplain in the region (either by remapping or flood risk reduction)
Remove 40% of the low water crossings from 10% annual chance floodplain in the region (either by remapping or flood risk reduction)	Remove 90% of the low water crossings from 10% annual chance floodplain in the region (either by remapping or flood risk reduction)
Increase the number of entities that utilize regional detention for floodplain management	n/a
Consider and incorporate nature-based practices in flood risk reduction projects	n/a
Establish dual usage regional storage facilities for flood mitigation and water supply	n/a
Increase the number of communities with documented, operational, and fully funded stormwater asset management plans	n/a
Increase number of new funding sources used to pay for implementation of flood management activities and decrease number of communities without a local funding source	n/a

Short Term (10 year)	Long Term (30 year)
Increase the number of entities that have a dedicated drainage fee to help implement future Flood Mitigation Evaluations (FMEs) and Flood Mitigation Projects (FMPs)	n/a

ES.4 Identification of Flood Mitigation Needs and Solutions

Based on the identified flood hazard areas, the RFP included an analysis of flood needs with a consideration of the greatest flood risk areas and greatest flood risk information gaps. Following this and with coordination between the RFPG and stakeholders, potential flood solutions were identified including Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs).

ES.4.1 Flood Mitigation Needs Analysis

Flood mitigation needs were identified based on both a quantitative comparison of the Task 2 exposure results at the county and subcounty level as well as a qualitative evaluation by the RFPG and stakeholders.

The quantitative analysis considered areas of greatest potential flood exposure based on at risk structures, population, roadways, critical facilities, agricultural area, and social vulnerability. It also included an evaluation of the greatest gaps in flood risk information and the areas with the greatest flood risk.

The qualitative analysis was conducted over several stakeholder workshop meetings and considered historic flooding events, flood prone areas, existing flood mapping and modeling availability, emergency needs, and other factors.

A summary of flood mitigation needs and at risk communities by county are shown in **Table ES.4**.

Table ES.4 Summary of Flood Mitigation Needs by County

County	Greatest Flood Risk Data Gap (Limited or No FEMA Flood Mapping Information)	Greatest Flood Risk Data Gap (Old FEMA Flood Mapping Information	Greatest Flood Risk	Top At Risk Communities by Estimated Number of Structures in Floodplain
Andrews	✓	-	-	-
Brewster	-	✓	✓	Alpine city
Crane	✓	-	-	Crane city
Crockett	-	✓	✓	Ozona CDP
Culberson	-	✓	✓	Van Horn town
Ector	-	-	-	-
Edwards	-	-	-	-
El Paso	-	-	✓	El Paso city, Socorro city, Fort Bliss CDP, Canutillo CDP, San Elizario city, Homestead

County	Greatest Flood Risk Data Gap (Limited or No FEMA Flood Mapping Information)	Greatest Flood Risk Data Gap (Old FEMA Flood Mapping Information	Greatest Flood Risk	Top At Risk Communities by Estimated Number of Structures in Floodplain
				Meadows North CDP, Clint town, Fabens CDP, Prado Verde CDP
Hudspeth	-	✓	✓	Dell City city
Jeff Davis	-	✓	✓	Fort Davis CDP
Loving	-	-	-	-
Midland	-	-	-	-
Pecos	✓	-	✓	Imperial CDP, Fort Stockton city
Presidio	-	✓	✓	Presidio city, Marfa city
Reagan	-	-	-	-
Reeves	✓	-	✓	Pecos city, Balmorhea city, Lindsay CDP, Toyah town
Schleicher	-	-	-	-
Sutton	-	✓	✓	Sonora city
Terrell	-	✓	-	Sanderson CDP
Upton	✓	-	-	McCamey city
Val Verde	-	-	-	-
Ward	-	✓	✓	Southwest Sandhill CDP, Monahans city, Thorntonville town, Barstow city
Winkler	✓	-	✓	Kermit city

ES.4.2 Process for Identifying Flood Mitigation Solutions

The primary objective of the Upper Rio Grande Regional Flood Plan (RFP) is to identify specific flood risks within the region and identify, evaluate, and recommend potential solutions to mitigate and manage these risks in alignment with the region's short-term and long-term goals. These solutions may include FMEs, FMSs, and FMPs, as defined below:

- Flood Management Evaluation – 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 – a proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring costs, and when implemented, will reduce flood risk, mitigating flood hazards to life or property; and
- Flood Management Strategy – a proposed plan to reduce flood risk or mitigate flood hazards to life or property.

FMSs and FMPs that were identified to be potentially feasible through the processes described Chapter 4 were selected for further evaluation as part of Task 4B to determine whether they have sufficient H&H modeling data to be analyzed for project impacts and benefits.

ES.4.3 Identification of Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs)

Due to the large portion of Region 14 which has limited or no available flood risk mapping or modeling available, a significant part of the process of identifying potential FMEs and potentially feasible FMSs and FMPs involved extensive stakeholder coordination. Through the coordination conducted in workshops, public meetings, and phone interviews, the RFPG identified and evaluated 22 potential FMEs, 14 potentially feasible FMPs, and 22 potentially feasible FMSs.

FMEs identified generally fell into the categories of project planning, storm water master plans (SWMPs) which also includes development of flood risk mapping, dam safety/emergency need, riverine risk related to sediment or levees, irrigation and stormwater interaction, and preparedness.

Most of the FMPs identified were detention/retention storage basins or related to transportation/mobility from the City of El Paso SWMP (2021) or the El Paso County SWMP (2021), which were both recently updated. The lack of modeled and evaluated stormwater projects meeting the minimum criteria for FMPs in the region is likely related to the lack of available or updated flood risk models and mapping. Due to the large number of projects in the City SWMP (96 projects) and in the County (69 projects), heavy coordination was involved with the City, County, and RFPG in selecting and prioritizing which projects would be evaluated within the limited schedule available for the RFP.

Potentially feasible strategy types vary between regulatory and guidance strategies, infrastructure projects, flood measurement and warning, and education and outreach. In general, FMSs do not typically fit into the FME or FMP categories for a variety of reasons. Below are a list of criteria that led to the decision to list a flood reduction action as an FMS rather than an FME or FMP:

- Studies, projects, and/or program development involving complex coordination between multiple entities (local, state, federal, or international);
- Associated with other FMEs, FMSs, or FMPs requiring a specified sequence of actions as part of a larger plan;
- Involve multiple projects with varying statuses of design/construction; and
- Include recurring costs

ES.5 Evaluation and Recommendation of Flood Solutions

The recommended FMEs, FMPs, and FMSs (also referred to as “Flood Solutions”) were discussed and refined with the RFPG throughout the regional flood planning process and were approved by the RFPG in a General RFPG meeting held July 20, 2022.

ES.5.1 Evaluation & Recommendation Process for FMEs, FMSs, and FMPs

As each FME, FMP, or FMS was evaluated throughout the regional flood planning process, relevant issues, changes, and refinements were presented and discussed with the RFPG during General RFPG meetings, meetings for Subcommittee 2 (FMPs), and/or meetings for Subcommittee 3 (FMEs and FMSs). Any feedback provided from the RFPG, stakeholders, or the general public was discussed with the RFPG and/or applicable subcommittee members, and agreed upon changes were incorporated into the evaluations or the scope associated with each flood solution.

ES.5.2 Summary of Evaluation Process for FMEs and FMSs without Project Specific Data

For FMEs and FMSs without project-specific H&H models or mapping, evaluations of the required parameters were typically based on the RFP 1% annual chance flood risk boundaries intersected with enhanced spatial layers for buildings, agricultural land, and other infrastructure, including roadways, low water crossings, and critical facilities. The sources for the development of these spatial layers and the methods used to estimate flood risk region-wide are documented in Chapter 2, Flood Risk Analyses.

In some instances, if reliable depth data were available, existing flood risk estimates were based upon a more detailed analysis of estimating maximum depths greater than 0.5 ft associated with the building footprint of each intersecting structure. Only maximum depths greater than 0.5 ft were considered in these analyses to account for potential raised finished floor elevations

ES.5.3 Methods for Evaluation of FMSs and FMPs with Project-Specific Data

The methods and assumptions related to flood risks and benefits varied depending on the project type and available modeling/mapping data for each project-specific FMS or FMP. However, in general, when proposed condition hydraulic model outputs or mapping were available, water surface elevations and ground elevations were used to estimate flood risk within El Paso County, and Fathom depth data were used for project-specific FMSs or FMPs located outside of El Paso County. Finished floor elevations were assumed to be 0.5 ft above ground elevations intersecting the footprint of a building. Where depth data were utilized to estimate 1% AC flood risk, raised finished floor elevations were considered by subtracting 0.5 ft from the maximum flood depth intersecting a building footprint. Within El Paso County, finished floor elevations of buildings were estimated by adding 0.5 ft to the average ground elevation within a building footprint.

FMSs and FMPs are required to demonstrate that they will not negatively affect a neighboring area. While this criterion did not require analyses to demonstrate for non-structural FMPs or FMSs, the documentation of engineering analyses and/or assumptions is required for FMSs or FMPs involving proposed flood control infrastructure. The methods for demonstrating no negative impact varied for each FMS or FMP involving flood infrastructure projects. To document the methods and assumptions associated with the negative impact analysis, it is necessary to explain the source and type of H&H models used in the flood risk analysis for existing and proposed conditions, which were provided in Chapter 5 appendices.

Each project-specific FMS and FMP was analyzed to estimate potential flood benefits as well as demonstrate no negative impacts on neighboring areas. Individual mapbook figures displaying zoomed-in project locations and existing downstream flood risk areas are provided for each project area. Chapter 5 appendices also document the Benefit Cost Analysis (BCA) and the process used to estimate that each FMP or Project-specific FMS will have no negative impact on neighboring areas.

ES.5.4 Summary of Recommendation Process

The process for recommending FMEs, FMSs, and FMPs includes coordination with the RFPG throughout the regional flood planning process. As new information became available or as evaluations were completed, evaluation results were shared with the RFPG during periodic General RFPG Meetings. The following General RFPG Meetings included votes by the RFPG on Recommended FMEs, FMPs, and/or FMSs:

- General RFPG Meeting held April 21, 2022;
- General RFPG Meeting held May 25, 2022; and
- General RFPG Meeting held July 20, 2022.

Each of the Recommended FMEs, FMSs, and FMPs are included in Appendices 5C, 5D, and 5E, respectively. The general reason for recommendation for each FME, FMS, and FMP is that the evaluated Flood Solutions were in alignment with RFPG and stakeholder goals. All of the flood solutions which were fully evaluated, and which are presented Appendices 4A, 4C, and 4E were also recommended by the RFPG.

In addition, each recommended FMP was evaluated based upon scoring criteria required for potential impacts and benefits from the FMP to flood risk, life and safety, the environment, agriculture, recreational resources, navigation, water quality, erosion, sedimentation, and implementation/permitting. This information is presented in Table 5F of Appendix 5F, "Data Entry Table for TWDB Scoring of Flood Mitigation Projects". The table was filled out according to specific criteria and instructions included in the Technical Guidelines provided by TWDB. Notes applicable to specific scores are also included in the table.

ES.6 Impacts and Contribution of Regional Flood Plan

Chapter 6 summarizes the overall impacts of the Regional Flood Plan (RFP), considering the potential for both positive and negative outcomes related to flood risk and multiple other considerations. Other resources which are not directly related to flood planning, but which can be strongly influenced by flood-related actions include water supply, the environment, agriculture, recreation, water quality, and navigation.

ES.6.1 Impacts of Regional Flood Plan

The methods applied to estimate potential increases in future conditions flood risk are documented in *Chapter 2 ("Flood Risk Analyses")*. The anticipated increased flood risk was modeled and mapped in the RFP based on the following:

- Best available flood risk modeling and mapping data;
- Future precipitation projections based on recent studies (for El Paso County watersheds only);
- Future land use planning documents (for El Paso County watersheds only); and
- Population projections throughout the region

Based on these methods, a future 1% annual chance and 0.2% annual chance floodplain was developed for Region 14 and compared to the existing conditions inundation areas for corresponding flood frequency boundaries. The extent of increased 1% annual chance risk inundation area from existing to future conditions is **242** square miles (sq. mi.). The extent of increased 0.2% annual chance risk inundation area from existing to future conditions (separate from the 1% annual chance risk inundation area) is **181** sq. mi. These anticipated increases in flood risk are estimated to be reduced if the FMEs, FMSs, and FMPs recommended in the RFP are performed.

As noted in *Chapter 4*, there are 20 out of the 23 counties within Region 14 that are in need of flood risk identification or in need of updated flood risk mapping. The exceptions are El Paso, Ector, and Val Verde Counties, which have recent flood risk mapping. Out of these 20 counties which need current floodplain mapping, there are 39 cities or Census Designated Places (CDPs) within Region 14, which have a combined jurisdictional area of 175 sq. mi. To address this need, there are 9 FMEs recommended for cities with outdated or no floodplain mapping. These 9 cities have a combined total jurisdictional area of **110 sq. mi**. These cities were selected for SWMP FMEs based on an assessment of cities within the region with the greatest number of structures at risk of 1% annual chance flooding.

As noted in *Chapter 2*, there are approximately 40,121 structures at risk of 1% annual chance flooding in the region with a total population of 115,530. There are an additional 14,290 structures within the 0.2% annual chance flood risk inundation area (separate from the 1% annual chance risk inundation area) with a population of 47,985. The recommended FMPs and project-specific FMSs analyzed for flood risk benefits are estimated to remove **11,964** structures from the 1% annual chance flood risk boundary with a combined population of approximately **31,233**. The recommended FMPs are estimated to remove **936** structures from the 0.2% annual chance flood risk boundary with an approximate population of **2,400**. Furthermore, the recommended FMPs and FMS are estimated to remove **41** low water crossings from the 1% annual chance flood risk boundary.

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

There are no recommended FMPs that would measurably contribute to water supply. However, there is one recommended FMS which is estimated to contribute to water supply (FMS ID: 142000002). In the RFP, this FMS is named, “Irrigation and Recharge Application of Captured Rainwater Runoff at Alpine.” It is also recommended in the adopted State Water Plan (TWDB, 2022) as well as in the current Far West Texas Water Plan (TWDB, 2021) for Region E, where it is identified as Strategy E-2, “Irrigation and Recharge Application of Captured Rainwater Runoff.”

The Water User Group identified for this strategy in the Region E Water Plan is the City of Alpine. The State Water Plan identified the City of Alpine as the Sponsor of the recommended strategy. Based on the information provided by the project planners and the Far West Texas Water Plan (TWDB, 2021) for Region E, this strategy is expected to directly increases water supply volume available during droughts of record for the City of Alpine.

The RFPG is also required to list recommended FMSs or FMPs that, if implemented, would negatively impact and/or measurably reduce:

- Water availability volumes that are the basis for the most recently adopted SWP; and
- Water supply volumes if implemented.

Based on the evaluations of recommended FMSs and FMPs previously discussed in *Chapter 5*, no measurable negative impacts are anticipated on water supply, water availability, or projects in the State Water Plan.

ES.7 Flood Response Information and Activities

The RFP includes a summary of flood emergency management activities across the Upper Rio Grande Region to address the preparedness, response, and recovery phases of flood emergencies. Information was gathered based on agency coordination, survey responses, and hazard mitigation planning documents.

Flood emergency preparedness activities include the development of emergency management and action plans, hazard mitigation plans, and the building of flood early warning and alert systems, flood gages, or automatic low water crossings. Several Emergency Action Plans (EAPs) have been developed for dams throughout the region including the City of El Paso High Hazard Dams EAP (2008), the Red Bluff Dam EAP (2021), and the Elephant Butte & Caballo Dams EAP (2018). In addition, Hazard Mitigation Plans (HMPs) have been developed for the Counties of Brewster, Ector, El Paso, Hudspeth, Jeff Davis, and Presidio. These HMPs, while primarily mitigation-focused, encourage interregional coordination with key flood planning stakeholders and assist with flood preparedness by reducing emergency response demands during a flood.

In addition to these planning documents, El Paso currently utilizes a flood early warning system based on early warnings provided by a dedicated meteorologist with coordination between EPWater, EPCWID1, and the operators of Caballo Dam in New Mexico. *Chapter 5 ("Evaluation and Recommendation of Flood Solutions")* of this RFP includes six recommended FMPs to develop or improve flood early warning systems for the City/County of El Paso and the Cities of Pecos, Alpine, Presidio, Fort Stockton, and Marfa. A general FMS is also recommended for the entire region to prioritize, fund, and develop new flood gages (rainfall and/or stream gages) to support flood warning system improvements. Lastly, an FMP is recommended to install automatic low water crossing gates along Alamito Creek in Marfa, including the installation of a monitoring and early detection gage.

In response to flooding emergencies, several communities in the region reported using a public alert or alarm system to broadcast alarms via an outdoor siren or send notifications via text messaging, website, or social media. Cities and counties coordinate with the Texas Department of Transportation (TxDOT) on road closures and traffic message boards. Emergency managers rely on publicly available information from the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), and the United States Geologic Survey (USGS). The Bureau of Reclamation El Paso Field Division (EPFD) works with offices and divisions from New Mexico to regulate releases from the Elephant Butte and Caballo Dams to minimize flows during a flood event.

Flood recovery activities most often include debris removal from culvert entrances and bridges by cities, counties, and TxDOT. Due to the region's arid landscape, sedimentation from arroyos is a common issue after floods, especially in El Paso where arroyos from the Franklin Mountains frequently deposit sediment impacting downstream culverts, roadways, agricultural land, and irrigation system infrastructure. In the event of significant flood damages, flood damage assessment and recovery efforts are supported with assistance and resources by FEMA Region VI and the Texas Division of Emergency Management (TDEM) Region 4.

ES.8 Administrative, Regulatory, and Legislative Recommendations

The Upper Rio Grande engaged with stakeholders within the region to develop administrative, regulatory, and legislative recommendations for consider by the Texas Legislature, TWDB, TCEQ, other water planning regions, and all stakeholders and participants in Texas' regional and state flood planning efforts. Prior to these engagements, individual interviews were conducted with comparative entities outside the region to solicit feedback for consideration by the RFPG. Four RFPG subcommittee meetings were held to develop recommendations for floodplain management and flood mitigation implementation. From these discussions, a list of region-specific needs was developed along with recommendations to address these needs. Recommendations are organized by stakeholders (i.e., for the El Paso County area and the flood planning area outside of El Paso County) as well as by type (i.e., legislative, regulatory/administrative, fundraising, and other recommendations). Recommendations from the legislative and regulatory/administrative categories are presented below in **Table ES.5** through **Table ES.8**, while details pertaining to the fundraising recommendations and other recommendations are provided in *Chapter 8 ("Administrative, Regulatory, and Legislative Recommendations").*

Table ES.5 Legislative Recommendations (El Paso County Area Stakeholders)

Need to address	Recommendation
Burden on sponsors for levee certification is excessive	Communicate with the federal government about lessening the burden for levee certification
Counties perceive lack of ability to regulate drainage outside of FEMA floodplains	Counties to consider adoption of drainage requirements beyond areas that are in flood zone (e.g., within County Road ROWs outside floodplains)

Need to address	Recommendation
Revolving state funds are not self-sustaining	Create specific revolving state funds to provide matching to federal dollars for FMPs

Table ES.6 Regulatory/Administrative Recommendations (El Paso County Area Stakeholders)

Need to address	Recommendation
Identified potential design standard improvements	Develop recommendations for inlets, curb cuts, on-site storage, sediment controls at inlets, discharges into irrigation drains, 2D modeling (include freeboard requirements)
Erosion in natural channels	Develop recommendations for design guidelines for erosion mitigation in arroyos
Issues with outfalls into Rio Grande	Develop guidelines for design of outfalls
EPCWID1 is concerned with the risk of loss of Clean Water Act exemptions associated with stormwater accumulated in irrigation drains	Recommend that USACE develop clear guidance relevant to situation in El Paso County to ensure exemption is retained
There are uncertainties in El Paso County associated with the capture of stormwater with the potential for reuse	Investigate permitting issues and develop clear guidance to ensure compliance and optimize opportunities for capture/blend
Improve coordination with other jurisdictions to facilitate floodplain management (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate floodplain management involving multiple jurisdictions. (e.g., create consensus requiring no adverse impact)
Codify use of most restrictive standard where conflicts exist	Revise local standards to codify this requirement and address adverse impact
Drainage component is not part of certificate of compliance (In Ector County there is no review of any building or development permit, no component for flood mitigation)	Counties should have the option to be empowered to enforce drainage requirements within the requirements for a certificate of compliance
ATV-induced erosion on state lands	Review existing regulatory/ admin controls and effectiveness. Recommend changes
Improve coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation planning involving multiple jurisdictions.
Improve coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation implementation involving multiple jurisdictions.
Coordinate with State Historic Preservation Office to develop acceptable mitigation practices for the El Paso region	Develop county-wide procedures for accelerating compliance, reducing delays in projects due to interaction with the historic preservation office.
Shortfalls with use of existing El Paso area MOUs with State Historic Preservation Office	Negotiate with the State Historic Preservation Office to address shortfalls

Table ES.7 Legislative Recommendations (Flood Planning Area Outside of El Paso County)

Need to address	Recommendation
New federal requirements addressing historic preservation	Develop a set of regional comments on new requirements to be provided to the federal agency
Counties perceive lack of ability to regulate drainage outside of FEMA floodplains	Counties to consider adoption of drainage requirements beyond areas that are in flood zone (e.g., within County Road ROWs outside floodplains)

Table ES.8 Regulatory/Administrative Recommendations (Flood Planning Area Outside of El Paso County)

Need to address	Recommendation
Unregulated/ minimally regulated development in Hudspeth County	Develop program to regulate drainage from development in Hudspeth County and similar counties that elect to participate
No technical personnel on staff nor funds to develop drainage criteria/standards	Provide regional coordination for technical assistance and/or funding to update drainage criteria and development standards
Improve coordination with other jurisdictions to facilitate floodplain management (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate floodplain management involving multiple jurisdictions. (e.g., create consensus requiring no adverse impact)
Codify use of most restrictive standard where conflicts exist	Revise local standards to codify this requirement and address adverse impact
Drainage component is not part of certificate of compliance (In Ector County there is no review of any building or development permit, no component for flood mitigation)	Counties should have the option to be empowered to enforce drainage requirements within the requirements for a certificate of compliance
Improve flood mitigation planning coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation planning involving multiple jurisdictions.
Improve flood mitigation implementation coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation implementation involving multiple jurisdictions.
Coordinate with State Historic Preservation Office to develop acceptable mitigation practices for the Upper Rio Grande Flood Planning region outside of El Paso County	Develop regional procedures for accelerating compliance, reducing delays in projects due to interaction with the historic preservation office.

ES.9 Flood Infrastructure Financing Analysis

The Region 14 RFPG has recommended a total of 58 flood mitigation actions to address flood risk across the planning region. Combined, these flood mitigation actions are anticipated to cost $160.3 million to implement. Given the challenges of funding flood management activities, local sponsors will likely be required to use a combination of funding sources to implement flood mitigation actions, including local, state, and federal sources. This chapter discusses some of the most common avenues of generating local funding and overviews various state and federal financial assistance programs available to communities for flood management.

TWDB requires that each RFPG assess and report on how local sponsors propose to finance recommended FMEs, FMSs, and FMPs. To determine the capabilities of the local sponsors to finance the projects, the RFPG conducted a survey for local sponsors to determine the funding needs of local sponsors and propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs.

While the overall response rate appears low, there is significant interest and continued participation demonstrated by major regional stakeholders. The communities that responded to the survey are listed as sponsors for a combined 46 of the 58 flood mitigation actions (79%) accounting for $156.5 million (97.6%) of the total implementation cost needed. As a result, even with a low overall response rate, the information received provides a representative picture of total funding needs across the basin.

Of the 11 entities that responded to the survey, the likely sources of funding indicated to implement flood management activities included general or dedicated revenues, bonds, tax notes, or utility fees. Just under half (5 of 11) of the respondents had not applied for grant funding in the past five years (one respondent left this blank). Of the remaining six respondents that had applied for grant funding, three had been successful in receiving a grant and loan, one had been unsuccessful, one had received an invitation for a full application but decided not to pursue the project, and one application was still under further review.

ES.10 Public Participation and Plan Adoption

The Upper Rio Grande RFPG held 16 formal Planning Group meetings between November 2020 and July 2022 to discuss relevant RFP topics, conduct pre-planning and administrative activities, receive updates from the technical consultant, and vote on specific measures. All meetings were posted and held in accordance with the Texas Open Meetings Act (OMA) with recordings and meeting minutes posted online on the RFPG website (www.urgfpg.org) following the meetings.

In addition to the regular RFPG and committee meetings, several public open house meetings were held throughout the region to facilitate engagement with the public and other flood planning stakeholders including two in El Paso (October 27, 2021, and June 8, 2022), one in Pecos (February 9, 2022), and one in Presidio (February 10, 2022).

From September to October 2021, the RFPG conducted a stakeholder survey to obtain flood-related information from the public and other flood planning stakeholders. As part of the survey, an interactive web map was also developed to collect feedback from the public regarding flood prone areas, critical infrastructure or resources, existing infrastructure, and existing or proposed flood mitigation projects.

Following the submittal of the Draft RFP to the TWDB, a Public Hearing was held in El Paso on September 14, 2022, to receive public comments. Printed copies of the Draft RFP were located in three publicly accessible locations in the region including the cities of El Paso, Pecos, and Presidio. The Draft RFP was also posted to the RFPG website for public review, and public comments were accepted electronically during the public review and comment period. The Final RFP was adopted by the RFPG on December 15, 2022, and submitted to the TWDB along with supporting materials on January 10, 2023.

The state and regional flood planning process is guided by 39 principles adopted in Title 31 Texas Administrative Code (TAC) §362.3. This RFP conforms with each of these flood planning guidance principles, including the requirement that the plan will not negatively affect any neighboring areas.

Chapter 1: Introduction and Description of the Upper Rio Grande Flood Planning Region

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1. Introduction and Description of the Upper Rio Grande Flood Planning Region

Sections 16.061 and 16.062 of the Texas Water Code direct the Executive Administrator of the Texas Water Development Board (TWDB) to prepare and maintain a comprehensive State Flood Plan. The overall goal of the State Flood Plan is to identify specific flood risks as well as flood studies, strategies, and projects to reduce those risks in coming years within Texas. This effort is aimed at better managing flood risk to reduce loss of life and property from flooding.

In April 2020, the TWDB adopted rules establishing 15 regional flood planning areas (**Figure 1.1**). Each planning area has its own regional flood planning group (RFPG) responsible for preparing a consensus-based Regional Flood Plan (RFP). The TWDB incorporates the resulting RFPs into the State Flood Plan, which is updated in 5-year cycles. It is anticipated that the current cycle of Regional Flood Plans will be finalized and adopted by January 2023. Subsequently, by September 2024, the TWDB will prepare its first State Flood Plan.

The Upper Rio Grande Flood Planning Region, designated by the TWDB as "Region 14" and led by the Upper Rio Grande Flood Planning Group (URGFPG), encompasses all or part of 23 West Texas counties as listed below and shown in **Figure 1.2** (partial counties denoted with asterisks):

- Andrews*
- Brewster
- Crane
- Crockett*
- Culberson
- Ector*
- Edwards*
- El Paso
- Hudspeth
- Jeff Davis
- Loving
- Midland*
- Pecos
- Presidio
- Reagan*
- Reeves
- Schleicher*
- Sutton*
- Terrell
- Upton*
- Val Verde*
- Ward
- Winkler

The planning area for Region 14 follows the Upper Rio Grande in West Texas along the US-Mexico border from the City of El Paso to the Amistad Reservoir in Val Verde County as well as the Pecos River from the New Mexico Border to the Rio Grande. This region is the largest of the fifteen state flood planning regions by area, covering more than 43,000 square miles across three river basins – the Upper Rio Grande, the Pecos River, and the Devils River.

The entirety of the Upper Rio Grande watershed area covers nearly 180,000 square miles, draining into the Lower Rio Grande through the Amistad Reservoir and, ultimately, into the Gulf of Mexico. A majority of the Upper Rio Grande watershed originates upstream of the Texas state line, with Texas representing only 24% of the total watershed area. The remainder of the watershed covers New Mexico (43%), Mexico (29%), and Colorado (4%).

The regional flood plan includes the following sections:

- Planning area description (Chapter 1)
- Existing and future condition flood risk analysis (Chapter 2)
- Evaluation and recommendations on floodplain management practices; Flood mitigation and floodplain management goals (Chapter 3)
- Identification of flood needs and identification and recommendation of flood solutions including flood management evaluations (FMEs), flood management strategies (FMSs), and flood mitigation projects (FMPs) (Chapter 4)
- Impacts of regional flood plan; contributions to and impacts on water supply development and the State Water Plan (Chapter 5)
- Flood response information and activities (Chapter 6)
- Administrative, regulatory, and legislative recommendations (Chapter 7)
- Flood infrastructure financing analysis (Chapter 8)
- Public participation and plan adoption (Chapter 9)

The overall goal of the State Flood Plan is “to protect against the loss of life and property,” as set forth in the Guidance Principles in 31 Texas Administrative Code (TAC) §362.3. Flood management evaluations, flood management strategies, and flood mitigation projects aim to mitigate flood events associated with a 1% annual chance flood event. During the process of developing flood management evaluations and strategies and flood mitigation projects within each region, benefits to water supplies, economic and environmental impacts, and public acceptance were considered. This includes local impacts to agriculture, recreational resources, transportation, and sustainability.

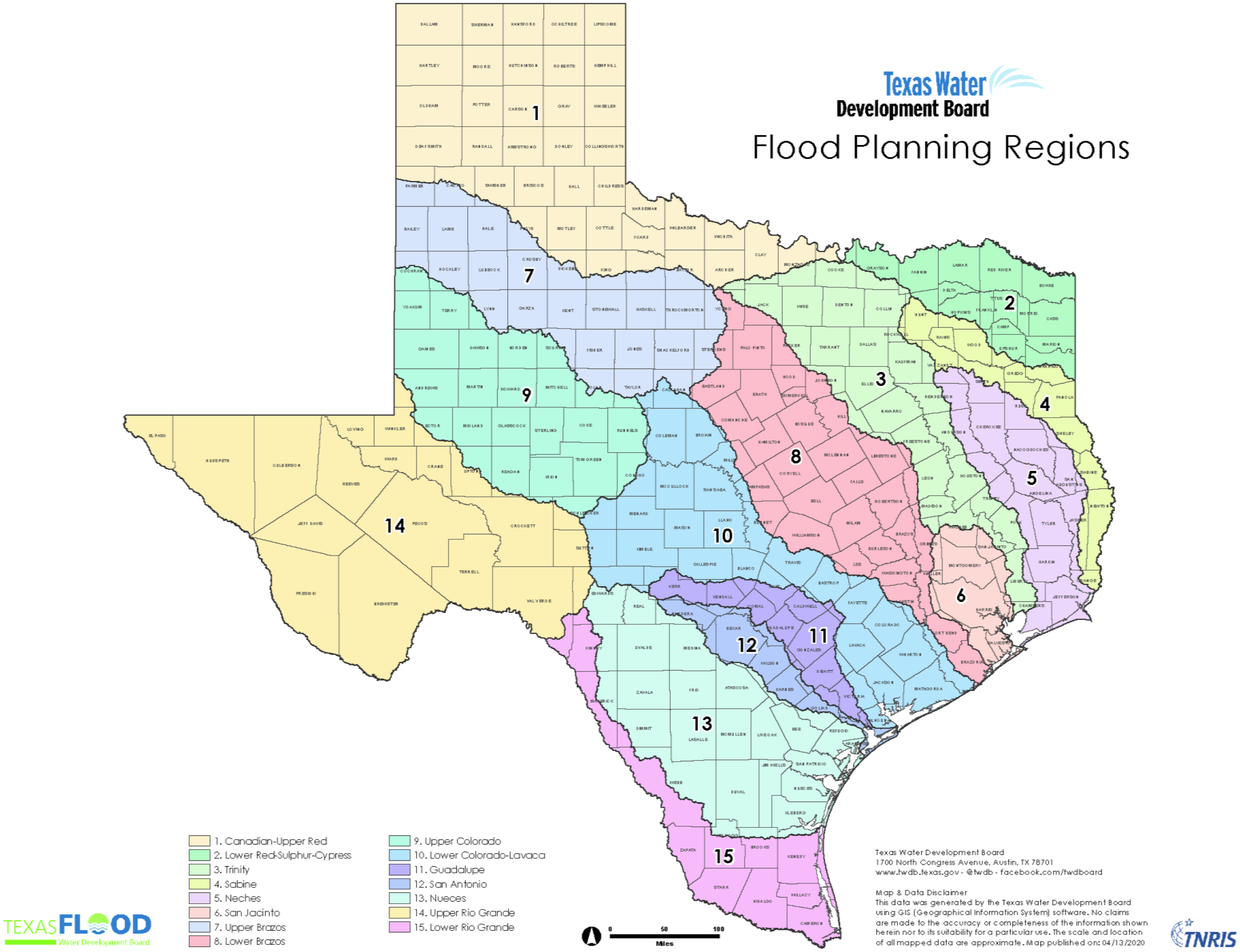


Figure 1.1 TWDB Designated Flood Planning Regions

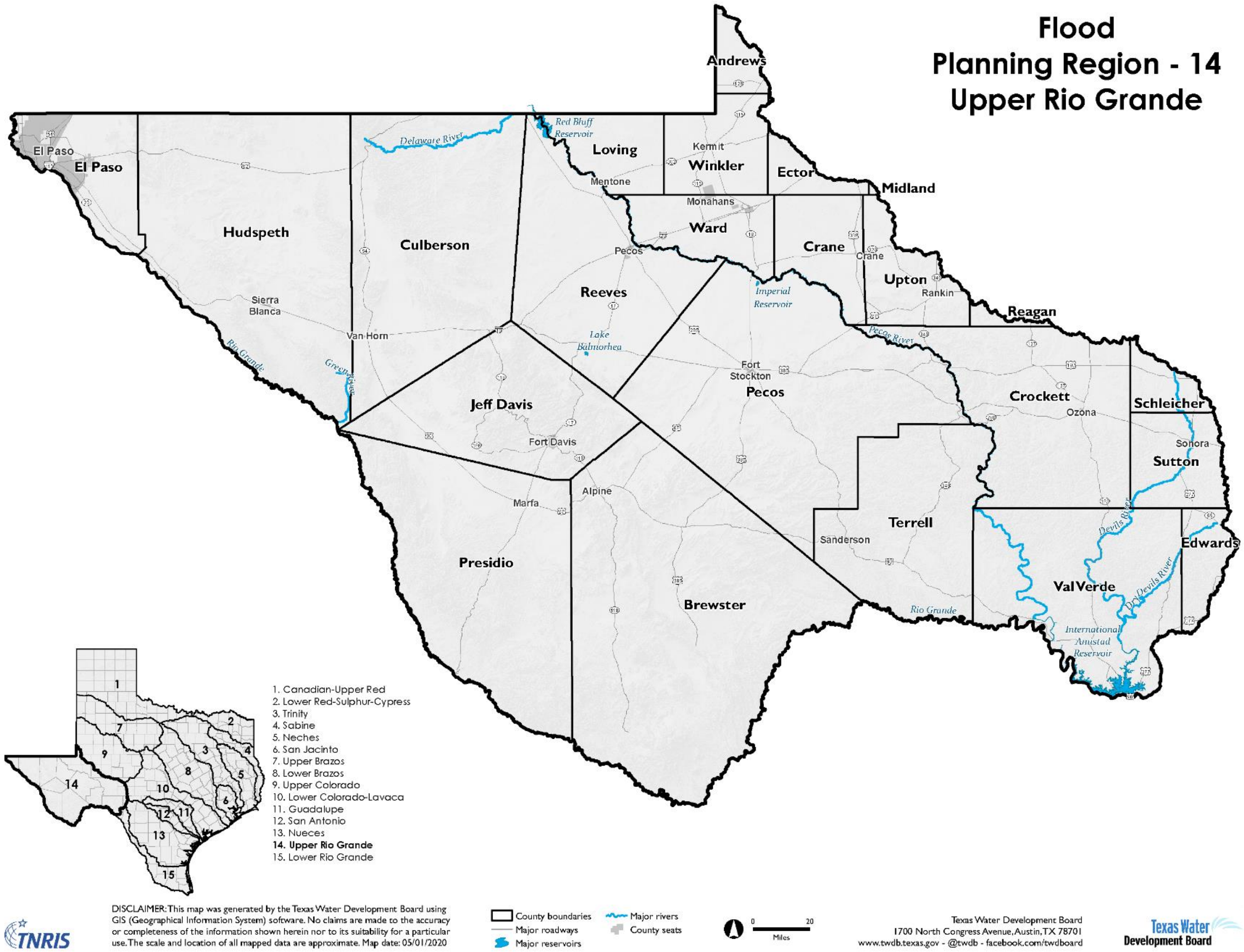


Figure 1.2 Upper Rio Grande Flood Planning Region (Region 14)

1.1 Social and Economic Characteristics

The Far West Texas region is well known for its wide-open expanses and rugged landscapes. Compared to other flood planning regions across the state, Region 14 remains primarily rural and less impacted by urban development.[1] Neverthless, flooding continues to pose a substantial risk to communities of all sizes across the region. The following section describes the social and economic characteristics of the region, including development, population, and economic activity.

1.1.1 Population & Development

Population

Regional county-level population estimates were obtained and compared from multiple sources including the TWDB Regional Water Plan (2021), the Texas Demographic Center Texas Population Projections Program (2018), the American Community Survey (ACS) 5-year Estimates (2016-2020), and the 2020 Decennial Census Redistricting Data Summary Files.

Existing (2020) populations by county in the region are summarized in **Table 1.1**. Populations were adjusted to reflect only the population estimated inside the Region 14 Flood Planning boundaries, excluding populations for urban centers outside the region such as the Cities of Midland and Odessa (represented in Region 9) as well as the City of Del Rio (represented in Region 15). In addition, populations for smaller counties such as Loving and Midland County were estimated using Landscan nighttime population estimates from the Oak Ridge National Laboratory (ORNL) datasets.

The top five counties by population in Region 14 include the Counties of El Paso (89%), Pecos (2%), Reeves (2%), Ward (1%), and Brewster (1%). Several of the region's largest cities are located in El Paso County, including the Cities of El Paso, Socorro, Horizon City, and San Elizario. Other prominent cities in the region by population include the City of Fort Stockton (Pecos County), the City of Pecos (Reeves County), the City of Alpine (Brewster County), the City of Monahans (Ward County), and the City of Presidio (Presidio County).

Population within Region 14 is projected to grow on pace with the rest of Texas between 2020 and 2050, with an estimated annual growth rate between 1.1% and 1.8%, according to the TWDB 2021 Regional Water Plan and 2018 Texas Demographic Center estimates. A more detailed analysis of future population trends is presented in *Chapter 2 (Flood Risk Analyses)*.

[1] Texas A&M Natural Resources Institute (NRI). *West Texas Landowner Report: Energy and Growth Trends.* December 2019. *https://nri.tamu.edu/media/2786/west-texas-landowner-report-final-20200115.pdf*

Table 1.1 Existing Population by County in Region

County	Estimated Population in Region, 2020	% of Population in Region
Andrews	138	<0.1%
Brewster	9,727	0.9%
Crane	5,056	0.5%
Crockett	4,111	0.4%
Culberson	2,695	0.3%
Ector	4,705	0.5%
Edwards	2,123	0.2%
El Paso	925,565	89.0%
Hudspeth	3,913	0.4%
Jeff Davis	2,398	0.2%
Loving	157	<0.1%
Midland	80	<0.1%
Pecos	17,718	1.7%
Presidio	8,692	0.8%
Reagan	3,853	0.4%
Reeves	15,125	1.5%
Schleicher	3,811	0.4%
Sutton	3,817	0.4%
Terrell	1,045	0.1%
Upton	3,690	0.4%
Val Verde	1,933	0.2%
Ward	11,454	1.1%
Winkler	8,033	0.8%
Total	1,039,839	100%

Social Vulnerability

The Social Vulnerability Index (SVI) is an index used by the Centers for Disease Control and Prevention (CDC) that measures 15 social factors from the U.S Census, including poverty, lack of vehicle access, and crowded housing, among others. The SVI can help public health officials and local planners better prepare for and respond to emergency events like flooding, hurricanes, disease outbreaks, or exposure to dangerous chemicals. The SVI ranges from zero (0) to one (1) with higher SVI values indicating a higher degree of vulnerability relative to other areas.

Figure 1.3 shows a percentile ranking of social vulnerability for each census tract in Region 14. Based on these estimates, the west portion of the region (including the Counties of El Paso, Hudspeth, Culberson, and Presidio) exhibits a high degree of vulnerability with SVI values of 0.8 or greater. SVI values are examined in further detail in *Chapter 4 (Flood Mitigation Solutions)*.

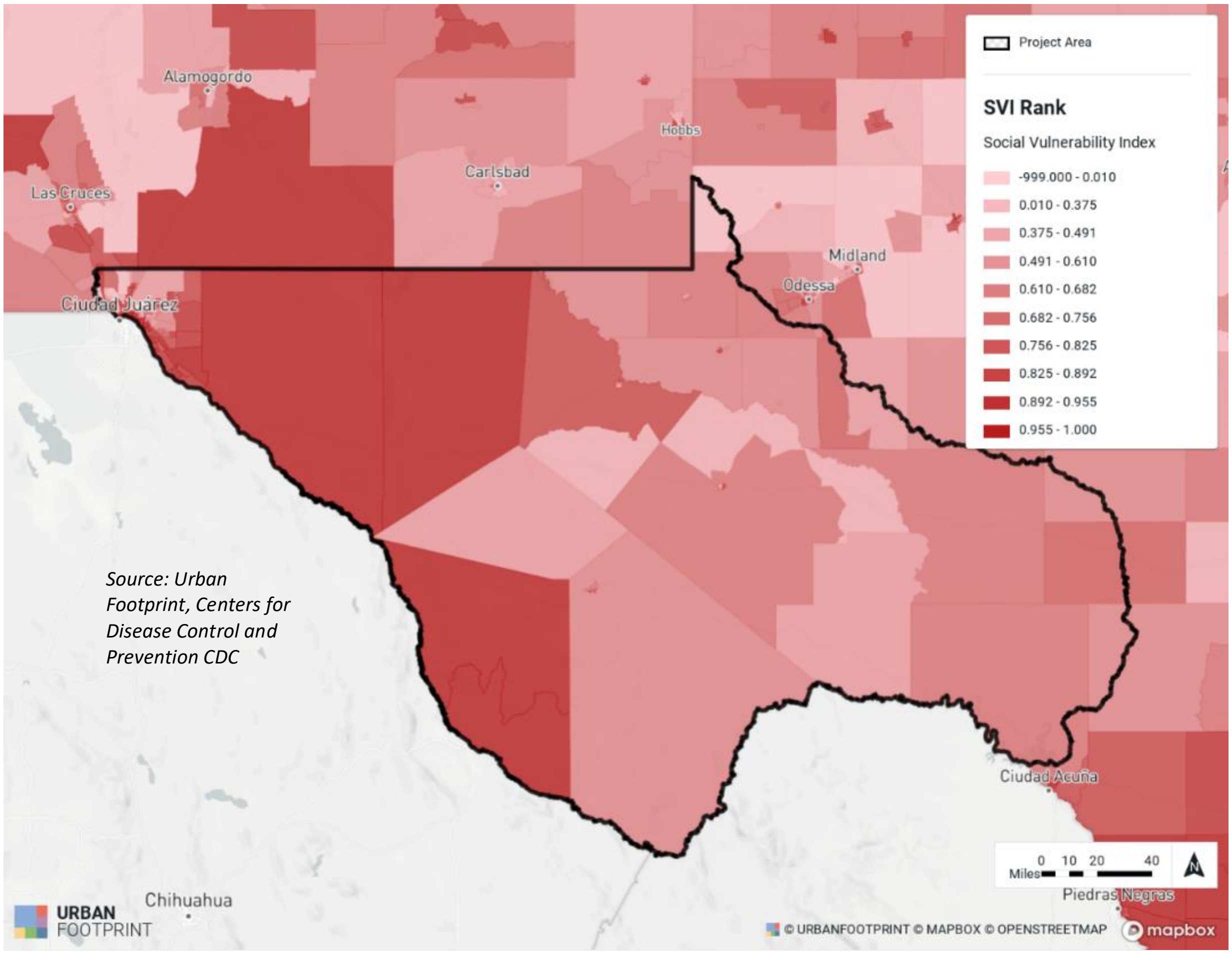


Figure 1.3 Social Vulnerability by Census Tract

Development

Regionwide land use data were obtained using Urban Footprint for a variety of Land Use types. These land use types are shown below in **Figure 1.4** and summarized in **Table 1.2**.

According to these estimates, nearly 90% of the region's area consists of natural, undeveloped land, and approximately 3% of the area is represented by parks and open space (such as Big Bend National Park and Guadalupe Mountains National Park). Of the remaining developed land use categories, the highest land use categories are residential (approximately 41% of developed areas) and agricultural cropland (approximately 39% of developed areas, excluding grassland/pasture). In total, all developed areas, which include residential, agricultural (excluding grassland/pasture areas), civic, commercial, industrial, mixed-use, and transportation/utilities land use types, make up approximately 2.0% of the total region by area.

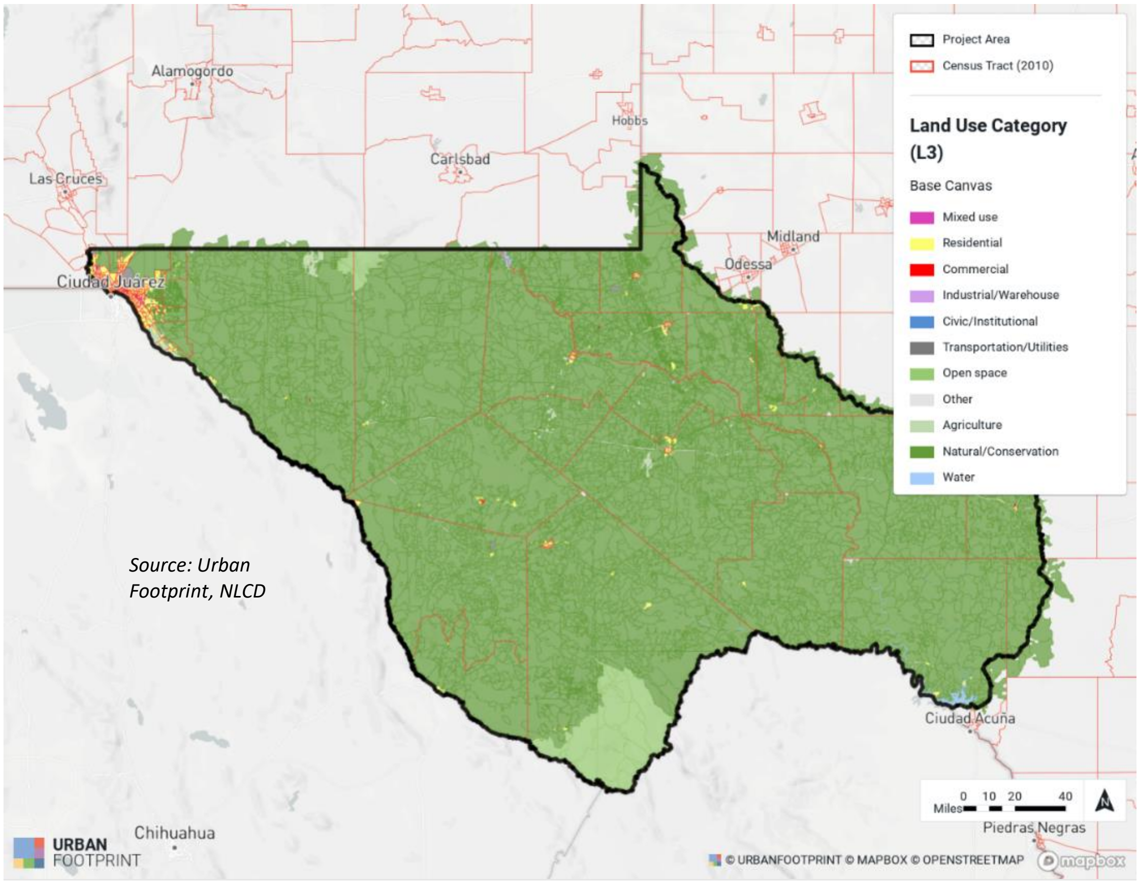


Figure 1.4 Regionwide Land Use

Table 1.2 Summary of Land Use Types

Land Use Type	Total Area (acres)	% of total
Agriculture (grassland/pasture)	1,571,000	6%
Agriculture (other crops)	206,000	<1%
Civic/Institutional	2,000	<1%
Commercial	13,000	<1%
Industrial	68	<1%
Mixed-use	27,000	<1%
Natural/Conservation	25,349,000	89%
Parks & Open Space	972,000	3%
Other	40,000	<1%
Residential	216,000	1%
Transportation/Utilities	25,000	<1%
Water	68,000	<1%

Source: USDA CropScape Data Layer used for agricultural areas (including grassland/pasture and other crops); Urban Footprint used for non-agricultural areas

1.1.2 Primary Economic Activities & At-Risk Sectors

To evaluate economic activities and trends across the region, industry and business data were obtained from Esri Business Analyst Data, Emsi Labor Market Analytics & Economic Data, and the Texas Almanac. Economic activity can be evaluated in the region both by total employment and by the concentration of industries relative to the national average.

As of 2021, the region employs an estimated 590,000 jobs across its 23 counties, with about 91,000 of these jobs added since 2010. In the past decade, jobs in the region have grown at an annual rate of 1.5%, faster than the U.S. average (0.9%) and similar to the Texas average (1.7%).

By total employment, the region's top five industries (representing approximately 45% of total jobs) include human health (healthcare, such as hospitals and pharmaceuticals), food services (restaurants and other food services), education (schools and universities, public and private), oil and gas upstream (oil extraction and related activities), and non-food retail. With the exception of the oil and gas upstream industry, the concentration of these industries in the region is similar to the average concentration of the industries across the U.S.

In terms of regional specialization (i.e., evaluating the concentration of industries relative to the national average), the region's top five industries include oil and gas upstream (oil extraction and related activities), oil and gas downstream (manufacturing from processed petroleum or support services for oil/gas), federal military, rental and leasing, and textile manufacturing. In particular, the region's oil and gas upstream industry is highly specialized, with a concentration 17 times higher than the U.S. average. Other noteworthy industries, based on Texas Almanac data, include tourism and ranching.

Table 1.3 lists the primary economic base of each county as well as the breakdown of mining and agricultural activities, according to data from the Texas Almanac.

Many economic sectors are susceptible to flood risks. In reviewing data for major businesses in the region, around 450 businesses with more than 100 employees were identified, and, among these, approximately 60 (14%) were found to be located in the existing 1% or 0.2% annual chance floodplains.

In the event of major flooding, post-disaster impacts to businesses include damages to properties, facilities and assets directly owned by the business, as well as disruptions to suppliers, customers and employees. A business' ability to recover and resume operations is typically dependent on its size since larger companies are more likely to have a continuity plan in place. For oil and gas industries, flooding can result in the disruption of oil and gas operations and damage to supply systems, such as ruptured flow lines and storage tanks.[2] For agricultural resources, extended periods of flooding may damage crops leading to reduced crop yields or total loss (the region's agricultural resources are discussed in further detail later in this chapter in Section 1.4).

[2] Cornell, Kenneth. *Environmental Exposure: Flood Risk in the Oil & Gas Industry.* April 7, 2014. https://www.insurancejournal.com/magazines/mag-features/2014/04/07/325072.htm

Table 1.3 Primary Economic Activities by County

County	Primary Economic Base	Mineral Deposits	Agriculture
Andrews*	Natural resources/mining; manufacturing; trade, construction; government/services; agribusiness.	Oil and gas.	Beef, cotton, sorghums, grains, corn, hay.
Brewster	Agriculture, tourism, government/ services, Sul Ross State University, mining.	Bentonite.	Beef cattle, meat goats, horses.
Crane	Oil and gas; agriculture; government/services.	Oil, gas production.	Beef cattle, goats.
Crockett*	Oil and gas, ranching, hunting leases.	Oil, gas production.	Sheep (first in numbers), goats; beef cattle.
Culberson	Tourism, government/services, talc mining and processing, agribusiness, sulfur mining.	Sulfur, talc, marble, oil.	Beef cattle; cotton, vegetables, melons, pecans; 6,000 acres in irrigation.
Ector*	Center for Permian Basin oil field operations, plastics, electric generation plants.	More than 3 billion barrels of oil produced since 1926; gas, cement, stone.	Beef cattle, horses are chief producers; pecans, hay, poultry; minor irrigation.
Edwards*	Hunting leases, tourism, oil, gas production, ranching.	Gas.	Second in number of goats. Mohair-wool production, Angora goats (first in numbers), sheep, cattle, some pecans. Cedar for oil.
El Paso	Government, military are major economic factors; wholesale and retail distribution center, education, tourism, maquiladora plants, varied manufacturing, oil refining, cotton, food processing.	Production of cement, stone, sand and gravel.	Dairies, cattle, cotton, pecans, onions, forage, peppers. Third in colonies of bees. 25,000 acres irrigated, mostly cotton.
Hudspeth	Agribusiness, mining, tourism, hunting leases.	Talc, stone, gypsum.	Most income from cotton, vegetables, hay, alfalfa; beef cattle raised; 18,000 acres irrigated.
Jeff Davis	Tourism, agriculture, McDonald Observatory.	Not significant.	Greenhouse tomatoes, beef cattle, horses, meat goats.
Loving	Oil and gas operations; cattle.	Oil, gas.	Cattle ranching.
Midland*	Among leading petroleum-producing counties; distribution, administrative center for oil industry; varied manufacturing; government/services.	Oil, natural gas.	Beef cattle, horses, sheep and goats; cotton, hay, pecans; some 11,000 acres irrigated.
Pecos	Oil, gas, agriculture, government/services, wind turbines.	Natural gas, oil, gravel, caliche.	Cattle, alfalfa, pecans, sheep, goats, onions, peppers, melons. Aqua-culture firm producing shrimp.
Presidio	Government/services, ranching, hunting leases, tourism.	Sand, gravel, silver, zeolite.	Cattle, tomatoes, hay, onions, melons. Some irrigation near Rio Grande.
Reagan*	Oil and gas production, hunting, ranching.	Gas, oil.	Cotton, cattle, sheep, goats.

County	Primary Economic Base	Mineral Deposits	Agriculture
Reeves	Oil and gas, agriculture, tourism, food processing, government/services, gravel.	Oil, gas, gravel.	Ranching, dairies, hay, cotton, cantaloupes, pecans, pistachios. Some 11,000 acres irrigated.
Schleicher*	Oil, ranching, and hunting.	Oil and natural gas.	Beef cattle, sheep, goats, and cotton, hay.
Sutton*	Natural gas, ranching, hunting.	Oil, natural gas.	Meat goats (first in numbers), sheep, cattle, Angora goats (second in numbers). Exotic wildlife. Wheat and oats raised for grazing, hay; minor irrigation.
Terrell	Ranching, hunting leases, oil, gas exploration, tourism.	Gas, oil, limestone.	Goats (meat, Angora); sheep (meat, wool); some beef cattle.
Upton*	Oil, wind turbines, farming, ranching.	Oil, natural gas.	Cotton, sheep, goats, cattle, watermelons, pecans. Extensive irrigation.
Val Verde*	Agribusiness, tourism, trade center, military, Border Patrol, hunting leases, fishing.	Production sand and gravel, gas, oil.	Sheep, Angora goats, meat goats (second in numbers); cattle; minor irrigation.
Ward	Oil, gas, government/services.	Oil, gas, caliche, sand, gravel.	Beef cattle, greenhouse crops, alfalfa, horses.
Winkler	Oil, natural gas, ranching, prison, some farming.	Oil, gas.	Beef cattle.

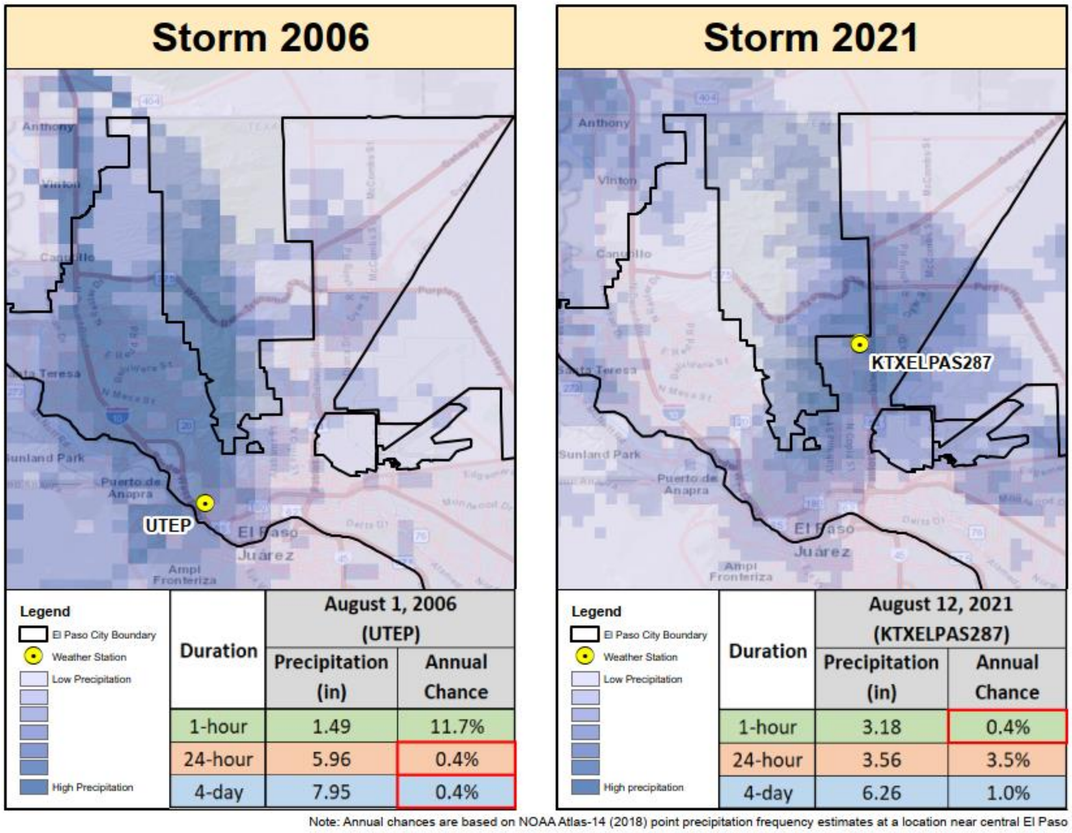
**indicates this county is partially within this RFPG and is also represented by at least one other RFPG*

1. *Source: Texas State Historical Association (Texas Almanac 2018-2019). Texas Comptroller of Public Accounts, Texas Economy.*

1.2 Historical Flooding

Flooding in Texas is principally associated with hurricanes, tropical storms, and high intensity storms. Flooding is usually caused by high precipitation volumes, long precipitation duration, and high precipitation intensity. Hurricanes and tropical storms have the potential for each dangerous mode of precipitation as they are large storms fed from warm oceans and can linger over a location. A summary of historical flooding events throughout the region is presented in **Table 1.4**.

El Paso County has experienced long duration/low intensity rain events (e.g., 7.95 inches over four days in 2006) and short duration/high intensity rain events (e.g., 3.18 inches over one hour in 2021) which result in various flood hazards and require different mitigation strategies. Both of these storm events, shown in **Figure 1.5**, had an extremely low Annual Exceedance Probability (AEP) of approximately 0.4% (or the 250-year return period). Both of these storms covered the streets in debris and caused significant damage.

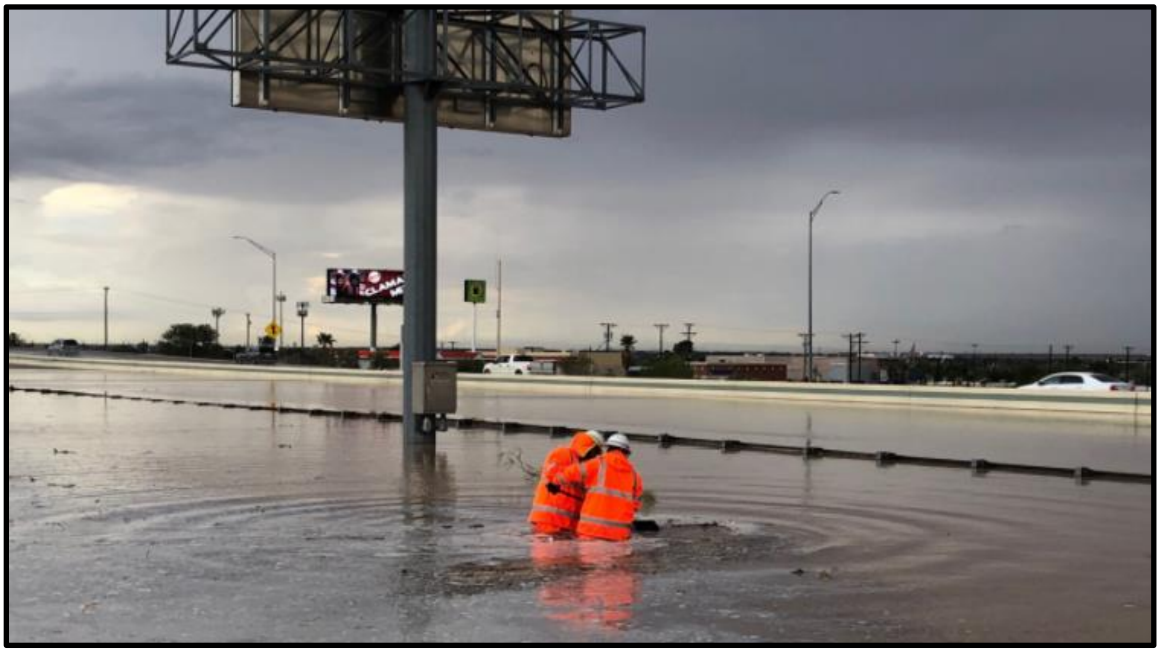


Duration	August 1, 2006 (UTEP)	
	Precipitation (in)	Annual Chance
1-hour	1.49	11.7%
24-hour	5.96	0.4%
4-day	7.95	0.4%

Duration	August 12, 2021 (KTXELPAS287)	
	Precipitation (in)	Annual Chance
1-hour	3.18	0.4%
24-hour	3.56	3.5%
4-day	6.26	1.0%

Figure 1.5 Precipitation and Annual Exceedance Probabilities of 2006 and 2021 Floods in El Paso, Texas

The August 2021 is an example of high precipitation intensity flooding (see **Figure 1.6**). This short, intense, extreme storm overwhelmed drainage infrastructure in east central El Paso. Several small flood control structures had major releases from emergency spillways, Interstate Highway (IH)-10, was overtopped, and numerous neighborhoods and streets experienced short term flooding.



U.S. 54 and Hercules Flooded from 2021 Storm. Source: KVIA News, https://kvia.com/traffic/2021/07/01/for-3rd-day-this-week-flash-floods-hamper-el-paso-commute/

Figure 1.6 Example of High-Intensity Flooding during 2021 Flood in El Paso, Texas

The August of 2006 storm in El Paso County (the most populated county in Region 14) is an example of a long duration high volume flood event in the region. The County received one year's worth of rainfall in two days, with more rain falling before and after the peak of the event. In addition to the exceptional volume, saturated conditions created more runoff than what would usually occur on dry ground, worsening the effects downstream. It led to the overtopping of Interstate IH-10, and sediment/debris flows from Franklin mountain arroyos into the city drainage infrastructure in west/ northwest El Paso and in northeast El Paso. The resulting blockage of drainage infrastructure led to extensive property damage. The storm caused $200 million in damages to businesses and homes, and an additional $115 million in damage to the city's stormwater system. The high stage in the Rio Grande coupled with limited drainage structure/ pump station capacity led to extensive flood damage in several locations within the flat riverine terrace adjacent to the Rio Grande.

A significant flooding event also affected Presidio, Texas, and Ojinaga, Mexico in September 2008, causing damaging flooding along the Rio Grande and Rio Conchos as shown in **Figure 1.7**. This storm, centered over the Rio Conchos watershed in Mexico, sent a massive flood down the Rio Conchos into the Rio Grande. Flooding occurred along the Rio Grande from the confluence with the Rio Conchos to Amistad Reservoir. This flood breached and/or overtopped both US and Mexican levees at locations along the Rio Conchos and the Rio Grande. Flooding in Presidio was primarily limited to the low-lying farmland adjacent to the levees.

Figure 1.7 Flooding along the Rio Grande and Rio Conchos in Presidio, Texas and Ojinaga, Mexico on September 19, 2008

Image: Jeff Bennett, Upper Rio Grande Regional Flood Planning Group

Western Texas has a history of damaging and dangerous floods. Despite the region's largely arid climate and low rainfall totals, extreme storms are influenced by weather systems from the Gulf of Mexico including warm fronts, tropical storms, and hurricanes. During previous hurricanes, Hurricane Paul caused 2.26" of rain in El Paso County in 1982, and Hurricane Alice caused 34" of rain in Val Verde County in 1954. Carefully analyzing and evaluating needs and improvements associated with stormwater infrastructure remains important for dealing with these severe events.

Another significant component of flooding in the region is the Upper Rio Grande watershed which has more than 76% of its area lying outside of the region in New Mexico, Mexico, and Colorado. It is estimated that only 5% of typical flow from New Mexico reaches Texas, as water supply in New Mexico is heavily managed to meet the needs of communities in New Mexico, Texas, and Mexico.

Historic Flooding occurred in April 2004 in Pecos and Reeves County, resulting in significant flooding downstream of Comanche Creek Dam in Fort Stockton and a collapsed I-20 bridge over Salt Draw between Toyah and Pecos (see **Figure 1.8**). In addition, a levee protecting Toyah was breached during the flood event.

April 2004 flood caused this I-20 bridge over Salt Draw to collapse, located between Toyah and Pecos. Source: NOAA and NWS; https://www.weather.gov/maf/2004_04_02_SevereWeather

Figure 1.8 Toyah and Pecos, Texas, 2004 Flood

Table 1.4 Historical Flood Events with the Upper Rio Grande Region

County	Date	Location	Significance	Source*
Brewster	September 9, 2008	Brewster	Indeterminate amount of rainfall caused $16.8M in flood damages. Large portions of FM-170 were inundated and suffered damage. Rio Grande Village was evacuated and facilities were closed for months.	6, 8
Brewster	October 1, 1990	Brewster	Indeterminate amount of rainfall caused $1.98M in flood damages.	6
Brewster	September 3, 1986	Brewster	Indeterminate amount of rainfall caused $1.18M in flood damages	6
Brewster	August 10, 1980	Chisos Basin, Pecos and Devils Rivers	Hurricane Allen caused 6" of rain over a 5 day period.	3
Culberson	September 24, 1978	Guadalupe National Park	Tropical Storm Paul caused 15" of rain in one day. (See Hudspeth County)	3
Edwards	June 23, 1948	Countywide	24" of rainfall caused $3.6M in damages	3
Edwards	June 10, 1935	Carta Valley	17.6" of rainfall caused $20M in damages	3
El Paso	August 12, 2021	City of El Paso, Franklin Mnt.	Some parts of El Paso received over 4 inches of rain in a short period of time creating significant flash flooding which included two deaths in the east side of the Franklin Mountains.	8
El Paso	June 28, 2021	City of El Paso	Some locations of the city received over 4 inches of rain in 36 hours. $500k in property damages occurred as water entered homes in parts of West El Paso when nearby drainage ponds overflowed. One death occurred on Thunderbird Trail after water rushed down the side of the mountain.	8
El Paso	July 31, 2006	City of El Paso, Franklin Mnt.	FEMA-1658-DR-Recorded the highest level in Rio Grande since 1912. Several storms contributed to high environmental moisture and more runoff that expected. 3.5" of rainfall was recorded for July 31st through August 1st. 19.5" of total rainfall was recorded 2006.	1, 2, 4
El Paso	August 1, 2002	City of El Paso, Franklin Mnt.	An intense storm over the mountains causes 1" of rain over a 10 minute period leading to flash floods.	1
El Paso	August 3, 1966	City of El Paso	2" of rain in under an hour caused flash flooding that damaged homes, businesses, and made several roads and railroads impassible.	1
El Paso	June 1884	City of El Paso	A storm of Indeterminate strength caused over $1M in damages to rail infrastructure.	3
El Paso	July 21, 1880	City of El Paso	3.3" of rain was recorded over two days in 1880.	2
Hudspeth	August 12, 2021	Sierra Blanca/ Allamoore	Heavy rains and flash flooding, washed out poorly maintained county roads, trapping ranchers and Sunset Ranch (20 acre) residents for 5+ days during monsoon season. Heaviest rains began 8/12. Residents and workers could not leave or access ranches until 8/18.	7

County	Date	Location	Significance	Source*
Hudspeth	September 24, 1978	Guadalupe National Park	Tropical Storm Paul caused 15" of rain in one day. (See Culberson County)	3
Hudspeth	September 14, 1974	Continental Ranch	23" of rain over 9 days.	3
Hudspeth	August 22, 1966	Dell City	12" of rain over two days caused $4.3M in damages, with 3' of flooding in 50 houses.	3
Midland	October 9, 1985	Midland	6" of rain over 2 days.	3
Pecos	April 4, 2004	Fort Stockton	A rare early morning severe weather event hit Fort Stockton area around 5am CDT. The area adjacent to Comanche Creek, which runs through James Rooney Memorial Park, was one of the worst flooded areas in Fort Stockton.	9
Presidio	June 27,2021	Marfa	5" of rainfall over two days created flash floods and high currents at low water crossings. One fatality occurred near a border control outpost where a jeep utility car was swept off a crossing.	10
Presidio	September 9, 2008	City of Presidio	Indeterminate amount of rainfall caused $1.17M in flash flood damages. During the summer of 2008, monsoon rainfall filled reservoirs across northern Mexico. On September 7, Governor Perry executed the State Emergency Plan, issued a Disaster Declaration for Presidio County, TX, and a Proclamation of State Disaster. On September 9, the levees near Redford, TX failed. This resulted in water covering the entire city of Redford. Water also topped the levees near Presidio Golf Course on the September 16th-17th, and IBWC reported cracks in the levees near the golf course.	6, 8
Presidio	April 4, 2004	Toyah	Indeterminate amount of rainfall caused $1.33M in flood damages.	6
Presidio	October 1, 1990	Presidio County	Indeterminate amount of rainfall caused $1.92M in flood damages.	6
Reeves	July 1, 1945	Kingston Farm	13.1" of rain over 3 days causing $52,000 in damages.	3
Schleicher	August 30, 1932	Eldorado	15.4" of rainfall	3
Schleicher	July 16, 1928	Eldorado	13" of rainfall in Eldorado caused 6 fatalities and $5M in damages	3
Sutton	September 22, 2018	Sonora	Flash flooding damaged or destroyed 250 houses after 16" of rain fell in a couple hours.	5
Sutton	August 26, 1932	Sonora	A long storm over 13 days caused 13.74" of rain to fall in Sonora causing 9 deaths and $1M in damages	3
Terrell	June 10, 1965	Sanderson	9" of rain fell over a period of 2 days causing flash floods. $2.7M in damages were caused, with 26 deaths and hundreds displaced.	3
Upton	October 4, 1986	McCamey	16" of rain over a day caused 1 death due to a flash flood washing a car off the road.	3
Val Verde	August 22, 1998	Del Rio	Tropical Storm Charlie caused 16" of rain over a single day with significant rapid rise in San Felipe	3

County	Date	Location	Significance	Source*
			Creek. Entire residential slabs were wiped down to the foundation. A total of 13 fatalities were recorded in relation to the storm and subsequent flooding.	
Val Verde	June 24, 1954	Langtry, Del Rio	Hurricane Alice moved inland up the Rio Grande. Several ranches in the region recorded rainfall of 35" causing significant flooding. International Bridge was destroyed when overtopped by 10' with the Rio Grande measuring 3 miles wides in Eagle Pass.	3

*Sources:
1) FEMA Study, https://elpasoready.org/history/
2) Robert Bettes 2021, KTSM, Accessed 17 December 2021, https://www.ktsm.com/weather/as-of-610-pm-today-is-the-25th-highest-rainfall-event-in-el-paso-history/
3) R. M. Slade & J. Patton 2002, USGS, Accessed 17 December 2021, https://www.floodsafety.com/texas/USGSdemo/county.htm
4) El Paso City-County Office of Emergency Management, Accessed 17 December 2021, https://elpasoready.org/history/
5) Joe Holley 2018, Houston Chronicle, Accessed 17 December 2021, https://www.houstonchronicle.com/news/columnists/native-texan/article/Flood-waters-ravage-a-little-West-Texas-town-13281371.php
6) Historical County Hazard Mitigation Plans
7) Hudspeth County Emergency Management Coordinator/County Administrator (email dated 4/26/2022).
8) NOAA Storm Events Database: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=48%2CTEXAS
9) National Weather Service: https://www.weather.gov/maf/2004_04_02_SevereWeather.
10) Ursula Muñoz-Schaefer, *High water at Alamito Creek overtakes 2 vehicles, killing 1 Marfa resident.* Big Bend Sentinel. Accessed July 19, 2022, https://bigbendsentinel.com/2021/06/30/high-water-at-alamito-creek-overtakes-2-vehicles-killing-1-marfa-resident/

1.3 Flood-Related Authorities & Regulation

The Upper Rio Grande Region spans multiple entities, including 23 counties, 30 municipalities, and 31 unincorporated areas. To prepare for potential flood impacts, flood risk planning and regulation is essential among authorities within the region. While cities and counties can engage in flood planning activities, the flood planning role extends to all political subdivisions with flood-related districts or authorities created under Article III, Section 52, or Article XVI, Section 59, of the Texas Constitution. This includes any political subdivision of the state, any interstate compact commission, and any nonprofit water supply corporation created and operating under Chapter 67.

The region includes several entities which have influence over the region's flood mitigation planning and responses efforts. These include 2 Councils of Government (Rio Grande COG and Concho Valley COG); 46 water supply and utility districts; 5 National Parks, 1 National Historic Site, 7 State Parks, 1 State Historic Site, 3 State Natural Areas, 3 Wildlife Management Areas, and the US Army's Fort Bliss. A detailed list of entities within the region is provided in **Appendix Table 1A**.

Flood-regulating entities, such as counties and incorporated areas, have the authority to define and enforce flood regulations and ordinances for flood mitigation. For communities which participate in the National Flood Insurance Program (NFIP), the Texas Water Code § 16.315 requires NFIP participants to adopt a floodplain management ordinance and to designate a local floodplain administrator who is responsible for ensuring floodplain management regulations are followed within the community. Other entities in the region play an important role in flood planning in various ways such as communicating flood response efforts, planning and maintaining flood infrastructure, and supporting flood-related development codes. **Table 1.5** provides a summary of political subdivisions with flood-related authority and shows that all 23 counties (100%) and 24 out of 30 municipalities (80%) within the region are active in some form of floodplain management activity.

Table 1.5 Political Subdivisions with Flood-Related Authority

Type of Political Entity	# of Entities	# of Entities Active in Flood Planning	% of Entities Active in Flood Planning
Municipality	30	24	80%
County	23	23	100%
Government/Council/Commission	19	17	89%
Water Supply & Utility District	58	51	88%
National Park, State Park, Wildlife Management Area	24	5	21%

The Upper Rio Grande basin faces unique challenges. These include flash flooding, significant sediment transport during rain events, limited populace to fulfil regulatory planning roles, vast private lands, a state border and an international border to consider when coordinating flood planning and emergency response. Local regulations and development codes, floodplain ordinances, zoning and land use policies, drainage and building design standards, flood plans, and hazardous mitigation plans exist and are in development to prepare for and mitigate negative impacts of stormwater in the region. These efforts are often conducted with the cooperation of county, city, utility districts, COG, private and government bodies to mitigate shared flood risks at the watershed scale.

A summary of existing floodplain regulations adopted by entities in the region is provided in **Table 1.6**. Local regulations and development codes, as well as their prevalence in Region 14, are discussed in greater detail in Chapter 3 (*Floodplain Management Practices and Goals*).

Table 1.6 Summary of Existing Flood Plans and Regulations

Type of Regulation	Count
Comprehensive Plan / Unified Development Code (UDC)	22
Drainage Criteria Manual /Design Manual	2
Floodplain and Drainage Ordinances	9
Land Use Regulations (Zoning and Subdivision Ordinances)	10

1.4 Agricultural Resources

More than 30 types of crops are grown in the Upper Rio Grande Region, with the top seven crops most at risk to flooding including grassland/pasture, cotton, alfalfa, pecans, winter wheat, oats, and sorghum. The top five counties for agricultural production include the Counties of Hudspeth (notably Dell City), El Paso, Jeff Davis, Pecos, and Presidio. Additional agricultural activities are listed by county in Section 1.1.2.

1.4.1 Crop Production and Value Per Yield

To identify the agricultural resources most at risk to flooding and their estimated values, a cursory level analysis was performed using historical crop production datasets and information from the United States Department of Agriculture (USDA) Cropscape dataset[3] and Texas A&M University. Yield per acre and normalized price per unit values were obtained from the 2021 USDA State Agriculture Overview[4] for Texas and the USDA Quick Stats tool[5], as shown in **Table 1.7**.

Detailed flood exposure analyses for all crop types were performed based on the estimated 1% and 0.2% annual chance flood hazard areas identified in *Chapter 2 (Flood Risk Analyses).*

Table 1.7 Crop Production Value Per Yield

Crop	Yield Per Acre	Value per Yield
Alfalfa	5.4 Tons/Acre	$209/Ton
Cotton	695 LB/Acre	$0.882/LB
Grassland	2 Tons/Acre	$147/Ton
Oats	45 BU/Acre	$4.4/BU
Pecans	1,000 LB/Acre	$1.31/LB
Sorghum	61 BU/Acre	$9.85/CWT*
Winter Wheat	37 BU/Acre	$6.5/BU

*1 CWT = 2.22 BU

1.4.2 Potential Factors Impacting Flood Damage to Crops

Flooding of crops may result in a wide range of outcomes, including no crop damage, damage requiring a replant of the crop, reduced crop yields, or the total loss of a crop. Some critical factors that impact the extent of damage from flooding are the type of crop, production stage at the time of flooding, depth of flooding, velocity of floodwaters, and duration of inundation. Other damages from floods include sedimentation that covers crops or reduces soil fertility, and increased soil salinity, which can damage roots and reduce yields for multiple planting seasons.

[3] USDA National Agricultural Statistics Service Cropland Data Layer. 2020. Published crop-specific data layer [Online]. Available at http://nassgeodata.gmu.edu/CropScape/ (accessed 2/23/2022). USDA-NASS, Washington, DC.
[4] 2021 State Agriculture Overview (https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=TEXAS)
[5] USDA Quick Stats Tool. Published database [Online]. Available at https://quickstats.nass.usda.gov/ (accessed 7/27/2022). USDA-NASS, Washington, DC.

One key factor of the impact that flooding will have on agriculture is the timing of the flood. In general, production stages for any crop would include field preparation, seeding/planting, growing season, and post-harvest/dormant. The production stage of the crop when flooding occurs can have a significant impact on the extent of damage/loss for the crop and the options available to the farmer to salvage the growing season. If a flood occurs prior to the start of field preparation, it may result in a delay of seeding, which could result in reduced yields at harvest. A damaging flood that occurs near the beginning of the growing season may require that the farmer rework the land and replant the same or a substitute crop to minimize loss at harvest. Flooding during the growing season may result in a reduced yield or loss of all or a portion of the crop. Depending on the crop, flooding during the harvest season may have little impact on production or it could result in a total loss.

In general, floods occurring during the growing season have the largest potential for damages/crop loss, as the crops are susceptible to damage while maturing; and if the crops are damaged, the farmer will have fewer options and less opportunity to salvage the growing season. In addition, when planting or replanting following a flood, the variable production costs are usually higher than without a flood due to the following reasons:

- Additional fertilizer must be applied to offset loss of soil fertility;
- Herbicides are often required to combat weed infestation;
- Additional preparation of seed beds is required; and
- Severe loss of nitrogen due to denitrification in saturated soils.

Information on the usual planting and harvesting month for the major crops in the study area was obtained from the Texas Agricultural Statistics, which is provided in **Table 1.8**.

Table 1.8 Crop Planting and Harvesting Schedule

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alfalfa	Planted												
	Harvested					8%	33%	32%	23%	4%			
Cotton	Planted			15%	37%	36%	12%						
	Harvested									6%	16%	44%	36%
Oats	Planted									28%	49%	23%	
	Harvested					33%	62%	5%	6%				
Pecans	Planted												
	Harvested								6%	33%	36%	21%	4%
Sorghum	Planted			5%	40%	43%	12%						
	Harvested							8%	33%	32%	27%		

Crop		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Winter Wheat	Planted									34%	47%	19%	
	Harvested					9%	74%	17%					

Precipitation by month can be used as a proxy to estimate the likelihood of when flood inundation could occur. While this does not determine if a flood event would occur, the likelihood of a flood occurring during months of higher precipitation is greater. Average monthly precipitation values for Climate Division 5[6] were divided by the total average annual precipitation to calculate the percentage of precipitation that occurs each month (**Table 1.9**). As the table shows, there is a higher chance of precipitation during the summer months, which would indicate a greater likelihood of flooding.

Table 1.9 Likelihood of Flooding by Month

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4%	4%	3%	4%	9%	13%	16%	15%	15%	9%	4%	4%

Source: NOAA National Centers for Environmental information, Climate at a Glance: County Time Series, published December 2020, retrieved on January 29, 2021 from https://www.ncdc.noaa.gov/cag/

While the season a flood occurs is important, the depth and duration that a crop is submerged is also an important factor in determining crop damages. Plants can be damaged from lack of oxygen if fully submerged and/or from root rot for long duration floods. Yield reductions could occur as a result of as little as one day of inundation for cotton, while other crops, such as grasslands, can withstand a week of inundation. **Table 1.10** provides a summary of anticipated damages from flooding by crop for the major crops found in the 1% annual chance floodplain within the study area.

Table 1.10 Anticipated Damages by Crop

Crop	Anticipated Damages Occurring During a Flood	Anticipated Damages Occurring During Reseeding/Recovery
Alfalfa/Hay/Sorghum[7]	*Dormant:* Can withstand flooding up to 10 days without significant loss *Harvest:* Can withstand submersion up to 3-4 days without significant loss	Limited reseeding of established fields may be necessary
Corn/Oats[8]	Can withstand flooding up to 48 hours with limited damage Greater yield losses likely earlier in the season	Flooding may have long term negative impact on crop yield and root damage

[6] Division 5 averages were between 2000 and 2021 from National Oceanic and Atmospheric Administration's (NOAA's) National Center for Environmental Information
[7] "Salvaging Crops After Flooding". North Dakota State University. Online. https://www.ndsu.edu/agriculture/ag-hub/salvaging-crops-after-flooding
[8] "Flooding Effects on Corn". Updated 2018. Corn Agronomy. University of Wisconsin. Online. http://corn.agronomy.wisc.edu/Management/L038.aspx

Crop	Anticipated Damages Occurring During a Flood	Anticipated Damages Occurring During Reseeding/Recovery
Cotton[9]	*Planting:* Water-logged soils can reduce crop growth rate *Harvesting:* Potential for crop loss	Stunted growth is a potential lingering effect
Pecans[10]	*Harvesting:* Beyond 5 days of flooding will prompt a photosynthesis reduction, and reduction in harvest.	If trees remain flooded for 35 days or more, they may lose part of their root system
Winter Wheat[11]	*Harvesting:* Yield reduction impacts to flooding in as few as 48 hours	If submerged more than 5 to 7 days, plants will die

Table 1.11 and **Table 1.12** provide estimates of percent crop yield loss for one and three days of inundation, which represent an estimate of the percentage of the mature crop value that is expected to be reported as damaged (assuming the crop was planted on the beginning of the season).

Table 1.11 Crop Damages from One-Day Inundation

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Corn	0%	0%	0%	4%	13%	22%	25%	27%	32%	24%	10%	0%
Oats	14%	22%	25%	27%	32%	24%	10%	0%	0%	0%	0%	4%
Winter Wheat	25%	24%	21%	11%	1%	0%	0%	0%	4%	13%	22%	25%

Source: HEC-FIA

Table 1.12 Crop Damages from Three-Day Inundation

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Corn	0%	0%	0%	12%	40%	66%	75%	82%	95%	72%	29%	0%
Oats	42%	67%	75%	81%	96%	73%	30%	0%	0%	0%	0%	13%
Winter Wheat	75%	72%	63%	34%	4%	0%	0%	0%	12%	40%	66%	75%

Source: HEC-FIA

The timing of the flood and the production stage of the crop during a flood can determine whether damage occurs and the potential extent of that damage. As shown previously in **Table 1.9**, there is a greater chance of precipitation during the summer months, which would

[9] "What should I do with a flooded cotton field? University of Georgia Cotton Team, 2013. Online. https://www.farmprogress.com/cotton/what-should-i-do-flooded-cotton-field
[10] Wells, Lenny. "Effects of Flooding on Pecan Trees." University of Georgia Cooperative Extension, 2014. Online. https://site.extension.uga.edu/pecan/2014/04/effects-of-flooding-on-pecan-trees/#:~:text=The%20pecan%20tree%E2%80%99s%20native%20environment%20is%20found%20along,in%20a%20river-bottom%3F%20The%20key%20is%20soil%20drainage.
[11] "Flooding Impacts Winter Wheat". North Dakota State University, 2009. Online. Flooding Impacts Winter Wheat — Extension and Ag Research News (ndsu.edu)

indicate a higher likelihood of flooding. In addition, as shown previously in **Table 1.8**, flooding occurring during this time would have an impact on the majority of the crops that are planted in the study area and could lead to crop damage or reduced yields. If flooding occurs in late spring or summer, the opportunity to replant a flooded field is limited given the time needed for soil dry-out and balancing. In those cases, crop production for the fall harvest would be significantly reduced.

While the timing of the flood is key, the depth and duration of submerged crops is also an important factor in determining crop damages from flooding events. Plants can be damaged from lack of oxygen if fully submerged and/or from root rot for long duration floods. Yield reductions could occur as little as one day of inundation for cotton (which has production value of over $16 million in the study area), while some crops can withstand a week of inundation, such as grassland (which has production value of nearly $85 million in the study area).

Overall, the longer the inundation, the greater the potential damages to the crops and the lower the production value for the counties. While the production values are for annual harvest, there is evidence that continued damages occur beyond the typical harvest from increased soil salinity, imbalanced soil, mold issues, and weed control.

Lastly, uncertainties related to flooding impacts to grassland/pasture areas are significant. Grasslands can often withstand multiple days of flooding without a significant negative impact, especially when the grass is dormant. At times, flooding may even increase the yield of grasslands because of the increased moisture content in the soil. Another consideration is if grasslands are being grazed at the time of the flooding, which could lead to negative impacts to the herd from increased disease and injuries. If flooding is extensive enough, the herd may need to be relocated to another pasture and/or provided with supplemental feed until the grasslands recover.

1.5 Natural Resources

Ephemeral, perennial, and intermittent watercourses are the dominant hydrologic features of arid landscapes and serve the vital functions of storing and moving water and sediment throughout their respective water catchments. Unfortunately, many of the streams in the deserts of west Texas are characterized by incised channels that quickly and efficiently collect and transport water and sediment downstream. Stream incision results from a combination of historic impacts including grazing pressure, logging and other vegetation impacts; physical impacts to streams; and ecosystem changes such as removal of beavers. Water catchments now have diminished water and sediment storage capacities.

The resulting rapid runoff and transport of flood waters, especially when land development and population growth result in increased frequency and severity of flood events, may disproportionately affect natural and agricultural resources. In addition, as streams become more deeply incised, the water table is lowered and the riparian vegetation is negatively affected.[12] Livestock and wildlife depend on intact riparian resources; In arid regions, about 60% of all vertebrate species and 70% of all threatened and endangered species depend on riparian areas.[13] and forage for livestock is often best in riparian areas. Flooding could have the following potential impacts on vegetation and wildlife species:

- Channel erosion leading to decreased floodplain connectivity and recharge of riparian aquifers.
- Loss of vegetation: forage for livestock and wildlife due to scouring.
- Loss of nesting or sheltering habitat for both livestock and wildlife due to vegetation impacts.
- For aquatic species, direct impacts to rearing and reproductive habitat due to flooding.
- Impacts to water quality in aquatic habitats.
- Impacts to streambed habitats due to increased sediment loading or sediment deposition.
- Impacts to streamflow in aquatic habitats.

A summary of federal- and state-listed threatened and endangered species in the Upper Rio Grande Region is provided in **Table 1.13**. Several protected species in the region are dependent on native riparian habitats (vegetation occurring along water bodies) and aquatic habitats. The western yellow-billed cuckoo (*Coccyzus americanus occidentalis*) is a federally threatened bird species that occurs in riparian habitats and potentially occurs in most Region 14 counties. The U.S. Fish and Wildlife Service (USFWS) has designated critical habitat for this species along much of Rio Grande in Brewster County. The southwestern willow flycatcher (*Empidonax traillii extimus*) is a federally endangered bird species occurring in riparian habitat. Critical habitat for this species has not been designated in the Region 14 Plan Area. Since these bird species nest in riparian habitats along water bodies, they may be affected by increasing frequency and severity of flood events.

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[12] USDA. 2020. Incised stream restoration in the Western U.S. USDA Northwest Climate Hub, https://www.climatehubs.usda.gov./hubs/northwest/topic/incised -stream-restoration-western-us. Accessed July 11, 2022.

[13] USDA. 2012. Threats to western United States riparian ecosystems: a bibliography. General Technical Report RMRS-GTR-269. December 2012.

Federally endangered and rare freshwater mussel species that occur in Region 14 may be affected by flood-induced impacts to water quality and streambed substrates. Protected freshwater mussels in the Region 14 Plan Area include the federally endangered Texas hornshell (*Popenaias popeii*), which occurs in the Rio Grande and Pecos Rivers, and the federal candidate species Texas fatmucket (*Lampsilis bracteata*), which occurs in the Colorado River basin.

Similar to many wildlife species, human settlements have always had a close connection to water sources. Hundreds of known archaeological sites and historic structures occur along the Rio Grande and other rivers and streams within the Region 14 Plan Area and a significant proportion of these occur within the 1% annual chance floodplain. Historic resources that may be negatively affected by flooding include:

- Cemeteries
- Historic districts
- Historic irrigation systems
- Historic structures (residences, businesses, public buildings, churches, missions, bridges, etc.)

A few examples of historic resources identified in the Region 14 Plan Area include the El Paso County Water Improvement District No. 1 (EPCWID) National Register District, the Elephant Butte Irrigation National Register District, Fort Bliss Main Post Historic District and National Cemetery, and San Elizario Historic District. Historic adobe structures may be particularly vulnerable to impacts from rising flood levels and/or flood frequency. Flood damage to foundations can also pose significant risk to the stability of historic structures.

Table 1.13 Threatened and Endangered Species Listings

Species Common Name[a]	Species Scientific Name	Federal Status*	State Status*	Federally Designated Critical Habitat in Region?	Where Found
Birds					
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	T		Yes	Breeds in riparian habitat and associated drainages; springs, developed wells, and earthen ponds supporting mesic vegetation; deciduous woodlands with cottonwoods and willows.
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	E	No	Thickets of willow, cottonwood, mesquite, and other species along desert streams
Rose-throated becard	*Pachyramphus aglaiae*		T	N/A	Riparian corridors; trees, woodlands, open forest, scrub, and mangroves; breeding April to July. Included on TPWD county species list for Jeff Davis County but no other counties in the planning area.

Species Common Name[a]	Species Scientific Name	Federal Status*	State Status*	Federally Designated Critical Habitat in Region?	Where Found
Tropical parula	*Setophaga pitiayumi*		T	N/A	Dense of open woods and understory long edges of rivers and other water bodies.
Interior least tern	*Sternula antillarum athalassos*	DL: Delisted	E	N/A	Nests along sand and gravel bars within braided streams, rivers; also known to nest on man-made structures, Rio Grande and Pecos rivers.
Fish					
Mexican stoneroller	*Campostoma ornatum*		T	N/A	Rio Grande tributaries in Brewster and Presidio counties.
Proserpine shiner	*Cyprinella proserpina*		T	N/A	Limited range includes Devils and lower Pecos rivers; Las Moras, Pinto, and San Felipe creeks; and Independence Creek in the Rio Grande watershed in western Texas. Associated with spring-fed tributaries and spring-runs. May be found in flowing pools, swift runs and riffles.
Leon Springs pupfish	*Cyprinodon bovinus*	E	E	Yes	Leon Creek, a tributary of the Pecos River (Pecos County); Diamond Y Spring. Natural spring-fed marshes, pools, and slow-flowing waters; usually near edges with minimal growth of vegetation.
Comanche Springs pupfish	*Cyprinodon elegans*	E	E	No	Restricted to small series of springs and their outflows, and man-made irrigation canals in the area of Balmorhea, Texas, including Phantom Springs (Jeff Davis County), San Solomon Springs, Griffin Springs and Toyah Creek (Reeves County). Native range: Comanche, Phantom Cave, San Solomon springs (Pecos and Reeves counties). Presently restricted to San Solomon and Phantom Cave and associated springs, and downstream irrigation canals.
Conchos pupfish	*Cyprinodon eximius*		T	N/A	Devils River and Alamito Creek.
Pecos pupfish	*Cyprinodon pecosensis*		T	N/A	Presently restricted to upper basin of the Pecos River.
Devils River minnow	*Dionda diaboli*	T	T	Yes	Devils River, San Felipe and Sycamore creeks in Val Verde County.
Roundnose minnow	*Dionda episcopa*		T	N/A	Clear spring-fed waters with stable temperatures.

Species Common Name[a]	Species Scientific Name	Federal Status*	State Status*	Federally Designated Critical Habitat in Region?	Where Found
Rio Grande darter	*Etheostoma grahami*		T	N/A	Essentially restricted to the mainstream and spring-fed tributaries of the Rio Grande and the lower Pecos River downstream to the Devils River and Dolan, San Felipe and Sycamore creeks.
Big Bend gambusia	*Gambusia gaigei*	E	E	No	Presently restricted to two artificial springfed pools in Big Bend National Park close to the Rio Grande.
Spotfin gambusia	*Gambusia krumholzi*		T	N/A	Restricted to San Felipe and Sycamore creeks in Texas.
Pecos gambusia	*Gambusia nobilis*	E	E	No	Restricted to two locations in Texas (Balmorhea springs complex and Diamond Y Draw).
Rio Grande chub	*Gila pandora*		T	N/A	Isolated population found in Little Aguja Creek in the Davis Mountains of Trans-Pecos Texas.
Headwater catfish	*Ictalurus lupus*		T	N/A	Limited to Rio Grande drainage, including Pecos River basin; springs, and sandy and rocky riffles, runs, and pools of clear creeks and small rivers.
Speckled chub	*Macrhybopsis aestivalis*		T	N/A	Found throughout the Rio Grande and lower Pecos River but occurs most frequently between the Rio Conchos confluence and the Pecos River.
Tamaulipas shiner	*Notropis braytoni*		T	N/A	Restricted to the Rio Grande basin in Texas including the lower Pecos River.
Chihuahua shiner	*Notropis chihuahua*		T	N/A	Limited to smaller tributaries of the Rio Grande in the Big Bend region.
Rio Grande shiner	*Notropis jemezanus*		T	N/A	Rio Grande drainage.
Mexican blindcat	*Prietella phreatophila*	E	E	No	Subterranean freshwater cave environments in the northern Coahuila, Mexico and Val Verde County, Texas portions of the Edwards-Trinity Aquifer.
Mammals					
White-nosed coati	*Nasua narica*		T	N/A	Woodlands, riparian corridors and canyons. Most individuals in Texas probably transients from Mexico.
Reptiles					
Chihuahuan mud turtle	*Kinosternon hirtipes murrayi*		T	N/A	Observed in permanent water along lower Alamito Creek in Presidio County.[b]

Species Common Name[a]	Species Scientific Name	Federal Status*	State Status*	Federally Designated Critical Habitat in Region?	Where Found
Crustaceans					
Diminutive amphipod	*Gammarus hyalelloides*	E	E	Yes	Known only from the Phantom Lake Spring system.
Pecos amphipod	*Gammarus pecos*	E	E	Yes	Springs.
Mollusks					
Pecos assiminea snail	*Assiminea pecos*	E	E	Yes	Semiaquatic; usually found on moist ground or beneath emergent plants within a few centimeters of flowing water; only known remaining Texas population at near Fort Stockton, Pecos County.
Crowned cavesnail	*Phreatodrobia coronae*		T	N/A	Springs.
Texas Hornshell	*Popenaias popeii*	E	E	Yes	Rio Grande and Pecos River.
Salina Mucket	*Potamilus metnecktayi*		T	N/A	Rio Grande Basin.
Diamond Y springsnail	*Pseudotryonia adamantina*	E	E	Yes	Known from a spring system and associated outflows in Pecos County.
Limpia Creek spring snail	*Pyrgulopsis davisi*		T	N/A	In and on mud and rocks among patches of watercress in spring-fed rivulets
Caroline's Springs pyrg	*Pyrgulopsis ignota*		T	N/A	Known only from Caroline Springs in Terrell County.
Presidio County spring snail	*Pyrgulopsis metcalfi*		T	N/A	Found in the outflows of springs in fine mud and dense watercress.
Phantom springsnail	*Pyrgulopsis texana*	E	E	Yes	Known only from three spring systems and associated outflows in Jeff Davis and Reeves counties.
Mexican Fawnsfoot	*Truncilla cognata*		T	N/A	Rio Grande Basin.
Phantom tryonia	*Tryonia cheatumi*	E	E	Yes	Known only from three spring systems and associated outflows in Jeff Davis and Reeves counties.
Gonzales tryonia	*Tryonia circumstriata*	E	E	Yes	Only known from a spring system and associated outflows in Pecos County.
Metcalf's tryonia	*Tryonia metcalfi*		T	N/A	Locality is a complex of small seeps that discharges into a broad arroyo. This species was found on mud, decaying vegetation, and on the undersides of rocks in water in Presidio County.
Carolinae tryonia	*Tryonia oasiensis*		T	N/A	Lower Pecos River basin in a complex of large springs, which is also known as T5 Springs.

Species Common Name[a]	Species Scientific Name	Federal Status*	State Status*	Federally Designated Critical Habitat in Region?	Where Found
Plants					
Pecos sunflower	*Helianthus paradoxus*	T	T	No	Perennially wet soils of subirrigated terraces just above the wettest sites.
Leoncita false-foxglove	*Agalinis calycina*		T	N/A	Grasslands on perennially moist, heavy, alkaline/saline, calcareous silty clays and loams in and around cienegas (desert springs) and seeps.
Little Aguja pondweed	*Potamogeton clystocarpus*	E	E	No	Submersed in still or slowly flowing water of pools in intermittent creeks and rooted in sand and gravel derived from igneous rock of surrounding mountain slopes.
Tobusch fishhook cactus	*Sclerocactus brevihamatus ssp. tobuschii*	T	E	No	Usually on level to slightly sloping hilltops; occasionally on relatively level areas on steeper slopes, and in rocky floodplains.
Texas snowbells	*Styrax platanifolius ssp. texanus*	E	E	No	Limestone bluffs, boulder slopes, cliff faces, and gravelly streambeds, usually along perennial streams or intermittent drainages in canyon bottoms.

* T = Threatened, E = Endangered, C = Candidate, DL = Delisted

[a] TPWD. 2022. Texas Parks and Wildlife Department Annotated County Lists of Rare Species. Last Update March 17, 2022.

[b] iNaturalist. 2022. Big Bend Mud Turtle (Subspecies Kinosternon hirtipes murrayi) · iNaturalist, accessed July 11, 2022.

1.6 Existing Natural Flood Mitigation Features

The arid climate and landscape associated with Region 14 provides a unique selection of natural flood mitigation features, but also requires careful consideration of groundwater recharge and discharge, geomorphology, and native ecosystems, which have a strong influence on sustainable flood benefits in a changing environment. Due to the region's arid landscape, sedimentation from arroyos is a common issue after floods, especially in El Paso where arroyos from the Franklin Mountains frequently deposit sediment impacting downstream culverts, roadways, agricultural land, and irrigation system infrastructure. Conventional flood protection infrastructure (e.g., dams, levees, channels, etc.) designed to decrease flood risk and capture sediment, can eventually have an adverse effect on natural sediment movement and downstream habitats which are sensitive to minimum seasonal flow cycles.

Therefore, it is important to consider stormwater operations and land management techniques that promote a healthy ecosystem, and design new stormwater infrastructure which mimics and utilizes surrounding natural flood mitigation features, where possible. The following natural features will be discussed in this section, along with their flood mitigation benefits and risks: floodplains; arroyos; natural depressions; wetlands; playa lakes; sinkholes; and alluvial fans. **Exhibit 1B** summarizes the existing flood infrastructure geodatabase and identifies both constructed and natural features. The locations of features described in this section are shown in **Map Exhibit 1** ("Existing Flood Infrastructure"), while non-functional or deficient flood mitigation features are shown in **Map Exhibit 3** ("Non-Functional or Deficient Flood Mitigation Features or Infrastructure").

1.6.1 Rivers and Tributaries

The watershed contributing to the Rio Grande (also known as the Río Bravo del Norte in Mexico), includes sub-basins for the Pecos River, the Devils River, and the Rio Conchos. The Rio Conchos joins from the Mexican side just upstream of the City of Presidio, Texas, while the Pecos River and the Devils River flow through Region 14. The Upper Rio Grande Basin and Bay Expert Science Team (URG BBEST) conducted an assessment of Sound Ecological Environment (SEE) for the Rio Grande Basin between the City of Presidio, Texas and Amistad Reservoir, including the Pecos and Devils River Basins. The results are documented in "Environmental Flows Recommendations Report" (URG BBEST, 2012), and the authors conclude that that the "Lower Pecos" reach of the Pecos River, the "Lower Canyons" reach of the Rio Grande (La Linda, Mexico to the headwaters of Amistad Reservoir) and the Devils River currently support a sound ecological environment. These reaches are identified with a condition of "Functional" and a deficiency description of "Non-deficient" in the RFP "Existing Flood Infrastructure" dataset. Specific flow recommendations to sustain or improve this status are provided in the report.

However, URG BBEST also concludes that the "Parks" reach of the Rio Grande (the Rio Conchos confluence to La Linda, Mexico) and the upper Pecos (between Red Bluff reservoir and Independence Creek) are not sound, and variable recommendations are made to improve or not degrade the environment in these reaches. These reaches are identified with a condition of "Non-functional" and a deficiency description of "Deficient" in the RFP "Existing Flood Infrastructure" dataset. Environmental flow recommendations provided by URG BBEST for the Pecos and the Rio Grande do not exceed the limitations of the 1944 Treaty with Mexico or the

Pecos River Compact, and include components for subsistence flows, base flows, high flow pulses, and overbank flows (URG BBEST, 2012).

Tributaries for all counties within Region 14 except for El Paso County were identified in the "Existing Flood Infrastructure" RFP dataset using the National Hydrography Dataset (NHD) spatial data provided by TWDB in the Flood Planning Data Hub.[14] In El Paso County, the stream lines developed in the El Paso County Federal Emergency Management Agency (FEMA) mapping project, completed by Compass PTS JV (Compass) in 2019, were used to identify the natural rivers and tributaries within the county.

1.6.2 Floodplains

Floodplains can provide flood mitigation benefits because these areas can absorb a great deal of water during flooding and slowly release them over time. When floodwaters can connect with a floodplain, floodwater velocity is reduced, and the water is delivered downstream over a longer period. Each of the rivers flowing through Region 14 and their vast tributary systems have their own diverse history and floodplain footprints, which have widened and narrowed over time depending on their topography, geology, flow sources, groundwater characteristics, and influences from development and complex socio-ecological systems. While the United States (U.S.) generally associates floodplains with risk, it is important to recognize the benefits of floods for ecology, water quality, and water supply purposes. "Flood policy—at least on the aspirational level—is shifting from flood 'control' to a new view that integrates ecosystem components and functionality as part of social-ecological systems." (Frontiers in Environmental Science, 2022).

The upper Rio Grande hydrology is affected by inflows from rivers and several large desert arroyos, runoff from monsoonal rains, groundwater inflows from aquifers, as well as hurricanes and tropical storms from both the Pacific Ocean and the Gulf of Mexico (URG BBEST, 2012). With segments that establish the border between two countries, the Rio Grande attracts many cultures, economies, and political interactions between the U.S. and Mexico. The political landscape controlling water rights and agricultural needs has had long term effects on the Rio Grande floodplain throughout the Region 14 boundary. Two particular reaches, which have been studied from an environmental and geomorphic perspective, and which are the focus of tourist attractions include the "Forgotten Reach" of the Rio Grande from Fort Quitman to the City of Presidio, Texas and the "Rio Grande Wild and Scenic River" which begins at the Big Bend National Park and ends at the boundary between Val Verde County and Terrell County.

1.6.3 Arroyos

Arroyos are dry washes and often steep-sided gullies that traverse steep terrain in semi-arid and arid landscapes, such as Region 14. Some are deeply incised and broken streams with significant unrealized storage capacity. If an arroyo does not enter an urban area, the defined channel tends to disappear where the terrain flattens out. Throughout El Paso County, many arroyos are named as "Flowpaths" followed by a number.

[14] U.S. Geological Survey. National Hydrography Dataset. Available at https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/national-hydrography-dataset-nhd

Increased impervious cover associated with new development and/or unregulated off-road vehicle activity can redirect and concentrate additional stormwater runoff, which can then form new arroyos, putting downstream communities at risk of flooding and sediment deposition. This has been a reported issue in El Paso and Hudspeth counties, where rapid development is taking place. It is important to establish effective construction permitting and stormwater management procedures and enforce appropriate regulations to prevent new arroyos from forming upstream of populated areas.

1.6.4 Natural Depressions

Natural depressions in the terrain can serve as flood storage to recharge the groundwater table and reduce or eliminate downstream flooding, depending on the size of the available storage volume. In the “Montana Sector” of El Paso, County, an ArcGIS (ESRI) spatial analysis was performed as part of the El Paso County Stormwater Master Plan (EP County SWMP) (AECOM, 2021) to identify large natural depressions for consideration in the development of hydrologic and hydraulic (H&H) models. The EP County SWMP spatial analysis results were used to identify a portion of the natural depressions identified in this report.

As the flow reaches the residential areas in the Montana Sector, the natural arroyos become less defined and the flow begins to disperse, traveling along the path of least resistance, until the arroyos disappear altogether in large natural depressions. While these depressions can store floodwater and reduce risk of flooding downstream, they can be a risk themselves if development occurs inside these low-lying areas, which has occurred in this rapidly growing area of northeast El Paso County.

Additional natural depressions were identified typically outside of city limits by reviewing surface water polygons developed during Phase 2 of the El Paso County FEMA mapping project (Compass, 2019). The publicly available preliminary mapping data were used as a basis for several flood-related data sets and will be referenced as “El Paso County Preliminary FEMA” (Compass, 2019) data throughout this report. The National Parks Service also provides publicly available land subsidence features spatial data in Terrell and Val Verde counties in the form of polygons, which were included in the RFP data set as natural depressions.

1.6.5 Wetlands

Wetlands are areas where water is present either at or near the surface of the soil for varying periods of time throughout the year. The U.S. Fish and Wildlife Service’s (USFWS) National Wetlands Inventory (NWI) was used to identify different types of wetlands throughout Region 14, including: freshwater emergent wetlands, freshwater forested/shrub wetlands, as well as wetlands associated with freshwater ponds, lakes, and riverine features.

Wetlands can provide flood mitigation benefits because they act similar to natural sponges, absorbing large volumes of water, and slowly releasing them over time. They can also slow the velocity of floodwater in a floodplain during and after a storm event. Wetland-associated habitats in the Chihuahuan Desert’s Rio Grande floodplain have undergone a 93% reduction over the past century (Hink and Ohmart 1984, Scurlock 1998). Constructed wetland projects can clean stormwater, graywater, and/or wastewater, improving habitat and enhancing biodiversity. Stormwater wetlands thoughtfully designed in urban settings can clean urban runoff, reduce flooding, and create spaces for tourists and the community to enjoy nature.

The 372-acre Rio Bosque Wetlands Park in southeast El Paso is a compilation of wetlands and riverside forest which serves as habitat for over 200 species of birds. The United States Army Corps of Engineers (USACE) is proposing improvements to the Wetlands Park to address issues associated with lower quality wetland habitats and a reduction in wildlife diversity compared to the Park's potential.

Southeast of the City of Presidio, Texas, the La Junta Heritage Center is creating a master plan to restore the La Junta site, including wetland and riparian restoration. The natural systems along this neglected segment of the Rio Grande have been greatly impacted by flood-control levies and flood events over the past several decades. Restoration efforts for the B.J. Bishops wetland would also provide economic benefits to this largely low-income, agricultural region. The nearby wetlands in the "Forgotten Reach of the Rio Grande", upstream of Presidio and near Candelaria, are a popular birding destination for tourists.

1.6.6 Playas

Playas are extremely flat, dried lake beds found in interior desert basins which form when evaporation processes exceed recharge. During flood events, due to their flat terrain, playa surfaces may be inundated for many miles, leading to a residual concentration of fine-grained sediment and salts after flood waters evaporate. As with other types of flat terrain flooding, playa lakes create a unique flood risk challenge, typically requiring long, attenuated hydrographs and 2D hydraulic analysis.

The Upper Rio Grande region consists of several playas, including most notably the West Texas Salt Basin, which stretches from Dell City to Van Horn. Based on maps available in studies from the New Mexico Geological Society Guidebook and the Texas Water Development Board, playa boundaries for the West Texas Salt Basin, covering approximately 560 square miles, were digitized and overlaid with available flood hazard layers.[15,16]

In addition to the West Texas Salt Basin, playa areas were identified and delineated near the Town of Pecos City (Mosquito Lake and Toyah Lake) as well as near Imperial north of the Pecos River. These playas, covering approximately 36 square miles, were identified based on discussions with stakeholders from Reeves County and the Town of Pecos City and digitized using aerial imagery.

1.6.7 Sinkholes

A sinkhole is a geologic feature characterized by ground depression with no external surface drainage. Stormwater runoff intercepted by a sinkhole typically ponds or drains into the subsurface. The size of sinkholes can vary significantly, from a couple square feet to hundreds of acres, and depths can vary from 1 ft to greater than 100 feet. In west Texas, the most common category of sinkhole is bedded salt dissolution. While sinkholes can be beneficial to flooding during storm events by capturing and removing surface water runoff, they are

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[15] Sharp, John M., Jr., James R. Mayer, and Eldon McCutcheon. Hydrogeologic Trends in the Dell City Area, Hudspeth County, Texas. New Mexico Geological Society Guidebook, 44th Field Conference, Carlsbad Region, New Mexico and West Texas, 1993, pp. 327-330. https://nmgs.nmt.edu/publications/guidebooks/downloads/44/44_p0327_p0330.pdf (accessed 2/14/2022)

[16] Angle, Edward S. Aquifers of West Texas (R356), Chapter 17: Hydrogeology of the Salt Basin. Texas Water Development Board, December 2001, page 233. https://www.twdb.texas.gov/publications/reports/numbered_reports/doc/R356/Chapter17.pdf (accessed 2/14/2022)

sometimes hazardous because they can form very quickly, jeopardizing buildings or roadways with little to no warning. They can develop due to natural or man-made activities.

According to FEMA, “the number of human-induced sinkholes has doubled since 1930, insurance claims for damages as a result of sinkholes has increased 1,200 percent from 1987 to 1991, costing nearly $100 million.” Areas in Texas prone to sinkhole development are located where underlying rock layers of salt, limestone, and gypsum occur. Human activity such as oil well drilling, can potentially exacerbate the danger in these areas. The Permian Basin is a large sedimentary basin which is known for oil well drilling, and covers a large portion of Region 14, stretching from Lubbock, past Midland and Odessa, and south toward the Rio Grande. While it is difficult to correlate a relationship between oil extraction locations and sinkholes, there is anecdotal evidence suggesting a relation between the two activities. In order to verify this relationship, sinkhole location data must be acquired. However, Texas government sinkhole data are extremely sparse at this time. The National Parks Service provides publicly available spatial data in Terrell and Val Verde counties in the forms of point locations of sinkholes.

Sinkholes have also formed in Region 14 during or immediately after significant flood events. This occurred during the April 2004 flood event along a County Road located southwest of the City of Pecos, as shown in **Figure 1.9.**

Sinkholes formed along this County Road southwest of Pecos, Texas during the April 2004 storm event.
Source: NOAA and NWS; https://www.weather.gov/maf/2004_04_02_SevereWeather

Figure 1.9 Sinkholes in Pecos, Texas, April 2004 Flood

1.6.8 Alluvial Fans

An alluvial fan is a fan-shaped mass composed of loose, unconsolidated materials deposited as the flow of a river decreases in velocity, typically found at a topographic break where stream channels become less confined. The downstream boundary, or “toe,” of an alluvial fan is located at an axial stream, lake or landform that was not formed by alluvial fan flooding processes. Alluvial fans are important to societies in arid and semiarid locations where they may be the principal groundwater source for irrigation farming. While these natural features decrease flood depths as they disperse upstream concentrated flows over wide areas, the shallow flow velocities on alluvial fans typically remain high, exposing downstream areas to debris flow, erosion hazards, and flood waters bulked with sediment. Moreover, as was observed in the August 2006 flood event in El Paso, Texas, the erosion and removal of stabilizing vegetation can increase the amount of sediment and debris available for transport during future flash flood events. In addition to the debris hazards that were experienced in the 2006 event, the City of El Paso experienced significant debris flow on the east side of the Franklin mountains during the August 2021 flood event, where multiple streets at the base of the mountains were buried with sediment and/or exposed to large boulders and debris from the flash flooding that occurred.

The El Paso Water Utilities and City of El Paso Stormwater Master Plan (EP City SWMP) (URS and MCi, 2009) identifies areas at risk of potential sediment and debris flow, and documents alluvial fan investigations, providing active fan process area maps. These risk areas are mapped on the east and west sides of the Franklin Mountains to help prevent future development from occurring in and around these areas. Recommendations in Appendix C of the EP City SWMP (URS and MCi, 2009) include the strategic design of new sediment basins with consideration of the mapped hazard areas and applying increased sediment bulking factors during the sizing of the basins. Regular maintenance of existing sediment basins following flood events can also decrease the risk of debris hazards downstream of those basins during future flood events.

In addition, the 2019 El Paso County Preliminary FEMA study included an investigation and floodplain mapping report for alluvial fans in El Paso County entitled, “Alluvial Fan Landform Assessment” (JE Fuller, 2019). This report documents the detailed assessment of geology and topography applied to identify and map flood hazards associated with alluvial fans. While several active alluvial fans were identified through field observations, most were either located on military reservation lands (with unexploded ordinance risks preventing future development) or they had been altered with flood/sediment mitigation structures which reduced the flow path uncertainty; these features were eliminated from the analysis. One area located near Vinton Road and Interstate 1 was found to meet the FEMA criteria for mapping alluvial fan flood hazard zones. The report states that due to the significant uncertainty associated with flow paths on alluvial fans, the Preliminary FEMA flood zones on these features had to be delineated using geomorphic data in conjunction with two-dimensional (2D) hydraulic modeling results (JE Fuller, 2019).

1.7 Constructed Major Flood Infrastructure

Region 14 includes the following existing stormwater infrastructure, which will be discussed in this section: stream crossings; levees; flood protection dams; detention and retention ponds; storm drain systems; stormwater canals; pump stations; and weirs. While statewide and nationwide data sets for dams and levees are available throughout the region, there was generally a lack of digital data for stormwater infrastructure in all Region 14 counties other than El Paso County. This section discusses available digital infrastructure data for constructed flood mitigation features incorporated into the RFP "Existing Flood Infrastructure" dataset. **Appendix Table 1B** summarizes the existing flood infrastructure geodatabase and identifies both constructed and natural features.

1.7.1 Stream and Low Water Crossings

Stream crossing features, including crossings at roadways and railroads as well as low water crossings, were identified using the following sources:

- Texas Statewide Low Water Crossings Inventory, maintained by TNRIS and publicly available at: https://data.tnris.org/collection?c=f692bfd4-4dea-4c8b-a14d-a5a73660c074#5.09/31.32/-100.08
- TxDOT Bridges Dataset, publicly available at: https://gis-txdot.opendata.arcgis.com/datasets/TXDOT::txdot-bridges/about
- El Paso County Interior Drainage Study for the City of El Paso and El Paso Water Utilities (2021)
- Drainage Study for FM 170 from Candelaria to US-67 (TxDOT, 2020)
- Drainage Study for SH-20 (Mesa Street) from Doniphan Drive to Texas Avenue (TxDOT, 2019)
- Spatial analysis by AECOM using a combination of centerline data for roadways and streams along with aerial imagery (2022)

Where possible, stream crossing level of service information was identified using detailed hydraulic analyses from previous studies. For other stream crossings where previous detailed analyses were not available, level of service information was estimated using available flood depth data (i.e., from 2019 Preliminary FEMA El Paso County Mapping and Fathom Cursory Floodplain Data). All crossings with an estimated level of service equal to or less than the 10% annual chance flood event were identified as low water crossings, including all crossings identified from the Texas Statewide Low Water Crossings inventory.

Further information pertaining to the level of service methodology and results is discussed in *Chapter 2 (Flood Risk Analyses).*

1.7.2 Levees

The following datasets were utilized in the development of levee spatial data for the RFP:

- National Levee Database (NLD), maintained by USACE and publicly available at: https://levees.sec.usace.army.mil/#/
- 2019 El Paso County Preliminary FEMA spatial data set; publicly available through at https://msc.fema.gov/portal/home
- The FEMA Mid-Term Levee Inventory (MLI) database; publicly available through FEMA's Regional Service Centers
- U.S. International Boundary and Water Commission (USIBWC) geospatial database, provided by USIBWC for the development of the RFP

Populations at risk for levees were estimated based on populations within service areas of levees, as documented in the National Levee Database.

1.7.2.1 Levee Accreditation

There are multiple unaccredited levee segments along the Rio Grande River through El Paso County that currently provide flood protection to adjacent areas. These levees are designed and operated by the USIBWC. A certified levee indicates that the levee segment is formally recognized by FEMA as providing flood risk reduction for the 1% annual chance (AC) flood on the applicable Flood Insurance Rate Map(s) (FIRMs). While the USIBWC levee segments through El Paso are typically designed to contain the 1% AC flood level with freeboard, in order to achieve FEMA accreditation, the levee systems must meet and continue to meet the minimum design, operation, and maintenance standards per Title 44, Chapter 1, Section 65.10 of the Code of Federal Regulations (44 CFR Section 65.10). This regulation specifies select items that need to be submitted and reviewed by FEMA to obtain levee accreditation, including the following:

- Documentation that the levee meets design criteria (freeboard, stability, settlement, etc.);
- Certified as-built levee plans showing tie-ins at roads, bridges, and high ground;
- Officially adopted operation and maintenance (O&M);
- Emergency Preparedness Plan (including documentation of flood warning systems, emergency notification flowchart); and
- Interior drainage evaluation.

The reasons specific levees are not accredited throughout the region vary based on the geology, topography, and hydrologic conditions at each identified levee segment. For example, in El Paso County, the reasons for unaccredited levees may include not meeting minimum freeboard or geotechnical requirements, tie-in requirements, and/or lack of an interior drainage study throughout the entire levee segment. Note, some levee segments extend into Doña Ana County, New Mexico and an interior drainage study has not been performed on the Rio Grande outside of El Paso County for these segments.

Per the RFP scope of work, if a levee is not accredited by FEMA, the levee segment was assumed not to be in place when developing the 1% AC flood map boundaries. This approach is consistent with the 2019 El Paso County Preliminary FEMA mapping approach, which was incorporated in the RFP flood mapping within El Paso County. These unaccredited levee segments are identified with a condition of “Non-functional” in the RFP “Existing Flood Infrastructure” dataset. As of June 2022, there is only one FEMA accredited levee in Region 14, which stretches along the U.S. side of the Rio Grande in El Paso County from International Dam to Zaragosa Road. This FEMA- accredited levee segment is identified with a condition of “Functional” in the RFP “Existing Flood Infrastructure” dataset.

Since the 2019 El Paso County Preliminary FEMA floodplains only incorporate flood protection from one FEMA-accredited levee segment, there are large portions of the county which will be mapped in the 1% AC flood hazard zone when the Preliminary FEMA maps become effective, assuming additional levee segments do not become FEMA-accredited before that time. The 1% AC flood inundation extents preliminarily mapped by FEMA in areas adjacent to unaccredited levees are based upon mapping and H&H models documented in the “FEMA Natural Valley Analysis Pre-LAMP Report” (FEMA, 2016), which considers all levee segments to be removed. This 1% AC “no-levee” flood mapping scenario is referenced as the “natural valley floodplain” throughout this report.

1.7.2.2 Interior Drainage Studies

Additional 1% AC spatial flood mapping and H&H models are available in El Paso County which consider the levees to be in place. These studies are required to be completed before a levee can be certified for accreditation and are referenced as “interior drainage studies” throughout this report; however, it is important to note that these flood maps are non-regulatory. The “El Paso County Interior Drainage Study” (AECOM, 2021) incorporates best available interior drainage studies for levee segments along the Rio Grande, where available, and developed new interior drainage flood maps and H&H models where previous interior drainage studies along the Rio Grande were not previously available in El Paso County. In the RFP, these interior drainage models and maps were utilized, where appropriate, to evaluate existing and proposed conditions for Flood Mitigation Projects (FMPs) affected by the natural valley floodplain in areas adjacent to non-certified levees.

1.7.2.3 Presidio Levees

Additional unaccredited levees exist along Cibolo Creek and the Rio Grande in the City of Presidio. While the Cibolo Creek levees are noted in the NLD as having an “Incipient Overtopping Annual Exceedance Probability (AEP)” of 0.001 (the 1,000-year flood event), the level of service annual probability was reported as “0.2” since the 0.2% AC flood (500-year) is the lowest exceedance value considered as a valid entry in the RFP geodatabase. The left Cibolo Creek levee, which was designed to protect the City of Presidio is identified as “Deficient” in the RFP “Existing Flood Infrastructure” database based upon the description of levee performance provided in the NLD which states, “There is a moderate likelihood of embankment erosion leading to poor performance given there are areas without riprap revetment or other forms of erosion protection. However, given the short flood durations and the levee material composed of compacted granular material it is believed the levee is moderately resistant to erosion.” USACE constructed the Cibolo Creek levees, which run along the northwest boundary of the City of Presidio; however, they are currently maintained and operated by Presidio County.

The Rio Grande levee which runs along the southern boundary of the City of Presidio, owned and operated by USIBWC, was designed to provide 4-ft of freeboard protection above the flood event associated with 42,000 cfs, which was documented to be less than the 5% A.C. (20-year flood) of 43,000 cfs in a report entitled, "Hydraulic Modeling Analysis for the Presidio/Ojinaga Flood Control Project" (USIBWC, 2003). However, during the September 2008 flood of the Rio Conchos and the Rio Grande, from Presidio to the Amistad Reservoir, sections of the Rio Grande levee on the U.S. side were damaged in the Presidio area (including the presence of boils), flooding low-lying agricultural areas adjacent to the levee. These levee failures required emergency responses from USIBWC, who coordinated with USACE and Texas Division of Emergency Management (TDEM) on temporary repairs including sand bags and plastic lining of the levees. While failed levee segments in the Presidio area were later repaired by USIBWC, breached Rio Grande levees protecting agricultural land adjacent to the City of Redford, located downstream of Presidio, were not repaired.

1.7.3 Flood Protection Dams

Multiple data sources were used to identify and complete "Existing Flood Infrastructure" data fields for flood protection dams in Region 14, including:

- National Inventory of Dams (NID), maintained by USACE;
- Texas Commission on Environmental Quality (TCEQ) database of dams regulated by the State of Texas, maintained by TCEQ; and
- Natural Resources Conservation Service (NRCS) database of NRCS-designed dams in Texas, maintained by the NRCS State office.

1.7.3.1 Data Sources

The NID database includes basic information for 127 dams in Region 14, including location, owner, purpose (water supply, flood control, irrigation, etc.), dimensions (height of dam, normal and maximum reservoir storage), and information on whether an Emergency Action Plan was developed and when. The TCEQ maintains an updated database of the same information for 122 state regulated Texas dams (i.e dams above the size thresholds of Texas Administrative Code Title 30, Part 1, Chapter 299). Dams of unregulated size are deemed not to provide a safety risk to lives in the event of a breach.

The TCEQ list also contains fields that provide the dam hazard class per Chapter 299, and hydraulic information about dam discharges during dam safety events (events much larger than the 1% AC event). The TCEQ dam database is provided to the USACE every two years minus the hazard class and hydraulic information. The Texas NRCS State office maintains a similar dam database of NRCS-designed dams in Texas, with dam hazard class per NRCS Technical Report 60. There are inconsistencies between TCEQ and NRCS hazard class determinations, which, because of the varying wording between the federal and state definitions, are not resolved. The TCEQ dam inventory is not readily available to the public (i.e. is not at a web link), but can be procured through a Public Information Request. The TCEQ dam inventory provided to the public will not include hazard class or the hydraulic information; thus, property owners are not readily aware of risk associated with a dam.

According to the TCEQ hazard classifications, the dam hazard classifications are as follows:

- High Hazard: In the event of failure, the hazards may include the loss of 7 or more lives, inundate 3 or more permanent habitable structures, and/or result in excessive economic loss.
- Significant Hazard: In the event of failure, the hazards may include the loss of 1-6 or more lives, inundate 1-2 permanent habitable structures, and/or result in appreciable economic loss.
- Low Hazard: In the event of failure, the hazards will not include loss of life, inundation of permanent habitable structures, or result in significant economic loss.

1.7.3.2 Data Input Assumptions

Due to the confidential nature of dam hazard classifications, the "Existing Flood Infrastructure" attribute, "Population Protected by Infrastructure" was not completed for dams as part of the RFP. However, the "Condition" attribute from the available data were compared, giving priority to the TCEQ data, to estimate whether a dam was "Deficient" or "Non-deficient" in the RFP dataset. Dams with a "Condition" of "FAIR" or "GOOD" in the TCEQ dataset were assumed to be "Non-deficient" while a condition of "POOR" was identified as "Deficient" in the RFP dataset.

Another attribute included in the TCEQ dataset is "Hydraulic Adequacy" attribute, which is identified by TCEQ as "YES," "NO," or "NOT DETERMINED". There are 27 dams in Region 14 that are determined to be hydraulically inadequate by TCEQ, while 51 dams are identified by TCEQ as hydraulically adequate. The hydraulically adequate dams were assigned a "CONDITION" rating of "Functional" in the RFP dataset; since the dams are assumed to meet their intended design level of service per it's current hazard classification. Per TCEQ, it is possible that prior "Not Determined" has been assigned in the "Hydraulically Inadequate" data field due to a myriad of factors, such as

- Not yet being studied for hydraulic adequacy based on the current hazard classification;
- Configuration issues – current dam/spillway(s) size/elevation/etc. not (or no longer) consistent with prior H&H study;
- Significant changes to drainage area (and/or upstream channel), along with the age of H&H study;
- Uncertainty if a dam (that was designed to be overtopped) can safely pass its design storm without suffering undue erosion; or
- Other issues that would 'invalidate' a prior H&H study

Furthermore, the Level of Service (LOS) associated with dams was assigned as either 1, indicating it can safely pass the 1% AC event or 0.2, indicating it can safely pass the 0.2% AC event based upon the hydraulic adequacy and the Probable Maximum Flood (PMF) percent passing, per the TCEQ dataset. If the dam was identified to pass 100% of the PMF per the TCEQ dataset, and the dam was determined to be hydraulically adequate, the LOS was assumed to be 0.2% AC (the 500-year flood and the largest flood considered a valid entry in the RFP dataset). Similarly, if the dam was hydraulically adequate and the percent PMF passing was less than 100%, but still equal to or greater than the PMF required per the TCEQ dataset, then the dam was assumed to have a LOS of 1% AC (i.e., it safely passes the 1% AC flood event).

1.7.4 Detention and Retention Ponds

The digital data sources for detention and retention ponds obtained for Region 14 were from the following sources, which were all located within El Paso County:

- 2019 El Paso County Preliminary FEMA (Compass, 2019) spatial data set (polygons); publicly available at https://msc.fema.gov/portal/home;
- EP City SWMP (URS and MCi, 2009) Electronic Files spatial data for ponds (points); and
- EPWater's City of El Paso stormwater infrastructure GIS dataset (EPWater, 2021) for pond (points).

Point and polygon features symbolizing ponds and basins from each spatial dataset were compared to eliminate duplicate features in the RFP dataset.

1.7.5 Storm Drains, Stormwater Canals, and Pump Stations

EPWater's City of El Paso stormwater infrastructure GIS dataset (EPWater, 2021) for Conduits, Channels, and Pump Stations was used to identify constructed infrastructure features within Region 14. These features were input as "Storm Drains", "Stormwater Canals", and "Pump Stations," respectively, for the "Infrastructure Type" attribute of the RFP geodatabase. In addition, the line features identified as "Agricultural_Drain" in the infrastructure geodatabase provided by EPWater were included as "Stormwater Canals" in the RFP dataset. In El Paso, there are multiple agricultural drains which are sometimes utilized for stormwater conveyance purposes during flood events. The EPWater dataset does not indicate the condition or level of service associated with the City infrastructure.

A report entitled, "Final Hydraulic Report/Drainage Study for the City of Presidio, Texas" (S&B Infrastructure, 2008) was obtained from the City of Presidio, which includes an "Appendix B – Structure Inventory" documenting the location and sizes of stormwater infrastructure in the City of Presidio at the time of that study. The digital data associated with the Appendix were not included in the electronic files provided with the report. S&B Infrastructure was contacted to obtain the electronic files associated with the report appendix but confirmed that digital versions of the data were no longer available. Therefore, these infrastructure data were not included in the RFP geodatabase.

1.7.6 Weirs

Only six weirs were identified in Region 14, all located in the northwest portion of El Paso County. These weir locations were obtained from the 2019 El Paso County Preliminary FEMA (Compass, 2019) spatial data set ("S_Gen_Struct.shp" polylines); which are publicly available at https://msc.fema.gov/portal/home. Five of these weirs are located on a channelized section Flowpath No. 4, and one is located immediately downstream of the Resler Channel crossing under IH-10.

1.8 Proposed or Ongoing Major Flood Infrastructure and Mitigation Projects

The table in **Appendix Table 1C** includes a summary of proposed or ongoing flood mitigation projects within Region 14, and **Map Exhibit 2** ("Proposed or Ongoing Flood Mitigation Projects") shows the location of the proposed or ongoing flood mitigation projects. These are projects within the region that already have committed funding for final design and/or construction. The status of each project in **Appendix Table 1C** states what phase each project is currently under. It should be noted that these projects are different from the Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) identified and recommended in Chapters 4 and 5 of the RFP, respectively; since they already have committed funding and some are even currently under construction. All of the projects are located within El Paso County, and two are located within El Paso city limits. Existing funding sources include the TWDB Flood Infrastructure Fund (FIF), El Paso Water, and USACE.

1.9 Relevant Existing Planning Documents

Appendix Table 1D provides a list of relevant existing planning documents for Region 14. The list is consistent with types of planning study documents referenced under 31 TAC §361.22. The most relevant planning documents for Region 14, which are directly related to Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs) evaluated in the RFP, are described below and organized by Study ID number associated with **Appendix Table 1D**.

3- DRAFT EPCWID Incident Report, Arroyo Flow and Flooding into Mesa Spur Drain Near Mankato Road, July 22, 2017 at 4 pm

- On July 22, 2017, a short duration intense rainfall event occurred in the watershed of the un-named arroyo that drains into the Mesa Spur Drain near Mankato Road in Socorro, Texas. This document is a collection of weather data from that event. The later named, "Mankato Arroyo" was evaluated as the SOC4 Flood Mitigation Project (FMP 143000021) in the RFP. SOC4 is a proposed sediment basin in the EP County SWMP (AECOM, 2021), and the project is a high priority for the El Paso County Water Improvement District No.1.

4- Final - Evaluation of Reduced Flow Capacity of the Rio Grande and the Impacts on the Operations of the Rio Grande Project Leasburg Dam to American Dam, Phase I - Main Channel and Floodways - Anthony, NM to American Dam

- This report documents existing conveyance capacity of the Rio Grande from NM Highway 225 to the American Diversion Dam in El Paso, Texas. The report, authored by a Joint Committee on Rio Grande Project Flood Risk documents the changes to flood risk and impact on Rio Grande Project operations resulting from accumulated sediment and vegetation in the main channel. The RFP Flood Management Evaluation (FME 141000001) is based on the findings and recommendations from this report.

13- El Paso Stormwater Master Plan Update (2021)

- The main purpose of the updated EP City SWMP (AECOM, MCi, 2021) was to update the original 2009 EP City SWMP to improve the drainage infrastructure of El Paso and reduce the flood risk to the public and property. Five FMPs and one FME from this document are evaluated in the RFP.

24- El Paso County Interior Drainage Study, Methodology and Mapping Results Report

- The purpose of the El Paso County Interior Drainage Study is to identify the sources of flooding from the landward sides of the levees along the 65 miles of the Rio Grande within El Paso County, where depths exceed 1 ft based on current conditions. The modeling and mapping from this study was utilized to help analyze existing damages and proposed benefits for FMPs affected by the natural valley floodplain, including NW3 (FMP 143000111) and NW26 (FMP 143000113).

25- El Paso County Stormwater Master Plan

- The EP County SWMP addresses stormwater needs in El Paso County, outside of City of El Paso limits. As the City master plan was being completed, El Paso County recognized that a similar effort was needed to address stormwater needs throughout the rest of the County. Four FMPs and one FME from this document are evaluated in the RFP.

33- Hudspeth County, Texas. Villa Alegre, Fort Hancock East Unit 1, & Fort Hancock East Unit 2. Colonia Area Study and Plan 2019 - 2029.

- The information gathered in this study sheds light on the housing needs of the community, helps to direct the formation of housing goals, and establishes a blueprint for future actions Hudspeth County might take to provide adequate housing for those residents. This document was the basis for the evaluation of FMP 143000009 and FME 141000014 in the RFP.

38- Technical Memorandum with Project Recommendation. Montoya Drain H&H Analysis.

- This Study was performed to provide a recommendation to El Paso Water regarding the use of a parcel of land as a potential site for floodwater detention. The project concept was later modified to include a constructed wetland on the same site. Project NW26 (FMP 143000113) from the EP City SWMP (AECOM, MCi, 2021) is based upon this Memo.

44- Pecos River Basin Salinity Assessment, Santa Rosa Lake, New Mexico, to the Confluence of the Pecos River and the Rio Grande, Texas, 2015. Scientific Investigations Report 2019-5071.

- The salinity of the Pecos River increases downstream and affects the availability of useable water in the Pecos River Basin. The document explains how specific areas might be contributing to the elevated salinity in the Pecos River and how salinity of the Pecos River has changed over time. FMS 142000007 is based upon information presented in this document.

49- Drainage Feasibility Study. Socorro Rd. Intersections with San Antonio St. and Main St.

- The City of San Elizario, Texas has continuously experienced flooding of the intersections of Socorro Rd. and San Antonio St., and Socorro Rd. and Main St. This study identifies existing flood risk and related drainage infrastructure, and analyzes three alternative improvements. FMP 143000003 is based upon this document.

59- Drainage Study for SH 20 (Mesa Street) From Doniphan Drive to Texas Avenue

- The drainage analysis includes assessing cross drainage structures of multiple varieties, evaluating the current level of service (LOS) of the roadway at all cross drainage structures, identifying locations where the roadway drainage system provides less than a 1% AC LOS and providing conceptual recommendations to mitigate localized flooding and erosion. FMP 143000005 was based upon this document.

78- A Watershed Protection Plan for the Pecos River in Texas

- This WPP addresses water quality concerns for the Pecos River in Texas. The Pecos River watershed is assessed, and baseline data is established for a voluntary watershed protection plan. FMS 142000007 is based upon information presented in this document.

87- Environmental Flow Recommendations Report

- The Upper Rio Grande Basin and Bay Expert Science Team (URG BBEST) conducted an assessment of Sound Ecological Environment (SEE) for the Rio Grande Basin between the City of Presidio, Texas and Amistad Reservoir, including the Pecos and Devils River Basins. Environmental flow recommendations provided for the Pecos and the Rio Grande include components for subsistence flows, base flows, high flow pulses, and overbank flows. FMS 142000006 is based upon information presented in this document.

Chapter 2: Flood Risk Analyses

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2. Flood Risk Analyses

Flood risks can be defined in terms of *flood hazards* (i.e., the location, magnitude, and frequency of flooding), *flood exposure* (i.e., who and what might be harmed within the region), and *vulnerabilities* (i.e., areas of exposure including communities and critical facilities which may be particularly susceptible to flood impacts). Flood risk may also be evaluated based on *existing conditions*, accounting for present-day land use and impervious cover, as well as based on *future conditions*, accounting for future land use and impervious cover trends as well as overall climate and precipitation trends.

The following chapter summarizes the existing and future condition flood risk analyses performed for the Upper Rio Grande region. Flood risks were estimated using the best available hydrologic and hydraulic modeling data within the region, including models developed specifically for the RFP.

The results of the flood risk analyses are intended for use by the RFPG to establish priorities in subsequent planning tasks and to identify areas requiring flood management evaluations (FMEs), flood management strategies (FMSs), and flood mitigation projects (FMPs). The flood risk maps presented in this RFP do not reflect the effective regulatory floodplains and do not supersede or change federal flood insurance requirements.

Similarly, the flood risk analyses in this chapter establish baseline flood risk levels as currently recognized by FEMA and other best available modeling. As a result, and in accordance with State RFP requirements, any existing levees in the region that do not meet FEMA accreditation are excluded from the baseline flood risk analysis. This consideration is especially applicable to El Paso County, where unaccredited levees are present along the Upper Rio Grande. Chapter 4 discusses potential solutions and improvements that would be needed to achieve certification of these levees.

2.1 Available Hydrologic and Hydraulic Models

In reviewing the flood studies described in *Chapter 1 (Introduction and Description of the Upper Rio Grande Flood Planning Region),* relevant flood-related models were identified and obtained. These models, and their associated flood risk data, were evaluated to identify flood hazards and data gaps for the regionwide flood risk analysis as well as to evaluate flood reduction impacts from potential FMSs and FMPs as discussed in *Chapter 4 (Flood Mitigation Solutions)*.

Table 2.1 provides a summary of flood-related models most relevant to the Upper Rio Grande RFP. In addition, descriptions of the associated planning documents are included in Chapter 1, and an overview of model coverage boundaries across the region are shown in **Map Exhibit 22** ("Model Coverage").

Two of the primary flood risk data sources used in the baseline flood risk analysis include the 2019 Preliminary FEMA El Paso County Mapping Study (Model IDs 1 and 11) and the 2021 Statewide Fathom 2D Study (Model ID 20). These studies are described in greater detail in Section 2.2.1 along with the methodology used for the identification of flood risks.

Several of the models listed in **Table 2.1** were not incorporated into the baseline flood risk analyses but are still relevant to flood planning in the region. For example, the models developed for the El Paso County Interior Drainage Study (Model IDs 3-10) were excluded since they represent flood risks based on the flood protection of unaccredited levees through most of El Paso. The remaining models were excluded from the flood risk mapping since they are primarily associated with evaluating proposed Flood Mitigation Projects (FMPs), Flood Management Evaluations (FMEs), and/or Flood Management Strategies (FMSs), which are addressed in Chapter 4.

Other relevant floodplain layers were identified for the region, although models for these floodplains were not located or obtained, since the models are either out of date, superseded by other models, or not publicly available. These floodplain layers include the First American Flood Data Services (FAFDS) dataset (containing digitized flood hazard information from previously published FIRMs and FISs), Base Level Engineering (BLE) data for El Paso County, FEMA Approximate layers for Val Verde and Ector Counties, and a floodplain study for Fort Bliss in El Paso County.

Table 2.1 Relevant Flood-Related Models

Model ID	Study ID	Location	Modeling Software	Source
3-10	24	El Paso County, within the Rio Grande Natural Valley Floodplain	FLO-2D, HEC-HMS, and HEC-RAS 2D	El Paso County Interior Drainage Study (El Paso Water and El Paso County, 2021)
1, 11	21, 22	El Paso County	HEC-HMS and HEC-RAS 2D	Preliminary FEMA El Paso County Mapping Study (FEMA, 2019) (Note: as of November 2021, preliminary models are being adjusted to address appeals submitted during the appeal process – no current timeline is available for completion)
39, 40	N/A	El Paso County	HEC-HMS and HEC-RAS 2D	El Paso County Future Conditions Analysis for Regional Flood Plan (AECOM, 2022)
15-22	26	El Paso County	HEC-HMS, HEC-RAS 1D, and CulvertMaster	El Paso County Stormwater Master Plans (El Paso County, 2010 and 2021)
38	N/A	Texas, statewide	Fathom 2D models	TWDB/Fathom (October 2021)
28, 29	N/A	Americas Ten Dam in El Paso	HEC-HMS and HEC-RAS 2D	Ongoing Planning and Design to Decommission Americas Ten Dam (El Paso Water)
2, 12	59	SH 20 (Mesa Street) From Doniphan Drive to Texas Avenue	HEC-HMS, EPA SWMM	Drainage Study for SH 20 (Mesa Street) From Doniphan Drive to Texas Avenue (TXDOT, 2019)
13, 14	57	FM 170 (Mesa Street) From Candelaria to US-67	HEC-HMS, HEC-RAS 1D	Drainage Study for FM 170 From Candelaria to US-67 (TXDOT, 2020)
27	88	City of Presidio	HEC-HMS, HY-8	Final Hydraulic Report/Drainage Study for the City of Presidio, Texas (S&B Infrastructure, 2008)
30, 31	89	Northeast El Paso	HEC-HMS, FLO-2D	Northeast Sump Improvements – Hydrologic and Hydraulic Analysis (MCi, 2017)
34	38	West El Paso	HEC-HMS	Montoya Drain H&H Analysis (AECOM)
35	90	West El Paso	HEC-HMS	Doniphan Storm Water Pump Stations PS-1 and PS-2 System Evaluation & Potential Improvements (URS, 2014)
32, 33	N/A	West El Paso	HEC-HMS, HEC-RAS 2D	NW16 from modified version of El Paso County Preliminary FEMA Hydraulic Model (WA2) and modified version of SH20 (Mesa Street) Hydrologic Model

Model ID	Study ID	Location	Modeling Software	Source
1, 11	49	San Elizario	HEC-HMS, HEC-RAS 2D	San Elizario Alt 3 from Preliminary FEMA El Paso County Mapping Study (FEMA, 2019)
41-47	24	El Paso County, within the Rio Grande Natural Valley Floodplain	HEC-HMS	El Paso County Interior Drainage Study (El Paso Water and El Paso County, 2021)
48	24	El Paso County, within the Rio Grande Natural Valley Floodplain	StormCAD	El Paso County Interior Drainage Study (El Paso Water and El Paso County, 2021)

2.2 Existing Conditions Analysis

Existing condition flood hazard analyses were performed at the region-wide level using best available data to determine the location and magnitude of both 1% annual chance (100-year) and 0.2% annual chance (500-year) flood events. To evaluate the level of service of low water crossings, flood risks for the 10% annual chance (10-year) event were also evaluated.

2.2.1 Existing Flood Hazard Identification

Several flood hazard datasets were evaluated for the 1% and 0.2% annual chance events to develop the existing conditions flood hazard area layers for the RFP. These datasets were prioritized and consolidated into a single overall "flood quilt" for the entire region. **Table 2.2** summarizes the flood hazard datasets evaluated in this study as well as their priority order in the final existing conditions flood quilt. These datasets are also described in further detail later in this section. Existing condition flood hazard areas identified as part of this analysis are shown in **Map Exhibit 4** ("Existing Condition Flood Hazard").

The final consolidated existing conditions flood hazard spatial files are included in a GIS geodatabase format along with the RFP. Existing condition flood hazard areas are contained in a single feature class ("ExFldHazard") which includes flood hazard areas for both 1% and 0.2% annual chance events. In cases of overlapping floodplain sources during consolidation, the flood frequency attribute field ("FLOOD_FREQ") was populated using the highest intensity storm event of the overlapping layers.

Any existing levees or dams in the region that do not meet FEMA accreditation, such as unaccredited levees in El Paso County, were excluded from the baseline flood hazard analysis and addressed separately in *Chapter 4 (Flood Mitigation Solutions)*.

Table 2.2 Existing Conditions Flood Hazard Datasets and Priorities

Flood Hazard Data Source	Description	Priority Order (1 – Highest)	
		El Paso County	Outside El Paso County
National Flood Hazard Layer Preliminary Data	Detailed mapping of flood hazards for 1% and 0.2% annual chance events subject to public review and finalization. Available in El Paso County only.	1	n/a
Base Level Engineering (BLE) Floodplain	Watershed-scale modeling and mapping using automated methods. Available in El Paso County only (but mostly superseded by NFHL Preliminary Data).	n/a	n/a
National Flood Hazard Layer Approximate Effective Data	Approximate studies (Flood Zone A) on the effective FIRM map. Available in Ector and Val Verde Counties only.	n/a	1
First American Flood Data Services (FAFDS)	Digitized flood hazard information from previously published FIRMs and FISs.	n/a	2
Cursory Floodplain (Fathom)	Regionwide flood hazard dataset developed using 3-meter resolution fluvial and pluvial models by Fathom	2 (Fort Bliss only)	3

To supplement the available flood hazard datasets, community feedback was requested to identify any other potential flood prone areas that may not be captured by existing mapping. These flood prone areas were collected throughout the planning process during in-person public meetings and through an online form and map survey. Additional information pertaining to the data collection and public input process is provided in *Chapter 9 (Public Participation and Plan Adoption)*.

National Flood Hazard Layer (NFHL) Preliminary Data

The NFHL is used by FEMA to represent the regulatory floodplains for the National Flood Insurance Program (NFIP). This layer includes flood hazard maps for the 1% and 0.2% annual chance storm events, as well as other lower intensity storm events. When the NFHL is updated, preliminary NFHL datasets are issued for public review and awareness of the proposed change. Preliminary datasets include both detailed and approximate flood study data and typically represent the best available information for their study area.

The FEMA El Paso County Mapping Study was issued as preliminary on July 8, 2020, and is intended to revise the existing FIS for El Paso County. The latest available floodplains from the Preliminary study were used as the top priority floodplain layer for El Paso County in the RFP existing conditions flood quilt.

The Preliminary study was divided into 11 watershed areas, shown in **Figure 2.1**, with a selection of streams to received detailed studies. All portions of the study, with the exception of the Horizon Arroyo (Stream 2), were developed using 2D hydraulic modeling and detailed terrain data to better represent the physical characteristics of the county. As of June 2022, the preliminary models are being adjusted to address public comments submitted during the appeal process, and revised preliminary draft floodplains are anticipated to be issued for public review in late fall of 2022. No current timeline is available for the new floodplain maps to become effective.

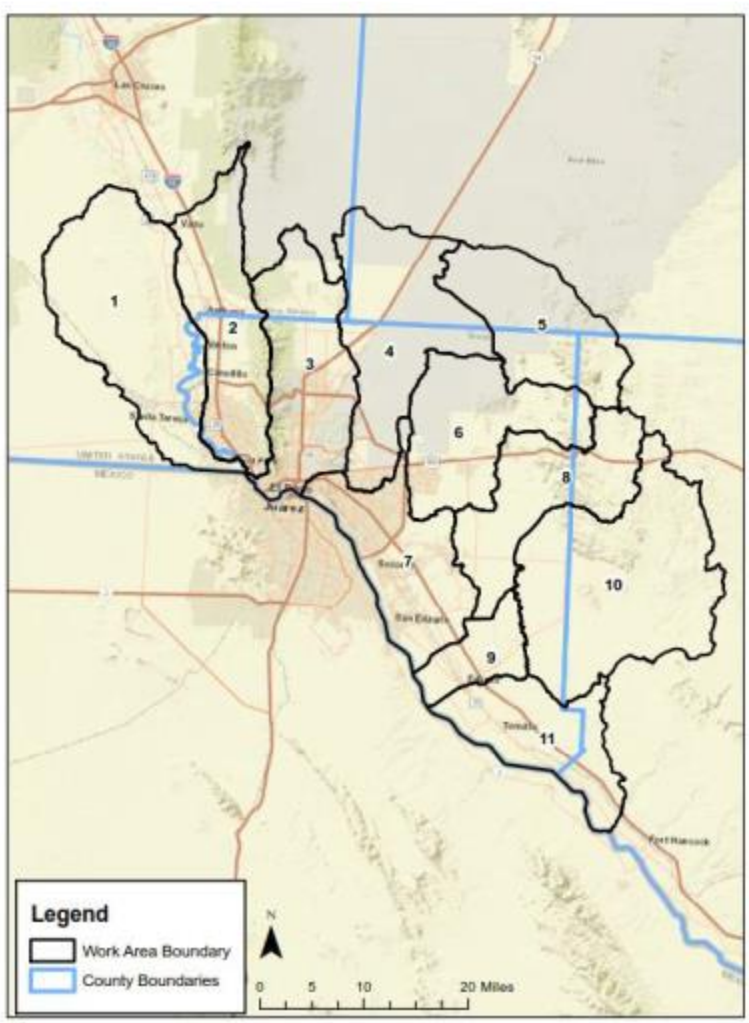


Figure 2.1 FEMA El Paso County Mapping Study Watershed Area Boundaries

Base Level Engineering (BLE) Floodplain

BLE floodplains are developed using automated methods for watershed-scale modeling and mapping. BLE floodplains were developed for El Paso County in 2016 for the FEMA Region IV RiskMAP Program and have since largely been superseded by the recent 2019 Preliminary FEMA El Paso County Mapping Study.

Fort Bliss in El Paso County is one exception to this, as the area is not covered in the 2019 Preliminary Mapping dataset, even though it is covered in the earlier BLE floodplains dataset. However, in this area, the Cursory Floodplain (Fathom) dataset was used to fill data gaps in the RFP existing conditions flood quilt and was selected over the BLE data because it is more conservative than the BLE data overall and overlaps with more than 95% of the buildings shown to be at-risk of flooding in the BLE layer. For this reason, and since the BLE floodplain is superseded by the Preliminary datasets for the rest of El Paso County, the BLE floodplain dataset was not used in developing the RFP existing conditions flood quilt.

National Flood Hazard Layer (NFHL) Approximate Effective Data

The effective NFHL contains current regulatory floodplains and includes both detailed and approximate flood study data. Two locations in the Upper Rio Grande Region have available NFHL Approximate floodplain data, including Val Verde County (with an effective floodplain date of July 22, 2010) and Ector County (with an effective floodplain date of March 15, 2012). These floodplains were used as the top priority floodplains in the RFP existing conditions flood quilt for both counties, replacing the lesser priority First American Flood Data Services (FAFDS) floodplain layer.

First American Flood Data Services (FAFDS) Floodplain

The FAFDS floodplain layer contains digitized flood hazard information from previously published FIRMs and FISs and is not available for viewing in the NFHL. While FAFDS floodplains are typically old and potentially outdated, they make up a large component of the available floodplain data in the Upper Rio Grande Region.

Due to the limited availability of more recent floodplain data across the region, FAFDS floodplains were utilized as the top priority floodplains in the RFP existing conditions flood quilt for 11 counties, including the Counties of Brewster, Crockett, Culberson, Edwards, Hudspeth, Jeff Davis, Midland, Presidio, Sutton, Terrell, and Ward. Effective map dates of these FAFDS floodplains are listed in **Table 2.3** by county.

Table 2.3 FAFDS Effective Map Dates by County

County	FAFDS Effective Map Date
Brewster	10/15/1985
Crockett	4/1/2004
Culberson	11/1/1985
Edwards	2/19/1982
Hudspeth	11/1/1985
Jeff Davis	7/18/1985
Midland	12/6/1999
Presidio	7/3/1985
Sutton	9/1/1987
Terrell	9/1/1987
Ward	10/23/1977-10/25/1977

FAFDS floodplains were not utilized for El Paso, Val Verde, or Ector Counties, where more recent floodplain data are available, or for the other nine counties where FAFDS floodplains are unavailable, including the Counties of Andrews, Schleicher, Pecos, Reagan, Upton, Crane, Loving, Reeves, and Winkler. Floodplains for these latter counties were populated in the RFP existing conditions flood quilt using the Cursory Floodplain (Fathom) dataset only.

Cursory Floodplain (Fathom)

The Cursory Floodplain dataset was developed for the TWDB by Fathom, consisting of both pluvial and fluvial floodplains. Both pluvial and fluvial floodplains were produced using 30-meter resolution models and mapped to a 3-meter resolution for the entire state of Texas. The dataset incorporates NOAA Atlas 14 rainfall data in all areas of the state and includes an estimation of flood hazards for the 20%, 10%, 1%, and 0.2% annual chance events.

At the request of the TWDB, the datasets were post-processed by Fathom to remove fluvial and pluvial cells with depths less than 0.5 feet. The Fathom datasets were provided by TWDB to each region in raster format. The datasets associated with the Upper Rio Grande Region were then processed for the RFP in accordance with additional TWDB post-processing specifications. The final post-processed Fathom floodplain layer was used in union with other available data to fill data gaps for the entire Upper Rio Grande Region outside of El Paso County and for Fort Bliss inside El Paso County.

While the Fathom dataset is useful at filling flood hazard data gaps, it also has several limitations as indicated in the TWDB Fathom dataset documentation (TWDB 2021)[1]:

- Cursory flood data may not appropriately depict flood risk associated with:
  - Constructed features that may alter flow patterns (roadways, railroads, urban areas, storm drainage systems, dams, levees, embankments, etc.)
  - Natural features that may not be fully represented in the 30-meter model (alluvial fans, sinkholes, small tributaries, waterbodies, areas of immediate topographic change, etc.)
  - Border areas along the Texas state boundary
- Limitations exist above bodies of water where underwater bathymetry might alter flood depths.
- Cursory flood depths were developed using a high-level statewide assessment and should be used as approximations of flood risk.

As a result of these limitations, the Fathom dataset was used as the lowest priority floodplain in the RFP existing conditions flood quilt for all parts of the region. However, in the case of nine counties where FAFDS floodplains were unavailable (including the Counties of Andrews, Schleicher, Pecos, Reagan, Upton, Crane, Loving, Reeves, and Winkler), the Fathom dataset was used as the primary floodplain dataset.

For additional insight, Aqua Strategies performed an evaluation for the Upper Rio Grande Region comparing a draft version of the Fathom dataset (developed using a 30-meter mapping resolution) with 1D-derived floodplain maps in the region. The comparison found reasonable similarities between the two sets of floodplains. This memorandum is provided for reference in Appendix 2C.

[1] Texas Water Development Board. Cursory Floodplain Data 3m Technical Documentation, October 2021. Accessed at https://twdb.maps.arcgis.com/sharing/rest/content/items/a59cbeae4a754cee9f38b17459521629/data

2.2.2 Existing Flood Hazard Data Gaps

While recent flood hazard mapping information is available for El Paso County, Ector County, and Val Verde County, the availability of recent flood hazard data across the rest of the region is much more limited. For the other areas outside of these three counties, as described in the previous section, the existing conditions flood hazard layer utilized a combination of digitized flood hazard areas from the FAFDS dataset (dating between 1977 and 2004) and the Cursory Floodplain Fathom dataset (with its previously-stated limitations).

As a result, two types of existing condition flood hazard data gaps were identified across the region based on data availability and reliability. The first type of data gap includes counties which do not have a broad coverage of available FAFDS information or any other available flood hazard data apart from the Fathom dataset. It also includes counties with limited FAFDS coverage (e.g., for small areas within selected municipalities) that do not have broad countywide coverage of flood hazard data. This first group is made up of five counties with no FAFDS coverage (including the Counties of Andrews, Crane, Loving, Reagan, and Schleicher) and four counties with limited FAFDS coverage (including the Counties of Pecos, Reeves, Upton, and Winkler).

The second type of data gap includes counties which do have broad coverage of FAFDS information in addition to the Fathom dataset but are in need of updated flood hazard information due to the age of the FAFDS floodplains. This second group is made up of 11 counties, including the Counties of Brewster, Crockett, Culberson, Edwards, Hudspeth, Jeff Davis, Midland, Presidio, Sutton, Terrell, and Ward.

Existing flood hazard data gaps, along with the public-provided flood prone areas, are shown in **Map Exhibit 5** (“Existing Condition Flood Hazard – Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas”).

2.2.3 Existing Flood Exposure

Based on the identified existing conditions flood hazard areas, a high-level existing flood exposure analysis was performed to identify who or what might be harmed within the region for the 1% and 0.2% annual chance flood events. The exposure analysis evaluated potential flood impacts to population, property, critical facilities, public infrastructure, roadways, and agricultural resources.

This section describes the exposure analysis methodologies for each flood risk type. Existing conditions flood exposure results are summarized at the regionwide level in **Table 2.4**, by county in **Figure 2.2**, and by flood risk type in **Figure 2.3**. In addition, detailed results are provided in **Appendix Table 2A** and illustrated at the regionwide level in **Map Exhibit 6** (“Existing Condition Flood Exposure”)**.**

Table 2.4 Existing Flood Exposure Summary

Exposure Type	Number of features		
	1% AC	0.2% AC*	Possible Flood Prone Areas
Floodplain Area (sq. mi.)	9,285	1,755	99
Structures (#)	40,121	14,290	8,426
Population (#)	115,530	47,985	35,740
Critical Facilities (#)	95	41	23
Roadway Segments (mi.)	3,047	746	178
Roadway Stream Crossings (#)	3,943	189	31
Agricultural Areas (sq. mi.)	615	135	21

*0.2% AC flood exposure results are reported separately from the 1% AC results and do not include cumulative flood hazard areas or property impacts from 1% AC flood hazard areas.

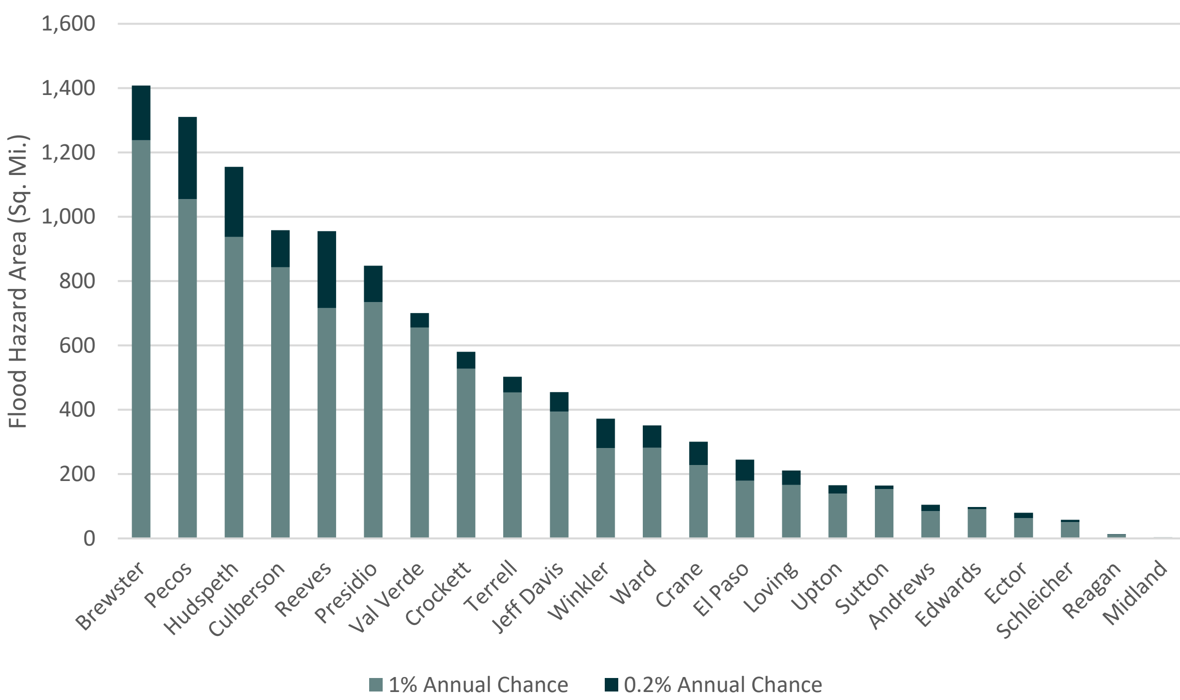
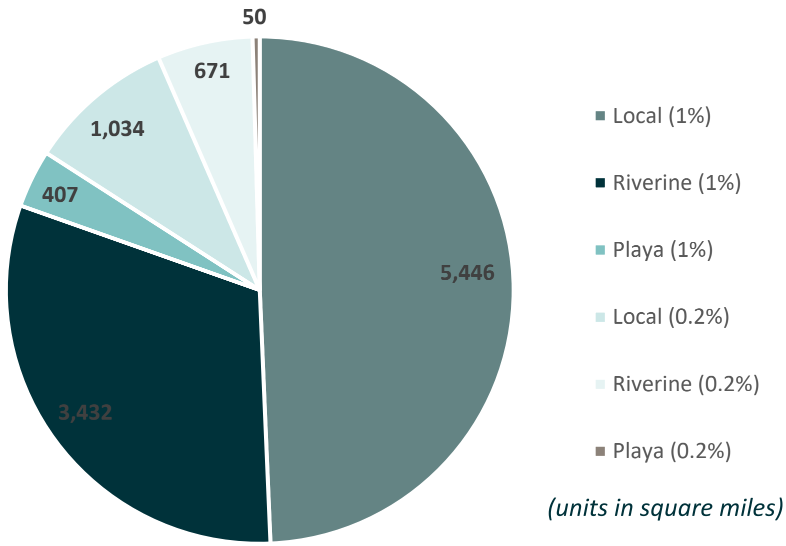


Figure 2.2 Total Existing Condition Flood Hazard Area by County



Note: Flood hazard areas with more than one potential flood risk type are characterized in this figure using a simplified priority order (i.e., playa, riverine, local).

Figure 2.3 Total Existing Condition Flood Hazard Area by Flood Risk Type

2.2.3.1 Population and Property

To estimate potential flood impacts to population and property, the "Texas Buildings with SVI and Estimated Population" dataset was used as developed by the TWDB and the Texas Natural Resources Information System (TNRIS).[2] This dataset contains building footprints across the region from multiple sources including Microsoft Buildings and Stratmap LiDAR as well as various building attributes for use in the exposure analysis including land use types (residential, non-residential, vacant, etc.), daytime and nighttime population estimates, and social vulnerability index (SVI) data.

Flood impacts to building property were estimated by intersecting the building footprints with the existing conditions 1% and 0.2% annual chance event flood hazard areas. Building impacts were summarized separately for residential and non-residential building types based on the land use types populated in the source buildings dataset.

Flood impacts to population were estimated based on the building population estimates. Building populations in the source buildings dataset were derived from the ORNL LandScan dataset, which uses available data and satellite imagery to capture ambient daytime and nighttime activity and estimate associated populations. Due to the typical movement of population during the day, an area's nighttime population estimates will typically match more closely to the total census-derived population compared to its daytime population estimates.

[2] Texas Water Development Board. Texas Buildings with SVI and Estimated Population (November 2021). Accessed from https://twdb-flood-planning-resources-twdb.hub.arcgis.com/pages/buildings-nov2021

In comparing the LandScan nighttime population estimates to the TWDB 2021 Regional Water Plan and 2020 Decennial Census population estimates, the LandScan nighttime population estimates were found to be significantly lower. In addition, due to limitations in the LandScan data from the TWDB buildings dataset, several buildings across the region were noted as having a zero population values for both daytime and nighttime populations. To correct for this (and to better match the LandScan population estimates with the population estimates from the TWDB 2021 Regional Water Plan and 2020 Decennial Census), a nighttime population of three people was added to all zero-population buildings. At a regionwide level, this method resulted in a close population match between the building populations and the previous population estimates, with the total building populations matching within 1% of the TWDB 2021 Regional Water Plan populations and within 6% of the 2020 Census data.

Once the building populations were adjusted, estimated population impacts were summarized by county for buildings in the existing condition flood hazard areas. Population impacts were initially summarized separately for daytime and nighttime populations, and the maximum of the two values was used as the total estimated population for the county.

2.2.3.2 Critical Facilities and Public Infrastructure

To identify potential flood risks to critical facilities and public infrastructure across the region, the following datasets were reviewed and obtained for the region:

- *Homeland Infrastructure Foundation-Level Data (HIFLD)* – an open-source dataset distributed by the U.S. Department of Homeland Security to support nationwide community preparedness, resiliency, and research. Layers are sourced from the Oak Ridge National Laboratory (ORNL), the United States Geological Survey (USGS), the National Geospatial-Intelligence Agency (NGA) Homeland Security Infrastructure Program (HSIP) Team, and the United States Environmental Protection Agency (EPA), among other sources. Several critical facilities layers were reviewed from the HIFLD dataset including:
    - EPA Facility Registry Service (FRS) Power Plants
    - Ferrous and Nonferrous Metal Processing Plants
    - Fire Stations
    - Hospitals
    - Police Departments/Local Law Enforcement Locations (Law Enf)
    - National Shelter System Facilities (including libraries, schools, civic centers, churches, and other large public facilities)
    - Natural Gas Processing Plants (NGPP)
    - Nursing Homes
    - Power Plants and Power Stations
- *National Pollutant Discharge Elimination System (NPDES) Database* – a dataset developed by the U.S. Environmental Protection Agency (EPA) with the locations of Wastewater Treatment Facilities/Plants (WWTF/WWTP) and Water Treatment

Facilities/Plants (WTF/WTP). Original points in the source database are typically located at discharge locations along creeks rather than at the facilities. To correct for this issue in the flood exposure analysis, the wastewater and water treatment plant points were manually reviewed and updated across the region using aerial imagery. Other facility locations were identified by EPWater and by manual review using Google Maps. Wastewater treatment plant points were also compared with EPA FRS Wastewater Treatment Plants data from the HIFLD dataset.

- *Texas Schools Database (2019-2020)* – developed by the Texas Education Agency (TEA) with the locations of public schools including Elementary Schools (EL), Middle Schools (MIDDLE), and High Schools (H S). Original points in the source database are located by street address rather than by physical building location. To correct for this issue in the flood exposure analysis, school locations were manually reviewed and verified across the region. In cases where there were multiple buildings on a school property partially inundated by the floodplain, the school point was moved to correspond to one or more of the buildings located in the floodplain.
- National Transportation Atlas Database (NTAD) – a public dataset distributed by the U.S. Department of Transportation (USDOT). The following layers were reviewed from this dataset:
    - Intermodal Freight Facility
    - Intermodal Transit Facility (including passenger transportation terminals such as intercity bus stations, rail transit stations, and other terminals)

Critical facilities and infrastructure features are populated in the accompanying RFP GIS geodatabase in the feature class (“ExFldExpPol”) including at-risk features for both 1% and 0.2% annual chance flood events. Critical facilities are discussed in additional detail in the following Section 2.2.4 (Existing Vulnerability).

2.2.3.3 Roadway Crossings and Segments

Potential roadway flood impacts were estimated using existing conditions flood hazard areas as well as detailed hydraulic analyses from previous studies. Both roadway crossings and roadway segments (i.e., roadways not crossing the stream centerline) were included in the flood exposure analysis. Additional details related to the stream crossings datasets used in this analysis are provided in Chapter 1 Section 1.7.1 (Stream Crossings).

Where possible, stream crossing flood exposure information was first identified using detailed hydraulic analyses from previous studies. Different studies define roadway flood risk in different ways. In the TxDOT Bridges Dataset, the Bridge Waterway Adequacy Classifications attribute defines flood risk in terms of overtopping potential, while the FM170 dataset defines risk in terms of level of service (the point at which the roadway is not overtopped). While the two classifications are similar, the variations in nomenclature have subtle implications for flood exposure analyses. For instance, a bridge that has an overtopping potential between 3-10 years may be flooded by a 10% annual chance event, while another bridge that has a 10-year level of service may not be flooded by the 10% annual chance event.

Based on this approach, the relationships shown in **Table 2.5** were developed to match flood frequency values to overtopping potential values (from the TxDOT Bridges Dataset) and level of service values (from the FM170 dataset). According to the TWDB "Exhibit D: Data Submittal Guidelines for Regional Flood Planning" document, valid entries for flood frequencies include the 10%, 4%, 1%, and 0.2% annual chance events.

Table 2.5 Roadway Crossing Flood Frequency Relationships

TxDOT Bridges Dataset	
Overtopping Potential (recurrence interval in years)	Flood Frequency (% Annual Chance)
<3	10
3-10	10
11-100	1
>100	0.2

FM170 Roadway Crossings	
Level of Service (recurrence interval in years)	Flood Frequency (% Annual Chance)
<5-yr	10
5-yr	10
10-yr	4
25-yr	1
50-yr	1
100-yr	0.2

Once the flood frequency relationships were developed, flood frequencies were populated for crossings that were included in these hydraulic studies based on their defined overtopping potential or level of service.

Next, roadway crossings that originated from the TNRIS Statewide Low Water Crossing Inventory were assumed to be overtopped by flood events of lower intensity than the 10% annual chance event (such as the 5-year or 20% annual chance event) based on information provided in the dataset's supporting documentation.

Lastly, for roadway crossings that were not populated with flood frequency values by either of the previous methods, flood frequencies were estimated using flood depths from the Fathom Cursory Floodplain dataset. Using this method, flood frequencies were identified for each roadway crossing based on the lowest intensity (highest frequency) overtopping flood event.

Additionally, exposed roadway segments were identified by intersecting roadway segments from the TxDOT Roadway Inventory dataset with the existing conditions flood hazard areas. For this regionwide analysis, roadway segmentation rules were preserved from the source TxDOT dataset, so that a single roadway segment flooded in multiple locations would count as a single flooded segment.

2.2.3.4 Agricultural Area and Value of Crops

Potential flood risks to agricultural areas were estimated by comparing existing conditions flood hazard areas with different crop areas as identified by USDA Cropscape data. Estimated crop impacts were summarized in terms of impacted crop acreage by county as well as by the estimated crop yield and crop production value. Esri ArcMap was used to intersect the spatial Cropscape data layer with both the 1% annual chance and the 0.2% annual chance floodplains to estimate the number of agricultural acres that could potentially be impacted as a result of the two storm events. This information was summarized by county and is provided in **Table 2.6**.

Additional details regarding the assumptions and datasets used in this analysis are provided in the regionwide summary located in *Chapter 1 Section 1.4 (Agricultural Resources)*.

Table 2.6 Study Area Crop Acreage by County

County	Crop Acreage in the 1% Annual Chance Floodplain	Crop Acreage in the 0.2% Annual Chance Floodplain
Andrews	11,637	14,757
Brewster	27,234	31,244
Crane	1,680	2,281
Crockett	4,205	4,608
Culberson	20,544	22,980
Ector	266	339
Edwards	210	220
El Paso	38,830	48,552
Hudspeth	157,199	195,945
Jeff Davis	33,773	39,480
Loving	2,710	3,586
Midland	3	3
Pecos	30,393	37,174
Presidio	28,584	34,076
Reagan	9	10
Reeves	11,524	17,005
Schleicher	2,426	3,082
Sutton	1,120	1,187
Terrell	1,688	1,900
Upton	937	1,027
Val Verde	14,342	14,902
Ward	2,503	3,263
Winkler	1,627	2,091
Total	**393,444**	**479,710**

Esri ArcMap was also used to estimate the acres, by crop, potentially impacted in the 1% and 0.2% annual chance floodplains. This information is provided in **Table 2.7** (sorted by acreage in the 1% annual chance floodplain). The major crops (by acreage) within the 1% annual chance floodplain in the Rio Grande region are grassland/pasture, cotton, alfalfa, and pecans.

Table 2.7 Summary of Crops in Study Area

Crop	Crop Acreage in the 1% Annual Chance Floodplain	Crop Acreage in the 0.2% Annual Chance Floodplain
Grassland/Pasture	288,639	359,938
Cotton	27,229	30,679

Crop	Crop Acreage in the 1% Annual Chance Floodplain	Crop Acreage in the 0.2% Annual Chance Floodplain
Fallow/Idle	20,646	23,299
Alfalfa	18,826	21,306
Pecans	14,132	15,282
Winter Wheat	9,110	11,640
Oats	4,765	5,322
Sorghum	2,760	3,464
Rye	1,577	2,156
Dbl Crop WinWht/Cotton	1,041	1,241
Other Hay/Non Alfalfa	894	1,140
Grapes	726	730
Peppers	667	668
Corn	626	707
Triticale	375	427
Dbl Crop WinWht/Sorghum	360	448
Watermelons	338	424
Peanuts	239	287
Barley	199	208
Onions	136	154
Pumpkins	85	99
Dbl Crop WinWht/Corn	29	36
Peas	17	20
Sod/Grass Seed	10	10
Dbl Crop Triticale/Corn	8	12
Rice	2	2
Soybeans	2	3
Millet	2	6
Herbs	1	1
Other Tree Crops	1	1
Dbl Crop WinWht/Soybeans	0	0
Durum Wheat	0	0
Sunflower	0	0
Sugarcane	0	0
Total	**393,444**	**479,710**
Total (excluding Fallow/Idle)	**372,798**	**456,411**

The four crops (excluding grasslands and fallow/idle land) with the highest acreage within the 1% annual chance floodplain for each of the study area counties are shown in **Table 2.8**. In addition, because of the prevalence of grasslands in the study area, the table includes grasslands as a separate column. **Table 2.9** presents the same information for crops located in the 0.2% annual chance floodplain.

Table 2.8 Acres of Cropland for Major Crops in the 1% AC Floodplain by County

County	Top Crop Impacts (with Impacted Acres), 1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Andrews	Cotton (153)	Winter Wheat (34)	Winter Wheat/Cotton (17)	Barley (3)	(11,390)
Brewster	Cotton (202)	Winter Wheat (85)	Alfalfa (57)	Sorghum (34)	(26,577)
Crane	Winter Wheat (77)	Cotton (35)	Pecans (18)	Sorghum (16)	(1,496)
Crockett	Winter Wheat (116)	Cotton (56)	Sorghum (17)	Triticale (11)	(3,960)
Culberson	Cotton (2,449)	Pecans (1,266)	Alfalfa (332)	Winter Wheat (254)	(8,843)
Ector	Cotton (8)	Winter Wheat (7)	Peanuts (2)	Alfalfa (1)	(246)
Edwards	Winter Wheat (63)	Sorghum (14)	Oats (12)	Corn (12)	(58)
El Paso	Cotton (13,565)	Pecans (11,390)	Alfalfa (847)	Corn (227)	(11,712)
Hudspeth	Alfalfa (13,464)	Cotton (5,957)	Oats (2,901)	Grapes (724)	(122,031)
Jeff Davis	Cotton (23)	Alfalfa (22)	Sorghum (6)	Corn (5)	(33,689)
Loving	Cotton (67)	Winter Wheat (63)	Other Hay/Non Alfalfa (2)	Winter Wheat/Sorghum (1)	(2,569)
Midland	Cotton (2)	Winter Wheat/Cotton (1)	(--)	(--)	(--)
Pecos	Winter Wheat (4,823)	Alfalfa (2,573)	Cotton (1,978)	Oats (1,312)	(14,817)
Presidio	Cotton (248)	Winter Wheat (189)	Sorghum (104)	Alfalfa (92)	(27,741)
Reagan	Cotton (3)	Sorghum (1)	(--)	(--)	(4)
Reeves	Winter Wheat (1,553)	Alfalfa (1,285)	Winter Wheat/Cotton (605)	Cotton (585)	(4,710)
Schleicher	Cotton (1,122)	Sorghum (457)	Winter Wheat (380)	Oats (97)	(14)
Sutton	Winter Wheat (648)	Cotton (70)	Sorghum (59)	Other Hay/Non Alfalfa (26)	(31)
Terrell	Cotton (53)	Winter Wheat (43)	Triticale (8)	Sorghum (7)	(1,530)
Upton	Winter Wheat (142)	Cotton (54)	Winter Wheat/Cotton (31)	Sorghum (23)	(245)
Val Verde	Oats (132)	Cotton (95)	Winter Wheat (57)	Sorghum (48)	(13,870)
Ward	Winter Wheat (93)	Sorghum (55)	Cotton (54)	Alfalfa (34)	(2,144)

County	Top Crop Impacts (with Impacted Acres), 1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Winkler	Cotton (444)	Alfalfa (73)	Winter Wheat (46)	Peanuts (42)	(961)

Table 2.9 Acres of Cropland for Major Crops in the 0.2% AC Floodplain by County

County	Top Crop Impacts (with Impacted Acres), 0.2% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Andrews	Cotton (192)	Winter Wheat (44)	Winter Wheat/Cotton (21)	Barley (5)	(14,441)
Brewster	Cotton (214)	Winter Wheat (90)	Alfalfa (60)	Sorghum (35)	(30,547)
Crane	Winter Wheat (81)	Cotton (47)	Pecans (21)	Sorghum (20)	(2,067)
Crockett	Winter Wheat (131)	Cotton (63)	Sorghum (18)	Triticale (12)	(4,333)
Culberson	Cotton (2,720)	Pecans (1,292)	Alfalfa (346)	Winter Wheat (266)	(10,760)
Ector	Cotton (9)	Winter Wheat (7)	Peanuts (2)	Alfalfa (1)	(316)
Edwards	Winter Wheat (66)	Sorghum (14)	Oats (13)	Corn (12)	(61)
El Paso	Cotton (14,633)	Pecans (12,145)	Alfalfa (886)	Corn (230)	(19,501)
Hudspeth	Alfalfa (13,717)	Cotton (6,693)	Oats (2,938)	Grapes (727)	(158,217)
Jeff Davis	Cotton (25)	Alfalfa (22)	Sorghum (6)	Corn (6)	(39,389)
Loving	Cotton (78)	Winter Wheat (78)	Other Hay/Non Alfalfa (3)	Winter Wheat/Sorghum (2)	(3,415)
Midland	Cotton (2)	Winter Wheat/Cotton (1)	(--)	(--)	(--)
Pecos	Winter Wheat (6,302)	Alfalfa (3,585)	Cotton (2,454)	Oats (1,730)	(16,831)
Presidio	Cotton (253)	Winter Wheat (207)	Sorghum (105)	Alfalfa (92)	(33,206)
Reagan	Cotton (3)	Sorghum (1)	(--)	(--)	(5)
Reeves	Winter Wheat (2,266)	Alfalfa (2,352)	Winter Wheat/Cotton (765)	Cotton (914)	(6,561)
Schleicher	Cotton (1,484)	Sorghum (541)	Winter Wheat (466)	Oats (128)	(18)
Sutton	Winter Wheat (675)	Cotton (75)	Sorghum (62)	Other Hay/Non Alfalfa (29)	(34)

County	Top Crop Impacts (with Impacted Acres), 0.2% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Terrell	Cotton (58)	Winter Wheat (44)	Triticale (8)	Sorghum (7)	(1,728)
Upton	Winter Wheat (157)	Cotton (60)	Winter Wheat/Cotton (34)	Sorghum (24)	(259)
Val Verde	Oats (133)	Cotton (100)	Winter Wheat (59)	Sorghum (50)	(14,407)
Ward	Winter Wheat (175)	Sorghum (156)	Cotton (62)	Alfalfa (52)	(2,610)
Winkler	Cotton (537)	Alfalfa (140)	Winter Wheat (61)	Peanuts (45)	(1,232)

To estimate the potential value of the agricultural resources within the 1% annual chance floodplain, the total acreage of each crop in the floodplain was multiplied by the average yield and by the normalized price per unit (as presented in Chapter 1). The estimated value for the major crops within the study area's 1% annual chance floodplain is approximately $148 million as shown in **Table 2.10**.

Table 2.10 Estimated Value of Top Agricultural Impacts

Crop	Number of Acres (1% AC)	Value of Major Crops (1% AC)*
Alfalfa	18,826	$21,247,000
Cotton	27,229	$16,691,000
Grassland	288,639	$84,860,000
Oats	4,765	$944,000
Pecans	14,132	$18,513,000
Sorghum	2,760	$3,682,000
Winter Wheat	9,110	$2,191,000
TOTAL		**$148,128,000**

* Values rounded to nearest thousand dollars

The estimated value for each of the four crops with the largest acreage (excluding grasslands and fallow/idle land) in the 1% annual chance floodplain for each county is shown in **Table 2.11**. In addition, the table includes grasslands as a separate column. **Table 2.12** presents the same information for crops located in the 0.2% annual chance floodplain.

Table 2.13 summarizes the damages by county for the major crop types for the 1% and 0.2% annual chance floodplains. Due to uncertainties related to flood damages to grasslands (as discussed in Chapter 1), this table includes estimated damages with and without grassland damages.

Table 2.11 Estimated Value of Crop Production for Major Crops in the 1% Annual Chance Floodplain by County

County	Top Crop Impacts by Acreage (with Estimated Damages), 0.1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Andrews	Cotton ($94,000)	Winter Wheat ($8,000)	Winter Wheat/Cotton ($4,000/$10,000)	Barley ($1,000)	($3,349,000)
Brewster	Cotton ($124,000)	Winter Wheat ($20,000)	Alfalfa ($65,000)	Sorghum ($20,000)	($7,814,000)
Crane	Winter Wheat ($19,000)	Cotton ($22,000)	Pecans ($24,000)	Sorghum ($10,000)	($440,000)
Crockett	Winter Wheat ($28,000)	Cotton ($34,000)	Sorghum ($10,000)	Triticale* ($2,000)	($1,164,000)
Culberson	Cotton ($1,501,000)	Pecans ($1,659,000)	Alfalfa ($374,000)	Winter Wheat ($61,000)	($2,600,000)
Ector	Cotton ($5,000)	Winter Wheat ($2,000)	Peanuts ($1,000)	Alfalfa ($2,000)	($72,000)
Edwards	Winter Wheat ($15,000)	Sorghum ($18,000)	Oats ($2,000)	Corn ($9,000)	($17,000)
El Paso	Cotton ($8,315,000)	Pecans ($14,921,000)	Alfalfa ($956,000)	Corn ($174,000)	($3,443,000)
Hudspeth	Alfalfa ($15,195,000)	Cotton ($3,652,000)	Oats ($574,000)	Grapes ($4,425,000)	($35,877,000)
Jeff Davis	Cotton ($14,000)	Alfalfa ($24,000)	Sorghum ($3,000)	Corn ($4,000)	($9,904,000)
Loving	Cotton ($41,000)	Winter Wheat ($15,000)	Other Hay/Non Alfalfas ($1,000)	Winter Wheat/Sorghum (--)/($1,000)	($755,000)
Midland	Cotton ($1,000)	(--)	(--)	(--)	(--)
Pecos	Winter Wheat ($1,160,000)	Alfalfa ($2,904,000)	Cotton ($1,213,000)	Oats ($260,000)	($4,356,000)
Presidio	Cotton ($152,000)	Winter Wheat ($46,000)	Sorghum ($63,000)	Alfalfa ($104,000)	($8,156,000)
Reagan	Cotton ($2,000)	Sorghum ($1,000)	(--)	(--)	($1,000)
Reeves	Winter Wheat ($374,000)	Alfalfa ($1,450,000)	Winter Wheat/Cotton ($145,000/$371,000)	Cotton ($358,000)	($1,385,000)
Schleicher	Cotton ($688,000)	Sorghum ($610,000)	Winter Wheat ($91,000)	Oats ($19,000)	($4,000)
Sutton	Winter Wheat ($156,000)	Cotton ($43,000)	Sorghum ($79,000)	Other Hay/Non Alfalfas ($8,000)	($9,000)
Terrell	Cotton ($33,000)	Winter Wheat ($10,000)	Triticale* ($2,000)	Sorghum ($4,000)	($450,000)
Upton	Winter Wheat ($34,000)	Cotton ($33,000)	Winter Wheat/Cotton ($8,000/$19,000)	Sorghum ($14,000)	($72,000)
Val Verde	Oats ($26,000)	Cotton ($58,000)	Winter Wheat ($14,000)	Sorghum ($29,000)	($4,078,000)

County	Top Crop Impacts by Acreage (with Estimated Damages), 0.1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Ward	Winter Wheat ($22,000)	Sorghum ($73,000)	Cotton ($33,000)	Alfalfa ($38,000)	($630,000)
Winkler	Cotton ($272,000)	Alfalfa ($82,000)	Winter Wheat ($11,000)	Peanuts ($48,000)	($283,000)

*Note: Triticale was calculated using Rye yield/price figures from USDA, as they did not exist for Triticale

Table 2.12 Estimated Value of Crop Production for Major Crops in the 0.2% Annual Chance Floodplain by County

County	Top Crop Impacts by Acreage (with Estimated Damages), 0.1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Andrews	Cotton ($117,000)	Winter Wheat ($11,000)	Winter Wheat/Cotton ($5,000/$13,000)	Barley ($2,000)	($4,246,000)
Brewster	Cotton ($131,000)	Winter Wheat ($22,000)	Alfalfa ($68,000)	Sorghum ($21,000)	($8,981,000)
Crane	Winter Wheat ($20,000)	Cotton ($29,000)	Pecans ($27,000)	Sorghum ($12,000)	($608,000)
Crockett	Winter Wheat ($32,000)	Cotton ($38,000)	Sorghum ($11,000)	Triticale* ($3,000)	($1,274,000)
Culberson	Cotton ($1,667,000)	Pecans ($1,692,000)	Alfalfa ($391,000)	Winter Wheat ($64,000)	($3,163,000)
Ector	Cotton ($6,000)	Winter Wheat ($2,000)	Peanuts ($2,000)	Alfalfa ($2,000)	($93,000)
Edwards	Winter Wheat ($16,000)	Sorghum ($9,000)	Oats ($2,000)	Corn ($10,000)	($18,000)
El Paso	Cotton ($8,970,000)	Pecans ($15,910,000)	Alfalfa ($1,000,000)	Corn ($177,000)	($5,733,000)
Hudspeth	Alfalfa ($15,481,000)	Cotton ($4,103,000)	Oats ($582,000)	Grapes ($4,446,000)	($46,516,000)
Jeff Davis	Cotton ($15,000)	Alfalfa ($25,000)	Sorghum ($4,000)	Corn ($4,000)	($11,580,000)
Loving	Cotton ($48,000)	Winter Wheat ($19,000)	Other Hay/Non Alfalfa ($1,000)	Winter Wheat/ Sorghum (--)/($1,000)	($1,004,000)
Midland	Cotton ($1,000)	(--)	(--)	(--)	(--)
Pecos	Winter Wheat ($1,516,000)	Alfalfa ($4,047,000)	Cotton ($1,504,000)	Oats ($343,000)	($4,948,000)
Presidio	Cotton ($155,000)	Winter Wheat ($50,000)	Sorghum ($63,000)	Alfalfa ($104,000)	($9,763,000)
Reagan	Cotton ($2,000)	Sorghum ($1,000)	(--)	(--)	($1,000)
Reeves	Winter Wheat ($545,000)	Alfalfa ($2,655,000)	Winter Wheat/Cotton ($184,000/$469,000)	Cotton ($560,000)	($1,929,000)
Schleicher	Cotton ($910,000)	Sorghum ($325,000)	Winter Wheat ($112,000)	Oats ($25,000)	($5,000)

County	Top Crop Impacts by Acreage (with Estimated Damages), 0.1% Annual Chance Floodplain				
	Primary Crop	Secondary Crop	Tertiary Crop	Quaternary Crop	Grasslands/Pasture
Sutton	Winter Wheat ($162,000)	Cotton ($46,000)	Sorghum ($37,000)	Other Hay/Non Alfalfa ($8,000)	($10,000)
Terrell	Cotton ($36,000)	Winter Wheat ($11,000)	Triticale* ($2,000)	Sorghum ($4,000)	($508,000)
Upton	Winter Wheat ($38,000)	Cotton ($36,000)	Winter Wheat/Cotton ($8,000/$21,000)	Sorghum ($15,000)	($76,000)
Val Verde	Oats ($26,000)	Cotton ($62,000)	Winter Wheat ($14,000)	Sorghum ($30,000)	($4,236,000)
Ward	Winter Wheat ($42,000)	Sorghum ($94,000)	Cotton ($38,000)	Alfalfa ($59,000)	($767,000)
Winkler	Cotton ($329,000)	Alfalfa ($158,000)	Winter Wheat ($15,000)	Peanuts ($52,000)	($362,000)

Table 2.13 Summary of Crop Production for the 1% and 0.2% AC Floodplain by County

County	1% Annual Chance Crop Damages		0.2% Annual Chance Crop Damages	
	With Grasslands	Without Grasslands	With Grasslands	Without Grasslands
Andrews	$3,459,000	$110,000	$4,385,000	$139,000
Brewster	$8,043,000	$229,000	$9,223,000	$242,000
Crane	$515,000	$75,000	$696,000	$88,000
Crockett	$1,238,000	$74,000	$1,358,000	$84,000
Culberson	$6,195,000	$3,595,000	$6,977,000	$3,814,000
Ector	$82,000	$10,000	$105,000	$12,000
Edwards	$61,000	$44,000	$55,000	$37,000
El Paso	$27,809,000	$24,366,000	$31,790,000	$26,057,000
Hudspeth	$59,723,000	$23,846,000	$71,128,000	$24,612,000
Jeff Davis	$9,949,000	$45,000	$11,628,000	$48,000
Loving	$813,000	$58,000	$1,073,000	$69,000
Midland	$1,000	$1,000	$1,000	$1,000
Pecos	$9,893,000	$5,537,000	$12,358,000	$7,410,000
Presidio	$8,521,000	$365,000	$10,135,000	$372,000
Reagan	$4,000	$3,000	$4,000	$3,000
Reeves	$3,825,000	$2,440,000	$6,015,500	$4,086,500
Schleicher	$1,412,000	$1,408,000	$1,377,000	$1,372,000

County	1% Annual Chance Crop Damages		0.2% Annual Chance Crop Damages	
	With Grasslands	Without Grasslands	With Grasslands	Without Grasslands
Sutton	$295,000	$286,000	$263,000	$253,000
Terrell	$499,000	$49,000	$561,000	$53,000
Upton	$166,500	$94,500	$179,500	$103,500
Val Verde	$4,205,000	$127,000	$4,368,000	$132,000
Ward	$796,000	$166,000	$1,000,000	$233,000
Winkler	$696,000	$413,000	$916,000	$554,000

2.2.4 Existing Vulnerability

Based on the results of the existing conditions flood risk identification and exposure analyses, an existing condition vulnerability analysis was performed to identify the level of resilience or vulnerabilities related to communities, critical facilities, and critical transportation routes.

The social vulnerability index (SVI) is developed by the Centers for Disease Control and Prevention (CDC) to indicate the relative vulnerability of every U.S. Census tract. The SVI ranks tracts on 15 social factors based on survey data collected by the U.S. Census, including poverty, income, employment, minority status, disability, housing status, and other variables. SVI values are calculated as a percentage, scaled as a decimal fraction between 0-1, with higher values indicating higher levels of vulnerability.

While building footprints from TNRIS Buildings Dataset had previously been assigned SVI values, these values were verified using the complete 2018 SVI dataset obtained from the CDC website.

Another indicator of community vulnerabilities is the colonia, a substandard housing development where residents may lack basic services such as drinking water, sewage treatment, and paved roads. Colonias are found in relatively high concentration along the Texas-Mexico border, and the Office of the Attorney General of Texas maintains a database of colonias locations used to help identify and assist vulnerable populations. Within the Upper Rio Grande Region, 338 colonias were identified with a majority located in the Counties of El Paso, Pecos, Presidio, Hudspeth, and Val Verde.

Table 2.14 shows the relative vulnerability of communities across the region, including incorporated and unincorporated communities, based on the number of structures in the 1% and 0.2% annual chance floodplains (unincorporated communities are also referred to as Census Designated Places or CDPs). In addition, the table provides two specific indicators of vulnerability, including the number of buildings in each community that are within colonias as well as the average SVI value of buildings in the floodplain. The top five communities by number of structures within colonias in the 1% annual chance floodplain were found to be the City of Socorro, the City of San Elizario, Canutillo, Sanderson, and the Town of Clint. The top five communities by average SVI of buildings in the floodplain were found to be Fabens, Redford, the City of Presidio, the City of San Elizario, and the Town of Van Horn. Five counties (Culberson, El Paso, Hudspeth, Presidio, and Reeves) contain areas with high SVI values (greater than 0.75).

In addition to summarizing SVI values by community, average building SVI values were summarized by county and reported as part of the existing conditions flood exposure results in **Appendix Table 2A**. An overview of regionwide existing condition vulnerability results is provided in **Map Exhibit 7** ("Existing Condition Flood Vulnerability including Critical Infrastructure"). Detailed maps of communities with more than 100 buildings in the floodplain are also provided as part of **Map Exhibit 15** ("Greatest Flood Risk") included with *Chapter 4.1 (Flood Mitigation Needs Analysis).*

Apart from direct flood risks to communities, flood risks to critical facilities and infrastructure also increase overall community vulnerabilities based on the potential for cascading negative impacts from loss of function during a flood. **Table 2.15** summarizes the potential vulnerabilities of critical facilities for the existing conditions 1% and 0.2% annual chance flood events by county. In addition, Section 2.4 provides qualitative descriptions of the expected loss of function for various critical facility types in the region.

Furthermore, flood risks along critical transportation routes lead to increased community vulnerabilities due to the potential for a community to become isolated during a flood from emergency services, such as police and fire departments or hospital, ambulance, and rescue services. Since the rate and urgency of emergency incidents is likely to increase during a flood event, reduced roadway access may be especially detrimental to community emergency response efforts. To identify critical routes across the region, roadways were categorized according to their TxDOT roadway classification, and the top 10% of roadways by annual average daily traffic (AADT) from each category were selected as critical routes. In addition to this analysis, major roadways appearing on commonly-used region-wide base maps were also considered to be critical routes. Critical routes with potential flood exposure were then identified as potential vulnerabilities. **Table 2.16** summarizes the potential vulnerabilities of critical routes for the existing conditions 1% and 0.2% annual chance flood events by county.

Table 2.14 Summary of Existing Conditions Vulnerability – Community Property Impacts

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain*
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Acala CDP	**3**	**3**	**5**	**3**	**0.932**
Agua Dulce CDP	**7**	**7**	**7**	**7**	**0.915**
Alpine city	1,643	0	1,837	0	0.574
Amistad CDP	11	11	11	11	0.549
Anthony town	**86**	**0**	**125**	**0**	**0.923**

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain*
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Balmorhea city	361	0	361	0	0.357
Barstow city	149	0	249	0	0.520
Box Canyon CDP	27	21	27	21	0.549
Butterfield CDP	**12**	**7**	**23**	**15**	**0.784**
Canutillo CDP	**676**	**298**	**683**	**302**	**0.759**
Clint town	**249**	**249**	**268**	**268**	**0.753**
Crane city	143	0	181	0	0.560
Dell City city	**293**	**0**	**293**	**0**	**0.932**
El Paso city	12,324	39	18,480	39	0.678
Fabens CDP	**200**	**12**	**528**	**12**	**0.980**
Fort Bliss CDP	1,145	0	1,836	0	0.344
Fort Davis CDP	131	0	163	0	0.408
Fort Hancock CDP	**54**	**29**	**92**	**39**	**0.932**
Fort Stockton city	168	0	316	1	0.586
Grandfalls town	71	0	227	0	0.520
Homestead Meadows North CDP	359	246	562	377	0.747
Homestead Meadows South CDP	8	0	14	0	0.519
Horizon City city	11	0	11	0	0.518
Imperial CDP	272	246	276	246	0.329
Iraan city	83	82	101	100	0.329
Kermit city	1,126	0	1,979	0	0.594
Lake View CDP	9	9	12	12	0.549
Lindsay CDP	**189**	**189**	**194**	**194**	**0.825**
Marathon CDP	89	85	117	109	0.512
Marfa city	**212**	**0**	**350**	**0**	**0.913**
McCamey city	172	0	437	0	0.658
Mentone CDP	2	0	11	0	0.502
Monahans city	440	0	802	0	0.683
Morning Glory CDP	**1**	**0**	**1**	**0**	**0.930**
Ozona CDP	944	0	1,046	0	0.608
Pecos city	1,944	7	2,798	7	0.587
Prado Verde CDP	112	57	112	57	0.095

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain*
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Presidio city	**655**	**0**	**674**	**0**	**0.951**
Pyote town	15	0	24	0	0.520
Rankin city	74	0	82	0	0.426
Redford CDP	**15**	**6**	**19**	**9**	**0.951**
San Elizario city	**544**	**421**	**544**	**421**	**0.938**
Sanderson CDP	258	258	313	313	0.453
Sheffield CDP	2	0	4	0	0.329
Sierra Blanca CDP	**36**	**36**	**38**	**38**	**0.932**
Socorro city	**2,578**	**1,228**	**3,106**	**1,630**	**0.919**
Sonora city	690	0	827	0	0.651
Southwest Sandhill CDP	794	0	1,005	0	0.520
Sparks CDP	7	4	21	17	0.695
Study Butte CDP	23	19	26	22	0.512
Terlingua CDP	4	3	4	3	0.512
Thorntonville town	195	0	333	0	0.520
Tornillo CDP	**49**	**43**	**214**	**199**	**0.930**
Toyah town	**101**	**101**	**101**	**101**	**0.825**
Valentine town	16	16	18	18	0.408
Van Horn town	**170**	**159**	**227**	**215**	**0.935**
Vinton village	**73**	**0**	**119**	**1**	**0.870**
Westway CDP	**36**	**34**	**63**	**60**	**0.785**
Wickett town	23	0	31	0	0.520
Wink city	23	0	41	0	0.544
All Other Colonias (outside boundaries of incorporated place or CDP)	-	1,818	-	2,026	-

*0.2% AC flood vulnerability results include cumulative property impacts from 1% AC flood hazard areas.

Communities in **bold have a high SVI (over 0.75)

Table 2.15 Summary of Existing Conditions Vulnerability – Critical Facilities

County	Potential Existing Conditions Critical Facilities Vulnerabilities	
	1% Annual Chance	0.2% Annual Chance
Andrews	• None identified	• None identified
Brewster	• EPA NPDES: CITY OF ALPINE MUNICIPAL WWTF • HIFLD Law Enf: ALPINE POLICE DEPARTMENT • HIFLD Law Enf: BREWSTER COUNTY SHERIFFS OFFICE • Hospital: BIG BEND REGIONAL MEDICAL CENTER • School: ALPINE EL • School: ALPINE H S • School: ALPINE MIDDLE	• Same as 1% Annual Chance
Crane	• National Shelter System Facility: Crane County Library	• HIFLD Law Enf: CRANE COUNTY SHERIFFS OFFICE / CRANE COUNTY JAIL • HIFLD NGPP: CORDONA LAKE GAS PLANT
Crockett	• EPA NPDES: MAIN WWTF • HIFLD NGPP: NELEH GAS SYSTEM • HIFLD NGPP: SOUTHWEST OZONA GAS PLANT • HIFLD NGPP: TIPPETT GAS PLANT • Intermodal Transit Facility: Caprock Diesel • National Shelter System Facility: Ozona Convention Center • School: OZONA EL • School: OZONA MIDDLE	• Same as 1% Annual Chance
Culberson	• None identified	• None identified
Ector	• None identified	• None identified
Edwards	• None identified	• None identified
El Paso	• EPA NPDES: CANUTILLO ISD WWTP • EPA NPDES: TORNILLO WWTF • Fire Station: El Paso Fire Department Station 9 • Fire Station: West Valley Fire Department Canutillo Station • Google: Bonnie Moorhouse Reverse Osmosis Water Treatment Facility • HIFLD Nursing Homes: ADAM MC CARE LLC • HIFLD Nursing Homes: VILLAS DEL SOL ASSISTED LIVING LLC • HIFLD: FORT BLISS (DEA EPIC) • Hospital: UNIVERSITY MEDICAL CENTER OF EL PASO • Intermodal Freight Facility, RAIL & TRUCK: EL PASO TERMINAL WAREHOUSES, INC.-EL PASO-TX • Intermodal Freight Facility, RAIL & TRUCK: SWIG COTTON-EL PASO-TX • National Shelter System Facility: DAACG • National Shelter System Facility: Nations Tobin Recreation Center • National Shelter System Facility: WELLINGTON CHEW SENIOR CENTER • School: CANUTILLO MIDDLE • School: CHAPIN H S • School: CLINT H S	• EPA NPDES: HORIZON REGIONAL MUD - HORIZON CITY WWTP • Fire Station: El Paso Fire Department Station 26 • Fire Station: El Paso Fire Department Station 31 • Fire Station: Montana Vista Fire Rescue Station 2 • Fire Station: West Valley Fire Department Anthony Station • HIFLD Nursing Homes: GOOD SAMARITAN SOCIETY--WHITE ACRES • HIFLD Nursing Homes: LA FAMILIA ASSISTING LIVING • HIFLD Nursing Homes: THE FOREST ASSISTED LIVING • HIFLD: HOOVER COMPANY • National Shelter System Facility: DON HASKINS REC CENTER • School: ANDRESS H S • School: CONSTANCE HULBERT EL • School: CROSBY EL • School: DAVINCI SCHOOL FOR SCIENCE AND THE ARTS • School: DOWELL EL

County	Potential Existing Conditions Critical Facilities Vulnerabilities	
	1% Annual Chance	0.2% Annual Chance
	• School: CLINT ISD EARLY COLLEGE ACADEMY • School: COOLEY EL • School: EL PASO ACADEMY WEST • School: EL PASO LEADERSHIP ACADEMY • School: HAWKINS EL • School: HENDERSON MIDDLE • School: JOSE H DAMIAN EL • School: LEE EL/National Shelter System Facility • School: MILAM EL • School: NEWMAN EL • School: RED SANDS EL • School: ROBBIN E L WASHINGTON EL • School: SAN ELIZARIO H S/National Shelter System Facility • School: STANTON EL • School: TEJAS SCHOOL OF CHOICE • School: THE LINGUISTIC ACAD OF EL PASO-CULTURAL DEMO SITE • School: WESTERN HILLS EL • School: WM DAVID SURRATT EL • School: YSLETA PK CENTER • School: ZACH WHITE EL	• School: H D HILLEY EL • School: H R MOYE EL • School: HORNEDO MIDDLE • School: LE BARRON PARK EL • School: MAGOFFIN MIDDLE/National Shelter System Facility • School: MARIAN MANOR EL • School: NORTH LOOP EL • School: RAMONA EL • School: TORNILLO EL
Hudspeth	• Fire Station: Hueco Volunteer Fire Department • School: DELL CITY SCHOOL	• Same as 1% Annual Chance
Jeff Davis	• EPA NPDES: FORT DAVIS WWTF	• Same as 1% Annual Chance
Loving	• HIFLD NGPP: PECOS RIVER PLANT	• Same as 1% Annual Chance
Midland	• None identified	• None identified
Pecos	• EPA FRS: CENTURY GAS PLANT • Fire Station: Imperial Fire Department • HIFLD NGPP: WAHA GAS PLANT • HIFLD: EAST PECOS SOLAR • Hospital: PECOS COUNTY MEMORIAL HOSPITAL • School: BUENA VISTA SCHOOL • School: FORT STOCKTON ALAMO EL • School: IRAAN J H • School: LYNAUGH UNIT	• EPA FRS: WAHA GAS PLANT • HIFLD NGPP: MITCHELL PLANT • HIFLD: ALAMO 6 • School: FORT STOCKTON HIGH
Presidio	• None identified	• School: PRESIDIO H S
Reagan	• None identified	• None identified
Reeves	• EPA NPDES: ORLA WWTP • Fire Station: Balmorhea Volunteer Fire Department • Fire Station: Toyah Volunteer Fire Department • HIFLD Law Enf: PECOS POLICE DEPARTMENT • HIFLD NGPP: EAST TOYAH GAS PLANT • National Shelter System Facility: Civic Center in Balmorhea • National Shelter System Facility: Community Center in Pecos City	• School: CROCKETT MIDDLE • School: PECOS H S

County	Potential Existing Conditions Critical Facilities Vulnerabilities	
	1% Annual Chance	**0.2% Annual Chance**
	• National Shelter System Facility: First Baptist Church - Balmorhea • School: AUSTIN EL • School: BALMORHEA SCHOOL/National Shelter System Facility	
Schleicher	• None identified	• None identified
Sutton	• EPA FRS: CITY OF SONORA • Fire Station: Border Line Volunteer Fire Department • HIFLD NGPP: SONORA GAS PLANT • Intermodal Transit Facility: Picos Food Mart • National Shelter System Facility: SUTTON COUNTY CIVIC CENTER	• HIFLD Law Enf: SONORA POLICE DEPARTMENT
Terrell	• Fire Station: Terrell County Volunteer Fire Department • Intermodal Transit Facility: Amtrak Station	• Same as 1% Annual Chance
Upton	• Fire Station: McCamey Volunteer Fire Department • HIFLD: CASTLE GAP SOLAR • HIFLD: UPTON COUNTY SOLAR	• Hospital: MCCAMEY HOSPITAL • School: MCCAMEY PRI
Val Verde	• None identified	• None identified
Ward	• Fire Station: Grandfalls Volunteer Fire Department • HIFLD NGPP: BONE SPRINGS GAS PROCESSING PLANT • HIFLD NGPP: MIVIDA JV PROCESSING PLANT • School: MONAHANS H S	• HIFLD Nursing Homes: MONAHANS MANAGED CARE CENTER • School: GRANDFALLS-ROYALTY SCHOOL • School: SUDDERTH EL
Winkler	• EPA FRS: EL PASO NATURAL GAS - KEYSTONE COMPRESSOR STATION • HIFLD Law Enf: WINKLER COUNTY SHERIFFS OFFICE / WINKLER COUNTY JAIL • HIFLD NGPP: HALLEY PLANT • Hospital: WINKLER COUNTY MEMORIAL HOSPITAL	• School: KERMIT EL • School: WINK EL

Table 2.16 Summary of Existing Conditions Vulnerability – Critical Routes

pe	Existing Conditions Critical Route Vulnerabilities	
	1% Annual Chance	**0.2% Annual Chance**
Andrews	• SW 900 Rd, resulting in access issues to South FM 181. • West Hwy 128 resulting in access issues.	• Includes existing condition 1% vulnerabilities. • SW 900 Rd, resulting in significant access issues to South FM 181. • West Hwy 128 resulting in significant access issues.
Brewster	• US67, Connection between Marfa and Alpine resulting in access issue to Alpine city, therefore access issues to the nearest hospital Big Bend Regional Medical Center. • N 5TH St. access issue to the Big Bend Regional Medical Center • SH-118, connection between Fort Davis and Alpine resulting in access issue. • Segments of US90 and intersection with US 385, resulting in access issues. • North US385, resulting in access issues, connection with Pecos County. • Roadway US67, connection from Alpine to Chancellor, resulting in access issues.	• Includes existing condition 1% vulnerabilities. • US67, Connection between Marfa and Alpine resulting in significant access issue to Alpine city, therefore access issues to the nearest hospital Big Bend Regional Medical Center. • Roadway US67, connection from Alpine to Chancellor, resulting in significant access issues. • Segments of US90 and intersection with US 385, resulting in significant access issues. • US385, connection between Marathon and Fort Stockton, resulting in significant access issue.
Crane	• Golf Course Rd, at intersection with US Highway 385 N resulting in access issues. • E 20 ST at intersection with US Highway 385 resulting in access issues. • US Highway 67, connection between Girvin Town and McCamey Town resulting in access issues.	• Includes existing condition 1% vulnerabilities. • US Highway 67, connection between Girvin Town and McCamey Town resulting in significant access issues. • Golf Course Rd, at intersection with US Highway 385 N resulting in significant access issues.
Crockett	• State Highway 163 S. Intersection with FM 1973. Resulting in access issues. The connection between Ozona city and Juno town. • Segments of IH10 resulting in access problems all along Crocket County. Main connector Route. • Segments of W US Highway 190, resulting in access problems. Connection between Iraan city and Crocket County. Possible problems accessing the nearest hospital: Iraan General Hospital.	• Includes existing condition 1% vulnerabilities. • State Highway 163 S. Intersection with FM 1973. Resulting in significant access issues. The connection between Ozona city and Juno town. • Segments of W US Highway 190, resulting in significant access problems. Connection between Iraan city and Crocket County. Possible problems accessing the nearest hospital: Iraan General Hospital. • Segments of IH10 resulting in significant access problems all along Crocket County. Main connector Route.
Culberson	• US90 Resulting in potential access issue, Connection Lobo to Van Horn. Access issue to Culberson Hospital located at Van Horn. • IH10 Resulting in Potential access issue. Connection between Hudspeth and Culberson Counties and possible access issue for Town of Van Horn. • Segments of East IH10 resulting in potential access issues. The connection between Van Horn and Kent may also be at risk leading to possible access issues for the nearest hospital, Culberson Hospital.	• Includes existing condition 1% vulnerabilities. • US180, Resulting in potential access issue between Pine Springs and Nickel Creek Station.

pe	Existing Conditions Critical Route Vulnerabilities	
	1% Annual Chance	**0.2% Annual Chance**
Ector	• County Rd 307, near White Horse Tank area, possible access issues. • IH20, Judkins area with possible access issues. • Penwell Town, Avenue A, Avenue B and Avenue J with possible access issues. • In Pleasant Farms town, Roads: W Ivory St., Thomas Blvd. and segments of US 385. Resulting in possible access issues.	• Includes existing condition 1% vulnerabilities. • Segments of County Rd 307, resulting in possible access issues. • Blockline Rd. Intersection with County Rd 307. Resulting in access issues. • IH20, Judkins area with significant access issues.
Edwards	• S US Highway 277, Connection between Sonora city and Loma Alta town resulting in access issues. • Segments of S IS Highway 377 along the county, resulting in possible access issues. Significant issues at Connection between Carta Valley town and N US Highway 277.	• Includes existing condition 1% vulnerabilities. • S US Highway 277, Connection between Sonora city and Loma Alta town resulting in significant access issues. • Segments of S IS Highway 377 along the county, resulting in significant access issues
El Paso	• Fabens Rd., intersection with IH10, resulting in potential access issue to the IH10. • West Spur 601, resulting in a potential access issue to the US 54. • East Spur 601, resulting in a potential access issue to Loop 375. • Pierce Ave, and Louisiana Ave. resulting in potential access issues to the El Paso VA Health Care System. • IH10 and US54 intersection, Durazno Ave, potential access issue to Hospitals, EP Children's Hospital, EP Psychiatric Center, and University Medical Center of El Paso.	• All Existing 1% data. • West Spur 601, and US 54 intersection, resulting in potential access issue to the nearest Hospital, El Paso VA Health Care System, critical. • Montana Ave. SH180 connection of El Paso County to Hudspeth County, Butterfield area resulting in potential access issue. • Fabens neighborhood, resulting in access issue to the nearest Police department, El Paso County Sheriff's Office, Access issue to the roads: Fassett St. Davis St. NW 3RD ST. Avenue H. Eubanks St. NW 3RD St. and CC Camp Rd.
Hudspeth	• Segments of roadway US62-180 may result in potential access issues between El Paso and Hudspeth County and Culberson County. • Segments of IH10 may result in potential access issues between El Paso/Hudspeth and Culberson/Hudspeth.	• This includes the Existing 1% • Hueco Ranch Rd. may result in potential access issues to the US62-180. • Segments of roadway US62-180 may result in potential access issues between El Paso and Hudspeth County and Culberson County. • Segments of IH10 may result in potential access issues between El Paso/Hudspeth and Culberson/Hudspeth.
Jeff Davis	• SH-118, the connection between Kent and Jeff Davis, resulting in access issues. • SH-118, the connection between Jeff Davis and Fort Davis, resulting in access issues. • SH-17, the connection between Fort Davis and Reeves County, resulting in access issues. • SH-118, the connection between Fort Davis and Alpine (Brewster County). • Roadway US90, the connection between Valentine and Culberson County, resulting in access issues.	• Includes existing condition 1% vulnerabilities. • SH-118, the connection between Kent and Jeff Davis, resulting in significant access issues. • SH-118, the connection between Jeff Davis and Fort Davis, resulting in significant access issues. • SH-17, the connection between Fort Davis and Reeves County, resulting in significant access issues. • SH-118, the connection between Fort Davis and Alpine (Brewster County), resulting in significant access issues. • SH-17, the connection between Marfa and Fort Davis, resulting in access issues.

	Existing Conditions Critical Route Vulnerabilities	
pe	**1% Annual Chance**	**0.2% Annual Chance**
Loving	• County Road 2 Intersection with RM 652, resulting in access issues. • West portion of RM 652, resulting in access issues to Orla in Reeves County. • South County Road 22 intersection with County Road 2, resulting in access issues to Loving County Sheriff's office. • Roadway 302 in intersection with County Rd. 200 (Metor Rd) resulting in access issues to Mentone.	• Includes existing condition 1% vulnerabilities. • South Portion of Road 302, resulting in access issues to US Hwy 285. • North County Road 2 resulting in significant access issues to RM652. • West portion of RM 652, resulting in significant access issues to Orla in Reeves County • South County Road 22 intersection with County Road 2, resulting in significant access issues to Loving County Sheriff's office.
Midland	• None identified	• None identified
Pecos	• Segments of US Highway 385 N, resulting in access issues. Connection between Fort Stockton and McCamey. • Segments of the IH10, resulting in access issues along Pecos County. IH10 segments near Fort Stockton may cause problems accessing the Pecos County Memorial Hospital. • Segments of US Highway 385 S, resulting in access issues. Connection between Marathon and Fort Stockton. • Segments of US Highway 285 S, resulting in access issues. Connection between Fort Stockton and Sanderson.	• Includes existing condition 1% vulnerabilities. • Segments of US Highway 385 S, resulting in significant access issues. Connection between Marathon and Fort Stockton. • Segments of US Highway 285 S, resulting in significant access issues. Connection between Fort Stockton and Sanderson. • Segments of the IH10, resulting in significant access issues along Pecos County. IH10 segments near Fort Stockton may cause problems accessing the Pecos County Memorial Hospital • Segments of US Highway 385 N, resulting in significant access issues. Connection between Fort Stockton and McCamey. • Segments of N US Highway 285, resulting in significant access issues. Connection between Mann Town and Fort Stockton. Possible problems accessing Pecos County Memorial Hospital.
Presidio	• US67, Connection between Presidio and Marfa, resulting in access issues. • US90, Connection between Marfa and Alpine, resulting in access issues. • US67, Intersection with roadway 170, resulting in access issues to presidio city.	• Includes existing condition 1% vulnerabilities. • US67, Connection between Presidio and Marfa, resulting in significant access issues. • US90, Connection between Marfa and Alpine, resulting in significant access issues.
Reagan	• None identified	• None identified
Reeves	• North County Road 118 may result in access issues to Pecos area. Therefore, possible access issues to the Reeves County Hospital. • Segments of the IH10 in possible access issues. • Roads: County Road 2, S Pigman St., W Schmidt Dr., S Texas St., W Stafford BL, S Cactus St., and W County RD with possible access issues to the Reeves County Hospital. • Roads: W F St, and W E St. with possible access issues to Pecos.	• Includes existing condition 1% vulnerabilities. • North County Road 118 may result in significant access issues to Pecos area. Therefore, possible access issues to the Reeves County Hospital. • South Central US 285 with possible access issues at Pecos area. • Segments of the IH20 in possible access issues near Pecos. • Segments of the IH10 in significant access issues. • Segments of the State Highway 17 in possible access issues.
Schleicher	• None identified	• None identified

pe	Existing Conditions Critical Route Vulnerabilities	
	1% Annual Chance	0.2% Annual Chance
Sutton	• S US Highway 277, Connection between Sonora city and Loma Alta town resulting in access issues. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital. • Segments of IH10, resulting in access issues. Significant problems at Sonora city. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital. • N US Highway 277, Segments near Sonora city resulting in access issues. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital.	• Includes existing condition 1% vulnerabilities. • Segments of IH10, resulting in access issues. Significant problems at Sonora city. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital • S US Highway 277, Connection between Sonora city and Loma Alta town resulting in access issues. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital.
Terrell	• US Highway 90 W, resulting in access issues. Connection between Dryden and Emerson. • US 285, resulting in access issue. Connection between Sanderson and Fort Stockton. • SH-349, resulting in access issues. Connection between Dryden and Sheffield.	• Includes existing condition 1% vulnerabilities. • US Highway 90 W, resulting in significant access issues along the county. Connection between Emerson and Val Verde County. • US 285, resulting in significant access issue. Connection between Sanderson and Fort Stockton. • SH-349, resulting in significant access issues. Connection between Dryden and Sheffield.
Upton	• US Highway 67, resulting in access issues at Rankin Town. Therefore, possible problems accessing the Hospitals: Rankin County Hospital District and Rankin County Hospital District. • Rankin Town, Roads: Francis St., 3rd Ave., Main St., Upon St, and 4th St. resulting in access issues. Therefore, possible problems accessing the Hospitals: Rankin County Hospital District and Rankin County Hospital District. • County Road 410 at intersection with Highway 385 S resulting in access issues. • McCamey Town, Roads: 7th St., Houston Ave., 11TH St., 6th St. Bowie Ave., 8th St., 4th St., Emerson Ave. and Ellis Ave. resulting in access issues. Possible problems accessing the McCamey Hospital.	• Includes existing condition 1% vulnerabilities. • County Road 410 at intersection with Highway 385 S resulting in significant access issue. • McCamey Town, Roads: 9th St, 10th St, 2ND St, 6Th St, Eisenhower St., Emerson Ave. Patton St. 1st.ST. resulting in access issues. Possible problems accessing the McCamey Hospital. • US Highway 67, resulting in significant access issues at Rankin Town. Therefore, possible problems accessing the Hospitals: Rankin County Hospital District and Rankin County Hospital District.
Val Verde	• Roadway FM 163 resulting in access issues along the county. Connection between Comstock and Ozona. • N US Highway 277, resulting in access issues along the county. Connection between Val Verde County and Edwards County.	• Includes existing condition 1% vulnerabilities. • W US Highway 90, resulting in access issues along the county. • Roadway FM 163 resulting in significant access issues along the county. Connection between Comstock and Ozona. • N US Highway 277, resulting in significant access issues along the county. Connection between Val Verde County and Edwards County.
Ward	• IH20 Connection between Ward and Reeves County, with possible access issues. • Business Loop 20, connection between Ward and Reeves County, with possible access issues. • S County Road 170, with possible access issues to Business Loop 20.	• Includes existing condition 1% vulnerabilities. • RM-2355 and County Road 146 with significant access issues. • S County Road 170, with significant access issues to Business Loop 20. • IH20, Monahans city area with significant access issues.

pe	Existing Conditions Critical Route Vulnerabilities	
	1% Annual Chance	**0.2% Annual Chance**
	• RM-2355 and County Road 146 with possible access issues. • IH20, Monahans city area with possible access issues. • Roads: Colorado St., 15th, 36th, and 45th St. located at Monahans city, with possible access issues.	• County Road 427 with possible access issues. • N State Highway 18 with possible access issues to Monahans.
Winkler	• County Road 101 with possible access issues. Connection between Winkler and Bennett County. • S Roadway 115, with possible access issues. Connection between Wink and Pyote town. • S State Highway 18, with possible access issues. Connection between Kermit and Monahans town. • W TX-302 at intersection with State Highway 18, possible access issues at Kermit town. Therefore, possible access issues to Winkler County Memorial Hospital.	• Includes existing condition 1% vulnerabilities. • S State Highway 18, with significant access issues. Connection between Kermit and Monahans town. • County Road 404, resulting in access issues. Connection between Ector County and Winkler. • W TX-302, resulting in significant access issues to Kermit town. Therefore, possible access issues to Winkler County Memorial Hospital.

2.3 Future Conditions Analysis

Future condition flood hazard analyses were performed to determine the location and magnitude of both 1% annual chance (100-year) and 0.2% annual chance (500-year) flood events under future conditions, accounting for future projections in land use and precipitation over the next 30 years.

Due to overall differences future trends as well as in data availability, different future conditions analysis methods were utilized for El Paso County and for the remainder of the Upper Rio Grande region outside of El Paso County. In El Paso County, future condition flood risk was estimated by developing new future condition 2D models with considerations for future land use and precipitation. Outside El Paso County, future condition flood risk was identified by estimating areas of future development and using the existing condition floodplains as a proxy for future condition floodplains within those areas. The following section describes the methodology and findings of these analyses.

2.3.1 Future Land Use and Development

According to population projections from the 2021 Regional Water Plan, the Upper Rio Grande Region is projected to grow in population between 2020-2050 by approximately 400,000, which is equivalent to a 38% increase over 30 years with an average annual growth rate of 1.08%. Three counties have major population centers located outside the region watershed boundaries and are excluded from this estimate, including Ector County (City of Odessa), Midland County (City of Midland), and Val Verde County (City of Del Rio). However, even when these population centers are included in the estimate, the projected region population growth rate remains generally unchanged over the same period. El Paso County is projected to see the highest future population growth compared to other counties in the region with an increase of approximately 370,000 by 2050 or 93% of the region's total growth.

El Paso County

To perform the future land use analysis for El Paso County, future population projection data were obtained from the El Paso Metropolitan Planning Organization (MPO) Regional Mobility Strategy (RMS) 2050 Metropolitan Transportation Plan (MTP). The RMS MTP provides existing (2017) and future (2050) population and employment estimates using more than 800 Traffic Analysis Zones (TAZs) throughout El Paso County, each ranging in size from 1 acre (for dense urban areas) to 158 square miles (for dispersed rural areas).

In order to develop future condition hydrologic models based on these future population projections, a statistical analysis was performed to correlate existing TAZ population densities with land use intensity classes from the National Land Cover Database (NLCD) land cover raster layer. The NLCD land cover layer was selected for this analysis, since the layer was previously used in the 2019 Preliminary FEMA study to estimate runoff curve numbers for the hydrologic model. The future condition analysis utilized a similar modified approach by estimating a future condition land cover layer with NLCD classes developed based on future population.

To perform the statistical correlation analysis, the 2016 NLCD Land Cover dataset was used to provide a reasonably close match compared to the existing 2017 population and employment estimates from the RMS MTP dataset. Referencing the 2016 NLCD Land Cover raster, polygons were delineated in GIS to identify representative NLCD class boundaries for "open space", "low intensity", "medium intensity", and "high intensity" categories. Upon delineating these representative zones for the four NLCD class types, the 2017 TAZ population and employment densities were converted to rasters, and zonal histograms were created for each zone based on the gridded TAZ densities. Using this process, correlations were developed between the NLCD intensity class zones and the TAZ densities. Correlations were defined separately for population and employment, identifying lower and upper bounds for each. The results of the correlation analysis are presented in **Table 2.17**.

These existing condition correlations were then used to estimate future condition NLCD classes based on the future condition TAZ densities. Future condition NLCD classes were estimated for population and employment separately, and the higher of the two resulting NLCD classes was assigned to the future condition NLCD class layer. The future condition NLCD class layer was then converted to a raster, and the portion of the raster within the Franklin Mountains State Park was removed from the analysis to avoid counting population growth in that area.

Table 2.17 NLCD and TAZ Correlation Ranges for Population and Employment

NLCD Class	Population		Employment	
	Lower Bound TAZ Density, population per sq. mi.	Upper Bound TAZ Density, population per sq. mi.	Lower Bound TAZ Density, population per sq. mi.	Upper Bound TAZ Density, population per sq. mi.
Open Space	100	1000	10	100
Low Intensity	1,000	3,500	100	300
Medium Intensity	3,500	12,000	300	3,500
High Intensity	12,000	-	3,500	-

Lastly, the future condition NLCD class layer was converted to runoff curve numbers using the same methodology discussed in the 2019 Preliminary FEMA Hydrology Report. In some instances, the estimated future condition curve number values were found to be lower than existing condition curve numbers from the 2019 Preliminary FEMA study (indicating a lower amount of runoff in future conditions). Therefore, as a conservative measure, a mosaic dataset was developed combining the maximum values from the existing condition and future condition curve number raster datasets to create the final future condition curve number raster.

A weighted area analysis was performed using the future condition curve number raster to estimate future curve number values for each of the 11 previously defined watersheds (or "work areas") from the 2019 Preliminary FEMA study. **Table 2.18** summarizes the final curve number values used for the future condition analysis (column #4), compared to curve numbers developed using the 2019 NLCD land cover dataset (column #1), the 2019 Preliminary FEMA study (column #2), and future condition NLCD class dataset without modifications (column #3).

Upon calculating the final future condition curve numbers for each work area, the 2019 Preliminary FEMA study hydrologic model parameters were updated with the new curve numbers for calculating the future condition flows.

Table 2.18 Future Runoff Curve Numbers (CN) for El Paso County

Work Area	Curve Number			
	#1 Existing Condition, NLCD (2019)	#2 Existing Condition, FEMA Preliminary Mapping (2019)	#3 Estimated Future Condition (2050)	#4 Estimated Future Condition (2050) Mosaic with FEMA CN*
WA 1	62	62	62	64
WA 2	77	77	79	80
WA 3	77	78	77	79
WA 4	64	65	64	66
WA 5	76	77	76	77
WA 6	69	69	73	73
WA 7	74	73	81	82
WA 8	74	75	75	76
WA 9	66	66	66	68
WA 10	76	79	76	79
WA 11	65	67	63	68

* The final future condition CN mosaic (#4) was developed by combining maximum raster cell values from the Existing Condition FEMA Preliminary Mapping (2019) CN raster (#2) and the Estimated Future Condition (2050) CN raster (#3).

Outside El Paso County

For the rest of the Upper Rio Grande Region outside of El Paso County, a simpler method was used to account for future land use changes. This method included identifying the potential limits of future development based on future county level population projections and then using the existing condition floodplains as a proxy for future condition floodplains within those areas.

To develop boundaries for the potential limits of future development, existing (2020) and future (2050) population estimates were obtained for each county in the region from the 2021 Regional Water Plan and the 2018 Texas Demographic Center population projection datasets. Using these two datasets, future population increases were calculated in terms of the percentage increase by 2050 for each county and for each population dataset as shown in **Table 2.19**. The maximum percent increase value from each dataset was used as the basis for creating a spatial buffer around existing developed areas to represent the limits of future development.

Spatial buffers were applied to existing development boundaries (incorporated and unincorporated area limits) by calculating the effective radius of each developed area (assuming a circular boundary) and scaling the effective radius by the percent future population growth rate of the area’s applicable county. This process produced a buffer distance for the projected area of future development over the next 30 years.

Table 2.19 Future Population Projections (2020-2050) by County

County	Population Estimates						
	TWDB Regional Water Plan (2021)			Texas Demographic Center (2018)			Max % Increase by 2050
	2020	2050	% Increase by 2050	2020	2050	% Increase by 2050	
Andrews	19,089	30,111	58%	22,269	100,655	352%	352%
Brewster	9,727	10,334	6%	9,133	7,816	-14%	6%
Crane	5,056	6,737	33%	6,209	18,425	197%	197%
Crockett	4,111	4,486	9%	4,040	4,224	5%	9%
Culberson	2,695	3,173	18%	2,245	1,594	-29%	18%
Ector	164,289	233,048	42%	184,841	494,892	168%	168%
Edwards	2,123	2,123	0%	1,991	1,641	-18%	0%
El Paso	925,565	1,296,927	40%	876,120	1,046,847	19%	40%
Hudspeth	3,913	4,511	15%	3,400	2,399	-29%	15%
Jeff Davis	2,398	2,398	0%	2,113	1,458	-31%	0%
Loving	82	82	0%	92	77	-16%	0%
Midland	169,062	232,357	37%	187,364	573,981	206%	206%
Pecos	17,718	22,021	24%	16,533	17,112	4%	24%
Presidio	8,692	10,972	26%	5,906	2,662	-55%	26%
Reagan	3,853	4,812	25%	4,226	8,150	93%	93%
Reeves	15,125	17,650	17%	15,707	22,013	40%	40%
Schleicher	3,811	4,350	14%	3,312	3,858	16%	16%
Sutton	3,817	4,279	12%	4,381	4,229	-3%	12%
Terrell	1,045	1,069	2%	1,054	1,017	-4%	2%
Upton	3,690	4,272	16%	3,983	6,559	65%	65%
Val Verde	54,694	71,566	31%	48,253	41,593	-14%	31%
Ward	11,454	13,029	14%	13,592	33,350	145%	145%
Winkler	8,033	10,147	26%	9,295	23,364	151%	151%

Once the areas of potential future development were identified, existing condition floodplains from the Fathom dataset were used as a proxy for future condition floodplains within those areas. This process is described in further detail in Section 2.3.3.

2.3.2 Future Precipitation

Future precipitation trends are influenced by changes in climate. Future climate projections for the Southwest and Southern Great Plains have primarily projected decreases to total annual precipitation and increased drought risk.[3] On the other hand, future increases to atmospheric

[3] Hayhoe, K., D.J. Wuebbles, D.R. Easterling, D.W. Fahey, S. Doherty, J. Kossin, W. Sweet, R. Vose, and M. Wehner, 2018: Our Changing Climate. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R.

temperatures have also been projected to increase the magnitude of extreme precipitation events throughout the U.S, as a result of increased atmospheric moisture carrying capacity.[4]

In addition to these projections, the Office of the Texas State Climatologist issued recommendations in April 2021 on accounting for future precipitation in Regional Flood Planning.[5] The analysis showed moderate trends of increasing rainfall near El Paso County based on trends in 100-year return values of 1-day precipitation amounts in NOAA Atlas 14 data. However, for the majority of the Upper Rio Grande region, results were inconclusive regarding future precipitation trends.

Furthermore, while increased rainfall is likely to result in increased runoff in urban areas where land cover is impervious, the Rio Grande and other rivers (which are primarily controlled by upstream dams) are less likely to see significantly increased flows during extreme precipitation events due to the influence of upstream controlling reservoirs.

Based on the recommendations from the Texas State Climatologist report, the future condition analysis for El Paso County was modified to include a 20% increase in precipitation. This amount corresponds to the report's high change scenario for urban watersheds in the 2050-2060 time horizon, whereas no changes were made along the Rio Grande due to the larger uncertainty of impacts for riverine watersheds.

For the rest of the Upper Rio Grande Region outside of El Paso County, no modifications were made to the future condition analysis to account for future precipitation. This is consistent with the inconclusive precipitation trends shown for a majority of the region east of El Paso County in the Texas State Climatologist report.

2.3.3 Future Flood Hazard Identification

The future conditions flood quilt was developed to include the future 1% and 0.2% annual chance events as described in the following section. Future condition flood hazard areas identified as part of this analysis are shown in **Map Exhibit 8** ("Future Condition Flood Hazard"). In addition, a comparison between the existing and future condition flood hazard areas is provided in Section 2.3.4.

El Paso County

Future conditions flood hazards were estimated for El Paso County by modifying the input parameters for the 2019 Preliminary FEMA models to account for future trends in land use and precipitation. Hydrologic (HEC-HMS) and hydraulic (HEC-RAS) models for each of the 2019 Preliminary FEMA study work areas were obtained and updated based on the findings presented previously in Sections 2.3.1 and 2.3.2.

Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 72–144. doi: 10.7930/NCA4.2018.CH2. Accessed at https://nca2018.globalchange.gov/chapter/2/

[4] Easterling, D.R., K.E. Kunkel, J.R. Arnold, T. Knutson, A.N. LeGrande, L.R. Leung, R.S. Vose, D.E. Waliser, and M.F. Wehner, 2017: Precipitation change in the United States. In: Climate Science Special Report: Fourth National Climate Assessment, Volume I [Wuebbles, D.J., D.W. Fahey, K.A. Hibbard, D.J. Dokken, B.C. Stewart, and T.K. Maycock (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 207-230, doi: 10.7930/J0H993CC. Accessed at https://science2017.globalchange.gov/chapter/7/

[5] Nielsen-Gammon, J., S. Jorgensen, 2021: Climate Change Recommendations for Regional Flood Planning. Department of Atmospheric Sciences, Texas A&M University. Accessed at https://climatexas.tamu.edu/files/CliChFlood.pdf

Updates to the hydrologic models included replacing the existing condition curve number inputs with future condition curve number inputs (to estimate future land use) and scaling the input rainfall by 20% (to estimate future precipitation increases).

After running the future condition hydrologic models for all work areas, the updated excess precipitation results were applied as inputs in the 2D hydraulic models. To account for interdependent work areas that share outflow and inflow boundary conditions, initial 2D simulations were performed to identify outflows greater than 1,000 cfs. In cases where flows from an upstream work area were found to have a significant impact on flows in a downstream work area, model inflows were updated for the downstream work area based on the outflows from the upstream work area.

Based on the results of the future condition 2D hydraulic analyses, future condition floodplains were mapped for all 11 work areas, covering El Paso County and the west part of Hudspeth County (corresponding to the HUC-8 watersheds 13040100 and 13030102). Whereas the 2019 Preliminary FEMA study did not include the area inside Fort Bliss, the area was included along with the rest of El Paso County in the future conditions results.

Future floodplain polygons for El Paso County were post-processed using 2D BLE Tools from a proprietary AECOM Hydraulics tool set. The tool delineates 1% and 0.2% flood hazard areas using stream centerlines and HEC-RAS outputs including water surface elevation and depth rasters. Floodplain polygons were delineated based on areas which have a depth of at least 1 foot and intersect the streamlines. Areas of isolated flooding disconnected from the stream centerline were removed during this process.

Finally, the future condition flood hazard areas were merged with the existing condition flood hazard areas ensuring that the future conditions flood hazard area is equal to or greater than the existing condition flood hazard area. This process also ensured that all flood hazard areas from the 2019 Preliminary FEMA study were included in the future conditions floodplain, since portions of the study were not delineated based on the 2D work area models but were instead delineated based on the results of other studies such as the Rio Grande Natural Valley Study.

Outside El Paso County

After estimating the limits of future development areas outside El Paso County (discussed in Section 2.3.1), proxy floodplains for these future development areas were selected by using the higher intensity *pluvial* floodplain from the existing conditions dataset as a proxy for future conditions. For example, within these areas, the 0.2% existing 3m Fathom pluvial floodplain was used as a proxy for the 1% future pluvial floodplain, while the 0.1% existing 30m Fathom floodplain [from an earlier July 2021 Draft Cursory version of the Fathom release] was used as a proxy for the 0.2% future pluvial floodplain. No changes were made to the fluvial floodplains during this process since, at the regionwide level, future development is estimated to impact localized runoff to a greater degree than watershed-scale riverine runoff.

For areas outside the limits of future development, future condition flood hazards were estimated to be equivalent to existing condition flood hazards without the need for a proxy floodplain. Due to the Upper Rio Grande region’s size and remote nature, it was assumed there would be no significant changes in land use outside the limits of future development.

2.3.4 Extent of Increase of Future Flood Hazard Compared to Existing Condition

A comparison showing the extent of increase between the existing condition and future condition flood hazard areas is summarized in **Table 2.20** and illustrated in **Map Exhibit 10** ("Extent of Increase of Flood Hazard Compared to Existing Condition").

As a result of the future conditions flood hazard analysis, future flood hazard areas in El Paso County were increased by a significantly greater degree than the future flood hazard areas outside of El Paso County. Whereas the future condition adjustments in El Paso County resulted in a total future condition flood hazard area between 1.5-2 times the size of the total existing condition flood hazard area, adjustments outside of El Paso County resulted in only a 1% increase in the flood hazard area change. Several reasons were noted to explain this difference:

- In El Paso County[6], future condition flood hazards included an additional rainfall adjustment of 20% to account for future precipitation projections; whereas, outside of El Paso County, a similar adjustment was not applied (discussed in Section 2.3.2);
- In El Paso County, future condition flood hazards were estimated by adjusting hydrologic model parameters based on detailed future population projections from the El Paso MPO; whereas, outside of El Paso County, future condition flood hazards were estimated by using higher intensity existing condition floodplains as a proxy for future condition floodplains (discussed in Section 2.3.3); and
- In El Paso County, future condition flood hazards were estimated for the entire area of the county; whereas, outside of El Paso County, future condition flood hazards were only estimated for areas of projected future development, which were approximated by applying a spatial buffer to the current development area equal to the county-level future population growth rates (discussed in Section 2.3.3).

Table 2.20 Extent of Increase of Future Flood Hazard Compared to Existing Condition

Flood Hazard	Extent	Total Existing Area (Sq. Mi.)	Total Future Area (Sq. Mi.)	Area Change (sq. mi.)	Area Change (%)
1% AC	El Paso County	179	356	175	99%
1% AC	Outside El Paso County	9,106	9,187	67	1%
0.2% AC*	El Paso County	66	105	105	59%
0.2% AC*	Outside El Paso County	1,689	1,702	76	1%

*0.2% AC flood hazard area results are reported separately from the 1% AC results and <u>do not</u> include cumulative 1% AC flood hazard areas.

[6] For the purpose of this comparison, "El Paso County" represents El Paso County watersheds which also include a small portion of west Hudspeth County.

2.3.5 Future Flood Hazard Data Gaps

Due to the limited availability of future condition flood hazard information across the region (such as detailed future land use data or future conditions flood studies), future flood hazard data gaps were identified for the entire region with one exception. As part of the RFP future flood hazard analysis described in the previous section, the watersheds of El Paso County and western Hudspeth County were evaluated under a potential 2050 future condition scenario (accounting for future population growth and future increases in precipitation), which fills the future flood hazard data gaps for these areas.

Future flood hazard data gaps, along with the public-provided flood prone areas, are shown in **Map Exhibit 9** ("Future Condition Flood Hazard – Gaps in Inundation Boundary Mapping and Identify Known Flood-Prone Areas").

2.3.6 Future Flood Exposure

Based on the identified future conditions flood hazard areas, a high-level future flood exposure analysis was performed to identify who or what might be harmed within the region for the future condition 1% and 0.2% annual chance flood events. The exposure analysis evaluated potential flood impacts to population, property, critical facilities, public infrastructure, roadways, and agricultural resources.

The methodology of the future condition exposure analyses was based on the methodology previously discussed for the existing condition exposure analyses in Section 2.2.3.

Future conditions flood exposure results are summarized at the regionwide level in **Table 2.21**, by county in **Figure 2.4**, and by flood risk type in **Figure 2.5**. In addition, detailed results are provided in **Appendix Table 2B** and illustrated at the regionwide level in **Map Exhibit 11** ("Future Condition Flood Exposure")**.**

Table 2.21 Future Flood Exposure Summary

Exposure Type	Number of features		
	1% AC	0.2% AC*	Possible Flood Prone Areas
Floodplain Area (sq. mi.)	9,543	1,807	161
Structures (#)	67,134	35,167	12,393
Population (#)	253,678	110,302	71,036
Critical Facilities (#)	178	56	19
Roadway Segments (mi.)	3,846	1,035	353
Roadway Stream Crossings (#)	1,467	585	147
Agricultural Areas (sq. mi.)	678	149	39

*0.2% AC flood exposure results are reported separately from the 1% AC results and do not include cumulative flood hazard areas or property impacts from 1% AC flood hazard areas.

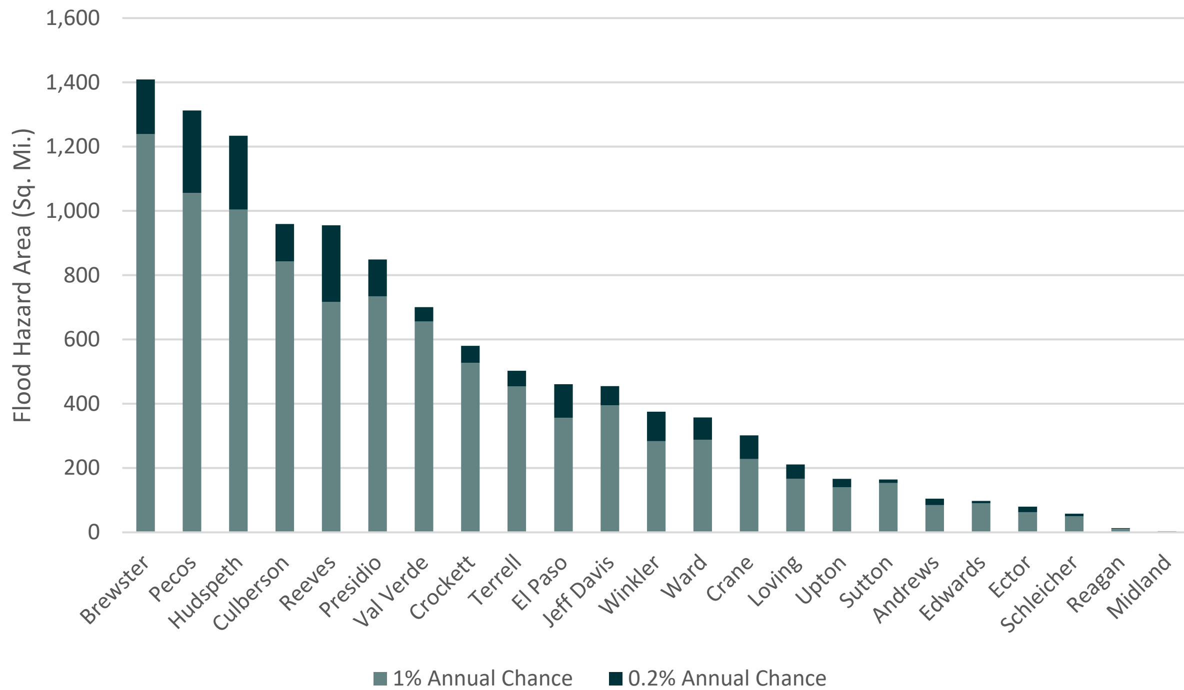
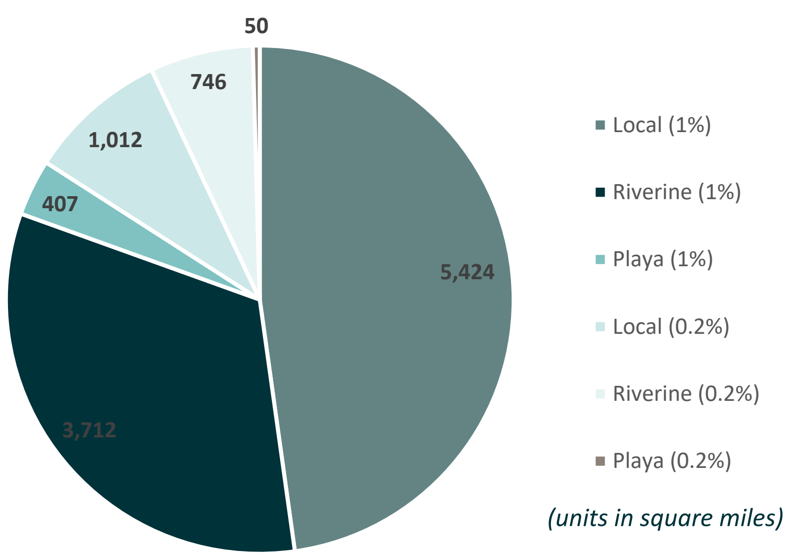


Figure 2.4 Total Future Condition Flood Hazard Area by County



Note: Flood hazard areas with more than one potential flood risk type are characterized in this figure using a simplified priority order (i.e., playa, riverine, local).

Figure 2.5 Total Future Condition Flood Hazard Area by Flood Risk Type

2.3.7 Future Vulnerability

Based on the results of the future conditions flood risk identification and exposure analyses, a future condition vulnerability analysis was performed to identify the level of resilience or vulnerabilities related to communities, critical facilities, and critical transportation routes.

The methodology of the future condition vulnerability analyses was based on the methodology previously discussed for the existing condition vulnerability analyses in Section 2.2.4.

Table 2.22 shows the relative vulnerability of communities across the region, including incorporated and unincorporated communities, based on the number of structures in the 1% and 0.2% future condition annual chance floodplains. The top five communities by number of structures within colonias in the 1% future condition annual chance floodplain were found to be the City of Socorro, Homestead Meadows North, Homestead Meadows South, the City of San Elizario, and the Town of Clint. The top five communities by average SVI of buildings in the floodplain were found to be Fabens, Redford, the City of Presidio, the Town of Van Horn, and the City of San Elizario.

In addition to summarizing SVI values by community, average building SVI values were summarized by county and reported as part of the future conditions flood exposure results in **Appendix Table 2B**. An overview of regionwide future condition vulnerability results is provided in **Map Exhibit 12** ("Future Condition Flood Vulnerability including Critical Infrastructure").

Table 2.23 summarizes the potential vulnerabilities of critical facilities for the future conditions 1% and 0.2% annual chance flood events by county, while **Table 2.24** summarizes potential vulnerabilities oof critical routes for the same events. In addition, Section 2.4 provides qualitative descriptions of the expected loss of function for various critical facility types in the region.

Table 2.22 Summary of Future Conditions Vulnerability – Community Property Impacts

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain**
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Acala CDP	**3**	**3**	**5**	**3**	**0.932**
Agua Dulce CDP	**357**	**346**	**468**	**451**	**0.902**
Alpine city	1,784	0	1,980	0	0.570
Amistad CDP	11	11	11	11	0.549
Anthony town	**258**	**3**	**264**	**3**	**0.925**
Balmorhea city	361	0	363	0	0.357
Barstow city	166	0	249	0	0.520
Box Canyon CDP	27	21	27	21	0.549

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain**
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Butterfield CDP	**26**	**18**	**26**	**18**	**0.784**
Canutillo CDP	**710**	**325**	**749**	**340**	**0.768**
Clint town	**406**	**406**	**493**	**493**	**0.753**
Crane city	182	0	242	0	0.560
Dell City city	**293**	**0**	**293**	**0**	**0.932**
El Paso city	29,043	72	50,174	128	0.711
Fabens CDP	**580**	**12**	**888**	**12**	**0.974**
Fort Bliss CDP	1,156	0	1,844	0	0.344
Fort Davis CDP	155	0	226	0	0.408
Fort Hancock CDP	**92**	**39**	**117**	**43**	**0.932**
Fort Stockton city	296	1	322	1	0.589
Grandfalls town	192	0	253	0	0.520
Homestead Meadows North CDP	1,222	881	1,612	1,179	0.754
Homestead Meadows South CDP	783	587	1,619	1,299	0.641
Horizon City city	926	5	1,898	7	0.540
Imperial CDP	272	246	276	246	0.329
Iraan city	101	100	120	119	0.329
Kermit city	1,293	0	2,075	0	0.593
Lake View CDP	12	12	12	12	0.549
Lindsay CDP	**189**	**189**	**194**	**194**	**0.825**
Marathon CDP	91	87	118	109	0.512
Marfa city	**285**	**0**	**488**	**0**	**0.913**
McCamey city	196	0	577	0	0.658
Mentone CDP	11	0	15	0	0.502
Monahans city	789	0	891	0	0.687
Morning Glory CDP	**96**	**67**	**134**	**94**	**0.930**
Ozona CDP	1,047	0	1,056	0	0.608
Pecos city	1,958	7	2,835	7	0.588
Prado Verde CDP	112	57	112	57	0.095
Presidio city	**666**	**0**	**754**	**0**	**0.951**
Pyote town	18	0	30	0	0.520

Place Name	1% Annual Chance Flood Risk		0.2% Annual Chance Flood Risk*		Average SVI of Structures in Floodplain**
	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	Number of Structures in Floodplain	Number of Structures in Floodplain within Colonias	
Rankin city	82	0	82	0	0.426
Redford CDP	**16**	**7**	**30**	**14**	**0.951**
San Elizario city	**816**	**502**	**1,050**	**678**	**0.934**
Sanderson CDP	291	291	323	323	0.453
Sheffield CDP	4	0	12	7	0.329
Sierra Blanca CDP	**38**	**38**	**50**	**50**	**0.932**
Socorro city	**4,382**	**2,222**	**6,066**	**3,245**	**0.903**
Sonora city	827	0	876	0	0.651
Southwest Sandhill CDP	828	0	1,046	0	0.520
Sparks CDP	115	111	212	206	0.695
Study Butte CDP	24	20	31	26	0.512
Terlingua CDP	4	3	6	5	0.512
Thorntonville town	217	0	333	0	0.520
Tornillo CDP	**186**	**179**	**228**	**210**	**0.930**
Toyah town	**101**	**101**	**101**	**101**	**0.825**
Valentine town	18	18	49	48	0.408
Van Horn town	**229**	**217**	**638**	**623**	**0.935**
Vinton village	**147**	**1**	**397**	**2**	**0.866**
Westway CDP	**93**	**90**	**164**	**160**	**0.785**
Wickett town	31	0	39	0	0.520
Wink city	41	0	70	0	0.544
All other colonias (outside boundaries of incorporated place or CDP)	-	2,410	-	3,193	-

*0.2% AC flood vulnerability results include cumulative property impacts from 1% AC flood hazard areas.

Communities in **bold have a high SVI (over 0.75)

Table 2.23 Summary of Future Conditions Vulnerability – Critical Facilities

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	**0.2% Annual Chance**
Andrews	• None identified	• None identified
Brewster	• EPA NPDES: CITY OF ALPINE MUNICIPAL WWTF • HIFLD Law Enf: ALPINE POLICE DEPARTMENT • HIFLD Law Enf: BREWSTER COUNTY SHERIFFS OFFICE • Hospital: BIG BEND REGIONAL MEDICAL CENTER • School: ALPINE EL • School: ALPINE H S • School: ALPINE MIDDLE	• Same as 1% Annual Chance
Crane	• HIFLD Law Enf: CRANE COUNTY SHERIFFS OFFICE / CRANE COUNTY JAIL • National Shelter System Facility: Crane County Library • **School: CRANE EL**	• HIFLD NGPP: CORDONA LAKE GAS PLANT • **National Shelter System Facility: Mountain View Community Center**
Crockett	• EPA NPDES: MAIN WWTF • HIFLD NGPP: NELEH GAS SYSTEM • HIFLD NGPP: SOUTHWEST OZONA GAS PLANT • HIFLD NGPP: TIPPETT GAS PLANT • Intermodal Transit Facility: Caprock Diesel • National Shelter System Facility: Ozona Convention Center • School: OZONA EL • School: OZONA MIDDLE	• Same as 1% Annual Chance
Culberson	• None identified	• **Intermodal Transit Facility: Pilot Travel Center** • **School: VAN HORN SCHOOL**
Ector	• None identified	• None identified
Edwards	• None identified	• None identified
El Paso	• **EPA NPDES: CANAL WTP** • EPA NPDES: CANUTILLO ISD WWTP • EPA NPDES: HORIZON REGIONAL MUD - HORIZON CITY WWTP • EPA NPDES: TORNILLO WWTF • **Fire Station: El Paso Fire Department Station 25** • Fire Station: El Paso Fire Department Station 26 • Fire Station: El Paso Fire Department Station 9 • **Fire Station: Montana Vista Fire Rescue Station 1** • Fire Station: Montana Vista Fire Rescue Station 2 • Fire Station: West Valley Fire Department Anthony Station • Fire Station: West Valley Fire Department Canutillo Station • Google: Bonnie Moorhouse Reverse Osmosis Water Treatment Facility	• **Fire Station: El Paso Fire Department Station 18** • Fire Station: El Paso Fire Department Station 31 • **HIFLD Nursing Homes: OASIS NURSING & REHABILITATION CENTER** • **Hospital: DEL SOL MEDICAL CENTER A CAMPUS OF LPDS HEALTHCARE** • **Intermodal Freight Facility, RAIL & TRUCK: UP-EL PASO-TX-201 DODGE** • **National Shelter System Facility: GARY DEL PALACIOS REC CENTER** • **National Shelter System Facility: Marty Robbins Recreation Center** • **National Shelter System Facility: Socorro Community Center**

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	**0.2% Annual Chance**
	• **HIFLD Law Enf: CLINT POLICE DEPARTMENT** • **HIFLD Law Enf: EL PASO COUNTY SHERIFFS OFFICE - HEADQUARTERS** • HIFLD Nursing Homes: ADAM MC CARE LLC • HIFLD Nursing Homes: GOOD SAMARITAN SOCIETY--WHITE ACRES • HIFLD Nursing Homes: LA FAMILIA ASSISTING LIVING • **HIFLD Nursing Homes: ROSEMARY WILLIAMS MELENDEZ CASA FELICITAS** • **HIFLD Nursing Homes: SUNRIDGE AT CAMBRIA** • **HIFLD Nursing Homes: THE ETERNAL YOUTH HOME** • HIFLD Nursing Homes: THE FOREST ASSISTED LIVING • HIFLD Nursing Homes: VILLAS DEL SOL ASSISTED LIVING LLC • HIFLD: FORT BLISS (DEA EPIC) • HIFLD: HOOVER COMPANY • **HIFLD: MONTANA POWER STATION** • **Hospital: EL PASO CHILDREN'S HOSPITAL** • **Hospital: PREMIER SPECIALTY HOSPITAL OF EL PASO** • **Hospital: THE HOSPITALS OF PROVIDENCE TRANSMOUNTAIN CAMPUS** • Hospital: UNIVERSITY MEDICAL CENTER OF EL PASO • Intermodal Freight Facility, RAIL & TRUCK: EL PASO TERMINAL WAREHOUSES, INC.-EL PASO-TX • Intermodal Freight Facility, RAIL & TRUCK: SWIG COTTON-EL PASO-TX • **Intermodal Freight Facility, TRUCK - PORT - RAIL: YELLOW-EL PASO-TX TERMINAL** • **Intermodal Transit Facility: Greyhound Station** • National Shelter System Facility: DAACG • National Shelter System Facility: DON HASKINS REC CENTER • **National Shelter System Facility: EPCC Administrative Building** • **National Shelter System Facility: Houchen Center** • **National Shelter System Facility: MULTIPURPOSE CENTER** • National Shelter System Facility: Nations Tobin Recreation Center • **National Shelter System Facility: San Pablo Lutheran Church** • **National Shelter System Facility: Socorro Entertainment Ctr** • **National Shelter System Facility: St. Ignatius Church**	• **School: ALICIA R CHACON** • School: ANDRESS H S • **School: CACTUS TRAILS** • **School: CARROLL T WELCH EL** • **School: CEDAR GROVE EL** • **School: COL JOHN O ENSOR MIDDLE** • School: DAVINCI SCHOOL FOR SCIENCE AND THE ARTS • **School: DEL VALLE H S/National Shelter System Facility** • **School: DELTA ACADEMY** • **School: DESERTAIRE EL** • **School: DOLPHIN TERRACE EL** • **School: EASTWOOD KNOLLS** • **School: EL DORADO H S/National Shelter System Facility** • **School: ESCONTRIAS EARLY CHILD CTR** • **School: FANNIN EL** • **School: FRANKLIN H S** • **School: GUILLEN MIDDLE** • **School: HARMONY SCIENCE ACAD (EL PASO)** • **School: HORIZON HEIGHTS EL** • School: HORNEDO MIDDLE • **School: HOWARD BURNHAM EL** • **School: HUECO EL** • **School: IDEA EDGEMERE ACADEMY** • **School: JANE A HAMBRIC SCHOOL** • **School: JEFFERSON H S** • **School: PASO DEL NORTE SCHOOL** • **School: PEBBLE HILLS H S** • **School: PRESA EL** • **School: RIVERSIDE H S** • **School: RIVERSIDE MIDDLE** • **School: SANCHEZ STATE JAIL** • **School: SCOTSDALE EL** • **School: SUN RIDGE MIDDLE; LUJAN-CHAVEZ EL/National Shelter System Facility** • **School: TIPPIN EL** • **School: YSLETA H S**

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	0.2% Annual Chance
	• National Shelter System Facility: WELLINGTON CHEW SENIOR CENTER • **School: AMERICAS H S/National Shelter System Facility** • **School: ANTHONY EL** • **School: ASCARATE EL** • **School: BONHAM EL** • School: CANUTILLO MIDDLE • School: CHAPIN H S • School: CLINT H S • School: CLINT ISD EARLY COLLEGE ACADEMY • **School: CLINT J H SCHOOL** • School: CONSTANCE HULBERT EL • School: COOLEY EL • School: CROSBY EL • **School: DESERT VIEW MIDDLE** • **School: DESERT WIND EL** • School: DOWELL EL • **School: EAST POINT EL** • **School: EASTWOOD H S/National Shelter System Facility** • **School: EASTWOOD MIDDLE** • School: EL PASO ACADEMY WEST • School: EL PASO LEADERSHIP ACADEMY • **School: GLEN COVE EL** • School: H D HILLEY EL • School: H R MOYE EL • School: HAWKINS EL • School: HENDERSON MIDDLE • **School: HORIZON H S** • **School: HORIZON MIDDLE** • **School: IRVIN H S** • **School: J M HANKS H S** • **School: JOHN DRUGAN SCHOOL** • **School: JOHNSON EL** • School: JOSE H DAMIAN EL • **School: JOSEFA L SAMBRANO EL** • **School: LA FE PREPARATORY SCHOOL** • School: LE BARRON PARK EL • School: LEE EL/National Shelter System Facility • **School: LORENZO LOYA PRI** • **School: MACARTHUR EL-INT** • School: MAGOFFIN MIDDLE/National Shelter System Facility • School: MARIAN MANOR EL • **School: MESITA EL** • School: MILAM EL • **School: MONTWOOD MIDDLE; ELFIDA CHAVEZ EL**	

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	**0.2% Annual Chance**
	• School: NEWMAN EL • School: NORTH LOOP EL • **School: PARKLAND H S/National Shelter System Facility** • **School: PARKLAND PRE K CENTER** • **School: PASODALE EL** • **School: POLK EL** • **School: PREMIER H S OF EL PASO** • School: RAMONA EL • School: RED SANDS EL • **School: RIO BRAVO MIDDLE** • School: ROBBIN E L WASHINGTON EL • School: SAN ELIZARIO H S/National Shelter System Facility • **School: SILVA HEALTH MAGNET** • **School: SOUTH LOOP EL** • School: STANTON EL • School: TEJAS SCHOOL OF CHOICE • **School: TELLES ACADEMY** • School: THE LINGUISTIC ACAD OF EL PASO-CULTURAL DEMO SITE • **School: TIERRA DEL SOL EL** • School: TORNILLO EL • School: WESTERN HILLS EL • **School: WILLIAM D SLIDER MIDDLE** • School: WM DAVID SURRATT EL • School: YSLETA PK CENTER • School: ZACH WHITE EL • **School: ZAVALA EL**	
Hudspeth	• Fire Station: Hueco Volunteer Fire Department • School: DELL CITY SCHOOL	• Same as 1% Annual Chance
Jeff Davis	• EPA NPDES: FORT DAVIS WWTF	• **School: VALENTINE SCHOOL**
Loving	• HIFLD NGPP: PECOS RIVER PLANT	• Same as 1% Annual Chance
Midland	• None identified	• None identified
Pecos	• EPA FRS: CENTURY GAS PLANT • Fire Station: Imperial Fire Department • HIFLD NGPP: WAHA GAS PLANT • HIFLD: EAST PECOS SOLAR • Hospital: PECOS COUNTY MEMORIAL HOSPITAL • School: BUENA VISTA SCHOOL • School: FORT STOCKTON ALAMO EL • School: FORT STOCKTON HIGH • School: IRAAN J H • School: LYNAUGH UNIT	• EPA FRS: WAHA GAS PLANT • HIFLD NGPP: MITCHELL PLANT • HIFLD: ALAMO 6
Presidio	• None identified	• School: PRESIDIO H S

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	**0.2% Annual Chance**
Reagan	• None identified	• None identified
Reeves	• EPA NPDES: ORLA WWTP • Fire Station: Balmorhea Volunteer Fire Department • Fire Station: Toyah Volunteer Fire Department • HIFLD Law Enf: PECOS POLICE DEPARTMENT • HIFLD NGPP: EAST TOYAH GAS PLANT • National Shelter System Facility: Civic Center in Balmorhea • National Shelter System Facility: Community Center in Pecos City • National Shelter System Facility: First Baptist Church - Balmorhea • School: AUSTIN EL • School: BALMORHEA SCHOOL/National Shelter System Facility	• School: CROCKETT MIDDLE • School: PECOS H S
Schleicher	• None identified	• None identified
Sutton	• EPA FRS: CITY OF SONORA • Fire Station: Border Line Volunteer Fire Department • HIFLD Law Enf: SONORA POLICE DEPARTMENT • HIFLD NGPP: SONORA GAS PLANT • Intermodal Transit Facility: Picos Food Mart • National Shelter System Facility: SUTTON COUNTY CIVIC CENTER	• Same as 1% Annual Chance
Terrell	• Fire Station: Terrell County Volunteer Fire Department • Intermodal Transit Facility: Amtrak Station	• Same as 1% Annual Chance
Upton	• Fire Station: McCamey Volunteer Fire Department • HIFLD: CASTLE GAP SOLAR • HIFLD: UPTON COUNTY SOLAR • Hospital: MCCAMEY HOSPITAL	• School: MCCAMEY PRI
Val Verde	• None identified	• None identified
Ward	• Fire Station: Grandfalls Volunteer Fire Department • HIFLD NGPP: BONE SPRINGS GAS PROCESSING PLANT • HIFLD NGPP: MIVIDA JV PROCESSING PLANT • HIFLD Nursing Homes: MONAHANS MANAGED CARE CENTER • School: GRANDFALLS-ROYALTY SCHOOL • School: MONAHANS H S • School: SUDDERTH EL	• Same as 1% Annual Chance
Winkler	• EPA FRS: EL PASO NATURAL GAS - KEYSTONE COMPRESSOR STATION • HIFLD Law Enf: WINKLER COUNTY SHERIFFS OFFICE / WINKLER COUNTY JAIL	• KERMIT EL

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

County	Future Conditions Critical Facilities Vulnerabilities*	
	1% Annual Chance	0.2% Annual Chance
	• HIFLD NGPP: HALLEY PLANT • Hospital: WINKLER COUNTY MEMORIAL HOSPITAL • School: WINK EL	

*Critical Facilities in **bold** were identified as potential vulnerabilities in future conditions flood events (1% or 0.2% annual chance) but were not previously identified as potential vulnerabilities in the existing conditions flood events (1% or 0.2% annual chance) listed in **Table 2.15.**

Table 2.24 Summary of Future Conditions Vulnerability – Critical Routes

County	Future Conditions Critical Route Vulnerabilities	
	1% Annual Chance	**0.2% Annual Chance**
Andrews	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities.
Brewster	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • Roadway 118, resulting in access issues to the hospital Big Bend Regional Medical Center.
Crane	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • US Highway 385 S, resulting in access issues. Problem accessing the Crane Memorial Hospital.
Crockett	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • Segments of IH10 near Ozona town, resulting in significant access issues.
Culberson	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • IH10 intersection with US90, may result in access issues to the nearest hospital, Culberson Hospital.
Ector	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities.
Edwards	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities.
El Paso	• Includes existing condition 1% vulnerabilities. • N Boone, Reynolds St. and N Concepcion St. resulting in potential access issues to Hospitals: EP Children's Hospital, EP Psychiatric Center, and University Medical Center of El Paso. • South US 54, Above intersection with IH10, potential access issue to main Highway. • Butterfield area, O Leary Dr. resulting in potential access issue to Montana Ave.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • N Mesa St. resulting in potential access issue to hospital: Las Palmas Rehabilitation Hospital. • Tierra Arroyo Dr. and Tierra Este Dr. resulting in potential Access issues to Hospital: The Hospitals of Providence east campus. • Homestead Meadows South area, roadway: N Ascension St. resulting in potential access to Agua Dulce.
Hudspeth	• Includes existing condition 1% vulnerabilities. • Segments of roadway US62-180 may result in potential access issues between El Paso and Hudspeth County and Culberson County. • Segments of IH10 may result in potential access issues between El Paso/Hudspeth and Culberson/Hudspeth.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • Hueco Ranch Rd. may result in potential access issues to the US62-180. • Segments of IH10 may result in potential access issues between El Paso/Hudspeth and Culberson/Hudspeth. • IH10 at the Sierra Blanca area may result in potential access issues.
Jeff Davis	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • SH-17, the connection between Marfa and Fort Davis, resulting in access issues near the intersection with SH-17.

County	Future Conditions Critical Route Vulnerabilities	
	1% Annual Chance	0.2% Annual Chance
Loving	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • South County Road 22 intersection with County Road 2, resulting in significant access issues. • Roadway 302 at the intersection with County Rd. 20 (Metor Rd) resulting in access issues to Mentone city.
Midland	• None identified	• None identified
Pecos	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • IH10 near Fort Stockton may cause problems accessing the Pecos County Memorial Hospital • N US Highway 285, near Fort Stockton may cause problems accessing the Pecos County Memorial Hospital.
Presidio	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • US67, Intersection with roadway 170, resulting in access issues to presidio city. • US90 Intersection with US67, resulting in access issues to Marfa city.
Reagan	• None identified	• None identified
Reeves	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • North Central US285 with possible access issues near Pecos area. • IH20 near Toyah town with possible access issues.
Schleicher	• None identified	• None identified
Sutton	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • Segments of IH10 at Sonora city resulting in access issues. Therefore, possible problems accessing Lilian M. Hudspeth Memorial Hospital • E 2ND St. resulting in access issues. Possible problems accessing Lilian M. Hudspeth Memorial Hospital.
Terrell	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities.
Upton	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • McCamey Town, Roads: 21St St. Medical Dr. resulting in access issues. Possible problems accessing the McCamey Hospital. • McCamey Town, Segments of US Highway 385-FM 305, resulting in access issues. Possible problems accessing the McCamey Hospital. • US Highway 67, resulting in significant access issues at Rankin Town. Therefore, possible problems accessing the Hospitals: Rankin County Hospital District and Rankin County Hospital District.

County	Future Conditions Critical Route Vulnerabilities	
	1% Annual Chance	0.2% Annual Chance
Val Verde	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities.
Ward	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • IH20, Monahans city area with significant access issues. • S State Highway 18 with significant access issues to Grandfalls Town.
Winkler	• Includes existing condition 1% vulnerabilities.	• Includes existing condition 0.2% and future condition 1% vulnerabilities. • S Roadway 115, with significant access issues. Connection between Wink and Pyote town. • S State Highway 18, with significant access issues. Connection between Kermit and Monahans

2.4 Expected Loss of Function

When key community assets are impacted by floods, the associated flood damages may result in reduced or total loss of function of the affected assets. These disruptions can also lead to cascading risks of harm to life, property, and transportation throughout the community. This summary discusses the potential impacts of flood events on the operations and expected functions for the following community assets:

- Fire Stations
- Hospitals
- National Shelter System Facility
- Schools
- Intermodal Freight Facility
- Intermodal Transit Facility
- Water treatment plants
- Wastewater treatment plants
- Police departments
- Assisted living facilities
- Natural gas processing plants
- Power plants
- Solar farms

Fire Stations

The public relies heavily on first responders and fire fighters during emergencies such as flood events, and the more substantial the incident, the greater the need for assistance delivered by the fire department and others with public safety missions. During flood events, fire departments coordinate with other agencies and respond to:

- Incidents caused by structural damage from moving water, disruptions to utility services and damage from debris being moved by the water.
- Evacuation of low-lying areas.
- Increased rescue problems or situations such as people trapped in structures by rising waters, and people trapped in motor vehicles by rising waters.
- Damage to infrastructure such as roads and bridges, limiting response. During flood events, the fire department usually works closely with law enforcement and the agencies that maintain the roads and highways.
- Some communities that are prone to severe flood pre-deploy specialized rescue teams when heavy rains are forecast or when ground saturation levels reach predetermined

points. These teams include rescue swimmers, small boat handlers, rope riggers, and team leadership.[7]

If fire service facilities are compromised due to being inundated, there may be cascading impacts on the communities they serve. Service personnel will have limited access to the equipment they need for their operations and this will impede their service delivery. Communication and coordination may be impacted or delayed if communication hubs situated within fire service centers are disabled due to water inundation. If fire service vehicles are parked in low lying areas, flooding of these vehicles will disable them and limit resources during rescue operations. It is therefore imperative that these facilities are prepared for flood events.

Hospitals

Hospitals provide critical services during flood events for vulnerable population groups. Severe flood events can impact medical services, ancillary services such as the functioning of pharmacies, laboratories, blood banks, mechanical systems such as ventilation and lift systems, water and sewer systems.

Severe flood events can both damage hospital facilities directly and disrupt access to them. Damage to the hospital facilities can result in loss of life at worst but also delays in providing routine medical services and emergency services to highly vulnerable populations. Flooding may also lead to direct costs due to damage to infrastructure, or expensive medical equipment. There may also be indirect costs of such as increased risk of outbreaks due to loss of laboratory and diagnostic support, and the loss income normally generated by health care services.[8]

The emergency power supply system is the most critical service in continued operation of a hospital during a power outage. Together with fuel supply and storage facilities, this system enables all the other hospital installations and equipment that have not sustained direct physical damage to function normally in any disaster. However, uninterrupted operation of a hospital during a power outage is possible only if adequate electrical wiring is installed in all the areas that require uninterrupted power supply. Since extra wiring and additional circuits for emergency power increase the initial construction costs of the building, the decision on the emergency power coverage requires a thorough evaluation of the relative vulnerability of various functions to power outage. As patients become more critically ill and the nature of diagnosis and treatment becomes more dependent on computers, monitors, and other electrical equipment, the need for emergency power is pertinent. In some healthcare facilities, to make critical services more accessible for maintenance and monitoring, they are placed on the ground floor or basement. This increases the risks from flooding to these services. Storm water can fill the basements and first floor and cause the backup generators to be inoperable. During flood events, sewers can overflow, back up, or breakdown. Waste disposal is essential for

[7] FEMA, 2008. *Special Report: Fire Department Preparedness for Extreme Weather Emergencies and Natural Disasters*. [online] Available at: <https://www.usfa.fema.gov/downloads/pdf/publications/tr_162.pdf> [Accessed 24 March 2022].

[8] Yusoff, N., Shafii, H., & Omar, R. (2017). The impact of floods in hospital and mitigation measures: A literature review. *IOP Conference Series: Materials Science And Engineering*, *271*, 012026. doi: 10.1088/1757-899x/271/1/012026

any hospital, because when the toilets back up, or sterilizers, dishwashers, and other automated cleaning equipment cannot be discharged, patient care is immediately affected.[9]

Elevator service is vulnerable not only to power outages, but also to direct damage to elevator installations. The flooding of elevator pits was a common problem during Hurricane Katrina, and responsible for the loss of elevator service.

In anticipation of severe flooding, timely evacuation of some or all of the hospital patients to facilities out of the disaster area may be a prudent choice for patient welfare. Severe floods can cause blockage of access roads, cutting off a hospital from normal evacuation routes. Surface escape routes can be under water and unusable, and air evacuation can be impaired if many ground level helicopter landing pads are under water. Elevated helipads located on roof tops or elevated parking structures are invaluable features in this type of an emergency. The spatial relationship of helipads to hospital building is another aspect that greatly influences the evacuation and reduced the risk of aggravating patients' condition. Helipads physically connected to the hospital are most useful, because patients could be transported directly and very rapidly from the upper levels of the hospital to the helipad without interference from other hospital functions.[9]

When an existing facility is exposed to flooding, or if a new facility is proposed to be in a flood hazard area, steps need to be taken to minimize the risks. A well-planned, designed, constructed, and maintained hospital should be able to withstand damage and remain functional after and during a flooding event.

National Shelter System Facilities

The National Shelter System is a network of facilities that can house individuals in the event of an issued evacuation for the facilities service area. The facilities included in this network are those have been designated as a Shelter by either the Federal Emergency Management Agency (FEMA) or the American Red Cross (ARC).[10] In addition to general population shelters, the system includes:

- Medical shelters, shelter-in-place locations (SIP)
- Household pet shelters, kitchens
- Points of Distribution (POD's), warehouses
- Warming, cooling, and respite centers
- Embarkation, Debarkation, and Reception processing sites
- Any type of shelter or facility related to the management of the people affected by the operation[11].

[9] FEMA. (2007). Risk Management Series Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds. *Risk Management Series*. Retrieved from https://www.wbdg.org/FFC/DHS/fema577.pdf

[10] National Shelter System Facilities. (2022). Retrieved 3 April 2022, from https://hifld-geoplatform.opendata.arcgis.com/datasets/geoplatform::national-shelter-system-facilities/about

[11] FEMA. (Not Dated). NATIONAL SHELTER SYSTEM – FACT SHEET. Retrieved from https://www.fema.gov/pdf/media/factsheets/2011/fema_national_shelter_system.pdf

Sheltering facilities are primarily for planned as survival places for the victims displaced after a flood event when rehabilitation is underway immediately afterwards. These will be used only for a short period of time during a flood.

Ideally, shelters should also be located outside areas known to be flood prone, including areas within the 100-year floodplain. Shelters in flood-prone areas will be susceptible to damage from hydrostatic and hydrodynamic forces associated with rising flood waters. Damage may also be caused by debris floating in the water. Most importantly, flooding of occupied shelters may well result in injuries or deaths. Furthermore, shelters located in flood-prone areas, but properly elevated above the 100-year flood elevation, could become isolated if access routes were flooded. As a result, shelter occupants could be injured, and no emergency services would be available.[12]

Schools

Existing schools that are in flood hazard areas are exposed to flood risk. The nature and severity of damage are functions of site-specific characteristics. Damages may impact the property, buildings, , service equipment, and also pose health and safety threats due to contaminated floodwater.

Regardless of the nature and severity of damage, schools impacted by floods are typically not functional while cleanup and repairs are undertaken. The length of closure impacts the ability of the school district to provide instruction and may setback students from achieving their education milestones. The duration of the closure depends on the severity of the damage and lingering health hazards. It may also depend on whether the building was fully insured or whether disaster assistance is made available quickly to allow speedy repairs and reconstruction. Sometimes, repairs are put on hold pending a determination of whether a school should be rebuilt on the same site. When damage is substantial, rehabilitation or reconstruction is allowed by FEMA only if full compliance with flood-resistant design requirements is achieved.[13]

Potential damage identified by FEMA include:[14]

- Health threats - Mold growth and contaminants in flooded schools can pose significant health threats to students and staff.
- Playing field surfaces - In addition to damage by erosion and scour, graded grass fields and applied track surfaces can be damaged by standing water and deposited sediments.
- Vehicles and buses - If left in flood prone areas, vehicles may not be functional and available for service immediately after a flood and must be replaced or cleaned to be serviceable.

[12] FEMA. (2006). Risk Management Series Design Guidance for Shelters and Safe Rooms. *Risk Management Series*. Retrieved from https://www.fema.gov/pdf/plan/prevent/rms/453/fema453.pdf

[13] National Clearinghouse for Educational Facilities. (2011). Flooding and Schools. *National Clearinghouse For Educational Facilities*. Retrieved from https://files.eric.ed.gov/fulltext/ED539485.pdf

[14] FEMA. (2010). Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds, *FEMA P-424*. Retrieved from https://www.fema.gov/sites/default/files/documents/fema_p-424-design-guide-improving-school-safety.pdf

- Site damage - School grounds may be subject to erosion and scour, with the possible loss of soil and damage to paved areas, including access roads. Large amounts of debris and sediment can accumulate on the site, especially against fences.
- Structural damage - Foundations can be eroded, destabilizing or collapsing walls and heaving floors.
- Saturation damage - Saturated walls and floors can lead to plaster, drywall, insulation, and tile damage, mold and moisture problems, wood decay, and metal corrosion.
- Utility system damage - Electrical wiring and equipment can be shorted, and their metal components corrode. Ductwork can be fouled and expensive heating and cooling equipment ruined. Oil storage tanks can be displaced and leak, polluting the areas around them. Sewers can back up and contaminate the water supply and building components.
- Content damage - School furniture, computers, files, books, lab materials and equipment, and kitchen goods and equipment can be damaged or contaminated.

Intermodal Freight Facility

Flooding events can disrupt the operations of freight transportation facilities and infrastructure. This may result in significant economic impacts due to delivery delays associated with rerouting in affected areas . The inability to deliver to locations that have been cut off from the freight network will also have economic impact. Overall, the cost rates of moving goods, increase as roads become impassable. The need to take alternate routes is likely to increase fuel consumption and lengthen driver on-duty time, both of which increases costs for companies and ultimately consumers. After a severe flood event, there is often increased competition for limited transportation resources and equipment such as shipping containers, trucks and trains. This limited capacity will naturally push costs up, but even if there is affordability, the capacity might be impossible to find. This overall disruption in the supply chain and increase in overall costs will impact community members access to necessary resources.

Water stagnation or other structural damage caused by the floods to freight facilities will limit its operations. It may reduce storage capacity and further stress the supply-chain.[15]

Intermodal Transit Facility

Transportation networks underpin socio-economic development by enabling the movement of goods and people. Disruptions due to flooding of roadway and rail tracks can cause operating services to reroute or suspend service to hard hit areas. Power outages can also disable transit service. Highways and arterials need electrical power to operate traffic lights and signs. Railroads require electricity to operate signal systems and crossing gates. Under this situation, it is likely that headway time will increase as transit is re-routed, travel speed is reduced and hence travel time increases. This leads to substantial economic costs to local commuters. Overall, accessibility to jobs decreases under flooded conditions. As most transit users are from

[15] Grenzeback, L. R., Lukman, A. T., & Systematics, C. (2008). *Case study of the transportation sector's response to and recovery from Hurricane's Katrina and Rita*. Transportation Research Board.

lower income communities, this raises an equity concern. The closure of transit facilities due to water stagnation will cut-off access for all its users.[16]

Water Treatment Facilities/Plants

Floods can impact the operations of water treatment plants. For example, reductions in the ability to feed raw water to the process tanks or damage to the Automatic Transfer Switch (which detects power failures, initiate generator startup, transfer load, and perform other functions without human intervention would render the facility inoperable. Additionally, the inability to provide high air pressure will limit the operation of pneumatic valves on the treatment process systems. This can also render the facility inoperable.[17]

Flood events may lead to water contamination or reduced water supply, which impacts consumers who rely on these systems for safe drinking water, cooking or cleaning. Depending on the severity of the flood, it could take up to several months to have a water professional monitor and certify it as safe for drinking. Without access to clean drinking water, consumers ultimately become reliant on bottled water which is likely to increase drastically in price during such a time. In poor and impoverished communities, this reality is even more detrimental because they may not have the economic means to "stock up" on bottled water in comparison to more affluent communities. Moreover, during a severe flood event, retail locations are often inaccessible and/or low on water supply as well.[18]

Wastewater Treatment Facilities/Plants

A wastewater treatment plant is most at risk for flooding when it's in a low-lying area near a water body from which it discharges its final effluent and enables gravity-fed collection systems. Pump stations, where differential head is insufficient for flow, are included in some systems and increases the likelihood of flooding. Pumps develop differential head, or differential pressure. This means the pump takes suction pressure, adds more pressure (the design pressure), and generates discharge pressure . In cases where the differential head is not adequate, the pump station will be located closer to the discharge location. If components are in areas vulnerable to flooding, designing them to be submersible is preferred.[19]

In older water systems, sanitary sewer overflow is an issue. Unexpected heavy rainfalls introduce too much water into the system and can cause pump stations and treatment plants to break down, as well as untreated sewage to overflow from manhole covers and pour into water

[16] He, Y., Thies, S., Avner, P., & Rentschler, J. (2021). Flood impacts on urban transit and accessibility—A case study of Kinshasa. *Transportation Research Part D: Transport And Environment*, *96*, 102889. doi: 10.1016/j.trd.2021.102889

[17] FLOOD RESILIENCE A Basic Guide for Water and Wastewater Utilities. (EPA, 2014). Retrieved from: https://www.epa.gov/sites/default/files/2015-08/documents/flood_resilience_guide.pdf

[18] Flooding's Impact on Public Water Supplies, Sanitation. (Water Utility Management, 2021). Retrieved from: https://www.waterworld.com/water-utility-management/article/14211783/floodings-impact-on-public-water-supplies

[19] Tips for Flood-Proofing Wastewater Treatment Plants. (Nielson, 2018). Retrieved from: https://atsinnovawatertreatment.com/blog/flood-proof-wastewater-treatment-plant/

bodies. The outflow of raw sewage can endanger the local aquatic ecosystem and impact water quality.20

Excess floodwater can contaminate private drinking water sources, such as wells and springs, when rainfall makes contact with the ground and comes into contact with contaminants such as animal waste. This increases the amount of bacteria, sewage, and other industrial waste or chemicals that seep into the water source or leaky pipes. Additionally, excess water makes it more difficult for water treatment devices to treat the water efficiently and effectively. If there is any contamination at any step of the water flow process, this puts consumers at risk of exposure to dangerous toxins that could result in serious harm such as wound infections, skin rashes, gastrointestinal illnesses, and tetanus.[21]

Police Departments

The police co-ordinate with emergency services during a major flood and assist with the evacuation of people from their homes when necessary. If police facilities are compromised due to being inundated, there may be cascading impacts on the communities they serve. Service personnel will have limited access to the equipment they need for their operations and this will impede their service delivery. Communication and coordination may be impacted or delayed if communication hubs that are situated within police stations are disabled due to water inundation. If police vehicles are parked in low lying areas, flooding of these vehicles will disable them and limit resources during rescue operations. It is therefore imperative that these facilities are prepared for flood events.

Assisted Living Facilities

Assisted living facilities tend to house vulnerable, medically frail elderly and disabled residents. The residents, in the case of severe floods, tend to have lesser resources and higher health risks during evacuation. If inundated during flood events, assisted living facilities will have limited capacity to provide the necessary care needed for its residents in the form of power, food and water, medications, and supplies.

Assisted living facilities ideally require an emergency stockpile of medications and medical supplies adequate to cover all residents in the facility for at least 72 hours and ideally, up to a week. In the case of both food and medications/supplies, facility leaders may face supply chain issues after severe flood events. Even if they have secured purchasing agreements with more than one vendor, if roadways are flooded, delivery may be difficult or impossible, and supplies may be scarce.[22]

[20] Sewage Floods Likely to Rise. (Scientific America, 2016). Retrieved from: https://www.scientificamerican.com/article/sewage-floods-likely-to-rise/

[21] Flooding's Impact on Public Water Supplies, Sanitation. (Water Utility Management, 2021). Retrieved from: https://www.waterworld.com/water-utility-management/article/14211783/floodings-impact-on-public-water-supplies

[22] Emergency Preparedness Planning for Nursing Homes and Residential Care Settings in Vermont. (JSI, 2010). Retrieved from: https://www.michigan.gov/documents/mdch/Emergency_Preparedness_Planning.-_Vermont_428874_7.pdf

Natural Gas Processing Plants

Impacts from flooding of natural gas processing plants can include damage to infrastructure assets and disruption to service. Severe flooding at the regional scale can lead to supply chain disruptions and delays in in transporting Liquified Natural Gas (LNG) products to the market. Natural gas processing plants in the study area include plants which produce petroleum products such as natural gas, propane, butane, and condensate from raw natural gas or carbon dioxide. Petroleum products such as propane and butane serve as fuel for other industrial processes.

In the case of carbon capture plants, flood damages could disrupt or reduce carbon sequestration and could cause an interruption in the production of methane gas, which is the byproduct of the carbon capture process. As methane is also used to retrieve oil and natural gas from underground deposits, interruptions to carbon capture facilities due to flooding could have cascading impacts on other parts of the oil and natural gas supply chain.

Severe flooding of facilities can impact labor productivity and safety. In some cases, it can lead to environmental contamination that will require separate remediation efforts. If damage to the facilities cannot be restored quickly after a flood event, the limitation in production will have economic consequences. This may be in the form of an increase in product price that could then cascade to other products in the supply-chain. For instance, liquid propane gas is a necessary ingredient in the production of propylene, the building block of the plastic polypropylene. That particular plastic is used in the making of automotive interiors and packaging.

Power Plants

Severe flooding can disrupt the electricity supply chain, including electricity generation, transmission and distribution. Flood risks to electricity generation are a consequence of the need for most power plants to be close to sources of cooling water for their operations. In most cases, these are located next to natural water bodies such as lakes. As a result, they tend to be located in low lying areas and are prone to flooding. Floods can impact power plants in several ways including damage to equipment, which can knock out the plant's electrical systems and disable its cooling mechanisms. This in turn, may limit or halt electricity generation. Power plants that require fossil fuels for operation can be impacted by limited fuel supply if there are delays in the supply chain or flood damage to transportation infrastructure such as roadways and ports.

After severe flood events, key community assets such as police and fire stations, and hospitals, will rely on backup generators until power is restored. Damage to the network would need to be fixed as soon as possible. In cases where the power plants are limited in generating electricity, even after transmission and distribution infrastructure is restored, the shortage in supply may lead to a rise in price, which will have a disproportionate impact on lower income communities. Shortages of electricity will impact every household and business is likely to have wide reaching economic and quality of life repercussions. [23]

[23] Climate change, disasters and electricity generation. Urban, F., & Mitchell, T. (2011). Retrieved from: https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.825.4966&rep=rep1&type=pdf

Solar Farms

When solar farms are located in low lying areas, they are prone to inundation which may impact their operations. Solar panels can be damaged by floods but selecting high quality components such as module junction boxes, backsheets and cables can dramatically increase the resilience of panels and a solar powered farm to floods.

The continuous immersion in water has the potential to adversely affect the bottom of solar panels, which consists of a module junction box and a backsheet. Cables that go from solar panels to inverters can potentially be damaged by flood water as these parts are exposed to the outside to a large extent. Design interventions and material selection can minimize damage.[24]

Solar farms play important role in community resilience. After severe flood events, key community assets such as police and fire stations and hospitals, rely on backup generators until power is restored. More frequent storms and flood events increases the importance of the electricity system to become less centralized so that when one component of the distribution or generation system stops working, others can remain online. A less centralized system would be less vulnerable to mass outages when a power line breaks or when a substation floods. A more decentralized system is well-suited to renewable energy, and solar energy in specific, which is spread out across the grid.[25]

[24] Can Solar Panels be Damaged by Floods? - Solar Mango – #1 guide for solar. (2022). Retrieved 6 May 2022, from https://www.solarmango.com/2016/08/07/can-solar-panels-damaged-floods/

[25] Solar Energy Largely Unscathed by Hurricane Florence's Wind and Rain - Inside Climate News. (2022). Retrieved 6 May 2022, from https://insideclimatenews.org/news/20092018/hurricane-florence-solar-panel-energy-resilience-extreme-weather-damage-wind-flooding/

Chapter 3: Floodplain Management Practices and Goals

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3. Floodplain Management Practices and Goals

The Upper Rio Grande Regional Flood Planning Group (RFPG) reviewed local regulations and solicited input from stakeholders across the region to develop floodplain management practices and flood protection goals for the Upper Rio Grande region as part of Task 3. Public input and feedback on the practices and goals were received at planning group meetings, public meetings, via an online survey, and through independent outreach by phone and email to stakeholders within the region. The data collection effort provided feedback from more than 100 entities on specific topics representing all counties and a majority of the municipalities in the region.

The Region 14 RFPG divided into subcommittees to focus on specific tasks of the flood plan development. Subcommittee 1 was assigned to address Task 3a, the evaluation and development of recommendations on Floodplain Management Practices, and Task 3b, Flood Mitigation and Floodplain Management Goals. Subcommittee 1 met for discussion and development of these objectives in September, October, and twice in November 2021. The floodplain management practices and goals that resulted from these conferences were presented to and approved by the general body of the RFPG during the November 30th, 2021, monthly meeting. The floodplain management standards and goals described in the following chapter are the result of these meetings and developed with respect to the region under the guidance of regional residents, stakeholders, and the planning group.

3.1 Evaluation and Recommendations on Floodplain Management Practices

The Upper Rio Grande RFPG is required to evaluate and recommend floodplain management practices for the region. From a floodplain management perspective, the region faces issues such as uncontrolled development in unincorporated areas and a lack of resources needed for community officials to effectively enforce drainage and/or development regulations. Standardized floodplain management and land use practices help to reduce existing and future flood risk and promote regionwide flood resiliency.

3.1.1 Evaluation of Floodplain Management Practices

Data Collection

Task 3a involved the collection and qualitative assessment of current floodplain management regulations within the region (i.e., floodplain ordinances, drainage design standards and other related policies). To begin this task, floodplain management regulations and related documents were collected via local entities' websites, as well as through the Federal Emergency Management Agency (FEMA) and other online resources. Follow up outreach via email, phone call, and via a web-based stakeholders survey provided further regulatory documents and information. These documents are summarized in **Table 3-1** and described in further detail in the following sections. A summary of floodplain practices across the region is shown on **Map Exhibit 13** ("Floodplain Management") and in **Appendix Table 3A**.

Table 3.1 Existing Floodplain Management Documents

Type of Regulation	Purpose of document	Entities with Document
Land Use Regulations (Zoning and Subdivision Ordinances)	Regulate types of land use and development in a community and can limit development in and near flood prone areas	Counties of Andrews, Brewster, Ector, El Paso, Midland, Presidio, Reeves, Sutton, Val Verde
Comprehensive Plan / Unified Development Code (UDC)	Guides development within an area for land use and both structural and infrastructure development and retrofit	Culberson County; City of El Paso
Hazard Mitigation Plan	Guides prevention and response for hazards in a region including stormwater/flood-related hazards	Concho Valley Council of Governments; Counties of Brewster, Ector, El Paso, Hudspeth, Jeff Davis; Presidio, Rio Grande Border (includes Counties of Pecos, Reeves, and Terrell)
FEMA Flood Insurance Study (FIS)	FEMA's report on flood hazard data for floodplain management and flood insurance in communities participating in the NFIP; Includes list of flood protection measures	Counties of Brewster, Ector, El Paso, Midland, Sutton, Val Verde; Cities of Alpine, Balmorhea, El Paso, Sonora, Van Horn
Floodplain and Drainage Ordinances	Regulate development within floodplain and the impact new development has on floodplain	All NFIP participants (see “National Flood Insurance Program [NFIP]” discussion below)
Drainage Criteria Manual/Design Manual	Minimum standards for the design of stormwater infrastructure to not increasing flood risk and increase resiliency	City of El Paso, Val Verde County, TxDOT

Land Use Regulations

Development impacts floodplains and flood storage. Local and regional land use plans often provide information regarding a community’s forecasted growth or land use regulations. In Region 14, with the exception of the City of El Paso, significant urban development is not expected, so most of the region’s local and regional governments do not have future land use estimates.

In Texas, cities have planning and zoning powers, while counties have the right to review and regulate the subdivision of land, as granted in *Section 232 of the Texas Local Government Code*. This requirement allows counties to review plats prior to development. Given the limitations of land use regulation that counties in Texas face, land use regulations like zoning and subdivision ordinances are used to influence land use and development.

Hazard Mitigation Planning

Hazard Mitigation Plans (HMPs) are developed to guide actions at the county or regional level to reduce potential hazard impacts and improve emergency response. These planning documents often address risks related to stormwater and flooding and consider characteristics such as land use, resilience, climate adaptation, and economic development plans.

The Rio Grande Council of Governments (RGCOG), representing Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, and Presidio Counties, has led coordination with many of these counties to develop HMPs. Several plans have been completed recently and are awaiting FEMA's approval, including for Brewster County, Jeff Davis County, and Presidio County. In addition, a HMP for Hudspeth County has been approved by FEMA and is waiting for local adoption.

In addition, the County of El Paso prepared a multi-jurisdictional hazard mitigation plan, which has been approved by FEMA and incorporated by participating jurisdictions. This plan was approved on August 16, 2021, and will expire in five years.

Flood Insurance Studies (FIS)/National Flood Insurance Program (NFIP)

FEMA Flood Insurance Studies (FIS) provide an overview of flood risk information for communities as part of the National Flood Insurance Program (NFIP). The NFIP is a program created by the US Congress in 1968 through the National Flood Insurance Act of 1968 and is managed and administrated by FEMA. The NFIP has two purposes: to share the risk of flood losses through flood insurance and to reduce flood damages by restricting floodplain development. NFIP participation is voluntary; however, it allows for discounted flood insurance premiums, eligibility for federal grants and loans, and federal disaster assistance.

All county and incorporated entities in the region are encouraged to enact ordinances that meet minimum requirements for NFIP Participation and remain active NFIP participants in good standing. While incorporated entities (cities/towns/villages) are independently eligible to participate in the NFIP, the participation of unincorporated communities is determined by the participation status of their associated county.

In the Upper Rio Grande Region, 75% of all eligible communities participate in the NFIP (40 out of 53), including 78% of counties (18 out of 23 counties representing 31 unincorporated communities) and 73% of incorporated places (22 out of 30). Communities not participating in the NFIP include seven incorporated places and five counties (including Coyanosa CDP, Imperial CDP, and Sheffield CDP in Pecos County and Lindsay CDP in Reeves County) as listed in **Table 3.2**.

Table 3.2 Communities Not Participating in the NFIP

Incorporated Places (Cities/Towns/Villages)	Counties
Barstow, City of	Andrews County
Kermit, City of	Edwards County
Rankin, City of	Reeves County
Thorntonville, City of	Pecos County
Valentine, Town of	Winkler County
Wickett, City of	
Wink, City of	

For communities to participate in the NFIP program, they must meet requirements based off their flood map zoning designation. NFIP food map zones are based on available mapping data from FEMA. The majority of the Upper Rio Grande Region is in a FEMA Zone A Special Flood Hazard Area. Zone A flood zones are subject to inundation by the 1% annual chance flood event as generally determined using approximate mapping methods. These areas do not have detailed hydraulic analyses and are without defined Base Flood Elevations (BFEs) and flood depths. As an exception to this, the City of El Paso and El Paso County do have detailed hydraulic analyses and include 1% annual chance Zone AE flood zones (with defined BFEs and flood depths) in addition to Zone A (approximate mapped areas) and Zone X (shaded) (for areas between the limits of Zone AE and the 0.2% annual chance event).

All communities in the region which do not participate in the NFIP are located either in a Zone A FEMA flood hazard area or are unmapped. The following NFIP criteria for Zone A and unmapped areas are taken from 44 CFR § 60.3 ("Floodplain management criteria for flood-prone areas").

No FEMA-Defined Flood Zone

- Development permits and proposals
  - Require development permits for all proposed construction to determine location relative to flood-prone areas
  - Review proposed development for all necessary permits
  - Review permit applications for flooding safety
  - Review subdivision/development proposals for flooding safety

- Flood resiliency for water supply and sanitary sewage systems
  - Require flood resiliency measures for new and replacement water supply systems within flood prone areas
  - Require flood resiliency measures for new and replacement sanitary sewage systems (including locating onsite waste disposal systems to avoid impairment or contamination during flooding)

FEMA Flood Zone A (no defined flood elevations)

- Require all standards from previous plus those applied to Zone A hazard areas (cumulative)

- Development permits and proposals
  - Require floodplain development permits for all proposed construction to determine location relative to Zone A hazard areas
  - Require all subdivision/development proposals greater than 50 lots (or 5 acres) include base flood elevation (BFE) data

- Base Flood Elevations (BFE) and lowest floor elevations
  - Obtain, review, and utilize BFE and floodway data available from a Federal, State, or other source
  - Where BFE data are utilized within Zone A (1) obtain elevations of structure lowest floor elevation (including basement), (2) obtain structure floodproofing information, (3) and maintain records of obtained information

- Watercourse alteration or relocation
  - Notify communities adjacent to a riverine area prior to any alteration or relocation of a watercourse
  - Assure that the flood carrying capacity within the altered or relocated watercourse is maintained

- Manufactured homes
  - Require that manufactured homes in Zone A shall be installed using methods which minimize flood damage

In addition to the baseline flood protection required for NFIP participation, FEMA rewards NFIP communities that take advanced measures for flood resilience with better insurance premiums. Advanced resiliency measures are characterized by TFMA's Higher Standards and measured by voluntary participation in the Community Rating System (CRS).

TFMA Higher Standards

The Texas Floodplain Management Association (TFMA) periodically publishes a survey of Higher Standards to document higher floodplain management standards adopted by Texas cities and counties. The survey collects information on various floodplain management practices adopted by communities such as freeboard requirements, stormwater storage, elevation requirements, land use controls, playa lake standards, and setbacks for development.

The City of El Paso is currently the only entity in the region with higher standards recognized by the 2018 TFMA Higher Standards Survey. Floodplain management standards for the City of El Paso vary depending on structure type, regulatory flood zone, and whether a Base Flood Elevation (BFE) has been established. Those standards can be found in Section 15 of Study ID: 92, the City of El Paso Drainage Design Manual (City of El Paso Engineering Department, 2008).

The Community Rating System (CRS)

The CRS is a voluntary incentive program that recognizes and encourages community floodplain management practices that exceed the minimum requirements of the NFIP. The three goals of the CRS are to 1) reduce and avoid flood damage to insurable property.; 2) strengthen and support the insurance aspects of the NFIP; and 3) foster comprehensive floodplain management. The rating system awards points to communities for flood resiliency activities and assigns a CRS class based on the accumulated points where 10 is the lowest score and 1 is the highest score or most activities performed.

The four CRS activity categories are:

- Public Information Activities – programs that advise people about flood hazard & insurance;
- Mapping and Regulations – programs that provide increased protection to new development;
- Flood Damage Reduction Activities – programs that provide increased protection to existing development; and
- Warning and Response – measures that protect life and property during a flood.

The City of El Paso is currently the only entity in the region enrolled in the CRS Program (earning an entry-level rating of 9).[1] Applications for CRS participation have also been submitted by El Paso County and City of Sonora and are under review with an expected rating date by the end of 2022.

3.1.2 Recommendations for Minimum Standards

The Upper Rio Grande RFPG is required to consider whether to recommend or adopt region-wide minimum floodplain management standards and land use practices. *Recommending* minimum practices by the RFPG encourages entities to adopt similar floodplain management practices within their communities. On the other hand, a*dopting* minimum practices by the RFPG requires potential sponsoring entities to adopt these minimum standards before their flood needs (FMEs, FMSs, and FMPs) may be considered for inclusion in the RFP and be eligible for potential state funding.

During the course of this first planning cycle of the 2023 Region/2024 State Flood Plan, the **Upper Rio Grande RFPG voted to recommend but not adopt** the following minimum standards for the region. In future planning cycles, the RFPG may reconsider whether to adopt these recommendations as minimum standards requirements.

- Participate (and maintain active status) in the National Flood Insurance Program (NFIP)
- Require development permits for all proposed construction to determine whether such construction is proposed within flood-prone areas and will be reasonably safe from flooding (44 CFR § 60.3a[1-4])
- Require new and replacement sanitary sewage and water supply systems within flood prone areas to be designed to minimize or eliminate infiltration of flood waters into the systems (44 CFR § 60.3a[1-5])
- Require additional minimum standards for flood-prone areas associated with designated special flood hazard areas (Zone A and AE) (44 CFR § 60.3b-d)
- Require additional minimum standards associated with mudslide (i.e.mudflow)-prone areas (44 CFR § 60.4)
- Require additional minimum standards associated with flood-related erosion-prone areas (44 CFR § 60.5)

These minimum standards recommendations were approved by the Upper Rio Grande RFPG during the General Meeting on November 30, 2021.

3.1.3 Recommendations for Floodplain Management Best Practices

In addition to the recommendations for minimum standards described above, the Upper Rio Grande RFPG considered other region-specific general recommendations. These recommendations include floodplain management best practices, such as adopting higher-than-minimum floodplain standards and participating in the FEMA CRS Program. Implementing these best practices will not only increase flood protection and resiliency in communities, but also provide direct economic benefit through improved insurance coverage during national disasters, discounts on flood insurance through the CRS Program, and increased eligibility for other

[1] CRS Rating classes range from 9 to 1 where CRS Class 1 is the highest possible classification. Most communities enter the program at a CRS Class 9 or Class 8 rating.

financial resources available in the form of disaster recovery and flood infrastructure planning grants and loans.

The following general recommendations were recommended by the RFPG during the first planning cycle. While these general recommendations are strongly encouraged, the RFPG does not anticipate adopting them as minimum standards in future planning cycles at this time.

- Establish local flood outreach and awareness programs (addressing flood risk, resiliency, and mitigation), including providing access to FEMA informational resources
- Coordinate with TxDOT and NWS to use flood warning signs, traffic message boards, and other media (TV, radio, social media) to communicate flood warnings
- Conduct public outreach to identify ongoing flood needs (data gaps, flood management strategies, and flood mitigation projects)
- Develop and maintain local stormwater asset management plans
- Adopt higher-than-NFIP-minimum standards (e.g., higher freeboard) and participate in the TFMA Higher Standards Survey
- Enroll in CRS Program for reduction in flood insurance premiums and flood risk
- Consider and incorporate nature-based practices in flood mitigation projects where possible

3.2 Flood Mitigation and Floodplain Management Goals

The Upper Rio Grande RFPG is required to adopt both Short-Term (10-year) and Long-Term (30-year) flood mitigation and floodplain management goals. These goals help to establish the RFPG's objectives and priorities for the first-cycle flood plan. With input from the Upper Rio Grande RFPG discussed during Subcommittee 1 meetings, 28 individual goals were identified with the following objectives:

- Improve floodplain management practices and design standards (Goals 14001001, 14001002, 14002001, 14002002, 14002003, and 14003001)
- Increase flood protection of unaccredited levees (Goals 14004001 and 14004002)
- Increase availability of flood gages (Goal 14005001)
- Improve region-wide flood warning and communication (Goals 14006001 and 14006002)
- Increase community flood awareness and Flood Plan participation (Goals 14007001, 14007002, and 14007003)
- Improve coverage of flood hazard data through flood mapping (Goals 14008001 and 14008002)
- Reduce flood risk to structures and low water crossings (Goals 14009001, 14009002, 14009003, 14009004, 14010001, and 14010002)
- Increase use of regional stormwater detention (Goal 14011001),
- Increase use of nature-based practices (Goal 14012001),
- Increase use of dual-use flood mitigation/water supply structures (Goal 14013001),
- Increase communities with stormwater asset management plans (Goal 14014001), and
- Increase communities with new and/or dedicated flood funding sources (Goals 14015001 and 14015002).

For each of the identified goals, the RFPG defined the goal term (short-term or long-term), target year (2033 for short-term goals or 2053 for long-term goals), goal application area (region-wide or specific HUC-8 watersheds), and method of measuring future progress against the goal. Additionally, AECOM identified residual risk, associated goal identification numbers, and consistency with overarching goals from the Guiding Principles outlined in TAC Chapter 362. A list of the 28 Short-Term and Long-Term goals is presented in **Appendix Table 3B.**

These goals were first adopted by the Upper Rio Grande RFPG during a General Meeting on November 30, 2021. A second revision to the goals was later adopted by the RFPG on May 25, 2022, including updates to the goals related to increasing the flood protection of unaccredited levees (Goals 14004001 and 14004002).

Chapter 4: Identification of Flood Mitigation Needs and Solutions

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4. Identification of Flood Mitigation Needs and Solutions

4.1 Flood Mitigation Needs Analysis

Based on the flood risk analyses described previously in *Chapter 2 (Flood Risk Analyses)* and the Regional Flood Planning Group (RFPG) goals identified in *Chapter 3 (Floodplain Management Practices and Goals)*, a needs analysis was performed to identify locations within the region which have the greatest flood mitigation and flood risk study needs.

Flood mitigation needs were identified based on a quantitative comparison of the Task 2 exposure results at the county and subcounty level as well as a qualitative consideration of the following factors outlined in the Task 4 Scope of Work (SOW):

a. The areas in the Flood Planning Region (FPR) that the RFPG identified as the most prone to flooding that threaten life and property;
b. The relative locations, extent, and performance of current floodplain management and land use policies and infrastructure located within the FPR, particularly within the locations described in (a);
c. Areas identified by the RFPG as prone to flooding that do not have adequate inundation maps;
d. Areas identified by the RFPG as prone to flooding that do not have hydrologic and hydraulic (H&H) models;
e. Areas with an emergency need;
f. Existing modeling analyses and flood risk mitigation plans within the FPR;
g. Flood mitigation projects already identified and evaluated by other flood mitigation plans and studies;
h. Documentation of historic flooding events;
i. Flood mitigation projects already being implemented; and
j. Other factors that the RFPG deemed relevant, such as flood projects with nature-based solutions and equal representation throughout the region.

The quantitative needs analysis included an evaluation of: (1) the greatest gaps in flood risk information; and (2) the areas with the greatest flood risk, as described in Sections 4.1.1 through 4.1.3. The qualitative needs analysis was conducted over several stakeholder workshop meetings, described as part of the flood solutions identification process overview in Section 4.2. Both quantitative and qualitative needs analyses were utilized to identify Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs) across the region as described later in this chapter in Sections 4.3 through 4.5.

4.1.1 Greatest Gaps in Flood Risk Information by County

Flood risk information gaps are areas that do not have sufficient flood risk data to estimate flood risks or to identify or compare project alternatives to mitigate the associated flood risks. These gaps may include areas that have limited or no Federal Emergency Management Agency (FEMA) regulatory flood mapping data as well as areas that have flood data lacking sufficient quality, such as outdated information or data with inadequate resolution. Summaries of the region's existing conditions and future conditions flood risk data gaps are presented in Chapter 2 Section 2.2.2 and Section 2.3.5, respectively.

To identify the greatest flood risk information gaps, counties were ranked based on the results of the existing conditions 1% annual chance (AC) flood exposure analysis from Chapter 2, accounting for the following flood hazard exposure estimate categories:

- Number of residential and non-residential properties and associated population;
- Number of roadway crossings;
- Length of roadway segments;
- Agricultural area;
- Number of critical facilities; and
- Average Social Vulnerability Index (SVI) of buildings in the floodplain.

The results of this county ranking analysis are presented in **Table 4.1**. Comparing these county ranks with the flood risk information gaps identified in Chapter 2, counties with the greatest flood risk data gaps were identified if they ranked among the top 10 (roughly equivalent to the top 40%) of all counties in the region for any of the flood exposure categories. These greatest flood risk data gaps are presented in **Map Exhibit 14** (Greatest Gaps in Flood Risk Information).

Based on this analysis, the greatest gaps in terms of areas with limited or no FEMA regulatory flood mapping data include the counties of Reeves, Winkler, Pecos, Andrews, Upton, and Crane (in ranked order).

Similarly, the greatest gaps in terms of areas with outdated FEMA regulatory flood mapping data include the counties of Brewster, Ward, Presidio, Crockett, Sutton, Hudspeth, Culberson, Jeff Davis, and Terrell (in ranked order).[1]

[1] Although Midland County was ranked among the top 10 counties for greatest flood risk data gaps based on "Average SVI of Buildings in the Floodplain", it was excluded from the final ranked list since there is only a small portion of the county which overlaps the Upper Rio Grande region.

Table 4.1 Greatest Flood Data Gaps by County (Exposure to 1% AC Flood Risk)

County Rank	County	Number of Structures in Floodplain	County	Residential Structures in Floodplain	County	Population	County	Roadway Stream Crossings (#)	County	Roadway Segments (miles)	County	Agricultural Areas (sq. mi.)	County	Critical Facilities (#)	County	Average SVI of Features in Floodplain or Flood-Prone Areas
1	El Paso	21,377	El Paso	16,860	El Paso	70,260	El Paso	457	El Paso	458	Hudspeth	246	El Paso	37	Culberson	0.935
2	**Reeves**	**3,535**	Brewster	1,615	**Reeves**	**10,707**	**Pecos**	**182**	**Reeves**	**337**	El Paso	61	**Reeves**	**10**	Hudspeth	0.932
3	Brewster	2,640	**Reeves**	**1,580**	Brewster	7,217	Presidio	101	Culberson	317	Jeff Davis	53	**Pecos**	**9**	Presidio	0.916
4	Ward	2,071	**Winkler**	**1,126**	Ward	4,189	Culberson	90	Hudspeth	288	**Pecos**	**47**	Crockett	8	El Paso	0.665
5	**Winkler**	**1,680**	Presidio	696	**Winkler**	**3,675**	Brewster	81	**Pecos**	**284**	Presidio	45	Brewster	7	Midland	0.664
6	Presidio	1,353	Crockett	680	**Pecos**	**3,424**	Crockett	80	Brewster	210	Brewster	43	Sutton	5	Sutton	0.651
7	Crockett	1,292	Sutton	492	Presidio	2,973	**Reeves**	**72**	Ward	196	Culberson	32	Ward	4	**Reeves**	**0.646**
8	**Pecos**	**1,040**	Ward	470	Crockett	2,392	Hudspeth	70	Crockett	187	Val Verde	22	**Winkler**	**4**	Crockett	0.607
9	Sutton	963	**Pecos**	**370**	Hudspeth	1,629	Jeff Davis	53	Val Verde	163	**Andrews**	**18**	**Upton**	**3**	Ector	0.593
10	Hudspeth	823	Ector	234	Sutton	1,562	Terrell	50	**Winkler**	**126**	**Reeves**	**18**	Hudspeth	2	**Crane**	**0.559**
11	Jeff Davis	660	Upton	185	Jeff Davis	1,431	Val Verde	38	Presidio	122	Crockett	7	Terrell	2	Reagan	0.558
12	Val Verde	577	Val Verde	147	Val Verde	1,393	Ward	30	Sutton	96	Loving	4	Crane	1	Winkler	0.555
13	Culberson	567	Terrell	146	Culberson	1,382	Schleicher	29	Jeff Davis	63	Schleicher	4	Jeff Davis	1	Val Verde	0.549
14	Terrell	391	Jeff Davis	135	Terrell	945	Upton	21	Terrell	51	Ward	4	Loving	1	Upton	0.539
15	Ector	340	Culberson	115	Ector	606	Edwards	11	Crane	41	Crane	3	Andrews	0	Schleicher	0.534
16	Upton	331	Hudspeth	44	Upton	599	Crane	7	Upton	28	Terrell	3	Culberson	0	Ward	0.531
17	Crane	277	Edwards	27	Crane	591	Loving	3	Ector	26	Winkler	3	Ector	0	Brewster	0.515
18	Loving	95	Schleicher	5	Loving	291	Reagan	1	Edwards	19	Sutton	2	Edwards	0	Loving	0.502
19	Edwards	58	Loving	2	Edwards	127	Winkler	1	Loving	17	Upton	1	Midland	0	Pecos	0.502
20	Schleicher	33	Midland	2	Schleicher	73	Andrews	0	Andrews	8	Ector	0	Presidio	0	Edwards	0.47
21	Andrews	9	Andrews	0	Andrews	41	Ector	0	Schleicher	5	Edwards	0	Reagan	0	Terrell	0.453
22	Midland	7	Crane	0	Midland	20	Midland	0	Midland	3	Reagan	0	Schleicher	0	Jeff Davis	0.408
23	Reagan	2	Reagan	0	Reagan	3	Sutton	0	Reagan	0	Midland	0	Val Verde	0	Andrews	0.234

Legend:

Greatest Gaps in Flood Risk (limited or no FEMA flood mapping information)

Greatest Gaps in Flood Risk (old FEMA flood mapping information)

4.1.2 Greatest Flood Risk by County and Community

Areas of greatest flood risk were identified at the county level by ranking each county based on the results of the existing conditions 1% AC flood exposure analysis from Chapter 2 and using the same exposure estimate categories as described in Section 4.1.1. In the county analysis, counties with the greatest flood risks were identified if they ranked among the top 6 (roughly equivalent to the top 25%) of all counties in the region for any of the flood exposure categories. The results of this county ranking analysis are presented in **Table 4.2**. Based on this analysis, the greatest flood risks by county include the counties of El Paso, Reeves, Brewster, Ward, Winkler, Presidio, Crockett, Pecos, Culberson, Hudspeth, Jeff Davis, and Sutton (in ranked order).[2]

In addition to ranking flood risk by county, subcounty entities were ranked (including both incorporated and census designated places [CDPs]) according to the estimated number of structures in the floodplain within each community. The results of the community ranking analysis are presented in **Table 4.3**. Based on this analysis, the top 10 subcounty entities by flood risk to structures include the City of El Paso, the City of Socorro, the City of Pecos, the City of Alpine, Fort Bliss CDP, the City of Kermit, Ozona CDP, Southwest Sandhill CDP, the City of Sonora, and Canutillo CDP (in ranked order).

Using the results of the existing conditions 1% AC flood exposure analysis, a spatial density analysis was also performed across the region to identify potential flood risk "hot spots." The results of this density analysis, along with detailed flood hazard and building exposure maps for the top-risk subcounty entities, are presented in **Map Exhibit 15** (Greatest Flood Risk).

[2] Although Midland County was ranked among the top 6 counties for greatest flood risks based on "Average SVI of Buildings in the Floodplain", it was excluded from the final ranked list since there is only a small portion of the county which overlaps the Upper Rio Grande region.

Table 4.2 Greatest Flood Risk by County

County Rank	County	Number of Structures in Floodplain	County	Residential Structures in Floodplain	County	Population	County	Roadway Stream Crossings (#)	County	Roadway Segments (miles)	County	Agricultural Areas (sq. mi.)	County	Critical Facilities (#)	County	Average SVI of Features in Floodplain or Flood-Prone Areas
1	El Paso	21,377	El Paso	16,860	El Paso	70,260	El Paso	457	El Paso	458	Hudspeth	246	El Paso	37	Culberson	0.935
2	Reeves	3,535	Brewster	1,615	Reeves	10,707	Pecos	182	Reeves	337	El Paso	61	Reeves	10	Hudspeth	0.932
3	Brewster	2,640	Reeves	1,580	Brewster	7,217	Presidio	101	Culberson	317	Jeff Davis	53	Pecos	9	Presidio	0.916
4	Ward	2,071	Winkler	1,126	Ward	4,189	Culberson	90	Hudspeth	288	Pecos	47	Crockett	8	El Paso	0.665
5	Winkler	1,680	Presidio	696	Winkler	3,675	Brewster	81	Pecos	284	Presidio	45	Brewster	7	Midland	0.664
6	Presidio	1,353	Crockett	680	Pecos	3,424	Crockett	80	Brewster	210	Brewster	43	Sutton	5	Sutton	0.651
7	Crockett	1,292	Sutton	492	Presidio	2,973	Reeves	72	Ward	196	Culberson	32	Ward	4	Reeves	0.646
8	Pecos	1,040	Ward	470	Crockett	2,392	Hudspeth	70	Crockett	187	Val Verde	22	Winkler	4	Crockett	0.607
9	Sutton	963	Pecos	370	Hudspeth	1,629	Jeff Davis	53	Val Verde	163	Andrews	18	Upton	3	Ector	0.593
10	Hudspeth	823	Ector	234	Sutton	1,562	Terrell	50	Winkler	126	Reeves	18	Hudspeth	2	Crane	0.559
11	Jeff Davis	660	Upton	185	Jeff Davis	1,431	Val Verde	38	Presidio	122	Crockett	7	Terrell	2	Reagan	0.558
12	Val Verde	577	Val Verde	147	Val Verde	1,393	Ward	30	Sutton	96	Loving	4	Crane	1	Winkler	0.555
13	Culberson	567	Terrell	146	Culberson	1,382	Schleicher	29	Jeff Davis	63	Schleicher	4	Jeff Davis	1	Val Verde	0.549
14	Terrell	391	Jeff Davis	135	Terrell	945	Upton	21	Terrell	51	Ward	4	Loving	1	Upton	0.539
15	Ector	340	Culberson	115	Ector	606	Edwards	11	Crane	41	Crane	3	Andrews	0	Schleicher	0.534
16	Upton	331	Hudspeth	44	Upton	599	Crane	7	Upton	28	Terrell	3	Culberson	0	Ward	0.531
17	Crane	277	Edwards	27	Crane	591	Loving	3	Ector	26	Winkler	3	Ector	0	Brewster	0.515
18	Loving	95	Schleicher	5	Loving	291	Reagan	1	Edwards	19	Sutton	2	Edwards	0	Loving	0.502
19	Edwards	58	Loving	2	Edwards	127	Winkler	1	Loving	17	Upton	1	Midland	0	Pecos	0.502
20	Schleicher	33	Midland	2	Schleicher	73	Andrews	0	Andrews	8	Ector	0	Presidio	0	Edwards	0.47
21	Andrews	9	Andrews	0	Andrews	41	Ector	0	Schleicher	5	Edwards	0	Reagan	0	Terrell	0.453
22	Midland	7	Crane	0	Midland	20	Midland	0	Midland	3	Reagan	0	Schleicher	0	Jeff Davis	0.408
23	Reagan	2	Reagan	0	Reagan	3	Sutton	0	Reagan	0	Midland	0	Val Verde	0	Andrews	0.234

Legend:

Greatest Flood Risk (shaded: rows 1–6)

Table 4.3 Estimated Number of Structures in Floodplain by Community

Rank	Community	County	Number of Structures in Floodplain within Community
1	El Paso city	El Paso	12,324
2	Socorro city	El Paso	2,578
3	Pecos city	Reeves	1,944
4	Alpine city	Brewster	1,643
5	Fort Bliss CDP	El Paso	1,145
6	Kermit city	Winkler	1,126
7	Ozona CDP	Crockett	944
8	Southwest Sandhill CDP	Ward	794
9	Sonora city	Sutton	690
10	Canutillo CDP	El Paso	676
11	Presidio city	Presidio	655
12	San Elizario city	El Paso	544
13	Monahans city	Ward	440
14	Balmorhea city	Reeves	361
15	Homestead Meadows North CDP	El Paso	359
16	Dell City city	Hudspeth	293
17	Imperial CDP	Pecos	272
18	Sanderson CDP	Terrell	258
19	Clint town	El Paso	249
20	Marfa city	Presidio	212
21	Fabens CDP	El Paso	200
22	Thorntonville town	Ward	195
23	Lindsay CDP	Reeves	189
24	McCamey city	Upton	172
25	Van Horn town	Culberson	170
26	Fort Stockton city	Pecos	168
27	Barstow city	Ward	149
28	Crane city	Crane	143
29	Fort Davis CDP	Jeff Davis	131
30	Prado Verde CDP	El Paso	112
31	Toyah town	Reeves	101

4.1.3 Summary of Flood Mitigation Needs

Combining the results of the quantitative needs analysis for the greatest flood risk data gaps and greatest flood risks, a summary of flood mitigation needs by county was developed as shown in **Table 4.4**. For reference, this table also includes the corresponding IDs to potential flood solutions for each county, including FMEs, FMPs, and FMSs, that were identified based on both quantitative and qualitative needs analyses. These flood solutions are described later in this Chapter in Sections 4.3 through 4.5 as well as in *Chapter 5 (Evaluation and Recommendation of Flood Solutions)*.

Table 4.4 Summary of Flood Mitigation Needs by County

County	Greatest Flood Risk Data Gap (Limited or No FEMA Flood Mapping Information)	Greatest Flood Risk Data Gap (Old FEMA Flood Mapping Information	Greatest Flood Risk	Top At Risk Communities by Estimated Number of Structures in Floodplain (from Table 4.3)	FMEs	FMPs	FMSs[a]
Andrews	✓	-	-	-	-	-	142000013
Brewster	-	✓	✓	Alpine city	141000023	-	142000002, 142000013, 142000017, 142000022
Crane	✓	-	-	Crane city	-	-	142000007
Crockett	-	✓	✓	Ozona CDP	141000025	-	142000007
Culberson	-	✓	✓	Van Horn town	-	-	-[a]
Ector	-	-	-	-	-	-	-[a]
Edwards	-	-	-	-	-	-	142000013
El Paso	-	-	✓	El Paso city, Socorro city, Fort Bliss CDP, Canutillo CDP, San Elizario city, Homestead Meadows North CDP, Clint town, Fabens CDP, Prado Verde CDP	141000001, 141000003, 141000004, 141000005, 141000006, 141000015, 141000018, 141000019, 141000033, 141000034, 141000035	143000003, 143000005, 143000011, 143000021, 143000024, 143000025, 143000097, 143000100, 143000105, 143000111, 143000113, 143000116	142000001, 142000004, 142000009, 142000010, 142000015, 142000017, 142000019, 142000020
Hudspeth	-	✓	✓	Dell City city	141000014, 141000022	143000009	142000003, 142000013, 142000017
Jeff Davis	-	✓	✓	Fort Davis CDP	-	-	-[a]
Loving	-	-	-	-	-	-	142000007
Midland	-	-	-	-	-	-	-[a]
Pecos	✓	-	✓	Imperial CDP, Fort Stockton city	141000012	-	142000007, 142000013, 142000024

County	Greatest Flood Risk Data Gap (Limited or No FEMA Flood Mapping Information)	Greatest Flood Risk Data Gap (Old FEMA Flood Mapping Information	Greatest Flood Risk	Top At Risk Communities by Estimated Number of Structures in Floodplain (from Table 4.3)	FMEs	FMPs	FMSs[a]
Presidio	-	✓	✓	Presidio city, Marfa city	141000002, 141000008	143000007	142000005, 142000006, 142000008, 142000013, 142000017, 142000023, 142000025
Reagan	-	-	-	-	-	-	-[a]
Reeves	✓	-	✓	Pecos city, Balmorhea city, Lindsay CDP, Toyah town	141000010		142000007, 142000013, 142000021
Schleicher	-	-	-	-	-	-	-[a]
Sutton	-	✓	✓	Sonora city	141000024	-	142000013
Terrell	-	✓	-	Sanderson CDP	-	-	142000007, 142000017
Upton	✓	-	-	McCamey city	-	-	-[a]
Val Verde	-	-	-	-	-	-	142000007
Ward	-	✓	✓	Southwest Sandhill CDP, Monahans city, Thorntonville town, Barstow city	141000026	-	142000007, 142000013
Winkler	✓	-	✓	Kermit city	141000021	-	142000013

[a]FMS 142000014 and FMS 142000016 are identified for all counties. FMS 142000013 includes the following entities as well as those listed in this table: City of Rankin, Town of Valentine, City of Wickett, and City of Wink.

4.2 Process for Identifying Flood Mitigation Solutions

The primary objective of the Upper Rio Grande Regional Flood Plan (RFP) is to identify specific flood risks within the region and identify, evaluate, and recommend potential solutions to mitigate and manage these risks in alignment with the region's short-term and long-term goals. These solutions may include FMEs, FMSs, and FMPs, as defined below:

- Flood Management Evaluation – 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 – a proposed project, either structural or non-structural, that has non-zero capital costs or other non-recurring costs, and when implemented, will reduce flood risk, mitigating flood hazards to life or property; and
- Flood Management Strategy – a proposed plan to reduce flood risk or mitigate flood hazards to life or property.

FMPs and FMSs that were identified as potentially feasible flood reduction projects with measurable benefits require the use of detailed H&H models to quantify flood risk reductions to structures and populations, including residential properties, agricultural land, and critical facilities. Furthermore, applicable FMSs and FMPs must be evaluated to adhere to General Mapping and Modeling Guidelines (defined in Section 3.5 of the Technical Guidelines) and ensure that no negative impacts are received by neighboring areas.

FMSs and FMPs that were identified to be potentially feasible through the processes described in this section were selected for further evaluation as part of Task 4B to determine whether they have sufficient H&H modeling data to be analyzed for project impacts and benefits. The FMP flow chart from Section 2.4B of the RFP Technical Guidelines (shown in **Figure 4.1**) was implemented as part of this screening process.

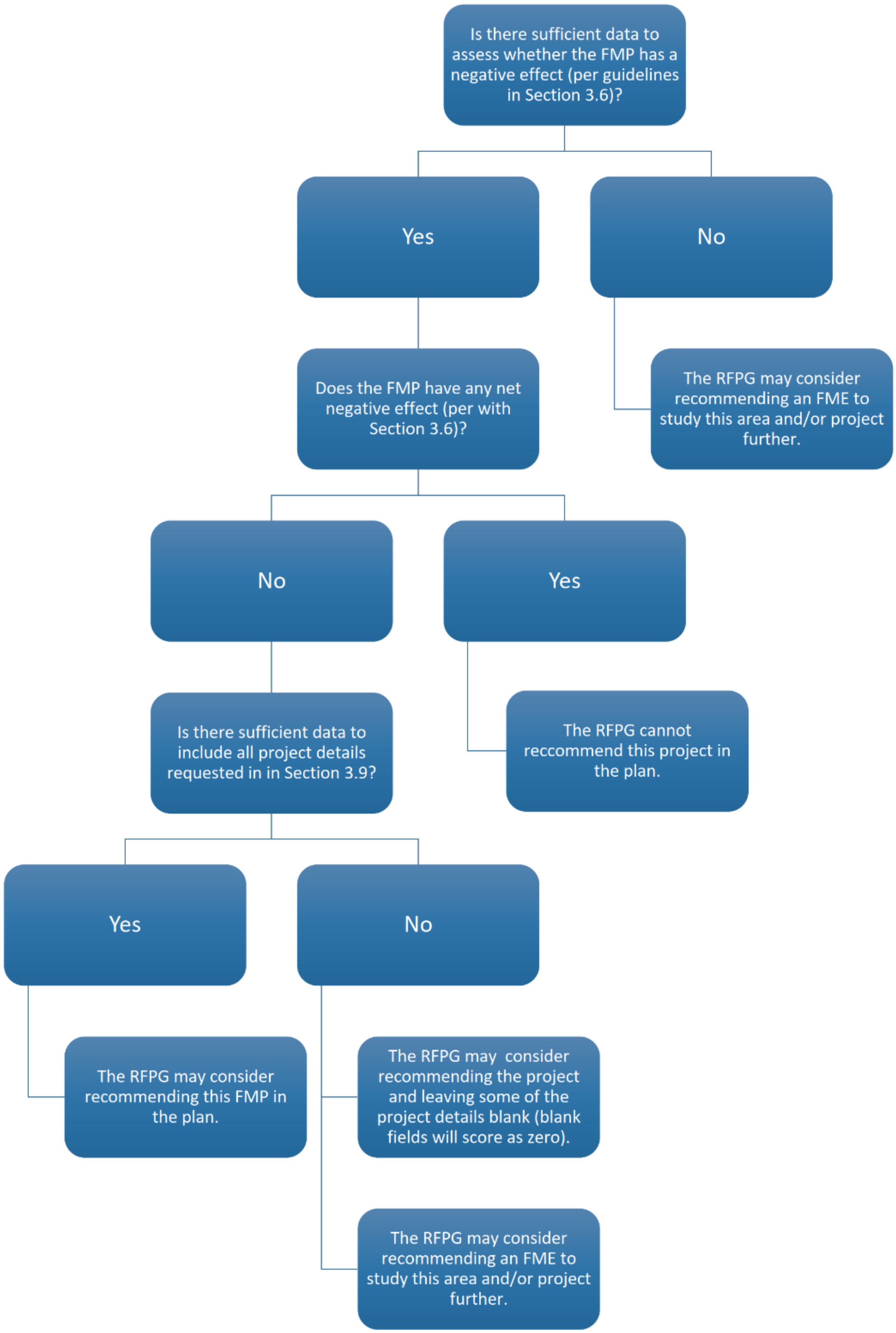

Figure 4.1 FMP Flowchart from Texas Water Development Board (TWDB) Technical Guidelines for Regional Flood Planning

If best available H&H models were deemed insufficient for quantifying project benefits and impacts, or if negative impacts are estimated for neighboring areas, those potentially feasible FMSs and FMPs were categorized instead as potential FMEs. The general scope items associated with those FMEs would include:

- Development of detailed H&H models;
- Evaluating alternatives to define flood mitigation projects resulting in no negative impacts;
- Quantifying project impacts and benefits; and
- Estimating project costs.

The process described in the following section would then be re-applied to the potentially feasible FMSs and FMPs to be considered for recommendation in either the amended RFP for this cycle or for the next RFP cycle.

There are some exceptions where FMSs cannot be modeled, but do not fall into the typical categories of FMPs or FMEs due to their requiring recurring costs or if it is an educational outreach program, for example. Other types of specific FMSs are described in Section 4.5, along with the reasons they were classified as FMSs. In addition, some FMPs or FMSs that were identified in the RFP may be non-structural, such as regulatory requirements for reduction of flood risk or early warning systems. These types of FMPs and FMSs are discussed in Sections 4.4 and 4.5, respectively. The RFPG approved the process for identifying FMEs, FMSs, and FMPs in a technical memorandum to the TWDB, signed January 7, 2022 and in a General RFPG Meeting held December 16, 2021.

4.2.1 Process for Identification of Potential FMEs and Potentially Feasible FMSs

A subcommittee of the RFPG was formed to identify and evaluate potential FMEs and potentially feasible FMSs (Subcommittee 3 for Task 4B, a-b). This subcommittee developed recommendations to define the process used to identify potential FMEs and potentially feasible FMSs, which were then voted on by the subcommittee, presented to the RFPG, and ultimately approved by the RFPG.

The RFPG-approved process for identification of potential FMEs and potentially feasible FMSs included these steps:

- Selection of recent historic storms, either by stakeholders or the public during the General RFPG Meetings, Subcommittee Meetings, or via the public survey process. The selected historic storms would then serve as the basis for identification of needs.
  - Selection of historic storms included the August 2006 storm affecting west and northwest El Paso County, the August 2021 storm affecting east central El Paso, and the September-October 2008 storm affecting the Rio Grande near Presidio.
  - Descriptions of these storms are provided in *Section 1.2 (Historical Flooding)* of *Chapter 1.*

- Within a series of subcommittee meetings:
  - Presentation by RFPG members, stakeholders, and public of experience during the selected events that describes flood-related problems.
  - In public discussion, development of a short description of each problem that defines a need.
  - In public discussion, proposal of FMEs and FMSs to address the need.
  - The subcommittee votes on how to proceed with each FMS and FME identified and makes a recommendation to the RFPG for approval.
  - The RFPG votes on whether to approve the subcommittee's recommendation.

Presentation by RFPG Members, Stakeholders, and Public of Flood Experience

Presenters were briefed at the beginning of Subcommittee 3 meetings to structure their experience of historic flooding as follows: (1) for each storm event discussed, give a tour of the general or specific locations of the experienced damages/ issues; and (2) present a map during the presentation showing locations as discussed. Notes were taken by RFPG consultant staff describing in brief terms the flood-related problem(s) experienced for each storm and location. Following the presentation, RFPG consultant staff queried the presenter to discuss and note each of the following broader issues:

- Primary public concerns;
- Adequacy of early warning;
- Issues with emergency route/ critical facility access;
- Post-flood cleanup issues; and
- Issues with agency coordination.

Background information on historic floods was presented to the subcommittee by:

- Active stormwater professionals at El Paso Water;
- Retired staff from City of El Paso (COEP) and El Paso Water;
- El Paso County Engineer;
- Staff at El Paso County Water Improvement District No. 1 (EPCWID1);
- Current and former staff from the U.S. International Boundary and Water Commission (USIBWC);
- Hudspeth County Emergency Management Coordinator/County Administrator; and
- In the event that a flood experience or potential need was identified by the general public or a stakeholder within the region who could not present their experiences or describe their flood-related issue in a subcommittee meeting, AECOM or a subcommittee member presented to the subcommittee on behalf of that person. In

addition, any flood damage centers that were identified by AECOM through a desktop analysis, but which have not been identified by the public or by stakeholders, were presented to the subcommittee or directly to the RFPG by AECOM. Following the presentation to Subcommittee 3, the subcommittee and/or RFPG decided whether to recommend the FME or FMS for approval by the RFPG.

Develop a Short Description of Each Problem that Defines a Need

In public discussion, the notes from each presentation were reviewed by the subcommittee and public attending the subcommittee meeting. The noted problems were reformulated as needs relevant to the region.

Propose FMEs and FMSs to Address the Need

During the public meetings, drainage issues and challenges were discussed along with identifying potential FMEs and FMSs. Identified FMEs and FMSs were presented, discussed, and refined at subsequent Subcommittee 3 meetings and/or General RFPG meetings as needed.

4.2.2 Process for Identification of Potentially Feasible FMPs

A subcommittee was formed to identify and evaluate potentially feasible FMPs (Subcommittee 2 for Task 4B, c). “Potentially feasible FMPs” comprise a subset of the full list of regional FMPs that are to be carried forward for technical evaluation and considered for recommendation in the RFP. This subcommittee proposed a process for identifying and selecting potentially feasible FMPs, which was then voted on by the subcommittee, presented to the RFPG, and approved by the RFPG. A recommended process was developed for each of two scenarios:

1. FMPs that are currently listed in an active Stormwater Master Plan (SWMP). An active SWMP is defined as current planning for future funding of selected stormwater infrastructure projects, where the projects have been identified, planned (i.e., undergone concept design and cost estimation) and prioritized via a public process; and
2. Other potential FMPs identified by the RFPG process and the public.

Identification of Potentially Feasible FMPs via an Active SWMP

The RFPG identified two recently updated SWMPs that reflect current needs and projects which are still under consideration by city and county officials: a list of 96 stormwater mitigation projects developed by El Paso Water for the City of El Paso (Study ID 13 in *Chapter 1 Appendix Table 1D - Relevant Existing Planning Documents Summary*), and a list of 69 stormwater mitigation projects developed by El Paso County (Study ID 26 in *Appendix Table 1D*). The recommended process for identifying potential FMPs from these two SWMPs is:

- Address all projects within each SWMP as a separate group;
- The subcommittee and public reviews and modifies the existing SWMP project ranking system (if they are ranked) per public discussion within a subcommittee meeting; and

- The subcommittee reviews the list of projects following re-ranking per the revised ranking system and chooses an option for selecting which projects ("Potentially Feasible FMPs") will undergo further evaluation. The project scores used in ranking will limit the number of projects carried forward into the evaluation phase.

Subcommittee 2 has reviewed and approved, with minor alterations, the ranking systems used in the City of El Paso and El Paso County SWMPs.

Identification of Potentially Feasible FMPs not Included in an Active SWMP

The recommended process for identifying "potentially feasible FMPs" from the identified full list of projects not included in an active SWMP is:

- Create a list of regional projects not included in an active SWMP;
- Develop an FMP scoring method in a subcommittee meeting;
- Apply the FMP scoring method to score each project in the regional list; and
- Via subcommittee consensus, select "Potentially Feasible FMPs" from the list using the developed project scores.

Create a List of Regional Projects not Included in an Active SWMP

The RFPG has identified potential FMPs developed outside of a SWMP process by these entities:

- USIBWC;
- EPCWID1;
- U.S. Army Corps of Engineers (USACE);
- Texas Department of Transportation (TXDOT); and
- Others (three counties and a water supply project by El Paso Water).

Develop the FMP Scoring Method in a Subcommittee Meeting

The following two lists of project scoring categories have been recommended to the RFPG by Subcommittee 2 and were voted upon and approved by the RFPG on December 16, 2021. These lists were recommended by Subcommittee 2 based on a comparison of these lists to the finalized Flood Mitigation and Floodplain Management Goals, documented in *Section 3.2 (Flood Mitigation and Floodplain Management Goals)*. These lists derive from similar lists of categories used in the City of El Paso SWMP, with added categories available through information developed as part of the exposure analysis documented in *Chapter 2*.

The first list, shown in **Table 4.5**, is a list of project benefits to be qualitatively compared between projects. These categories were assigned a range of potential scoring points per subcommittee judgement of the relative importance of each category.

Table 4.5 Proposed Benefit Categories and Data Sources

Source	Benefit Category	Current Data Source	Range of Potential RFPG Scoring Points	
			No Benefit	Provides Benefit
City of El Paso SWMP	Increase Dam Safety	National Inventory of Dams, Chapter 299 TWC	0	4
	Reduce Flooding of Property	Best available risk maps, TWDB structure inventory	0	3-4
	Remove 100+ Properties from the Flood Zone	Best available risk maps, TWDB structure inventory	0	4
	Reduce Flooding of IH-10	FMP location versus IH-10	0	1-3
	Reduce Flooding of Major Arterial Roadways	Road classification database	0	3
	Reduce the Risk Associated with Debris Flow	Review of aerial photography to ID mobile bed arroyo	0	3-4
	Reduce Maintenance	Review of aerial photography to ID mobile bed arroyo	0	1-4
	Reduce Nuisance Flooding	Review of likely flat terrain-related routine flooding	0	2
TWDB	Reduce # of low water crossings in floodplain	RFP Task 2 exposure dataset	0	1-3
	Reduce # of vulnerable buildings in floodplain	RFP Task 2 exposure dataset	0	1-3
	Reduce # of critical buildings in floodplain	RFP Task 2 exposure dataset	0	1-4

The second list, shown in Table 4.6, is of federal, state, and local agencies with potential permit authority. The difficulty of obtaining an agency permit for each project was qualitatively judged, adding a positive or negative score adjustment to each project.

Table 4.6 Scoring Adjustments Agencies with Permit Authority

Permit Agency	
• Railroad Permit	• Texas Parks and Wildlife
• USIBWC	• Historic District / Archaeologic
• Texas Commission on Environmental Quality (TCEQ)	• Land Acquisition
• USACE	• Street, Utility, and Amenities Reconstruction
• EPCWID1 / Elephant Butte Irrigation District (EBID) Permit	• Environmental Impacts
• TxDOT Permit	• Other Ordinances (Parks, Unexploded Ordnances, Open Space)
• Fort Bliss Permit	
Scoring Adjustments for Permit Required: Yes (-1), No (0)	
Scoring Adjustments for Permit Complexity: Easy (+1), Normal (0), Difficult (-1), Unknown (-2)	

Apply the FMP Scoring Method to Score Each Project in the Regional List

For each project, the scoring method considers:

- Total scored benefits from **Table 4.5**.
- Total score adjustments from **Table 4.6**.
- The total score when adding the scored benefits from Table 4.5 to the score adjustments from **Table 4.6**.
- After scoring of each project, the list of projects is sorted in order of descending score value.

Select Potentially Feasible FMPs based on Project Scores

The last step in the process for selecting potentially feasible FMPs that are not included in SWMPs is via Subcommittee 2 consensus, selecting "Potentially Feasible FMPs" from the sorted list using the developed project scores.

Combining and Prioritizing All Groups of Feasible FMPs

After the process described above is implemented to rank FMPs within groups of separate SWMPs and projects not selected from SWMPs, projects in each group were separated into tiers with no more than five projects in each tier (Tier 1 being the highest priority in each group). Then, an additional round of prioritization and ranking was needed to combine all the projects into a single list of FMPs for evaluation. The agreed upon process for further prioritization of projects identified by the RFPG included selecting an equal number of projects (the top tier) from each group identified (five from the El Paso County SWMP, five from the City of El Paso SWMP, and five projects that were not selected from SWMPs). This combined list of FMPs for Region 14 was sorted within a Subcommittee 2 meeting based upon the following factors (in order of sorting priority):

- The ranking/tier of each project within their respective groups;
- Complexity of the required H&H modeling analyses;
- Remaining time and budget to complete the RFP;
- Desire to have an equal number of projects from each group (each separate SWMP and the group of non-SWMPs); and
- One additional project was added to the top 15 for evaluation due to the desire of the RFPG to select projects throughout different areas of the region as opposed to focusing all of them in the most populated county, i.e., El Paso County.

Despite the efforts of the RFPG to identify and select FMPs for evaluation throughout all areas of the region, due to the lack of recent/available H&H models and planning documents in regions outside of El Paso County, the majority of the selected FMPs (12 of the initial 16 projects) were located in El Paso County. This initial set of prioritized projects selected for evaluation as potentially feasible FMPs in the RFP is provided in **Table 4.7**, along with the associated sorting criteria.

Table 4.7 Initial Prioritized List of FMPs for Evaluation

Overall Evaluation Order	FMP Name	Description	Evaluation Complexity/ Level of Effort	Category Name	Category (3rd Sort Priority)	Tier (1st Priority Sort)	Category LOE Rank (2nd Sort Priority)
1	Develop and Implement Floodplain Ordinance to Regulate Development at Hudspeth County	Coordinate with Hudspeth County Commissioners, Road & Bridge Departments, Safety & Inspection Departments, & County Attorney to draft a floodplain ordinance (or modify existing subdivision ordinance) to regulate development standards in Hudspeth County.	Less Complex	Not in SWMP	1	1	1
2	HAC3	Sediment/Retention Basin	Less Complex	El Paso County SWMP	2	1	1
3	EA10A	Build sediment/detention basin upstream of Paseo del Este Drive	Less Complex	COEP/El Paso Water SWMP	3	1	1
4	SOC4	Sediment/Detention Basin at “Mankato Arroyo”	Less Complex	Not in SWMP	1	1	2
5	FAB1	Sediment/Retention Basin	Less Complex	El Paso County SWMP	2	1	2
6	NW16	Expand channel from Village Ct to Doniphan Dr	Average	COEP/El Paso Water SWMP	3	1	2
7	Regional Pond and Storm Drain System at San Elizario	Construct an 11.5 ac-ft regional Pond and storm drain system with drainage inlets and approximately 740-ft of 30" RCP. Described as Alternative 1 from 12/5/2018 City of San Elizario “Drainage Feasibility Study”. (During the evaluation process, Alternative 3 was selected instead of Alternative 1).	Average	Not in SWMP	1	1	3
8	CAN1	Reconstruction of the channel with concrete lining	Less Complex	El Paso County SWMP	2	1	3
9	NW3	Construction of New larger capacity Doniphan Pump Station to replace PS1, with new force main directly to the Rio Grande. Install new catch basin with mechanical bar screen upstream of PS2.	Average	COEP/El Paso Water SWMP	3	1	3
10	SH20 Drainage Improvements from Doniphan Drive to Texas Avenue	Improvements to inlet and culvert capacities at 14 crossings, with cost estimates and prioritizations available.	Average	Not in SWMP	1	1	4
11	MON3	Sediment/Retention Basin	More Complex	El Paso County SWMP	2	1	4

Overall Evaluation Order	FMP Name	Description	Evaluation Complexity/ Level of Effort	Category Name	Category (3rd Sort Priority)	Tier (1st Priority Sort)	Category LOE Rank (2nd Sort Priority)
12	NW26	Acquire land, construct a permanent wetland, install a storm drain system to Doniphan Drive, construct pipeline to Doniphan Pump Station and build new pump station to control flood levels.	Average	COEP/El Paso Water SWMP	3	1	4
13	Excavate Fort Bliss Sump	Excavate Ft. Bliss Sump for additional storage capacity (not in SWMP)	Average	Not in SWMP	1	1	5
14	SSA4	Detention Basin SSA4	More Complex	El Paso County SWMP	2	1	5
15	NE3B	Alcan Pond: new catch basin to capture FP15 upstream	Average	COEP/El Paso Water SWMP	3	1	5
16	Install Flood Gates in Marfa and Monitoring Gage on North Alamito Creek and Highway 17	Add flood gates to Alamito Creek low water crossings in Marfa, and a monitoring gage/early detection on North Alamito Creek under Hwy 17 Bridge (between Marfa and the airport). This would provide 5-10 minutes early warning to allow Presidio County Office of Emergency Management to deploy before imminent road flooding.	Less Complex	Not in SWMP	1	2	6

Secondary Process for Identification and Selection of Potential FMEs, FMSs, and FMPs

The estimation of region-wide 1% AC flood risk has identified a number of regional locations outside of El Paso County with high numbers of estimated structures-at-risk, as discussed in Section 4.1. In general, the data collection process for the RFP has identified few incorporated and unincorporated areas outside of El Paso County with stakeholders who have presented awareness of or current plans for addressing this risk. Through public outreach efforts, including three public "road show" meetings in the cities of El Paso, Pecos, and Presidio, discussed in *Chapter 10 (Public Participation and Plan Adoption)*, additional areas of significant flood risk were identified and discussed with each appropriate local stakeholder, expanding the list of potential regional FMPs.

If no FMP or FMS is previously identified by Subcommittees 2 and 3 for areas at risk of 1% AC flooding, or if the best available H&H models lack sufficient detail to allow for evaluations of FMPs or FMSs, then FMEs to develop detailed H&H models and evaluate flood mitigation alternatives are selected for the at-risk areas. Subcommittee 3 reviewed the higher risk areas identified in Section 4.1 and assigned FMEs for these areas, so that these FMEs can be performed at a later date to identify potential FMSs and FMPs in the amended RFP or in future RFP cycles. Based upon recommendations from Subcommittee 3, the RFPG voted for approval of the potential FMEs.

Refinements to the List of Evaluated FMPs

Throughout the evaluation phase of the first cycle of the RFP, the status of two of the projects from the El Paso County SWMP that were selected for evaluation changed, as alternative sources of funding were identified. Therefore, the RFPG agreed those projects no longer needed to be evaluated (CAN1 and FAB1) for the RFP. In addition, other high priority FMPs and FMSs continued to be investigated as they were brought to the attention of the RFPG by different stakeholders throughout the planning cycle; however, none of these additional projects were determined to have sufficient modeling and documentation to be considered as potentially feasible FMPs or FMSs in the RFP, and they were instead considered as potential FMEs, per the secondary process discussed in the previous section.

4.3 Identification of FMEs

Based on analyses and decisions described in Sections 4.1 and 4.2, the RFPG identified and evaluated 22 potential FMEs throughout Region 14. The extent of these identified FME study areas is shown in **Map Exhibit 16**, along with counties which have existing mapping needs. The FMEs are also listed in an evaluation table with supporting data in **Table 4A** of **Appendix 4A**. A narrative of each FME identified is provided in **Appendix 4B**, including the following:

- Discussion on flood risk;
- SOW assumed for each FME; and
- Cost breakdown of labor fee by task.

Table 4A documents the desktop analysis results of each FME and lists RFP data fields for classifications of FMEs, which require the RFPG to choose from a list of acceptable inputs for attributes such as "Flood Risk Type" and "Study Type." **Table 4.7** includes more region-specific descriptions of FMEs combined with TWDB-allowable categories to provide a more complete representation of the evaluated FMEs for Region 14. Due to the lack of reliable floodplains, modeling, or flood planning documents available outside of El Paso County, the identification of FMEs and FMSs for evaluation required extensive coordination with local stakeholders to understand unique flood issues associated with each part of the region. The types of FMEs identified to address specific flood risks are based upon RFPG and stakeholder goals, which are documented in *Chapter 3 (Floodplain Management Practices and Goals)*.

Table 4.8 Classification of Evaluated FMEs

FME ID	Project Planning	SWMPs	Dam Safety/ Emergency Need	Riverine Risk Related to Sediment or Levees	Irrigation and Stormwater Interaction	Preparedness
141000001	-	-	-	✓	✓	✓
141000002	✓	✓	-	✓	-	-
141000003	✓	-	-	-	✓	-
141000004	✓	-	-	-	✓	-
141000005	✓	✓	-	-	✓	-
141000006	✓	-	-	-	-	-
141000008	✓	-	-	✓	-	-
141000010	✓	✓	-	-	-	-
141000012	✓	-	✓	-	-	-
141000014	✓	✓	✓	-	-	-
141000015	-	-	-	✓	✓	✓
141000018	-	-	-	-	✓	✓
141000019	✓	-	-	-	✓	-

FME ID	Project Planning	SWMPs	Dam Safety/ Emergency Need	Riverine Risk Related to Sediment or Levees	Irrigation and Stormwater Interaction	Preparedness
141000021	✓	✓	-	-	-	-
141000022	✓	✓	-	-	-	-
141000023	✓	✓	-	-	-	-
141000024	✓	✓	✓	-	-	-
141000025	✓	✓	✓	-	-	-
141000026	✓	✓	-	-	-	-
141000033	✓	✓	-	-	-	-
141000034	✓	-	✓	-	-	-
141000035	✓	-	✓	-	-	-

4.3.1 Project Planning and SWMPs

The primary study type of the FMEs identified is "Project Planning," with 19 of the 22 FMEs falling into this category. The remaining three FMEs were categorized with the Study Type "Preparedness" in **Table 4A**. Project planning FMEs were primarily selected by the RFPG for evaluation because it was noted during the identification process that very few entities had SWMPs outside of El Paso County, despite there being significant numbers of structures at risk in multiple cities throughout the region (see **Table 4.3**). Eleven of the 19 Project Planning FMEs propose to develop SWMPs; however, some of these FMEs include other more specific tasks as well. The lack of SWMPs in the region is likely related to the lack of updated flood risk maps and H&H models. However, developing these planning documents is essential to reducing flood risk in populated areas, and the public availability of LiDAR terrain throughout the region allows for detailed flood risk models to be developed and used to plan proposed flood improvements. Hazard Mitigation Plans were reviewed for proposed flood-related projects/studies/needs; however, most of these plans in the region were outdated at the time of the selection of FMEs, FMSs, and FMPs for the RFP.

City of Presidio Flood Planning Documents

The only other flood infrastructure planning documents outside of El Paso County that were identified for consideration in the RFP were for the City of Presidio, and both were based upon the same modeling analysis from 2008. The original planning document, entitled, "Final Hydraulic Report/Drainage Study for the City of Presidio, Texas" (S&B Infrastructure, 2008) was developed prior to a TXDOT roadway project, which has since paved several of the roadways throughout the city. These roadways were incorporated into the designs of the proposed improvements by proposing inverse crowns to redirect flows. This planning document was also referenced in the "City of Presidio Comprehensive Plan (2020-2030)", but the existing hydrologic and culvert hydraulic models available from the 2008 study were not updated. Also, the proposed improvements were altered in the Comprehensive Plan relative to the original planning document. Proposed ponds/sediment basins were relocated upstream of the city rather than downstream, as they were located in the original document. Proposed condition models were not developed for either of the City of Presidio planning documents. FME ID 141000002 proposes to update the H&H models for watersheds draining to the City of Presidio from natural arroyos to the north, as well as developing H&H models for Cibolo Creek, which has an unaccredited levee protecting the City of Presidio from riverine flooding.

FMEs to Develop FMPs from El Paso SWMP Projects

Due to the fast-paced schedule and limited budget associated with this first cycle of Regional Flood Planning, only a limited number of FMPs could be evaluated from the robust list of projects in the recently updated El Paso City and County SWMPs (96 projects in the City plan and 69 in the County plan). Following the FMP prioritization and selection process described in Section 4.2.2, continued coordination took place with El Paso Water and El Paso County stormwater officials to review the details and status of each project from the SWMPs that was not selected for evaluation as an FMP through the approved Subcommittee 2 scoring and ranking process. This coordination led to the selection of 52 El Paso Water projects and 21 El Paso County projects from their respective SWMPs.

4.3.2 Dam Safety and Emergency Needs

A Hudspeth County stakeholder alerted the RFPG to flood risk associated with two dams identified by TCEQ as “hydraulically inadequate” that are located upstream of rapidly developing Fort Hancock and Acala CDPs. As noted in *Chapter 1, Introduction and Description of the Upper Rio Grande Flood Planning Region,* there are 27 dams (approximately 25% of the dams in the region) that are identified by TCEQ as hydraulically inadequate in Region 14. As is the case with many dams throughout Texas, significant development has occurred downstream of Camp Rice Arroyo Dam 1 and Alamo Arroyo Dam 3, located in Hudspeth County.

A colonia-wide SWMP is proposed as FME ID: 141000014, which includes the development of dam rehabilitation alternatives in a Supplemental Watershed Plan for both dams, as defined by the Natural Resources Conservation Service (NRCS). This FME includes a SWMP for Fort Hancock CDP, which is required before an implementation strategy (identified in FMS ID: 142000008) for constructing the stormwater improvements can be performed.

Additional hydraulically inadequate dams identified upstream of populated areas in the region include the following:

- FME ID 141000012 - Comanche Creek Dam upstream of Fort Stockton in Pecos County;
- FME ID 141000024 - Dry Devils and Lowry Dams 3, 4, 5, 7, 8, 10, & 12 upstream of Sonora in Sutton County; and
- FME ID 141000025 - Johnsons Draw SCS Site 7 Dam upstream of Ozona in Crockett County.

The FMEs for Sonora and Ozona also include Supplemental Watershed Plans; however, Comanche Creek Dam does not include one, since it is not an NRCS dam.

All four of these dam-related FMEs include the development of SWMPs for the downstream cities at risk and are identified as having an "Emergency Need" in **Table 4A**. In this RFP, the classification of a proposed action as an "Emergency Need" is reserved for actions related to Emergency Response (such as early warning systems) or significant flood protection infrastructure that has been identified as inadequate by authorities responsible for inspecting and regulating stormwater infrastructure, such as TCEQ Dam Safety.

4.3.3 Riverine Flood Risk Related to Sediment or Levees

Eight of the FMEs identified by the RFPG are categorized as having a "Riverine" flood risk type. Riverine flooding typically occurs along rivers or streams when the runoff exceeds the capacity of the channel. For significant creeks or rivers adjacent to populated areas, levees are sometimes constructed to protect the populated areas from out-of-bank flooding. This is the case for segments of the Rio Grande, including those running through El Paso County and the City of Presidio. This is also the case for Cibolo Creek which flows into the Rio Grande on the western border of the City of Presidio. In arid landscapes such as Region 14, the accumulation of sediment in arroyos and rivers such as these can have a significant effect on flood risk if natural flood patterns or regular maintenance are not achieved. FMEs 141000001 and 141000002 both address flood risk related to these significant sources of flooding in El Paso and Presidio, respectively. In Presidio, the FME includes a coincident peak analysis to assess the probability of peak flows from Cibolo Creek aligning with peak flows in the Rio Grande, creating an even more disastrous flood event. In addition, coincident peaks in the Rio Conchos at the confluence with the Rio Grande will be studied in the FME.

While FME 141000001 is categorized as a "Preparedness" Study type and is primarily related to maintenance of sediment and vegetation in the Rio Grande floodway to prevent overtopping of levees, the Cibolo Creek FME 141000002 is part of a larger strategy (FMS ID: 142000008) to develop a levee certification package for the FEMA accreditation of the "Cibolo Creek Left Levee" (per the National Levee Database) located along the City of Presidio side of the creek. As part of the levee accreditation requirements, an interior drainage study must be performed for the levee adjacent to the city. Since flow in the city limits is primarily draining from north to south, along the outer edge of the levee and is not ponding against the levee, the cost estimate for this FME did not assume a significant effort for the required interior drainage analysis, as it would likely be developed as part of the SWMP analysis.

FMEs 141000008 and 141000015 are both also related to sediment causing flood risk and maintenance issues for entities such as USIBWC, El Paso Water, and EPCWID1. USIBWC is responsible for clearing sediment in problem areas of the Rio Grande, and El Paso Water has urban/local runoff issues with sediment clogging their storm drains and culverts. High intensity storms on the Franklin mountains can wash sediment and large masses of debris into the streets, as it did in the recent August 2021 storm.

4.3.4 FMEs Related to Irrigation Systems in El Paso

EPCWID1 manages the vast and complex system of irrigation canals and drains in El Paso County and coordinates closely with both City and County stormwater officials, as well as with neighboring irrigation districts (EBID and Hudspeth County Conservation and Reclamation District 1) to aid in managing stormwater during emergency flood events. In the Subcommittee 3 stakeholder workshop, discussed as part of the FME/FMS identification process in Section 4.2.1, RFPG members shared the history of emergency response efforts and coordination that took place between EPWater and EPCWID1 to utilize drains designed to discharge to the Rio Grande as flood relief strategies for the river, which was close to overtopping at some locations. EPCWID1 was able to open irrigation gates at the river to allow flow from the Rio Grande into the irrigations system and helped prevent segments of Rio Grande levees from potentially overtopping or breaching during the 2006 flood. It was reported in the workshop that the high flood levels in the Rio Grande were also related to significant sediment build-up, which is the reason FME 141000001 was established and approved by the RFPG.

In addition to relieving Rio Grande flooding, when necessary, EPCWID1 also has relieved urban/local flood infrastructure from exceeding capacities during interior flood events by allowing El Paso Water to utilize EPCWID1's Mesa Drain for flood control purposes. However, since this drain was not designed for this purpose, it needs to be studied, including the development of a 1D hydraulic HEC-RAS model to evaluate several Mesa Drain crossings, which are identified in the El Paso County SWMP as being undersized. This was the driver for creating FME 141000004, which has been included in grant requests by EPCWID1, who worked closely with the RFPG to review and update best available cost estimates and SOWs needed to document the FME.

FME 141000003 was reported by EPCWID1 as a significant need due to a new arroyo which has formed and causes overtopping of State Highway (SH) 20 in southeast El Paso County. The significant amount of uncontrolled flow over SH20 causes a flood safety hazard to the public. The newly formed arroyo is also a flood risk to agricultural areas (pecan orchards) on the other side of SH20 and transports a significant amount of sediment into EPCWID1's irrigation drain, which runs adjacent to SH20. This study will involve coordination with TXDOT to establish a flood mitigation alternative, likely involving a sediment basin and a siphon to allow the significant flood source to cross under both the roadway and the adjacent drain.

4.4 Identification of FMPs

Based on analyses and decisions described in Sections 4.1 and 4.2, the RFPG identified and evaluated 14 potentially feasible FMPs, which are listed with supporting data in **Table 4C** of **Appendix 4C**. The extent of these identified FMP study areas is shown in **Exhibit Map 17**, along with contributing watersheds. In addition, **Appendix 4D** includes a narrative of each FMP identified, including the following information extracted from associated SWMPs or other feasibility studies:

- Flood risk discussions;
- Project descriptions;
- Breakdown of cost estimates, which include land values, where applicable, as well as final design and construction contingencies. All costs are adjusted to September 2020

dollars (a requirement for the RFP), using the Construction Cost Index (CCI) and the Consumer Price Index (CPI), where appropriate; and

- Figures showing project components and locations.

The 14 potentially feasible FMPs which were evaluated for the RFP have been labeled with the following Project Types:

- One FMP is a non-structural project (FMP ID: 143000009), categorized as “Other” in **Table 4B**;
- Two FMPs are related to storm drains (FMP IDs: 143000005 and 143000111);
- One FMP is for preparedness (FMP ID: 143000007);
- One FMP is a channel improvement (FMP ID: 143000097); and
- The remaining nine FMPs are detention ponds.

These Projects align with the listed RFPG and stakeholder goals shown in **Table 4B**, as documented in *Chapter 3 (Floodplain Management Practices and Goals)*.

4.4.1 Sources of Potentially Feasible FMPs

A variety of structural and non-structural FMPs were selected by the RFPG to address flood risks related to major access routes, residential and commercial structures, agricultural property and infrastructure, and regulation of development. The sources of each FMP and the types of flood issues addressed are discussed in this section.

Non-Structural FMPs and Emergency Needs

Two non-structural FMPs were identified by the RFPG for evaluation. FMP ID: 143000009 is associated with Hudspeth County developing and implementing a floodplain ordinance to regulate development, and FMP ID: 143000007 includes installing a flood gage upstream of Marfa and adding flood gates to roadways at four low water crossings (LWCs).

The Hudspeth County regulatory need was communicated to the RFPG at a Subcommittee 3 workshop by the County Emergency Management Coordinator/Administrator. The issue is related to rapid development, outdated and insufficient floodplain mapping, and limited availability to process and monitor the amount of development that is occurring. The need for this FMP was also documented in the “Colonia Area Study and Plan 2019-2029” (Grantworks, 2019) and in a Fiscal Year 2023 earmark for federal funding, submitted to the Congressman of the 23rd District of Texas in April 2022 (the funding request was initially accepted, but later deemed ineligible).

The LWCs and flood gage project in Marfa (FMP ID: 143000007) was brought to the RFPG’s attention through coordination with Presidio County Emergency Management, who informed the RFPG that a flood-related death occurred on June 27-28, 2021 at one of the LWCs considered in the FMP. The location where a driver was swept away in his vehicle is the LWC of Alamito Creek near the intersection of Neville Street and Dallas Street. The other three proposed locations for automatic road closure gates are also for Alamito Creek LWCs near the intersections of Waco Street and Dean Street, Dallas Street and Spring Street, and Lincoln Street and A Street. This recent flood casualty at the FMP site is the reason that the FMP is documented as having an emergency need and an estimated reduction in fatalities in **Table 4B**. No other FMPs were identified as an emergency need by the RFPG.

The City of Marfa had recently procured a bid for the four LWCs and the flood gage from High Sierra Electronics. This bid is included in **Appendix 4G** for reference and includes an option to wave annual maintenance fees for a one-time training, which City of Marfa confirmed is their preference. Therefore, it was assumed this FMP would be a fixed cost, with no recurring costs.

A related strategy that was identified (FMS ID: 142000025) includes a separate bid for an additional early warning system in Marfa, which does include recurring monthly costs. The RFPG coordinated with High Sierra Electronics, who assisted in preparing the additional bid for FMS ID: 142000025 (also included in **Appendix 4G**), and ensured there is not an overlap in equipment or services proposed in the two bids provided.

FMPs Affecting Mobility and Localized Flooding

Three of the FMPs identified for evaluation are related to mobility and localized flooding, with two of the projects affecting the same roadway, Doniphan Drive. FMP IDs: 143000111 and 143000113 are relatively close in proximity to each other and mitigate flooding on Doniphan Drive by capturing runoff to the roadway on either side of a known localized ponding area between Sunland Park Drive and Racetrack Drive. Doniphan Drive is a major access route and has a roadway classification of “Principal Arterial.” Both of the FMPs relieve flooding from a segment of Doniphan Drive identified in the “Incident Management Plan Standard Operating Guidelines” (TXDOT, 2011) as a detour route for Tier 3 traffic incidents occurring on IH-10 between Sunland Park Drive and Paisano Drive.

The known local ponding area on Doniphan Drive is adjacent to a multi-box culvert with sluice gates, draining to the Rio Grande. This ponding area has caused repeated nuisance flooding in El Paso for several years, including during the recent storm event on June 28, 2021, when the world-famous Rosa’s Cantina was inundated for long durations with both flood water and sediment/debris. The owner, who reportedly could not initially open the door due to the amount of mud and water in the building, eventually found eight inches of water in the building and stated for news reporters, “After 13 years, this is probably our fifth time flooding but this is definitely one of the worst,” Telles said *(Source: https://kfoxtv.com/ news/local/severe-flooding-in-west-el-paso-caused-extensive-damage-to-properties)*.

El Paso Water funded a feasibility study for FMP ID: 143000111 entitled, “Doniphan Storm Water Pump Stations PS1 and PS2 System Evaluation and Potential Improvements” (Study ID 90 from *Chapter 1*), which evaluated alternatives and recommend immediate, short-term, and long-term improvements. One of the mid- to long-term improvements (labeled Project G in the feasibility study and “NW3” in the City of El Paso SMWP) is associated with this FMP and involves constructing a storm drain system to intercept flooding on the southern extension of Racetrack Drive. The intercepted flow would be coming from the northeast side of Loop 375, and it would be conveyed to a new 110-cfs pump station (with 1% AC capacity) to be constructed next to the existing "Pump Station 1," discharging directly into the Rio Grande.

El Paso Water also funded a separate feasibility study for FMP ID: 143000113 entitled, "Montoya Drain H&H Analysis" (Study ID 38 from *Chapter 1*), which evaluated flooding of Doniphan Drive from a different location (from the northwest, along Doniphan). This project is identified in the City of El Paso SWMP as "NW26." The Project will intercept runoff coming from the northwest along Doniphan Drive and Doniphan Ditch with a storm drain system and/or trench drain and convey flow to the southwest, along the northern extension of Racetrack Drive. The diverted runoff would need to cross Montoya Drain (with either a siphon or pipe bridge) and discharge into a proposed pond on undeveloped property, located adjacent to a Rio Grande levee in Sunland Park, New Mexico.

This general project area surrounding the Doniphan pump station and Montoya Drain wetland FMPs is known to have a high water table, which also causes issues for EPCWID1 draining Montoya Drain into the Rio Grande (FME ID: 141000019 increases the capacity of the Montoya Drain for stormwater conveyance in this area). Therefore, the proposed pond, which will also serve as a constructed wetland habitat, is proposed to include a series of groundwater dewatering wells with submersible pumps to lower the groundwater table when the pond storage volume is needed for the 1% AC event. In addition, the project could benefit the irrigation districts (EPCWID1 and EBID) needing to discharge flow in Montoya Drain to the Rio Grande when groundwater is high. This project provides a nature-based solution with stormwater benefits to a critical roadway, and it reduces flooding in the nearby known ponding area where residential and commercial structures are at risk.

A roadway drainage improvement (FMP ID: 143000005) affecting mobility on SH20, also known as Mesa Street, was identified from the TXDOT feasibility study entitled "Drainage Study for SH20, from Doniphan Drive to Texas Avenue" (AECOM, 2019). SH20 is a major access route and has a roadway classification of "Principal Arterial". Conceptual designs for the eight prioritized and recommended improvements from the SH20 Study (all of which are part of the FMP) will improve the capacity of drainage crossings on a critical route from conveying less than the 20% annual chance event to a 10% annual chance level of service. All of the projects are on a segment of SH20 identified in the "Incident Management Plan Standard Operating Guidelines" (TXDOT, 2011) as a detour route for Tier 3 traffic incidents occurring on IH-10 between Executive Center Boulevard and Schuster Avenue.

Channel Expansion FMP

One FMP identified for evaluation in the RFP by El Paso Water (FMP ID: 143000097) involves the expansion of the upper segment of the White Spur Drain in Northwest El Paso (labeled "NW16" in the City of El Paso SWMP). This concrete channel, located in a commercially developed area of northwest EL Paso, conveys stormwater runoff from along SH20 (Mesa Street) and from local drainage systems in the surrounding shopping developments. The downstream portion of the channel, on the other side of Doniphan Drive, is significantly wider than the upper section. Commercial buildings adjacent to the narrower upper section are at risk due to the insufficient capacity of the channel. The channel widening project would not only help contain the 100-

year flows within the channel, but it would lower the tailwater on storm drains discharging to the channel from surrounding roadways and commercial developments.

Sediment and Flood Storage FMPs

The remaining nine FMPs are flood and sediment storage basins or ponds, which are identified in the El Paso County and City of El Paso SWMPs. These projects typically involve detaining and/or retaining runoff upstream of developed areas and/or agricultural areas and critical routes that are known to have flooding issues. They were identified in their respective SWMPs, and by the RFPG because they are considered a high priority for El Paso Water and El Paso County. While each of the flood sources and related flooding issues is unique to the project area, all of the storage solutions were designed to have capacity for at least the 1% AC event.

One of these storage basins (FMP ID: 143000021, labeled “SOC4” in the El Paso County SWMP) was identified by EPCWID1 after a flood event on July 22, 2017 caused damages to commercial development detention ponds, which failed, releasing additional flow into the newly-formed arroyo. This flood source causes erosion, sediment, and flooding issues for downstream rural residences as well as agricultural land and infrastructure, including the Mesa Spur Drain.

Another storage project (FMP ID: 143000100, labeled as NE3B in the City of El Paso SWMP) is a proposed pond in a highly developed area of northeast El Paso. The FMP concept was initially developed in a feasibility study entitled, “Northeast Sump Improvements – Hydrologic and Hydraulic Analysis” (MCi, 2017), where it was modeled in conjunction with the Will Ruth Pond, a proposed project being funded by the Flood Infrastructure Fund. While the FMP does not contribute to any additional flood benefits downstream of Will Ruth Pond, it does intercept runoff and relieve flooding upstream of Will Ruth Pond.

4.5 Identification of FMSs

Based on analyses and decisions described in Sections 4.1 and 4.2, the RFPG identified and evaluated 22 potentially feasible FMSs, which are listed with supporting data in **Table 4E** of **Appendix 4E**. The extent of these identified FMS study areas is shown in **Exhibit Map 18**, along with HUC-12 watersheds. A narrative of each FMS identified is provided in **Appendix 4F**, including the following:

- Discussion on flood risk;
- SOW assumed for each FMS; and
- Cost breakdown of labor fees, construction costs, and/or recurring costs.

These strategies align with the listed RFPG and stakeholder goals shown in **Table 4E**, as documented in *Chapter 3 (Floodplain Management Practices and Goals)*. Almost all of the strategies are associated with Urban/Local and/or Riverine Flood Risk, and strategy types vary between the following:

- Six FMSs are for regulatory and guidance purposes;
- Three FMSs include infrastructure projects;

- Six FMSs are for flood measurement and warning; and
- Two FMSs include education and outreach.

In general, FMSs do not typically fit into the FME or FMP categories for a variety of reasons. Below are a list of criteria that led to the decision to list a flood reduction action as an FMS rather than an FME or FMP:

- Studies, projects, and/or program development involving complex coordination between multiple entities (local, state, federal, or international);
- Associated with other FMEs, FMSs, or FMPs requiring a specified sequence of actions as part of a larger plan;
- Involve multiple projects with varying statuses of design/construction; and
- Include recurring costs.

This section describes the general types of potentially feasible FMSs identified for Region 14, with discussion of specific strategies to explain the importance of varying components affecting each overall flood reduction plan.

4.5.1 FMSs Requiring Complex Coordination

Region 14 has several unique flood-related issues involving multiple entities and stakeholders, sometimes requiring inter-state or international agreements. These types of objectives may require multiple studies or coordination between different entities who may not typically partner on projects. If an initial study is required to quantify flood benefits, but it also requires identifying all necessary stakeholders as well as identifying complex political obstacles and documented agreements, as in the Binational Streamflow Recommendations for Big Bend Reach of Rio Grande/Rio Bravo (FMS ID: 142000006), that flood reduction solution was classified as an FMS rather than an FME. In this example, water rights agreements between the U.S. and Mexico would need to be explored before the opportunity to accomplish the broader goal of releasing environmental flows from the Luis León Dam in Mexico could be deemed as feasible.

Similarly, the type of multi-step process needed to accredit all of the Rio Grande levees in El Paso (FMS ID: 142000001) will require coordination between USIBWC, FEMA, and local stakeholders sponsoring the interior drainage studies (City of El Paso, El Paso County, Doña Ana County, and Hudspeth County) to package and deliver all of the requirements for levee certification. As part of the RFP process, multiple coordination meetings have been conducted between the USIBWC and local stakeholders, as well as between those stakeholders and FEMA. However, each levee segment remaining to be certified in El Paso County has a unique status and set of issues keeping it from being certified. The first step in planning a solution to accomplish the RFPG short-term goal (Goal ID: 14004001) of certifying all levees in El Paso County is to identify the outstanding issues associated with each segment and prioritize which segments should be accredited first, considering population at risk and several other factors.

Due to the high level of complexity and coordination involved in this plan, this solution was categorized as an FMS rather than an FMP or an FME.

Another example of a strategy with complex coordination necessary is FMS ID: 142000004, which involves facilitating discussions between El Paso Water, El Paso County, and the U.S. Army to address the subject of unexploded ordnances (UXOs) on Fort Bliss property, where both the City and the County have planned flood control projects in their respective SWMPs.

4.5.2 FMSs Requiring Associated FMEs, FMSs, or FMPs

If a study or project was identified that requires an initial FME, FMS, or FMP to take place before it can occur, it was also categorized as an FMS. Associated FMEs, FMSs, and FMPs are listed in **Table 4E** for seven of the identified FMSs. For example, FMS ID: 142000003 includes a portion of funding for construction of drainage swales along roadways, documented in the "Colonia Area Study and Plan 2019-2029" (Grantworks, 2019), but first requires FME ID: 141000014 to be performed, which includes developing a SWMP. This strategy also includes a recurring cost associated with an educational outreach program, also documented in the "Colonia Area Study and Plan 2019-2029" (Grantworks, 2019).

4.5.3 Multi-Project FMSs with Varying Statuses of Design or Construction

Similarly, if specific phases or portions of an overall plan have already been designed or constructed, it was classified as an FMS. An example is FMS ID: 142000002, which is a strategy recommended for the City of Alpine in the current Region E Water Plan. This nature-based solution involves three related projects centered around Kokernot Park to accomplish a shared goal of reducing stormwater in roadways while promoting green infrastructure and harvesting rainwater. In this strategy, one of the projects has been constructed, with reconstruction of some portions of that project still pending. Another site location is planned for construction by the City Streets Department in Fall of 2022, and the third phase is not expected to be constructed by TXDOT until 2024. The City confirmed they are still seeking grants, and no funding is currently available. All previous planning time and plants/trees installed to date have been donated.

4.5.4 FMSs Including Recurring Costs

Bids are provided for early warning systems for the City and County of El Paso, as well as for the cities of Pecos (FMS ID: 142000021), Alpine (FMS ID: 142000022), Presidio (FMS ID: Presidio), Fort Stockton (FMS ID: Fort Stockton), and Marfa (FMS ID: 142000025). The general scope and equipment proposed in each system was prepared for each entity as part of the RFP based upon availability of nearby rain/flow gages, radar availability, and the needs and general budget available for such a system by each entity. All of these systems include recurring costs, which are specified in the cost summary tables in **Appendix 4H**. In addition, a bid document is available for each FMS in **Appendix 4G**.

Other FMSs with recurring costs are FMS ID: 142000003 (Fort Hancock Colonia-wide public outreach strategy discussed above), FMS ID: 142000013 (support for at-risk communities to join and/or enforce the National Flood Insurance Program), and FMS ID: 142000014 (developing new flood gages throughout the region). More information on these FMSs, as well as all other potentially feasible FMSs shown in **Table 4E** can be found in the narratives provided in **Appendix 4F.**

Chapter 5: Evaluation and Recommendation of Flood Solutions

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5. Evaluation and Recommendation of Flood Solutions

This chapter discusses the evaluation and recommendation of Flood Management Evaluations (FMEs), Flood Mitigation Projects (FMPs), and Flood Management Strategies (FMSs) by the Regional Flood Planning Group (RFPG). It describes the general process for evaluating these flood solutions, including the more detailed hydraulic analyses associated with specified FMSs and FMPs. Zoomed in Exhibit Maps are provided for individual flood solutions, and summarized evaluation results tables are presented for recommended flood solutions. The recommended FMEs, FMPs, and FMSs (also referred to as "Flood Solutions") presented in this chapter were discussed and refined with the RFPG throughout the regional flood planning process and were approved by the RFPG in a General RFPG meeting held July 20, 2022.

5.1 Evaluation Process for FMEs, FMPs, and FMSs

As each FME, FMP, or FMS was evaluated throughout the regional flood planning process, relevant issues, changes, and refinements were presented and discussed with the RFPG during General RFPG meetings, meetings for Subcommittee 2 (FMPs), and/or meetings for Subcommittee 3 (FMEs and FMSs). Any feedback provided from the RFPG, stakeholders, or the general public was discussed with the RFPG and/or applicable subcommittee members, and agreed upon changes were incorporated into the evaluations or the scope associated with each flood solution. As FMPs were considered for evaluation, if necessary hydraulic and hydrologic (H&H) modeling was not available, that information was shared with the RFPG, and those projects were evaluated as FMEs rather than FMPs.

Flood Solution evaluations which require additional explanation of methods and assumptions are discussed in this section. These methods and assumptions were applied to estimate specific required flood risk indicators identified in **Appendices 4A, 4C,** and **4E** of *Chapter 4, Identification of Flood Mitigation Needs and Solutions*, respectively. Zoomed-in boundaries of FMEs, FMPs, and FMSs are shown in individual mapbook figures associated with **Exhibit Maps 19, 20,** and **21**, respectively, in **Appendix 5G**. The blue index box label numbers shown in the Index Map of each Exhibit Map in **Appendix 5G** are based upon the last three digits of their respective FME, FMP, and FMS ID numbers, respectively. For example, in **Exhibit Map 21**, Recommended Flood Management Strategies, the index box labeled "24" on the Index Map represents the extent of the zoomed-in mapbook figure for FMS ID: 142000<u>24</u>. The associated mapbook figure is numbered Map 21.<u>24</u> and shows the zoomed-in boundary for the strategy. Since there are a total of <u>22</u> FMSs recommended in the Regional Flood Plan (RFP), this mapbook figure is Map 21 of <u>22</u>.

Information associated with existing flood risk, scope of work (SOW), cultural resources background (FMPs only), and cost estimates for each FME, FMP, and FMS is provided in narratives included in **Appendices 4B, 4E,** and **4F** of *Chapter 4, Identification of Flood Mitigation Needs and Solutions*, respectively.

5.1.1 Cost Estimates and Potential Funding Sources

Scopes and cost estimates documented in the narratives for typical FMEs include tasks such as Data Collection, Engineering Analysis, Alternatives Development/Selection, Report/ Documentation, and Stakeholder Coordination. Some exceptions include FMEs which involve Supplemental Watershed Plans and Environmental Assessments for the development of alternatives for rehabilitation of dams (FME IDs: 141000012, 141000024, 141000025).

Typical additional costs for FMSs include construction costs or recurring costs, if applicable to the strategy. FMP cost estimates include capital cost breakdowns showing original construction costs estimated from associated SWMPs, converted to September 2020 dollars using the Construction Cost Index, land cost estimates converted to September 2020 dollars using the Consumer Price Index, and the following contingencies:

- 35% Construction Contingency;
- Final Design (20% of Total Construction Cost);
- Permitting (10% of Total Construction Cost); and
- Geotech (15% of Total Construction Costs).

The assumed construction contingency of 35% is consistent with assumptions applied to both the City of El Paso SWMP and the El Paso County SWMP, the primary sources of most of the FMPs evaluated. The additional cost percentages associated with final design, permitting, and geotechnical costs are also consistent with assumptions applied to new projects developed in the 2021 El Paso County SWMP.

A survey was sent to the identified sponsors of each FME, FMP, and FMS to: 1) request permission to include the entity as a sponsor in the RFP, 2) receive feedback on costs estimated and SOWs, and 3) query potential funding sources of each sponsor and possible match percentages. The results of the funding survey are incorporated in the "Potential Funding Sources and Amount" column of the evaluation tables shown in **Appendices 4A, 4C,** and **4E.** Additional results of the funding survey are summarized and discussed in greater detail in *Chapter 9, Flood Infrastructure Financing Analysis*.

5.1.2 Model and Mapping Availability

Only FME evaluation tables require indication of whether floodplain mapping or H&H models, which could potentially be utilized for the FME, are already being developed, or if they are anticipated to be available in the near future. It can be seen in the FME evaluation table in **Appendix 4A** that most available or anticipated H&H models or flood mapping are extremely out of date for all FME areas outside of El Paso County. The reported dates do not consider the anticipated Texas Water Development Board (TWDB) and Federal Emergency Management Agency (FEMA) modeling and mapping effort to develop Base Level Engineering data covering all of Region 14 by 2023.

5.1.3 Emergency Need

As discussed in Chapter 4, flood solutions were identified to be an emergency need based on the following criteria:

- Flood solution is associated with emergency flood response activities, e.g., early warning systems; or
- Flood control infrastructure protecting a populated area has been identified as inadequate by authorities responsible for inspecting and regulating stormwater infrastructure, e.g., FMEs involving dam rehabilitation alternatives based on determination of the dam to be “hydraulically inadequate” by the Texas Commission of Environmental Quality (TCEQ) Dam Safety.

Evaluations resulted in emergency needs being identified for four FMEs (all involve dam rehabilitations for hydraulically inadequate dams per TCEQ), seven FMSs (new stream gages and early warning systems), and one FMP (new stream gage and flood gates).

5.1.4 Evaluation Methodology without Project-Specific Models or Mapping

The evaluation tables in **Appendices 4A, 4C**, and **4E** of Chapter 4 have specific attributes that are common to all three types of flood solutions, and others that are specific to FMEs, FMSs, or FMPs. For example, all FMEs, FMSs, and FMPs include the following analyses:

1. A reference to the specific flood mitigation or floodplain management goal to be addressed;
2. A determination of whether it meets an emergency need;
3. An indication regarding the potential use of federal funds or other sources of funding as a component of the total funding mechanism;
4. A quantitative reporting of the estimated overall cost of the flood solution;
5. A quantitative reporting of the estimated existing 1% annual chance (AC) flood risk affecting the following estimated risk indicators:
    a. Number of structures (all building types, excluding sheds or uninhabitable structures);
    b. Number of residential structures;
    c. Population;
    d. Low water crossings;
    e. Critical facilities;
    f. Number of roads closures occurrences; and
    g. Acres of active farmland and ranchland.

General Methodology for Existing Risk without Project-Specific Data

For FMEs and FMSs without project-specific H&H models or mapping, evaluations of the parameters listed above were typically based on the RFP 1% annual chance flood risk boundaries intersected with enhanced spatial layers for buildings, agricultural land, and other infrastructure, including roadways, low water crossings, and critical facilities. The sources for the development of these spatial layers and the methods used to estimate flood risk region-wide are documented in *Chapter 2, Flood Risk Analyses*.

In some instances, if reliable depth data were available, existing flood risk estimates were based upon a more detailed analysis of estimating maximum depths greater than 0.5 ft associated with the building footprint of each intersecting structure. Only maximum depths greater than 0.5 ft were considered in these analyses to account for potential raised finished floor elevations.

Methods for Road Closures without Project-Specific Data

An exception is the "Estimated Number of Road Closures" required data field. Exhibit D of the Data Submittal Guidelines for the RFP states that the "Estimated Number of Road Closures" to be reported in evaluation tables is the "estimated number of road closure occurrences in the past 10 years." Since there is not an accessible database that was identified to retrieve this information for the large number of roadways in all areas affected by FMEs, FMSs, and FMPs, high level assumptions were applied. Where project-specific modeling or mapping data were not available and proposed benefits were not analyzed, the 10% AC risk inundation boundaries from the preliminary FEMA data set in El Paso and from the Fathom data set outside of El Paso were used to estimate the number of road segments intersecting the existing inundation boundaries. Roadway segments are defined as continuous lengths of road between intersections, or on highways, between exits.

Methods for Low Water Crossings without Project-Specific Data

As discussed in *Chapter 2, Flood Risk Analyses*, a low water crossing spatial geodatabase layer was developed for the RFP based upon the TNRIS statewide low water crossing database as well as data sets from existing studies identified in Region 14 during the flood planning process. Low water crossings were assumed to be crossings inundated by flood events more frequent (lower intensity) than the 10% AC flood. This low water crossing data set was utilized to estimate the number of low water crossings intersecting the existing 1% AC flood risk boundary developed for the RFP.

5.1.5 Evaluation Methodology for Project-Specific FMSs and FMPs

For FMSs and FMPs that have project-specific H&H models or mapping data available, those data were utilized to estimate the existing flood risk as well as flood risk reductions associated with the indicators listed in 5-a through 5-g from Section 5.1.4. In addition, the FMS and FMP evaluation tables both include the following information which is not in the FME evaluation table:

1. Number of structures removed from the 0.2% AC flood risk;

2. Cost per structure removed;
3. Nature-based solutions;
4. Negative impacts;
5. Negative impact mitigation; and
6. Water supply benefits.

While the presence of nature-based solutions is only required to be reported as “Yes” or “No” for each FMS, FMPs require a calculated percentage of the total project cost for those components of the project. There were four FMSs identified as having nature-based solutions, and one FMS identified to have a water supply benefit. There were no FMPs identified as having nature-based solutions or water supply benefits.

Methods for Structures at Risk with Project-Specific Data

The methods and assumptions related to flood risks and benefits varied depending on the project type and available modeling/mapping data for each project-specific FMS or FMP. However, in general, when proposed condition hydraulic model outputs or mapping were available, water surface elevations and ground elevations were used to estimate flood risk within El Paso County, and Fathom depth data were used for project-specific FMSs or FMPs located outside of El Paso County. Finished floor elevations were assumed to be 0.5 ft above ground elevations intersecting the footprint of a building. Where depth data were utilized to estimate 1% AC flood risk, raised finished floor elevations were considered by subtracting 0.5 ft from the maximum flood depth intersecting a building footprint. Within El Paso County, finished floor elevations of buildings were estimated by adding 0.5 ft to the average ground elevation within a building footprint.

Ground elevations were estimated from the digital terrain surface utilized in the 2019 Preliminary FEMA hydraulic models developed for El Paso County. The topographic sources of this terrain mosaic vary spatially, but primarily consist of Rio Grande QL2 LiDAR data within El Paso city limits, collected in the Fall of 2014. The different sources of the terrain mosaic are documented in the Hydraulic Report for the Preliminary FEMA study (Study ID 21, from **Appendix Table 1D** of *Chapter 1, Introduction and Description of the Upper Rio Grande Flood Planning Region*). A figure of the topographic data sources from Study ID 21 is shown below for reference.

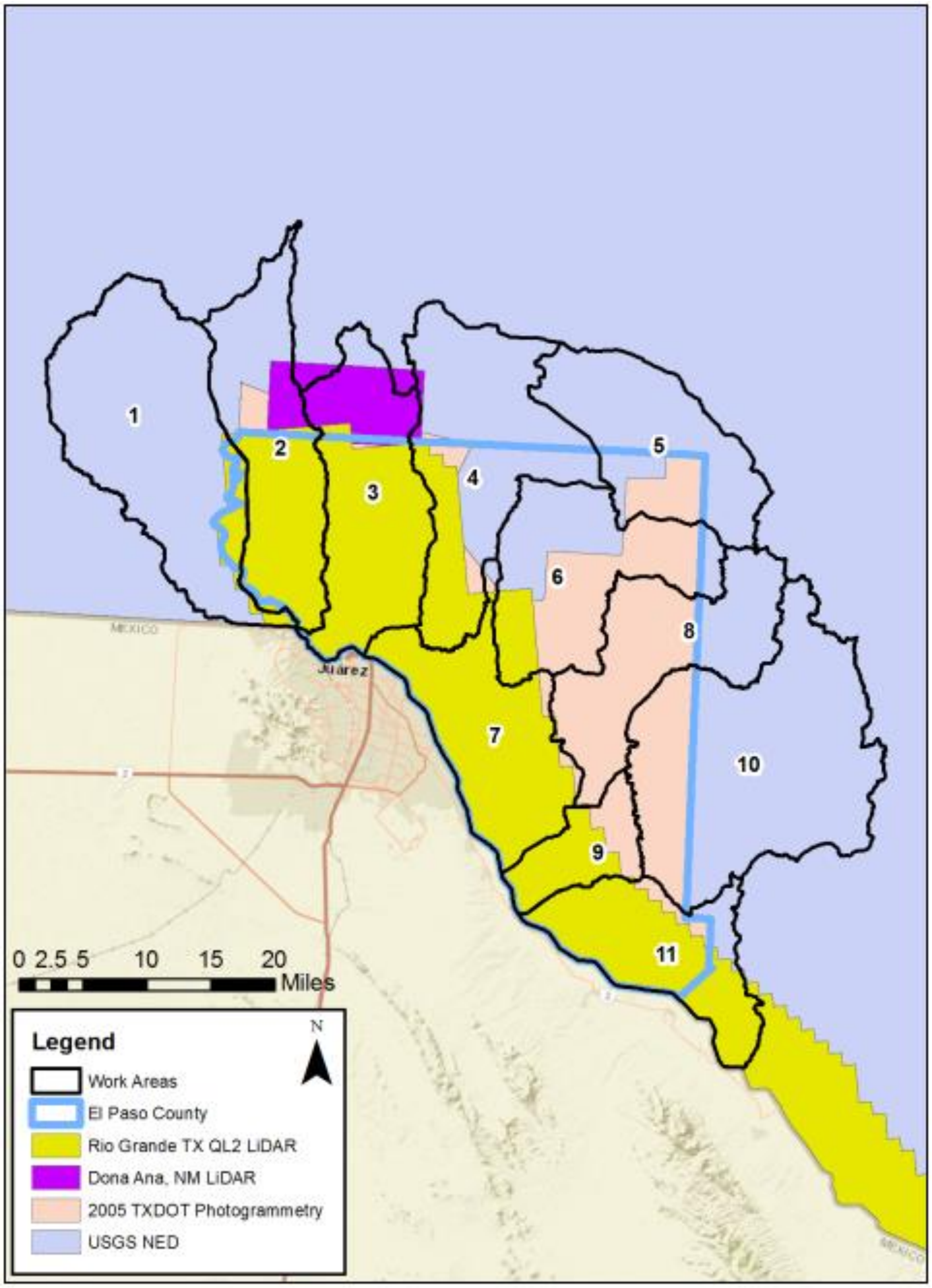

Figure 5.1 Sources of Preliminary FEMA Hydraulic Modeling Terrain (from Study ID 21)

Methods for Structures Removed from 0.2% AC Flood with Project-Specific Data

While all FMPs specified as having 1% AC post-project level-of-service in **Appendix Table 4C** were capable of containing the 1% AC flood based on hydrologic modeling of the upstream watershed, the exact configurations of outfall pipes and auxiliary spillways of detention structures was not modeled at this planning level; so there is uncertainty as to the downstream discharge associated with the 0.2% AC flood event. To be conservative, FMPs and FMSs associated with roadway drainage, storm drain, or channel improvement infrastructure projects were assumed not to have any structures removed from the 0.2% AC flood risk.

However, for FMPs involving detention/retention structures, maximum storage capacities associated with original construction costs were compared to total inflow volumes of the 0.2% AC flood to estimate potential downstream discharges for that event. Diversions were set up in each applicable FMP proposed condition hydrologic models to divert all upstream runoff from the 0.2% AC event into a sink until the total inflow volume reached the capacity of each detention/retention structure. All excess runoff beyond the reported capacity of each structure was discharged downstream. The resulting discharge hydrograph was applied to the corresponding post-project 2D hydraulic model immediately downstream of each proposed structure.

Pre- and post- project water surface elevations were compared at downstream structures at risk to measure reductions in 0.2% AC flood risk. This approach assumed no outflow through a principal or auxiliary spillway. This is a conservative assumption, since outflow from principal and/or auxiliary spillways would likely limit the releases from the 0.2% AC flood.

Methods for Road Closures with Project-Specific Data

In locations where pre- and post-project modeling and mapping data were available for the 1% AC event, roadway closures were estimated based on a scaling factor applied to the 1% AC flood depths on inundated roadways. The scaling ratio was obtained by dividing the 1% AC, 24-hour duration rainfall depth by the 10% AC 24-hour rainfall depth. If the reduced maximum depth on each road segment after applying the scaling factor was less than 0.5 ft, a road closure was assumed for that road segment.

Methods for Low Water Crossings with Project-Specific Data

In locations where pre- and post-project modeling and mapping data are available for the 1% AC event, the number of low water crossings at risk in pre-project and post-project conditions was based upon whether the low water crossing point layer, described in *Chapter 2*, intersected the pre- and post-project 1% AC floodplains.

Methods for Evaluating Water Supply Benefits and Impacts

To report an FMP or FMS as having a water supply benefit, it must be included as a recommended strategy in the most recently adopted State Water Plan with all relevant evaluations relating to Identification and Evaluation of Potentially Feasible Water Management Strategies and Water Management Strategy Projects (as required under §357.34[e]). In addition, FMSs or FMPs that contribute to water supply may not result in an overallocation of a water source based on the water availability allocations in the most recently adopted State Water Plan. Only one potentially feasible FMS meets these criteria (FMS ID: 142000002, Irrigation and Recharge Application of Captured Rainwater Runoff at Alpine). This FMS is recommended in the most recently adopted State Water Plan (TWDB, 2022) as well as in the current Far West Texas Water Plan (TWDB, 2021) for Region E, where it is identified as Strategy E-2, "Irrigation and Recharge Application of Captured Rainwater Runoff." Details related to the water supply benefits of this strategy and its evaluation methods are provided in *Chapter 6, Impacts and Contribution of Regional Flood Plan.*

While FMS ID: 142000002 is the only water supply project evaluated in the RFP, two other recommended water supply projects from the most recently adopted State Water Plan and Region E Water Plan were identified as having flood benefits in the initial data collection phase of the RFP. These strategies are:

- Strategy E-14, EPW - Hueco Bolson Artificial Recharge; and
- Strategy E-18, El Paso County - EPCWID1 - Regulating Riverside Reservoir.

Based on the FMP selection and prioritization process for identifying potentially feasible FMPs, described in *Chapter 4, Identification of Flood Mitigation Needs and Solutions*, the above strategies were presented to the RFPG and included in the FMP scoring/ranking process. Due to limited budget and time available for FMP and FMS evaluations, and because other potentially feasible FMPs were anticipated to have more significant expected flood benefits, the RFPG chose not to evaluate these two strategies.

Methods for Evaluating Negative Impacts with Project-Specific Data

FMSs and FMPs are required to demonstrate that they will not negatively affect a neighboring area. While this criterion did not require analyses to demonstrate for non-structural FMPs or FMSs such as FMP ID: 143000007 (stream gage and flood gates in Marfa) or FMP ID: 143000009 (Hudspeth County floodplain ordinance), the documentation of engineering analyses and/or assumptions is required for FMSs or FMPs involving proposed flood control infrastructure.

The methods for demonstrating no negative impact varied for each FMS or FMP involving flood infrastructure projects. To document the methods and assumptions associated with the negative impact analysis, it is necessary to explain the source and type of H&H models used in the flood risk analysis for existing and proposed conditions. This level of explanation is provided for project-specific FMSs in **Appendix 5A**, and for project-specific FMPs in **Appendix 5B**. These appendices provide an overview of modeling methods and assumptions for specific FMSs and FMPs, respectively, as well as documentation explaining why none of the proposed FMSs or FMPs are anticipated to have a negative impact on neighboring areas. In addition, **Appendix Table 5D** ("Flood Mitigation Projects Recommended by RFPG") includes a column entitled, "How No Negative Impact was Determined," which specifies the method and/or models used to assess pre-project vs. post-project conditions to confirm that no negative impacts are anticipated on neighboring areas to FMPs.

Since no negative impacts are anticipated, there are no negative impact mitigations recommended to address potential negative impacts of FMSs or FMPs. **Appendix 5H** includes a table of building IDs which were analyzed for FMPs which have project-specific models and floodplain mapping for existing and proposed conditions. These tables demonstrate no negative impacts of depths at buildings for the proposed 1% annual chance event relative to existing conditions. In addition, the spatial data (GIS building polygons) associated with the data table in **Appendix 5H** is provided in the "FPR14_Supplemental" geodatabase for the Region 14 RFP, named "Appendix_5H_FMP_Flooded_Structures.gdb"

H&H Modeling and Mapping Methods for FMSs

Evaluations of all potential FMEs and most potentially feasible FMSs were performed at a reconnaissance or screening-level, unsupported by associated detailed H&H analyses. The exceptions were the following three FMSs, which had specified hydrologic, hydraulic, and/or mapping information available that could be used to estimate proposed FMS benefits:

- FMS ID: 142000001, FEMA Levee Accreditation for All Rio Grande Levees at El Paso (see **Exhibit Map 21.01**);
- FMS ID: 142000004, Coordination with Ft. Bliss for FMP Permitting and Maintenance Access (see **Exhibit Map 21.04**); and
- FMS ID: 142000008, Develop Certification Package for Cibolo Creek Channel and Levee (see **Exhibit Map 21.08**).

Individual mapbook figures displaying zoomed-in project locations and existing downstream flood risk areas are provided as part of **Exhibit Map 21** (see specified mapbook figure numbers listed above for each FMS). In addition, **Exhibit Map 22** shows a region-wide map of H&H model coverage extents, with coverage areas displayed according to Model IDs. Each Model ID coverage area also has an individual mapbook figure (44 total).

Each of these three FMSs were analyzed to estimate potential flood benefits as well as demonstrate no negative impacts on neighboring areas. Methods and assumptions related to these evaluations are discussed for each FMS in the **Appendix 5A**, along with documentation of the process used to estimate that each project-specific FMS noted above will have no negative impact on neighboring areas. The remaining FMSs are not estimated to have a direct effect on 1% AC flooding; therefore, no flood benefits or impacts are anticipated or reported.

H&H Modeling and Mapping Methods for FMPs

Appendix 5B explains sources of H&H models, mapping, and other information utilized to estimate pre-project and post-project benefits for specific FMPs evaluated in the RFP. Each project-specific FMP was analyzed to estimate potential flood benefits as well as demonstrate no negative impacts on neighboring areas. Individual mapbook figures displaying zoomed-in project locations and existing downstream flood risk areas are provided as part of **Exhibit Map 20** (with specified mapbook figure numbers corresponding to the last three digits of each FMP ID). In addition, **Exhibit Map 22** shows a region-wide index map of H&H model coverage extents, with coverage areas displayed according to Model IDs. Each Model ID coverage area also has an individual mapbook figure (44 total). **Appendix 5B** also documents the Benefit Cost Analysis (BCA) and the process used to estimate that each FMP will have no negative impact on neighboring areas.

5.1.6 Evaluations Applicable to FMPs Only

For applicable FMPs involving infrastructure projects, evaluation data fields unique to just FMPs include the following estimates:

- Reductions in injuries or fatalities (if available);

- Pre- and Post- Project Levels of Service;
- Social Vulnerability Index; and
- Benefit Cost Ratio (BCR).

This section describes methods associated with evaluating each of the risk indicators above.

Methods for Reductions in Injuries or Fatalities

Since this is the first cycle of the RFP, these attributes were not required. However, one of the potentially feasible FMPs evaluated affects public safety at a low water crossing where a flood-related death occurred in Marfa in 2021. The low water crossings and flood gage project in Marfa (FMP ID: 143000007) includes installing a stream gage upstream of Marfa to aid in providing early warning. It also includes installing road closure gates at four low water crossings in Marfa. The flood-related death occurred on June 27-28, 2021, at one of the low water crossings considered in the FMP. The location where a driver was swept away in his vehicle is the low water crossing of Alamito Creek near the intersection of Neville Street and Dallas Street. For this reason, FMP ID: 143000007 is anticipated to have one reduction in fatalities due to the FMP.

Pre- and Post- Project Levels of Service

Each potentially feasible FMP involving flood protection infrastructure was evaluated using H&H modeling and mapping, as described in **Appendix 5B**. The information available to estimate pre-project levels of service depended on the flood events modeled previously in the original studies where projects were initially conceived. In most cases, only 1% AC flood events were previously modeled for pre-project conditions, and those conditions involved flood damages to property. Therefore, in most cases, the minimum event known to cause flood damages is the 1% annual chance storm, and the pre-project level of service is reported as "<1% annual chance". If previous studies documented the pre-project levels of services for higher frequency events than the 1% annual chance, and provided the associated models for those evaluations, a pre-project level of service is identified in **Appendix 4C** according to the highest frequency (lowest intensity) flood event known to incur damages on public property.

Since the 1% and 0.2% AC events were modeled for all proposed FMPs associated with stormwater detention/retention structures, the post-project level of service could be documented for each of those projects. All projects which were reported to be designed for the 1% annual chance event in previous studies were documented as providing a 1% annual chance level of service. This required engineering judgment in some cases where a detention structure is proposed to include a principal spillway outfall, which would allow outflow during an event. Since the exact principal spillway elevations and configurations were not provided, the previously reported capacity for the detention/retention structure was compared to the total inflow volume for 1% annual chance event with no outflow assumed. In cases where the total inflow exceeded the structure's reported capacity with no outflow, engineering judgment was applied to estimate whether the proposed principal spillway described in the previous study would allow for sufficient discharge from the structure, such that the 1% annual chance capacity would not be exceeded in a flood event.

Estimating the level of service for the 0.2% annual chance required different assumptions, since the elevation and dimensions of an auxiliary spillway outfall can have a significant effect on water surface elevations and outflows of a detention/retention structures. Since the precise outflow configurations were not reported or modeled in previous studies for all projects, only the FMPs with model results showing they could contain the entire 0.2% AC flood with no outflow were reported to have a 0.2% AC post-project level of service.

Social Vulnerability Index

The buildings layer used to estimate number of structures at risk for the 1% AC event was attributed with data from the Social Vulnerability Index (SVI) and day/night population data documented in *Chapter 2* to report the corresponding SVI and population at risk data for each flood solution, respectively.

Benefit Cost Ratio

Consistent with TWDB guidelines, benefits associated with FMPs considered in the evaluation process are based upon pre-project and post-project water surface elevations relative to estimated finished floor elevations, assumed to be raised 0.5 ft above existing ground. The existing ground elevation for each building was estimated by calculating the average ground level within each building footprint, based upon the same topographic data used to estimate water surface elevations. Annual structural benefits were estimated for the 1% and 0.2% AC events by comparing the depth of water above each finished floor elevation to the residential and commercial building depth-structure damage curves and depth-content damage curves provided in the FEMA BCA toolkit 6.0 by TWDB.

Benefit Cost Analysis (BCA) methodology was adopted from the El Paso County SWMP 2021 methods with updates applied for the purposes of the RFP, including the use of the FEMA BCA toolkit 6.0 depth-damage and depth-content curves. Each detention/retention basin project expected to have significant undeveloped flow contributing to it was assumed to have annual operation and maintenance (O&M) costs of $10,000 associated with sediment clearing.

The sum of the annual structural and agricultural benefits was divided by the annualized project cost with a discount rate of 2.75% and a planning horizon of 50 years to obtain the BCR for each project. Flooded roadways were not directly evaluated for benefits associated with the BCR, so it is anticipated that the projects will have higher BCRs than presented in the FMP evaluation table (**Appendix 4C**). A summary of the estimated BCR calculations for each of the FMP which reported any 1% AC benefits is provided in **Appendix 5B**.

5.2 Recommendation Process for FMEs, FMSs, and FMPs

The process for recommending FMEs, FMSs, and FMPs includes coordination with the RFPG throughout the regional flood planning process. As new information became available or as evaluations were completed, evaluation results were shared with the RFPG during periodic General RFPG Meetings. The following General RFPG Meetings included votes by the RFPG on Recommended FMEs, FMPs, and/or FMSs:

- General RFPG Meeting held April 21, 2022;

- General RFPG Meeting held May 25, 2022; and
- General RFPG Meeting held July 20, 2022.

Each of the Recommended FMEs, FMPs, and FMSs are included in **Appendices 5C**, **5D**, and **5E**, respectively. The general reason for recommendation for each FME, FMS, and FMP is that the evaluated Flood Solutions were in alignment with RFPG and stakeholder goals. All of the flood solutions which were fully evaluated, and which are presented **Appendices 4A, 4C**, and **4E** were also recommended by the RFPG. Two projects from the El Paso County SWMP (CAN1 and FAB1) were initially identified to be evaluated as FMP for the RFP, but the evaluations were not completed because likely alternative funding sources were identified for each project. There were no potential FMEs or potentially feasible FMSs or FMPs that were evaluated and found to be infeasible by the RFPG.

Even projects with a lower BCR than expected were recommended by the RFPG, as it was recognized that including the flood solution in the RFP would be a minimum requirement to allow the sponsors to apply for funding for the study, strategy, or project in the future. At the time when sponsors apply for funding, there may have been additional studies performed which can demonstrate higher benefits and a higher benefit cost ratio, which they can submit at that time for consideration. This is the RFPG's understanding based upon communication with TWDB. For example, future grant applications for the same FMPs included in this RFP may include modified designs to alternatives, an increased number of frequency storms analyzed, and/or listing additional benefits that may become associated with each FMP, depending on the evolution of each project.

In addition, each recommended FMP was evaluated based upon scoring criteria required for potential impacts and benefits from the FMP to flood risk, life and safety, the environment, agriculture, recreational resources, navigation, water quality, erosion, sedimentation, and implementation/permitting. This information is presented in **Table 5F** of **Appendix 5F**, "Data Entry Table for TWDB Scoring of Flood Mitigation Projects". The table was filled out according to specific criteria and instructions included in the Technical Guidelines provided by TWDB. Notes applicable to specific scores are also included in the table.

Chapter 6: Impacts and Contribution of Regional Flood Plan

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6. Impacts and Contribution of Regional Flood Plan

This chapter summarizes the overall impacts of the Regional Flood Plan (RFP), considering the potential for both positive and negative outcomes related to flood risk and multiple other considerations. Other resources which are not directly related to flood planning, but which can be strongly influenced by flood-related actions include water supply, the environment, agriculture, recreation, water quality, and navigation. It is important to consider all aspects of flood solutions that were evaluated and are recommended as part of the RFP. That way, any potential negative outcomes can be addressed early in the planning phase, and the opportunities for synergy with multiple other potential benefits can be explored and optimized.

6.1 Impacts of Regional Flood Plan

This section includes an overview of potential impacts associated with recommended Flood Management Evaluations (FMEs), Flood Management Strategies (FMSs), and Flood Mitigation Projects (FMPs). The Regional Flood Planning Group (RFPG) evaluated each recommended flood solution to identify direct and indirect potential outcomes to each flood solution that are both positive and negative.

This section includes:

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

6.1.1 FME impacts

The RFPG identified and recommends a broad range of FMEs to lay the foundation for increased flood awareness and management of both flood-related and environmental issues. While the specific benefits associated with each FME cannot be quantifed until certain studies have been completed, the FME evaluation table presented in **Appendix 4A** of *Chapter 4* does quantify the existing risk in the general areas affected by each FME. A summary of the total count for each evaluated flood risk exposure indicator, which would be benefitted by completing all of the FMEs, is provided in **Table 6-1**. These reported quantities are not based on sum totals from the full evaluation table in **Appendix 4A.** Instead, significantly overlapping areas were removed from the totals to avoid double-counting in certain areas.

Table 6-1. Summary of Potential 1% Annual Chance Event Exposure within FME Areas

Exposure Type	Quantity for Existing Conditions*
Structures (count)	37,989
Habitable Structures (count)	27,611
Population (count)	127,887
Critical Facilities (count)	102
Low Water Crossings (count)	260
Road Length (miles)	1,170
Agricultural Land (acres)	86,770

*Quantities are approximate and may contain overlapping between some FMEs

The general types of FMEs recommended include the following:

- Project planning
- Storm water master plans (SWMPs)
- Dam Safety and Emergency Needs
- Preparedness and riverine risk related to sediment or levees
- Irrigation and stormwater interaction

Most of the recommended FMEs actually fall into more than one of the categories above. The specific FMEs associated with each of the general types above are listed in Section 4.3 of *Chapter 4*. The potential positive and negative impacts of each of these general FME types are provided in this section.

Project Planning FME impacts

The primary benefit associated with FMEs that identify and evaluate flood infrastructure projects is that conceptual projects can be refined and modeled to quantify potential flood benefits, costs, and negative impacts. In addition, after these project planning FMEs are completed (up to the 30% design level), each project will have a greater chance of being funded through a future grant or funding opportunity. Potential negative impacts to project planning include the possibility that a project may be categorized infeasible as a result of the study, for a variety of reasons. In which, case Project sponsors would have paid for a study that ultimately resulted in no action being taken. However, this is still an important and necessary step in all flood mitigation planning.

SWMP FME impacts

The recommendation of SWMP FMEs was based upon communities with the greatest number of structures at risk of 1% annual chance flooding, using best available risk mapping. In most cases, the cursory Fathom floodplain mapping was the most reliable source available to assess existing flood risk, which indicates a need for updated detailed flood mapping throughout the region. El Paso is an exception; since it has recent Preliminary Federal Emergency Management Agency (FEMA) mapping and recently updated City and County SWMPs. SWMPs are highly beneficial for each community where they are recommended because they not only identify potential flood mitigation projects, but they also establish detailed floodplain mapping and identify/quantify areas of high flood risk.

Potential negative effects of SWMPs are that they may identify significant areas of flood risk, which could effect the market value of certain properties. Since mapping developed from SWMPs are not regulatory, there is not an over-arching entity (such as FEMA) standardizing the quality and methods used for identifying and mitigating flood risk. This means the quality standards can vary significantly, depending on the firm completing the study and the amount of funding available for the study. If approximate flood risk mapping identifies specific areas at risk, and the study becomes publicly available information, there is the potential for the real estate market to react in a negative way toward areas thought to be at risk of flooding.

All SWMPs involve stakeholder coordination to identify flood-related projects and needs most important to each community. For example, FME IDs: 141000002 and 141000023 specify the consideration of nature based solutions and stream restoration for the cities of Presidio and Alpine, respectively. The RFPG identified issues related to incised channels and diminished storage capacity in Alpine and Moss Creeks upstream of the City of Alpine and in Cibolo Creek upstream of the City of Presidio. "Channel and floodplain restoration can enhance the ability of a channelized or incized reach to temporarily store the flow and dissipate the energy of passing flood waves"[1]. In addition, nature-based enhancements in area streams that slow flood waters and increase recharge would provide benefits for the environment (habitat), sedimentation/erosion issues (geomorphology), as well as water supply (aquifer recharge).

Dam safety and emergency needs impacts

Dams upstream of populated areas which are identified by the Texas Commission on Environmental Quality (TCEQ) as being hydraulically inadequate were considered an emergency need in the RFP. Studies to rehabilitate such dams are recommended in six different FMEs. These FMEs are beneficial because they address the need to rehabilitate flood control infrastructure that may have reached its design life. Potential negative aspects of dam rehabilitiation or decommissioning projects is that they can take a relatively long time to complete due to several federal and state regulations and requirements, and they can be expensive if state or federal funding is not acquired.

Impacts of FMEs for preparedness and riverine risk related to sediment or levees

FMEs related to riverine flooding or levees are important and beneficial in areas where significant populations are at risk of flooding on the landward side of a levee, such as in the El Paso region. In these cases, the build-up of sediment or vegetation in the channel floodway due to lack of maintenance can significantly increase flood risk to populated areas. Establishing minimum flood conveyance capacities and methods for consistently measuring/monitoring

[1] Sholts, Joel. Hydraulic analysis of stream restoration on flood wave propagation. University of North Carolina at Chapel Hill. 2009, pp. 43.

flood capacity would help alert the responsible parties when maintenance is needed for flood safety purposes. It also benefits the agricultural community, since the ability of the irrigation system to drain into the Rio Grande can be significantly affected by sediment build-up in the river.

A potential negative impact associated with these types of studies is that they may identify areas which are important to maintain from a flood safety perspective, but which may be restricted from typical vegetation clearing methods due to the presence of a protected species or habitat. In these stream reaches, it can be a much more expensive process, and can take much longer to establish the desired flood capacity.

Impacts of irrigation and stormwater interaction

Particularly in El Paso County, an extensive irrigation system woven through both urban and rural areas can play a critical role in stormwater conveyance; and thus, requires coordination between multiple entities such as El Paso County Water Improvement District No. 1 (EPCWID1), El Paso Water, El Paso County, and the U.S. Section of the International Boundary and Water Commission (USIBWC). It is important to facilitate stormwater planning coordination between these different entities, as they all may benefit or be negatively impacted by potential issues that can arise related to maintenance, communication, or emergency response activities.

For example, El Paso has the potential to convey stormwater through segments of the irrigation system, if necessary, during extreme flood events. While it would be a benefit to the areas relieved of flooding, there is potential risk to downstream agricultural property when diverting stormwater through the system, as it was not designed for that specific purpose. This is why it is recommended to perform modeling and design increased capacities for culvert crossings in the Lower Mesa Drain (FME ID: 141000004). This study and design would provide the information needed to allow El Paso Water and EPCWID1 to decide how much stormwater can be diverted through the system during pre-project and post-project conditions without causing downstream negative impacts.

Potential negative impacts of performing studies related to the irrigation and stormwater system interactions is that there are many stakeholders involved with highly sensitive and political issues. This can complicate the decision on which entity will fund associated studies or implementation resulting from studies. For these reasons, most FMEs involving complex coordination between multiple entities on politically charged subjects are recommended as strategies, as they can involve multiple studies or steps before implementation can actually occur. However, FME ID: 141000001 was recommended as an FME and not an FMS, because an initial study has already been performed (Study ID 4), which identifies and quantifies both flood risk and maintenance issues, paving the way for recommended actions to be implemented. The recommended FME would leverage knowledge gained from Study ID 4, as well as from updated hydrologic and hydraulic modeling that is expected to be available in 2022 from an ongoing USIBWC study within the same river reach of the Rio Grande.

6.1.2 FMP impacts

FMPs were analyzed using best available hydrologic and hydraulic modeling, which was refined as part of the RFP in some instances, to quantify positive and potential negative impacts. The potentially feasible FMP evaluation table included in **Appendix 4C** documents these impacts based on pre-project and post-project flood risk indicators. **Table 6-2** summarizes the results of the analyses performed, and quantifies the overall impact of all recommended FMPs in the RFP.

Table 6-2. Summary of Impacts from FMPs in 1% Annual Chance Event

Exposure Type	Pre-Project Conditions	Post-Project Conditions	Difference (Exposure Reduction from FMPs)
Structures (count)	1,971	1,448	523
Habitable Structures (count)	869	431	438
Population (count)	5,524	3,855	1,669
Critical Facilities (count)	8	7	1
Low Water Crossings (count)	125	116	9
Road Length (miles)	371	352	19
Agricultural Land (acres)	1,420	1,235	185

In addition to the 1% annual chance flood benefits noted above, the recommended FMPs are estimated to remove a total of 936 structures from the 0.2% annual chance flood risk inundation boundary.

No negative impact statement

The TWDB has a statutory requirement to "…not negatively affect a neighboring area," particularly as a result of structural flood mitigation projects. This requirement is base on Texas Water Code 16.062(h) and (i). Additionally, the TWDB rules include a definition of "Negative Effect" to mean, "An increase in flood-related risks to life and property, either upstream or downstream of the proposed project." 31 TAC 361.10.

For the purposes of the RFP, each recommended FME, FMP, and FMS was reviewed to investigate potential negative impacts to surrounding properties. Since all of the FMEs and FMSs include non-structural recommendations (studies, program development, coordination, early warning systems, etc.), there is not a potential for direct negative flooding impacts. However, for FMPs involving proposed flood control infrastructure, analyses were performed using project-specific models and mapping, considering proposed project intentions, infrastructure components, and model results. *Chapter 5* documents the project-specific methodologies and results of these "no negative impact" assessments for each FMP in **Appendix 5B**. In addition, **Appendix Table 5D** ("Flood Mitigation Projects Recommended by RFPG") includes a column entitled, "How No Negative Impact was Determined," which specifies the method and/or models used to assess pre-project vs. post-project conditions to confirm that no negative flood impacts are anticipated on neighboring areas to FMPs.

The overall result of the reviews and analyses performed is that when implemented, the recommended FMPs are estimated not to negatively affect neighboring areas located within or outside of Region 14. Project sponsors will ultimately be responsible for ensuring the final project designs of each project will have no negative impact prior to construction.

Impacts Related to Proposed Project Scoring

To develop a single ranked list for the State Flood Plan, the TWDB must collect data by which to rank projects across the state. The intent of the project ranking is to reflect the State Flood Plan primary objective of protecting against loss of life and property while also accommodating a sufficiently wide range of project types and project geographies. To aid in the ranking process, quantitative and qualitative data were used by the RFPG to score each recommended FMP in 15 categories specified in TWDB's Technical Guidelines for Regional Flood Planning (2021). These categories include assessment and scoring related to potential impacts and benefits from the FMP to flood risk, life and safety, the environment, agriculture, recreational resources, navigation, water quality, erosion, sedimentation, and implementation/permitting. This information is presented in **Appendix 5F** of *Chapter 5,* "Data Entry Table for TWDB Scoring of Flood Mitigation Projects".

Detailed methods were specified in the RFP Technical Guidelines for assigning scores to each category; however, the method weighting each score to calculate a combined total score has not been specified at this time. As part of the scoring process, desktop analyses were performed to identify potential environmental and cultural resources impacts for each FMP. Any environmental benefits or potential permitting/implementation impacts associated with protected species/habitat or cultural resources in the area were identified Scoring Notes 12, 13, and 14 of the table in **Appendix 5F**.

Cultural Resources Background Reviews

Projects in Texas can come under the purview of the National Historic Preservation Act (NHPA) and the Antiquities Code of Texas (ACT). Both are administered by the Texas Historical Commission (THC), the State Historic Preservation Office in Austin, Texas. If an undertaking is federally permitted, licensed, or partially funded, the project must comply with Section 106 of the NHPA. The ACT requires projects on land owned or operated by a political subdivision of the State of Texas to assess whether the project will impact cultural resources that meet the requirements for listing as a State Antiquities Landmark (SAL). Projects under control of political subdivisions of the State of Texas, such as water agencies, counties, and city-owned entities, must comply with the ACT.

As part of the RFP impacts assessment for each recommended FMP, a cultural resources records review was performed to determine if any cultural resources were recorded within or immediately adjacent to the proposed project areas. To conduct this review, an archaeologist reviewed the relevant U.S. Geological Survey (USGS) 7.5-minute quadrangle maps on the Texas Archeological Sites Atlas (Atlas), the THC's archaeological database. This source provided information on the nature and location of previously recorded archaeological sites, locations of National Register of Historic Places (NRHP) districts and properties, sites designated as SAL, Official Texas Historical Markers, Recorded Texas Historic Landmarks, linear historic features, and cemeteries.

The results of the cultural resources background review are reflected in Scoring Note 14 of **Appendix 5F** as well as in the narratives for each FMP included in **Appendix 4D**. These cultural resources background reviews were based on preliminary project boundaries. Any future changes to project area boundaries, project impact footprints, and more detailed project designs may require additional background review that could result in changes to regulatory requirements.

Post Project and Future Risks Associated with FMPs

Flood recovery activities most often include debris removal from culvert entrances and bridges by cities, counties, and the Texas Department of Transportation (TxDOT), who maintain employees to perform assessment of damages and debris removal. The recommended FMPs for proposed detention/retention sediment basins will reduce this maintenance burden in downstream areas in addition to reducing or eliminating significant expenses associated with floodwater depositing sediment on agricultural land.

Six recommended FMPs, listed at the beginning of **Appendix 5B** of *Chapter 5*, include detention/retention storage basins with earthen embankments. Sediment storage capacity is included as a design criteria for structures expecting high sediment loads. The design of sediment storage capacity is a requirement for Natural Resources and Conservation Service (NRCS) dams, but it is not a Texas Commission on Environmental Quality (TCEQ) design requirment for dams.

Regular maintenance and inspections are required to maintain the intended minimum storage capacity and to identify potential risks associated with erosion, integrity, or performance of the structure. An annual maintenance cost of $10,000 was considered in the Benefit Cost Analysis (BCA) performed for each of these structures.

An Operation and Maintenance Manual and an Emergency Action Plan (EAP) with breach inundation hydraulic modeling and mapping will be required for any proposed structure classified as a dam per TCEQ regulations. These requirements will define the risk of potential catastrophic failure due to a dam breach and the potential for future increases to these risks due to lack of maintenance.

6.1.3 FMS impacts

Each recommended FMS was reviewed to identify the potential for both positive and negative impacts. While the specific benefits associated with most FMSs cannot be quantifed until certain studies or designs have been completed, the FMS evaluation table presented in **Appendix 4E** of *Chapter 4* does quantify the existing risk in the general areas affected by each FMS, as well as flood risk benefits estimated for three of the FMSs which had relevant project-specific models or mapping available. The project-specific analyses performed for each of these three FMSs (including assessment of no negative impacts) is documented in **Appendix 5A** of *Chapter 5*. **Appendix 5A** also includes discussions on the remaining FMSs, explaining why they were not analyzed for project-specific benefits and why they are also estimated to have no negative impact to neighboring areas.

Based on results from the FMS evaluations documented in Appendix 4E, a summary of the overall flood risk indicators for existing conditions are provided in Table 6-3. These results summarize just the FMSs which were not analyzed for project-specific flood benefits and may contain overlapping areas. However, significantly overlapping areas and region wide FMEs were not included in the totals to avoid double counting certain areas, where possible.

Table 6-3. 1% Annual Chance Exposure for FMSs not Analyzed with Models or Mapping

Exposure Type	Quantity for Existing Conditions*
Structures (count)	34,830
Habitable Structures (count)	23,927
Population (count)	107,451
Critical Facilities (count)	71
Low Water Crossings (count)	822
Road Length (miles)	2207
Agricultural Land (acres)	77829

*Quantities are approximate and may contain overlapping between some FMSs

Results from the three project-specific FMS analyses documented in **Appendix 5A** have significant flood benefits, for the 1% annual chance event. These FMSs include two levee certification FMSs (one on the Rio Grande in El Paso County and one on Cibolo Creek in the City of Presidio). The third FMS analyzed includes complex coordination between EPWater and The U.S. Army to construct two flood control structures and maintain two existing dams on Fort Bliss Military base property. Combined results from these three FMSs are reported in **Table 6-4**, below.

Table 6-4. 1% Annual Chance Impacts for Analyzed FMSs (142000001, 142000004, 142000008)

Exposure Type	Pre-Project Conditions for Only Project-Specific FMSs	Post-Project Conditions for Only Project-Specific FMSs	Difference (Exposure Reduction from Only Project-Specific FMSs)
Structures (count)	12,082	1,121	10,961
Habitable Structures (count)	10,488	862	9,626
Population (count)	32,365	2,801	29,564
Critical Facilities (count)	38	8	30
Low Water Crossings (count)	39	7	32
Road Length (miles)	240	58	183
Agricultural Land (acres)	23,486	5,622	17,864

In general, FMSs do not typically fit into the FME or FMP categories for a variety of reasons. Below is a list of criteria that led to the decision to list a flood reduction action as an FMS rather than an FME or FMP:

- Studies, projects, and/or program development involving complex coordination between multiple entities (local, state, federal, or international);
- Associated with other FMEs, FMSs, or FMPs requiring a specified sequence of actions as part of a larger plan;
- Involve multiple projects with varying statuses of design/construction; and
- Include recurring costs.

Positive and negative impacts associated with these aspects of FMSs are discussed in this section.

Impacts of FMSs for complex coordination between entities

Potential negative impacts associated with complex coordination between multiple entities is the overalll strategies can be expensive and take a long time to implement. This could be related to the time needed to gain permits and approvals from multiple entities, or due to politically sensitive issues affecting international, federal, state, or local agreements.

Benefits to facilitating this type of coordination between entities are associated with a more holistic approach to flood planning. If all the necessary stakeholders are involved early on in making planning decisions that affect not only flood risk, but sometimes environmental and water supply issues, the overall plan is more likely to be successful and leverage the necessary resources to optimize benefits in multiple scoring categories that are documented in **Appendix 5F** of *Chapter 5,* "Data Entry Table for TWDB Scoring of Flood Mitigation Projects".

For these reasons, FMSs typically include a significant amount of budget for stakeholder coordination. In addition, scopes of work specified in the FMS narratives included in **Appendix 4F** include analyses of a strategy from differet stakeholder perspectives. For example, Presidio County Emergency Management identified drainage issues related to vegetation and sediment for communities located adjacent to the Rio Grande and FM 170, between the City of Presidio and Candelaria. This strategy involves coordination with TXDOT (FM170 drainage), local stakeholders (communities draining to the Rio Grande), and USIBWC (who has jurisdiction over projects affecting the Rio Grande).

Positive benefits of this strategy include improved roadway and local drainage for communities as well as reduced riverine flood risk for communities if sedimentation issues are identified and resolved. However, the RFPG has noted that this area is a protected habitat for birds, and a tourist attraction, which must be considered when evaluating alternatives for vegetative clearing. In addition, there are numerous wells in the floodplain between Candelaria and Presidio. These are anticipated to be shallow wells in unconfined riparian aquifers. Any effort to increase conveyance velocities could potentially negatively impact some of these wells. These potential issues are identified in the scope of the FMS to ensure these potential risks are identified in the data collection phase.

Impacts of FMSs with multiple phases and associated FMEs, FMPs, or FMSs

If not carefully planned and monitored, potential negative impacts can result from FMSs that require associated studies, strategies, or projects to be completed prior to implementation, or which have different phases of design and construction on multiple project components of a larger plan. Either of these circumstances introduce complexities to the planning process, which is why it is important to clearly identify which phases should be constructed or studied sequentially. This can have cost saving benefits by avoiding re-work or investigation of solutions to a problem that has already been studied. For these reasons, associated FMEs, FMS, or FMPs are included in all evaluation tables, and are discussed within the applicable narratives. If not carefully planned and tracked, there could be the potential for negative impacts associated with increased costs or increased flood risk to neighboring areas. An example would be implementing a solution in one area before flood mitigation measures could be implemented that would prevent negative impacts to neighboring areas.

Impacts of FMSs with recurring costs

Most of the FMSs which include recurring costs are associated with flood early warning systems. These FMSs are also identified as emergency needs by the RFPG. While early warning has clear safety benefits associated with emergency response, significant recurring costs can be a financial burden too great for some of the small communities that need these services the most. For these reasons, multiple FMSs and FMPs are recommended for early warning systems or devices, which include a variety of options.

For example, FMP ID: 143000007 and FMS ID: 142000025 both address early warning in Marfa, where a death from a vehicle swept away at a low water crossing occurred in 2021. One option proposed for early warning includes a fixed cost (the FMP), and another includes a more robust system with recurring service fees (the FMS). Alternatively, FMS ID: 142000014 is recommended to apply a region-wide planning approach to select the optimum locations for new flood gages throughout Region 14. While recurring costs would still be necessary, if multiple entities are involved and benefit from the system, there are opportunities for cost sharing amongst larger groups or over-arching entities, making the strategy more affordable for all involved.

6.1.4 Summary of RFP Impacts

The methods applied to estimate potential increases in future conditions flood risk are documented in *Chapter 2 ("Flood Risk Analyses")*. The anticipated increased flood risk was modeled and mapped in the RFP based on the following:

- Best available flood risk modeling and mapping data;
- Future precipitation projections based on recent studies (for El Paso County watersheds only);
- Future land use planning documents (for El Paso County watersheds only); and
- Population projections throughout the region

Based on these methods, a future 1% annual chance and 0.2% annual chance floodplain was developed for Region 14 and compared to the existing conditions inundation areas for corresponding flood frequency boundaries. The extent of increased 1% annual chance risk inundation area from existing to future conditions is **242** square miles (sq. mi.). The extent of increased 0.2% annual chance risk inundation area from existing to future conditions (separate from the 1% annual chance risk inundation area) is **181** sq. mi. These anticipated increases in flood risk are estimated to be reduced if the FMEs, FMSs, and FMPs recommended in the RFP are performed.

As noted in *Chapter 4*, there are 20 out of the 23 counties within Region 14 that are in need of flood risk identification or in need of updated flood risk mapping. The exceptions are El Paso, Ector, and Val Verde Counties, which have recent flood risk mapping. Out of these 20 counties which need current floodplain mapping, there are 39 cities or Census Designated Places (CDPs) within Region 14, which have a combined jurisdictional area of 175 sq. mi. To address this need, there are 9 FMEs recommended for cities with outdated or no floodplain mapping. These 9 cities have a combined total jurisdictional area of **110 sq. mi**. These cities were selected for SWMP FMEs based on an assessment of cities within the region with the greatest number of structures at risk of 1% annual chance flooding.

As noted in *Chapter 2*, there are approximately 40,121 structures at risk of 1% annual chance flooding in the region with a total population of 115,530. There are an additional 14,290 structures within the 0.2% annual chance flood risk inundation area (separate from the 1% annual chance risk inundation area) with a population of 47,985. The recommended FMPs and project-specific FMSs analyzed for flood risk benefits are estimated to remove **11,964** structures from the 1% annual chance flood risk boundary with a combined population of approximately **31,233**. The recommended FMPs are estimated to remove **936** structures from the 0.2% annual chance flood risk boundary with an approximate population of **2,400**. Furthermore, the recommended FMPs and FMS are estimated to remove **41** low water crossings from the 1% annual chance flood risk boundary.

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

Flood management and water supply management are fundamentally interrelated. Strategies and projects which reduce flood risk may also augment or diminish water availability. To address this, the RFP included an evaluation of potential impacts from the recommended FMSs and FMPs on water supply development or the State Water Plan (SWP).

This effort included:

- A region-wide summary and description of the contribution that the RFP would have to water supply development including a list of the specific FMSs and FMPs that would contribute to water supply; and
- A description of any anticipated impacts that the RFP FMSs and FMPs may have on water supply, water availability, or projects in the SWP.

6.2.1 Contributions to Water Supply Development

There are no recommended FMPs that would measurably contribute to water supply. However, there is one recommended FMS which is estimated to contribute to water supply (FMS ID: 142000002). In the RFP, this FMS is named, “Irrigation and Recharge Application of Captured Rainwater Runoff at Alpine.” It is also recommended in the adopted State Water Plan (TWDB, 2022) as well as in the current Far West Texas Water Plan (TWDB, 2021) for Region E, where it is identified as Strategy E-2, “Irrigation and Recharge Application of Captured Rainwater Runoff.”

This nature-based solution in the City of Alpine involves three rainwater catchment basins centered around Kokernot Park to accomplish a shared goal of reducing stormwater in roadways while improving water quality, groundwater infiltration, and saving water supply costs associated with landscaping irrigation systems. The stormwater is proposed to be diverted from roadways to a natural swale that runs parallel to the road at a lower elevation using curb cuts. A series of basins with designed native plantings and excavated 16 inches (in.) to 24 in. deep are proposed to capture and infiltrate runoff.

While no hydrologic or hydraulic models or proposed drawings are currently available, runoff calculations and estimates of impervious cover were used to estimate total volume of water drained to each collection point in average and drought years. These estimates were based upon the following assumptions:

- 33% of the watershed area is impervious
- 66% of the watershed area is permeable

- < 0.2 in. rainfall event will not produce runoff
- By design the system for high frequency (low intensity) events, the average annual effective rainfall is 7.2"
- 80% of the water falling on impervious surfaces will run off
- 30% of the water falling on permeable surfaces will run off
- A drought year is defined as 75% of average annual rainfall
- A square foot of surface will shed 0.6 gallons per inch of rain
- Catchment areas were delineated for the three project locations based on Interferometric Synthetic Aperture Radar (IFSAR), with the following areas associated with each project location (project locations are provided in a figure included with the FMS narrative in **Appendix 4F**):
  - Location 1: 25 acres (ac.)
  - Location 2: 8.75 ac.
  - Location 3: 312.5 ac.

Based on the assumptions above, **Table 6-5** shows the expected volume of water that will drain to each of the 3 proposed catchment locations.

Table 6-5. Estimated runoff volume drained to each basin in average and drought years

Basin Location	Gallons (Average Year)	Gallons (Drought Year)	Acre-ft (Average Year)	Acre-ft (Drought Year)
1	2,187,583	1,640,687	6.7	5.0
2	765,654	574,241	2.3	1.8
3	27,344,790	20,508,593	83.9	62.9

The Water User Group identified for this strategy in the Region E Water Plan is the City of Alpine. State Water Plan identified the City of Alpine as the Sponsor of the recommended strategy. Based on the information provided by the project planners and the Far West Texas Water Plan (TWDB, 2021) for Region E, this strategy is expected to directly increases water supply volume available during droughts of record for the City of Alpine.

6.2.2 Impacts on the State Water Plan

The RFPG is required to list recommended FMSs or FMPs that, if implemented, would negatively impact and/or measurably reduce:

- Water availability volumes that are the basis for the most recently adopted SWP; and
- Water supply volumes if implemented.

For example, an FMS or FMP that involves reallocating a portion of reservoir storage that is currently designated for water supply purposes to be used, instead, for flood storage, would measurably reduce the water availability at that water source in the most recently adopted state water plan.

Sections 16.051 and 16.055 of the Texas Water Code direct the Executive Administrator of the TWDB to prepare and maintain a comprehensive State Water Plan. The overall goal of the State Water Plan is to address water supply needs at the local level with the consideration of balancing affordable water supply availability and conserving the State's natural resources. The State Water Plan serves as a flexible guide for the development and management of all water resources in Texas.

In February 1998, the TWDB adopted rules establishing 16 regional water planning areas. Similar to the regional flood planning process, each planning area is responsible for preparing a consensus-based Regional Water Plan (RWP) that will provide for the water needs of its region for the next 50 years. The TWDB incorporates the results of each RWP into the State Water Plan, which is updated in 5-year cycles. The most recent State Water Plan was published in 2022, incorporating results from the 2021 Regional Water Plans.

Of the 16 Regional Water Planning Regions in Texas, three regions – Regions E, F, and J – are within the bounds of the Upper Rio Grande Flood Planning Region, as shown in **Figure 6.1**.

Water Planning Region E

Region E ("Far West Texas") consists of seven counties from the Upper Rio Grande Flood Planning Region (URGFPR), including the Counties of Brewster, Culberson, El Paso, Hudspeth, Jeff Davis, Presidio, and Terrell. Within the URGFPR, Region E overlaps three major aquifers (most notably the Hueco-Mesilla Bolson aquifer along the Rio Grande in El Paso and Hudspeth Counties) and six minor aquifers (including the Igneous aquifer in Jeff Davis, Brewster, and Presidio Counties). Due to the limited availability of surface water, a majority of the region relies on groundwater sources for water, while only a small portion of the water supply is sourced from controlled flows in the Rio Grande and direct reuse water. None of the recommended FMSs or FMPs are anticipated to negatively impact or measurably reduce the yield or operation of these existing aquifers or direct use sources in Region E.

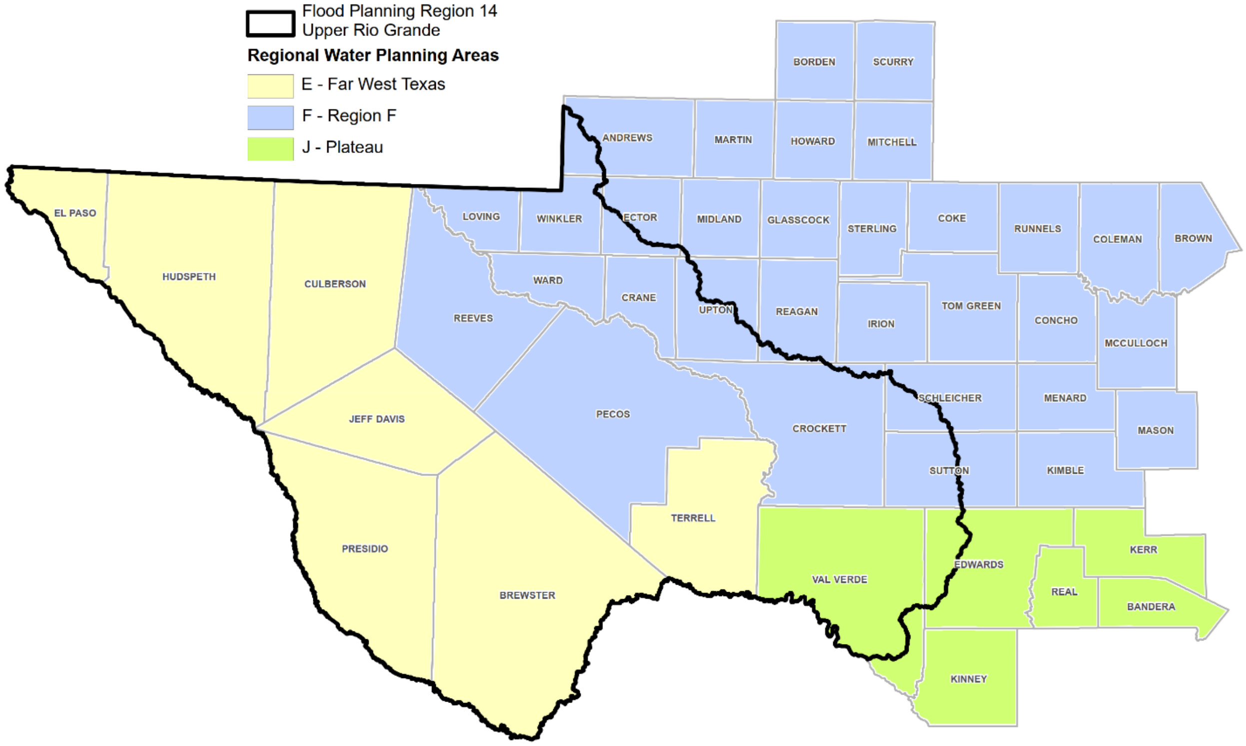

Figure 6.1 Region 14 Overlap with Water Planning Regions

Water Planning Region F

Region F consists of 14 counties from the URGFPR, including the Counties of Andrews, Crane, Crockett, Ector, Loving, Midland, Pecos, Reagan, Reeves, Schleicher, Sutton, Upton, Ward, and Winkler. Within the URGFPR, Region F overlaps two major aquifers – the Pecos Valley and Edwards-Trinity aquifers – as well as four other minor aquifers. The region also includes the 279,000 acre-foot Red Bluff Reservoir along the Pecos River in Loving and Reeves Counties and Lake Balmorhea along Toyah Creek in Reeves County. Based on historical water use data from the 2021 Regional Water Plan, approximately 75% of the region's water is supplied by groundwater, while approximately 15% of the water supply is sourced from surface water reservoirs and less than 10% comes from direct water reuse. None of the recommended FMSs or FMPs are anticipated to negatively impact or measurably reduce the yield or operation of these existing aquifers, reservoirs, or direct use sources in Region F.

Water Planning Region J

Region J ("Plateau") consists of two counties from the URGFPR, including the Counties of Edwards and Val Verde. Within the URGFPR, Region J overlaps with parts of the Edwards-Trinity aquifer. The region also includes the 3.4 million acre-foot Amistad Reservoir along the Rio Grande, which is managed jointly by the United States and Mexico in accordance with international treaties through the International Boundary and Water Commission (IBWC). Flows of the mainstream Rio Grande and Pecos and Devils Rivers provide only limited amounts of water for irrigation, livestock, and wildlife. None of the recommended FMSs or FMPs are anticipated to negatively impact or measurably reduce the yield or operation of the Amistad Reservoir or Region J aquifers.

Ecologically Unique River and Stream Segments

In addition, as part of the water planning process, each water planning group has the option to include recommendations for the designation of Ecologically Unique River and Stream Segments in their adopted regional water plan (31 TAC 357.43). Based on these recommendations, the Texas Legislature may then designate a river or stream segment to be of unique ecological value, restricting state financing for the construction of a reservoir along the segment. In the 2021 Region E RWP, ten stream segments within the boundaries of state-managed properties were recommended for the ecologically unique designation, eight of which have received designation by the Texas Legislature.[2]

In particular, two of the recommended ecologically unique stream segments overlap with one FME and one FMS in the Regional Flood Plan, including the Alamito Creek segment (FME ID: 141000008) and the Rio Grande Wild and Scenic River segment (FMS ID: 142000006). The segment of Alamito Creek that is protected is within the boundaries of Big Bend Ranch State Park, and the Rio Grande Wild and Scenic River segment is within Big Bend National Park. Since both of these flood solutions are associated with initial studies and not the implementation of projects, neither is estimated to be affected by the ecologically unique designation, which restricts financing for the construction of reservoirs along protected segments.

While the Alamito Creek study will investigate potential locations for sediment basins, the protected stream segment will be eliminated from consideration due to this restriction. The recommended FMS involving the study of binational streamflow recommendations for the Big Bend Reach of Rio Grande/Rio Bravo will not consider any alternatives associated with constructing a reservoir on the Rio Grande.

Overall Impact on the State Water Plan

Based on the evaluations of recommended FMSs and FMPs previously discussed in *Chapter 5*, no measurable negative impacts are anticipated on water supply, water availability, or projects in the State Water Plan.

[2] In the 2021 Regional Water Plans, both Region F and Region J decided to not recommend any river or stream segments as ecologically unique.

Chapter 7: Flood Response Information and Activities

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Figures

7. Flood Response Information and Activities

This chapter provides a summary of emergency management activities across the Upper Rio Grande Region, addressing the preparedness, response, and recovery phases of flood emergencies. Information was gathered based on agency coordination, survey responses, and hazard mitigation planning documents. Survey responses were obtained from the RFP stakeholder survey discussed in *Chapter 10 ("Public Participation and Plan Adoption"),* through which stakeholders and participants were asked to share the emergency response measures that their jurisdiction currently uses or plans to implement for flood events.

Chapter 8 ("Administrative, Regulatory, and Legislative Recommendations") included in this Flood Plan offers recommendations by the URGRFPG for consideration by the Texas Legislature, TWDB, TCEQ, other water planning regions and all stakeholders and participants in Texas' regional and state flood planning efforts which propose new recommendations that could potentially be incorporated as a flood response activity.

7.1 Flood Emergency Management Overview

Emergency management, as defined by FEMA, addresses disasters as recurring events with four phases: Mitigation, Preparedness, Response, and Recovery. Definitions and examples of each phase are listed in the TWDB *Technical Guidelines for Regional Flood Planning* document, as shown in **Table 7.1** below.

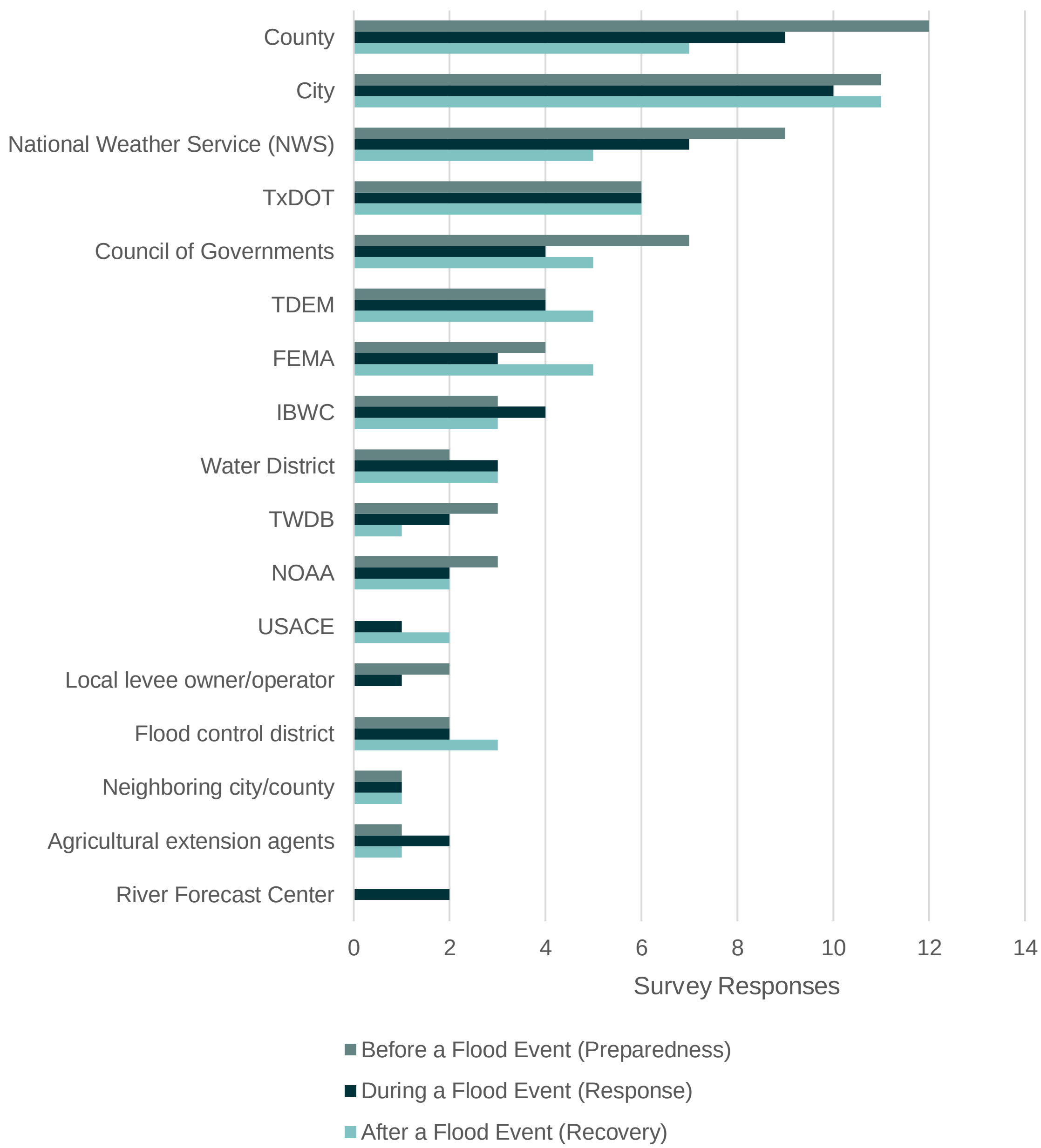
Table 7.1 Flood Emergency Management Phases

Phase	General Definition	Example Activities (not an exhaustive list)
Flood mitigation	"The implementation of actions, including both structural and non-structural solutions, to reduce flood risk to protect against the loss of life and property." (Title 31 Texas Administrative Code §361.10(k))	See *Technical Guidelines for Regional Flood Planning* Section 3.2(2-3) examples of structural and non-structural Flood Mitigation Projects.
Flood preparedness	Actions, aside from mitigation, that are taken before flood events to prepare for flood response activities	Developing emergency management and evacuation plans, preparing staging areas, and building flood early warning systems
Flood response	Actions taken during and in the immediate aftermath of a flood event	Conducting evacuations, providing shelters, closing flooded roads, and operating flood warning systems
Flood recovery	Actions taken after a flood event involving repairs or other actions necessary to return to pre-event conditions	Repairs to damaged infrastructure, storm event debris removal

Flood mitigation is the primary focus of the regional flood planning process with the outcome of identifying and recommending FMEs, FMSs, and FMPs by the RFPG. As discussed in *Chapter 5 ("Evaluation and Recommendation of Flood Solutions")*, several FMSs and FMPs were also recommended pertaining to flood preparedness, such as the installation of early warning systems and automatic low water crossing road closure gates. The remainder of this chapter focuses on existing regional activities related to the latter three phases of flood emergency management – preparedness, response, and recovery.

The figure below provides a visual summary on the responses received from the entities regarding the coordination happening before, during and after flood events, which correspond to the preparedness, response, and recovery activities, respectively.

Figure 7.1 Entity Coordination Before, During, and After Flood Event



7.2 Relevant Planning Documents

Chapter 1 Section 1.9 and Appendix 1D of the RFP include a summary of existing planning documents pertaining to the Region 14 flood plan. Several of these documents are relevant to flood preparedness activities, including:

- Rio Grande Council of Governments (RGCOG) Multi-Action Hazard Mitigation Planning (Counties of Brewster, Ector, El Paso, Hudspeth, Jeff Davis, and Presidio)
- El Paso County Hazard Mitigation Action Plan
- City of El Paso High Hazard Dams Emergency Action Plan (EAP)
- Elephant Butte & Caballo Dams EAP
- Federal Flood Assessment Conference Recommendations and Proceedings
- Emergency Action Plan, City of El Paso High Hazard Dams

7.3 Flood Preparedness Activities

Flood emergency preparedness activities include the development of emergency management and action plans, hazard mitigation plans, and the building of flood early warning and alert systems, flood gages, or automatic low water crossings.

Several Emergency Action Plans (EAPs) have been developed for dams throughout the region including the City of El Paso High Hazard Dams EAP (2008), the Red Bluff Dam EAP (2021), and the Elephant Butte & Caballo Dams EAP (2018).

In addition, Hazard Mitigation Plans (HMPs) have been developed for the Counties of Brewster, Ector, El Paso, Hudspeth, Jeff Davis, and Presidio. These HMPs, while primarily mitigation-focused, encourage interregional coordination with key flood planning stakeholders and assist with flood preparedness by reducing emergency response demands during a flood.

In addition to these planning documents, El Paso currently utilizes a flood early warning system based on early warnings provided by a dedicated meteorologist with coordination between EPWater, EPCWID1, and the operators of Caballo Dam in New Mexico. To manage flows along the Rio Grande, the UIBWC has a Water Accounting Division to oversee flow data and assist with reservoir operation criteria during flood events. The U.S. Army Corps of Engineers (USACE) informs communities of the risks of living behind levees by maintaining levee information in the National Levee Database, performing Levee Risk Screening, and communicating the results to sponsors and owners of levee systems as well as the community.

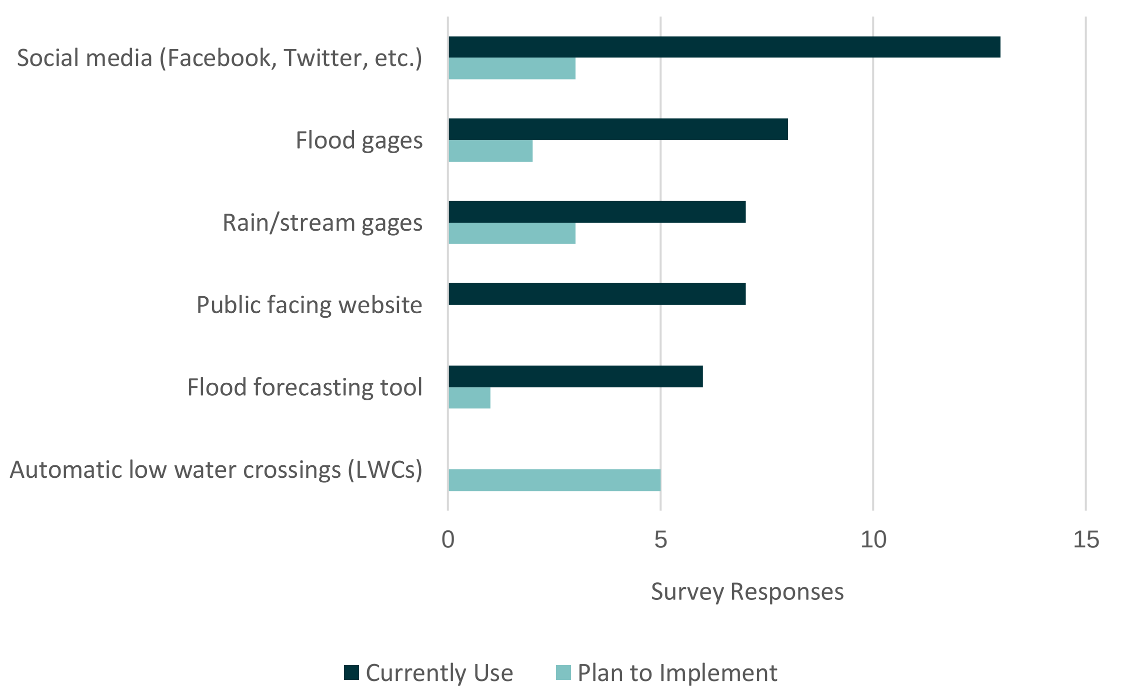
Chapter 5 ("Evaluation and Recommendation of Flood Solutions") of this RFP includes six recommended FMPs to develop or improve flood early warning systems for the City/County of El Paso and the Cities of Pecos, Alpine, Presidio, Fort Stockton, and Marfa. A general FMS is also recommended for the entire region to prioritize, fund, and develop new flood gages (rainfall and/or stream gages) to support flood warning system improvements. Lastly, an FMP is recommended to install automatic low water crossing gates along Alamito Creek in Marfa, including the installation of a monitoring and early detection gage.

A summary of region-specific flood preparedness activities reported through the RFP stakeholder survey is provided in **Figure 7.2**. The majority of the respondents currently use social media as a measure to prepare for flood events, whereas the largest preparedness measure planned to be implemented by respondents is to implement automatic low water crossings.

Communication between entities across the region is essential before, during, and after storm events. While many counties have a Reverse 9-1-1 emergency text system for county residents to receive flood warning messages, there is interest in advancing communication and cooperation across the region to improve the safety of residents of the region and improve the accessibility of emergency response during storm events.

In the City of El Paso, residents at risk of flooding are offered the resource of free sandbags to fortify their properties from flooding when storm events are anticipated for the city. While this is a temporary solution to their need for infrastructure improvements, it has served as a tangible community education activity. Public understanding of flood risk is an important component of increasing the resiliency of the community from the risks of flood related injuries.

Figure 7.2 Flood Preparedness Measures Used by Survey Respondents



Additional information is provided below regarding the National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), and the El Paso County Hazard Mitigation Plan.

National Weather Service (NWS) and NOAA

The NWS is currently in the process of implementing Flood Early Warning System (FEWS) flood forecast system, called the Community Hydrologic Prediction System (CHPS). NOAA/NWS RFCs are emphasizing development of improved streamflow routing with the use of dynamic, unsteady streamflow routing, including near real-time event-based flood inundation mapping, within CHPS. This is a more reliable and accurate way to understand the behavior of flood patterns to anticipate when these will occur.

NOAA Flood Safety Awareness Safety & Preparedness

The NOAA's page includes information about safety awareness and preparedness. Good preparation and knowing what to do in a flood will increase people's safety and chances of survival. It can also help minimize potential flood damage and accelerate recovery efforts. The Flood Safety Brochure offers information to public on what to do before, during, and after a flood.

El Paso County Hazard Mitigation Action Plan

The El Paso County Hazard Mitigation Action Plan identifies several flood hazards throughout the county and has developed mitigation actions. These actions are listed in **Table 7.2** below and provide additional information related to the county's flood preparedness goals and current activities.

Table 7.2 El Paso County Hazard Mitigation Plan – Major Actions

Type	Action
Dam Failure	Implement education and awareness program utilizing media, social media, bulletins, flyers, etc. to educate citizens of hazards that can threaten the area and mitigation measures to reduce injuries, fatalities, and property damages.
Dam Failure	Acquire and install generators with hard wired quick connections at all critical facilities.
Dam Failure	Harden/retrofit critical facilities to hazard-resistant levels.
Dam Failure	Create a map of inundation for the County operated Dams.
Dam Failure	Create an alert system for residents notifying them of potential dam failure.

Type	Action
Dam Failure	Implement the recommendations of the El Paso City / County EAP regarding dam safety.
Dam Failure	Enhance the area-wide Emergency Notification System (Everbridge).
Dam Failure	Install and update EZInet at the 911 Communication Center. It will allow for the organization upgrade from Enhanced 911 (E911) to Next Generation 911 (NG911).
Dam Failure	Develop alternative evacuation routes/plans and designate emergency thoroughfares, particularly in areas with limited capacity. Educate citizens on evacuation routes and procedures.
Dam Failure	Distribute NOAA bulletins.
Flood, Dam Failure	Inspect and implement building requirements for critical infrastructure buildings to be protected from natural hazards. Harden/retrofit critical facilities to hazard-resistant levels.
Flood, Dam Failure	Create an evacuation plan in case of dam failure or flooding condition
Flood, Dam Failure	Acquire/relocate new public buildings to be out of high hazard areas.
Flood	Create a comprehensive map with identified hazards and potential alert zones.
Flood	Inspect, monitor, and educate owners of arroyos (drywashes) to prevent illegal dumping, remove overgrown vegetation and re-establish flow paths within private property.
Flood	Update 2010 Storm Water Master Plan.
Flood	Implement/construct projects identified by storm water master plan.
Flood	Upgrade alert systems and notification to the public at low water crossings.
Flood	Improve current programs for clearing debris from drains, culverts, and ponds by purchasing new equipment.
Flood	Increase drainage capacity, add stormwater detention and/or retention basins as deemed necessary to reduce flood risk.

Type	Action
Flood	Reduce urbanized flooding conditions by creating channels and upgrading pump stations to remove standing water.
Flood	Require that electric utility lines be buried when new roads are constructed or reconstructed.
Flood	Adopt and enforce ordinance that meet minimum Federal and state requirements to comply with NFIP.
Flood	Stabilize arroyos in steep locations and that show signs of erosion with native vegetation.
Flood	Acquire and demolish repetitive loss properties. Acquire high risk vacant land and maintain as open space.
Flood	Excavate stormwater detention basins to increase capacity.
Flood	Increase capacity for conveyance of stormwater away from areas of ponding.
Flood	Update Flood Damage Prevention Ordinances when new FIRMs are adopted (new preliminary FIRMS are currently under review).
Flood	Adopt and implement a routine tree trimming program that clears tree limbs near power lines and/or hanging in right-of-way; Remove dead trees from right-of way and drainage systems on a scheduled basis.
Flood	Acquire and install generators with hard wired quick connections at all critical facilities.
Flood	Maintain certification in the National Weather Service Storm Ready Program
Flood	Remove dead trees from right-of way and drainage systems on a scheduled basis. Maintain Ponding area for proper drainage.
Flood	Educate community on the dangers of low water crossings through the installation of warning signs and promotion of "Turn Around, Don't Drown" Program.
Flood	Undertake a comprehensive drainage study for the Socorro/San Antonio St. area
Flood	Upgrade stormwater system in high-risk areas throughout the city.

Type	Action
Flood	Construct regional pond in a portion of 1445 San Antonio St. Implement drainage improvements such as drainage inlets, approximately 740-ft of 30-inch reinforced concrete pipe (RCP) storm sewer system, pavement replacement, perimeter fencing, and an access driveway. The capacity of this public regional pond is 11.54 Ac-ft, which completely retains the total expected storm water flow of 10.4-Ac-ft from a 100-year storm event.
Flood	Update Flood Damage Prevention Ordinances when new FIRMs are adopted (new preliminary FIRMS are currently under review).
Flood	Implement education and awareness program utilizing media, social media, bulletins, flyers, etc. to educate citizens of hazards that can threaten the area and mitigation measures to reduce injuries, fatalities, and property damages.
Flood	Incorporate higher standards for hazard resistance in local application of the building code.
Flood	Implement a flood awareness program by providing FEMA/NFIP materials to mortgage lenders, real estate agents and insurance agents and place them in local libraries.
Flood	Adopt regulations to limit amount of impervious cover in conjunction with new development.
Flood	Incorporate requirements to ensure stormwater infrastructure is added to all roadway projects.
Flood	Increase drainage capacity; add stormwater detention and/or retention basins as deemed necessary to reduce flood risk.
Flood	Add requirement to Building Permit application that applicant signify whether the location is part of a Special Flood Hazard Area.
Flood	Require that electric utility lines be buried when new roads are constructed or reconstructed.
Flood	Improve stormwater drainage through enhanced maintenance.
Flood	Trim or prune trees along roadways to prevent interference with power lines during high winds.

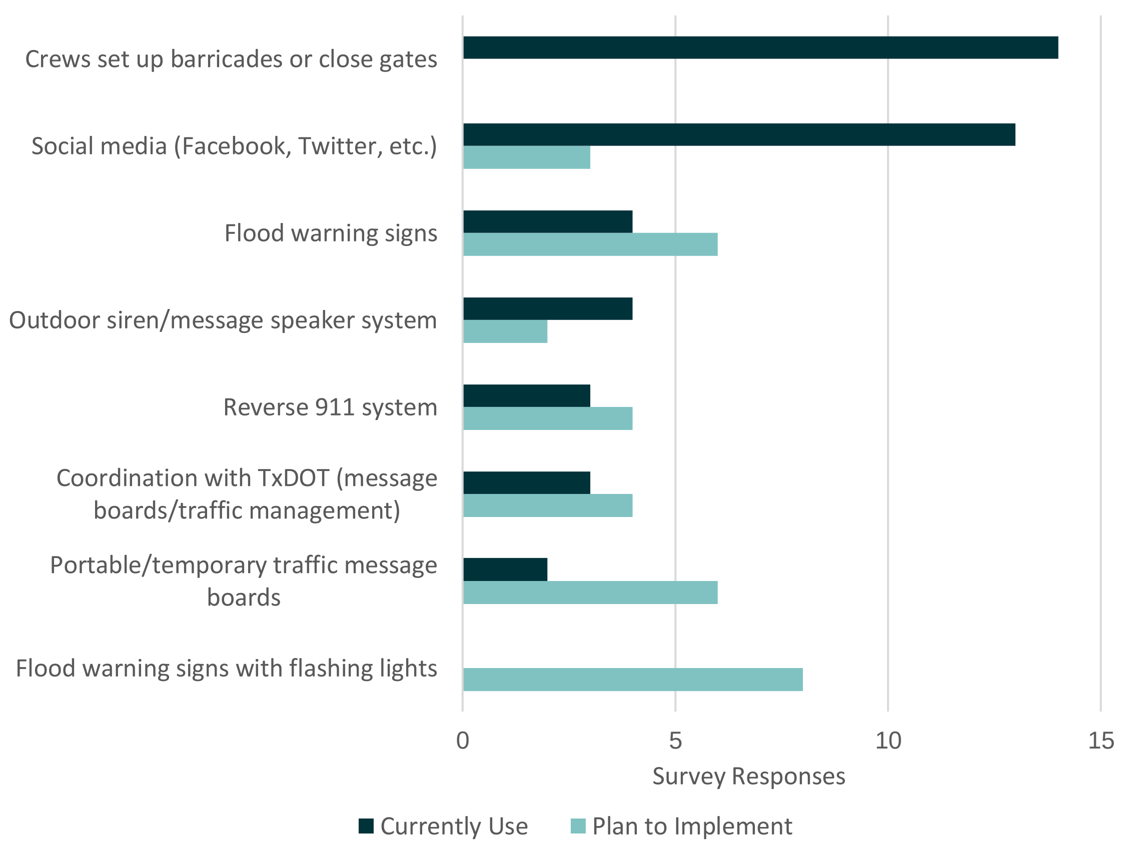
7.4 Flood Response Activities

In response to flooding emergencies, several communities in the region reported using a public alert or alarm system to broadcast alarms via an outdoor siren or send notifications via text messaging, website, or social media. Based on information provided through the RFP stakeholder survey, the City of Pyote uses a public alert system, Crockett County utilizes alarms and texting notifications, City of Sonora uses the Nixle Alert system, and the Town of Horizon Town of Horizon uses a flood warning system through notifications on the City website and social media.

Cities and counties coordinate with the Texas Department of Transportation (TxDOT) on road closures and traffic message boards. Emergency managers rely on publicly available information from the National Oceanic and Atmospheric Administration (NOAA), the National Weather Service (NWS), and the United States Geologic Survey (USGS). The Bureau of Reclamation El Paso Field Division (EPFD) works with offices and divisions from New Mexico to regulate releases from the Elephant Butte and Caballo Dams to minimize flows during a flood event.

A summary of region-specific flood response activities reported through the RFP stakeholder survey is provided in **Figure 7.3**.

Figure 7.3 Flood Response Measures Used by Survey Respondents



7.5 Flood Recovery Activities

Flood recovery activities most often include debris removal from culvert entrances and bridges by cities, counties, and TxDOT. Due to the region's arid landscape, sedimentation from arroyos is a common issue after floods, especially in El Paso where arroyos from the Franklin Mountains frequently deposit sediment impacting downstream culverts, roadways, agricultural land, and irrigation system infrastructure. In the event of significant flood damages, flood damage assessment and recovery efforts are supported with assistance and resources by FEMA Region VI and the Texas Division of Emergency Management (TDEM) Region 4. The roles of each of these agencies are described in further detail below.

FEMA National Disaster Recovery Framework

The National Disaster Recovery Framework (NDRF) enables effective recovery support to disaster-impacted states, tribes, territorial and local jurisdictions. The primary value of the NDRF is its emphasis on preparing for recovery in advance of disaster. It is always in effect, and elements can be implemented at any time. They focus on the following factors that can help ensure a more effective recovery process:

- Comprehensive Scope
- Effective Decision-Making and Coordination
- Integration of Community Recovery Planning Processes
- Well-Managed Recovery
- Proactive Community Engagement, Public Participation, and Public Awareness,
- Effective Financial and Program Management
- Organizational Flexibility
- Resilient Rebuilding
- Health Integration

The FEMA Region VI Mitigation Division's role includes the following items:

- To assist the local governing bodies in recording and assessing the location and extent of damages from the extreme weather event in the declared disaster area(s).
- To provide recommendations for actions to take following a storm event. As part of their recommendations as part of recent Federal Flood Assessment Conference Recommendations and Proceedings (documented in Chapter 1 Appendix Table 1D), FEMA Region VI's assessment team made the following recommendations:
    - That horizontal vertical control data be gathered and complied for identified high water mark locations
    - That a flood inundation map or a map indicating the areas that received flood damage be developed
    - That areas that received severe flooding damage, and especially areas that are experiencing growth and development and/or re-development, be studied using technical hydrology and hydraulic floodplain analysis to determine appropriate velocities, potential flooding problem locations and flooding depths

  - That flood frequencies be determined by damage center location or drainage basin for approximately 10 locations, based on the most intense storm of that area

Texas Division of Emergency Management (TDEM)

The Texas Division of Emergency Management (TDEM) coordinates the state emergency management program, which ensures the state and its local governments respond to and recover from emergencies and disasters and implement plans and programs to help prevent or lessen the impact of emergencies and disasters. TDEM implements programs to increase public awareness about threats and hazards, coordinates emergency planning, provides an extensive array of specialized training for emergency responders and local officials, and administers disaster recovery and hazard mitigation programs in the State of Texas. Some of the response and short term activities provided are as follows:

- EOC support upon request
- Assist EMC with short/long-term recovery needs
- DSO development assistance
- Debris management guidance
- Disaster finance guidance
- Procurement and contract guidance
- LTRG, COAD and VOAD engagement
- Volunteer and donations management support
- Mass Care (evacuation/sheltering)
- Road assessment and repair prioritization assistance
- Damage assessments (rapid/self-reporting survey)
- Facilitate collection of damage data through multiple platforms
- Facilitate transfer of damage data to TDEM Recovery Coordinators to streamline potential Joint Preliminary Damage Assessments with federal partners post-disaster

Chapter 8: Administrative, Regulatory, and Legislative Recommendations

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8. Administrative, Regulatory, and Legislative Recommendations

This chapter outlines recommendations developed by the Regional Flood Planning Group (RFPG) for the following items required for Task 8:

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

In this regard, the Upper Rio Grande Regional Flood Planning Group (URGRFPG) established Subcommittee 4 to develop recommendations for consideration by the URGRFPG.

The following recommendations are offered by the URGRFPG for consideration by the Texas Legislature, TWDB, TCEQ, other water planning regions and all stakeholders and participants in Texas' regional and state flood planning efforts. Each policy includes background information, policy statement(s), and action(s) the URGRFPG recommends.

8.1 Development of Recommendations

8.1.1 Regional Flood Risk

Per the risk analysis results presented in Chapter 2 and 4, by far the largest risks of flood impact in the Upper Rio Grande Flood Planning Region (URGFPR) are located in El Paso County. Map 15 ("Greatest Flood Risk") in Chapter 4 depicts the location of the 31 cities/ CDPs in the URGFPR with the highest numbers of buildings estimated to be at risk of inundation in the 1% AC flood. Eight of these 31 (City of El Paso, City of Socorro, Fort Bliss CDP, Canutillo CDP, City of San Elizario, Homestead Meadows North CDP, Fabens CDP, and Prado Verde CDP) are located within El Paso County and have in aggregate approximately 18,000 buildings estimated to be at risk of inundation in the 1% AC flood. The remaining 23 cities/ CDPs in the URGFPR have in aggregate approximately 11,000 buildings estimated to be at risk of inundation in the 1% AC flood. El Paso County also is differentiated from the broader region by a unique combination of issues described in Section 8.2.1 and 8.2.2.

8.1.2 Formation of Subcommittee 4

The Upper Rio Grande Regional Flood Planning Group (URGRFPG) established Subcommittee 4 to develop recommendations for this chapter for consideration by the URGRFPG. Subcommittee 4 includes these members of the RFPG:

- Gilbert Saldana, Voting Member, Counties
- Anita Keese, Non-Voting Member, Texas Commission on Environmental Quality
- Omar Martinez, Voting Member, Water Districts, Chairman
- Gisela Dagnino, Voting Member, Water Utilities
- Levi Bryand, Voting Member, Water Utilities

8.1.3 Subcommittee 4 Activities

Initial Development

The initial engagement with the RFPG on Task 8 occurred during the identification of FMEs and FMSs during execution of Task 4B(a-b). During the third meeting of Subcommittee 3 on November 10, 2021, a series of presentations were made by regional stakeholders (El Paso Water Utility/ City of El Paso, EPCWID1, USIBWC1) that related experience in recent major floods, occurring in 2006 and 2021 in El Paso County, and occurring in 2008 in Presidio. Hudspeth County also related the needs of that county. The meeting developed a consensus list of needs arising from the related experiences, to include needs associated with agency coordination, regulatory shortfalls, and jurisdiction-specific floodplain management resource (staffing, regulatory) shortfalls. The FMEs and FMSs developed to meet these needs provided the starting inputs to these Task 8 recommendations. Input from the broader URGRFPR (beyond Hudspeth County and City of Presidio) was notably absent from this initial list of identified needs and associated recommended FMEs/FMS.

Preparation for Subcommittee 4 Meetings

In order to improve input from stakeholders across the broader region, there were several parallel efforts on the part of the RFPG.

Individual Meetings with Stakeholders. Direct approaches were made to the cities/ CDPs with over 400 buildings-at-risk in the 1% AC flood (see Map 15, Chapter 4). Meetings were held with smaller cities/ CDPs absent from the Subcommittee 3 meetings (Socorro, Pecos, Alpine, Kermit, Sonora, San Elizario, Presidio). These meetings provided context and prompts for effective participation in the regional Subcommittee 4 meetings.

Data Collection Meeting with Large Stakeholder. A meeting with held with Milton Rahman, Harris County Engineer on March 29, 2022, to solicit general input on regulatory strategies used by the County and their legal basis. This information was relayed to Gilbert Saldana, El Paso County in Subcommittee 4.

Data Collection meetings with Small Stakeholders. Prior to the Subcommittee 4 meetings, interviews were conducted with state-wide entities of similar population size to those invited to attend from the URGRFPG to get their feedback on Task 8. A summary of those entities interviewed along with their 2020 Census population noted in parentheses for comparison purposes is provided below:

- City of Marlin (5,551)
- Falls County (16,968)
- Nueces County (353,178)
- City of Alvin (27,140)
- Bordon County (631)
- Martin County (5,676)
- Mitchell County (8,685)

Although the population of Nueces County and City of Alvin, respectively, is greater than the entities targeted for this meeting, they provided an interesting perspective and additional feedback for the subcommittee to consider.

8.1.4 Subcommittee 4 Meetings (June 16, 2022)

Two Subcommittee 4 meetings were held on June 16, 2022; one for stakeholders located within El Paso County, and one for stakeholders representing the broader region. The agenda specified discussion for four Task 8 areas for recommendation: (1) legislative action, (2) administrative/ regulatory action, (3) other related actions, and (4) procedural funding actions/ ideas. During the discussion with the meeting attendees, each of the three categories for action (floodplain management, flood mitigation planning, and flood mitigation implementation) were addressed within each of the four Task 8 areas.

Subcommittee 4: El Paso County-Focused Meeting

Stakeholder attendees at the first meeting (including Subcommittee 4 members) are noted below.

- Annette Gutierrez, Rio Grande Council of Governments, Executive Director
- Omar Martinez, Water Districts, Chair RFPG Subcommittee 4
- Gilbert Saldana, Counties, Voting Member
- Gisela Dagnino, Water utilities, Voting Member
- Anita Keese, Texas Commission on Environmental Quality, Non-Voting Member
- Peggy O'Brien, Rio Grande Council of Governments, Local Governments Manager
- Levi Bryand, Water utilities, Voting Member
- Richard Bagans, Texas Water Development Board, Planner

These attendees include representatives from these El Paso County jurisdictions: El Paso Water, El Paso County, Rio Grande COG, and EPCWID1. Reference **Appendix 8A** for a copy of the presentation slides from the first meeting of Subcommittee 4.

Subcommittee 4: Broader Planning Region (outside El Paso County)-Focused Meeting

In order to obtain feedback from the broader planning region, a number of rural counties (Hudspeth, Presidio, Reeves, Brewster, and Winkler) and cities (Pecos, Kermit, Sonora, Alpine, Marfa, Fort Stockton, and Presidio) were invited to attend the second meeting; individual emails were sent out in advance by the COG along with follow up phone calls prior to the meeting. Stakeholder attendees to the meeting (including Subcommittee 4 members) are noted below.

- Annette Gutierrez, Rio Grande Council of Governments, Executive Director
- Omar Martinez, Water Districts, Chair RFPG Subcommittee 4
- Jeff Bennett, Environmental Interests, Voting Member
- Richard Bagans, Texas Water Development Board, Planner
- Taylor Nordstrom, AECOM Engineering Consultant,
- Anita Kreese, Texas Commission on Environmental Quality, Non-voting member
- Leo Hung (Guest), Reeves County, Judge
- Jerry D. Bullard (Guest), Reeves County, Emergency Management Coordinator
- Arturo Fuentes (Guest), City of Sonora, City Manager
- Elijah Casas, Texas General Land Office, Community Outreach Coordinator
- Judy Lucio, Texas Division of Emergency Management, Chief for Disaster Finance
- Peggy O'Brien, Rio Grande Council of Governments, Local Governments Manager
- Cinderela Guevara, Presidio County, Judge
- Joanna Mackenzie, Hudspeth County, County Administrator
- Marci Tuck, City of Alpine, Grant Writer

Reference **Appendix 8B** for a copy of the presentation slides from the second meeting of Subcommittee 4.

8.2 Recommendations

As noted above, the administrative, regulatory, and legislative issues within the Upper Rio Grande Flood Planning Region (URGFPR) can be best understood by separating the jurisdictions geographically: those within El Paso County, and those outside El Paso County. Regional Flood Planning Group (RFPG) recommendations to address administrative, regulatory, and legislative issues are therefore provided separately for these two geographic regions.

8.2.1 Recommendations from Stakeholders Within El Paso County

Those jurisdictions located within El Paso County have a unique combination of these flood-related issues:

- Large dense urban area with a large associated population-at-risk.
- A wide range of property values.
- Risk from flooding of the Rio Grande. This risk is jointly managed: from the riverine side by the US International Boundary Water Commission (IBWC); and from the interior drainage side (i.e., the side of river levee intercepting drainage into the river).
- Risks uniquely associated with drainage from steep mountainous terrain (sediment/ debris transport).
- Risks uniquely associated with federal management of the US Army at Fort Bliss (i.e., unexploded ordinance on firing ranges), which includes a large portion of the tributary watershed of the city/ county.
- Risks uniquely associated with “mesa” terrain: large, very flat, sparsely vegetated watersheds that drain to steep arroyos that drop into the Rio Grande terrace.
- Risks uniquely associated with an historically (and currently) irrigated riverine terrace. This terrace is traversed by feeder canals that interrupt and divert stormwater, and irrigation drains designed for irrigation return flows but also intercept and convey stormwater. Addressing flood risks associated with these structures involves close coordination between the El Paso County Water Improvement District No. 1 (EPCWID1) and the cities in El Paso County, and El Paso County itself.
- Risks associated with continuous new development.

In this area, the variety of terrain creates challenges to floodplain management and setting appropriate drainage standards, and the unique combination of involved agencies (the usual range of permit agencies, plus USIBWC, US Army and EPCWID1) creates challenges to providing the necessary multi-agency planning, permitting, and implementation. The recommendations provided in **Table 8.1** through **Table 8.4** below are primarily focused on addressing the above unique challenges. These recommendations are largely in the form of recommendations for future, more detailed action by the RFPG, involving the collective actions of stakeholders to develop specific language to address the identified issue.

Table 8.1 Legislative Recommendations (El Paso County Area Stakeholders)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	-	Burden on sponsors for levee certification is excessive	Communicate with the federal government about lessening the burden for levee certification
Floodplain Management	-	Counties perceive lack of ability to regulate drainage outside of FEMA floodplains	Counties to consider adoption of drainage requirements beyond areas that are in flood zone (e.g., within County Road ROWs outside floodplains)
Flood Mitigation Implementation	-	Revolving state funds are not self-sustaining	Create specific revolving state funds to provide matching to federal dollars for FMPs

Table 8.2 Regulatory/Administrative Recommendations (El Paso County Area Stakeholders)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	FMS15	Identified potential design standard improvements	Develop recommendations for inlets, curb cuts, on-site storage, sediment controls at inlets, discharges into irrigation drains, 2D modeling (include freeboard requirements)
Floodplain Management	FMS16	Erosion in natural channels	Develop recommendations for design guidelines for erosion mitigation in arroyos
Floodplain Management	FMS17	Issues with outfalls into Rio Grande	Develop guidelines for design of outfalls
Floodplain Management	-	EPCWID1 is concerned with the risk of loss of Clean Water Act exemptions associated with stormwater accumulated in irrigation drains	Recommend that USACE develop clear guidance relevant to situation in El Paso County to ensure exemption is retained
Floodplain Management	-	There are uncertainties in El Paso County associated with the capture of stormwater with the potential for reuse	Investigate permitting issues and develop clear guidance to ensure compliance and optimize opportunities for capture/blend
Floodplain Management	-	Improve coordination with other jurisdictions to facilitate floodplain management (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate floodplain management involving multiple jurisdictions. (e.g., create consensus requiring no adverse impact)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	-	Codify use of most restrictive standard where conflicts exist	Revise local standards to codify this requirement and address adverse impact
Floodplain Management	-	Drainage component is not part of certificate of compliance (In Ector County there is no review of any building or development permit, no component for flood mitigation)	Counties should have the option to be empowered to enforce drainage requirements within the requirements for a certificate of compliance
Flood Mitigation Planning	FMS9	ATV-induced erosion on state lands	Review existing regulatory/ admin controls and effectiveness. Recommend changes
Flood Mitigation Planning	-	Improve coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation planning involving multiple jurisdictions.
Flood Mitigation Implementation	-	Improve coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation implementation involving multiple jurisdictions.
Flood Mitigation Implementation	-	Coordinate with State Historic Preservation Office to develop acceptable mitigation practices for the El Paso region	Develop county-wide procedures for accelerating compliance, reducing delays in projects due to interaction with the historic preservation office.
Flood Mitigation Implementation	-	Shortfalls with use of existing El Paso area MOUs with State Historic Preservation Office	Negotiate with the State Historic Preservation Office to address shortfalls

Table 8.3 Fundraising Recommendations (El Paso County Area Stakeholders)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Flood Mitigation Implementation	FMS1	Certification of Levees in El Paso County	Establish formal involvement of relevant El Paso County Stakeholders
Floodplain Management	-	Lack of fees for County Drainage	Provide regional support to interested counties to investigate feasibility of forming a county stormwater utility

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	-	Federal grants have a monetary-based threshold requirement that puts areas such as El Paso (with comparatively low property values in flood-prone areas) at a disadvantage to compete with federal flood mitigation funds.	Develop regional recommendation to FEMA to reconsider monetary-based damage threshold requirements to compete for federal flood mitigation grants.
Flood Mitigation Planning	-	Collect appropriate data to present a complete plan to obtain HUD funds for flood planning. Prepare documentation for post-disasters	Increase coordination between City-County-and HUD to develop procedures and databases which meet HUDs requirements
Flood Mitigation Implementation	-	Lack of regional assistance to available resources to apply for funds identifying funding sources	TWDB should create an online resource so that regions have assistance to apply for funds and identifying funding sources

Table 8.4 Other Recommendations (El Paso County Area Stakeholders)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	FME1	Maintenance of Rio Grande Channel in El Paso County	Formal involvement of El Paso County Stakeholders
Floodplain Management	-	Coordinate with TxDOT to get clarity on maintenance at specific locations within jurisdictions	Create an MOU to clarify maintenance responsibilities at specified crossings
Floodplain Management	--	Coordinate grading plan/other permit approvals with consideration of flood risk	No permits shall be issued unless grading plans have been approved
Flood Mitigation Planning	FME6, FMS4	Control of sediment from Franklin Mtns in areas with UXO	Control of sediment from Franklin Mountains from Eastern El Paso County
Flood Mitigation Planning	-	No systematic data collection post-flood event	State should create a repository for post flood data (e.g., high water marks, photos)

8.2.2 Recommendations from Stakeholders Outside El Paso County

Those jurisdictions representing the broader planning region outside of El Paso County have a few similar flood-related issues; however, they also have unique flood-related issues associated with their rural classification:

- Large rural region comprised of communities having lower populated areas.
- Lack of resources and services available to support floodplain management and flood mitigation planning for rural areas located outside of El Paso County.
- Need for improving coordination with other jurisdictions and organizations (i.e., TxDOT, IBWC, TPW, Private Entities) to facilitate floodplain management and flood mitigation planning.
- Need for updated maps, resources to join/maintain NFIP, and support for securing funding to update master drainage plans.
- Risks uniquely associated with drainage from steep mountainous terrain (sediment/ debris transport).
- Risks uniquely associated with "mesa" terrain: large, very flat, sparsely vegetated watersheds that drain to steep arroyos that drop into the Rio Grande terrace.
- Risk from flooding of the Rio Conchos in Presidio County, including binational planning needed to address this issue.
- Risks associated with unregulated and/or minimally regulated new development, especially in Hudspeth County.

The primary theme of the feedback received from the stakeholders located outside of El Paso County focused on the general lack of resources, technical staff, training, funding, etc. for small communities and low populated counties to address floodplain management and flood mitigation planning. The recommendations provided in **Table 8.5** through **Table 8.8** below are primarily focused on addressing the above unique challenges. These recommendations are largely in the form of recommendations for future, more detailed action by the RFPG, involving the collective actions of stakeholders to develop specific language to address the identified issue.

Table 8.5 Legislative Recommendations (Flood Planning Area Outside of El Paso County)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Flood Mitigation Implementation	-	New federal requirements addressing historic preservation	Develop a set of regional comments on new requirements to be provided to the federal agency
Floodplain Management	-	Counties perceive lack of ability to regulate drainage outside of FEMA floodplains	Counties to consider adoption of drainage requirements beyond areas that are in flood zone (e.g., within County Road ROWs outside floodplains)

Table 8.6 Regulatory/Administrative Recommendations (Flood Planning Area Outside of El Paso County)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	FME14	Unregulated/ minimally regulated development in Hudspeth County	Develop program to regulate drainage from development in Hudspeth County and similar counties that elect to participate
Floodplain Management	-	No technical personnel on staff nor funds to develop drainage criteria/standards	Provide regional coordination for technical assistance and/or funding to update drainage criteria and development standards
Floodplain Management	-	Improve coordination with other jurisdictions to facilitate floodplain management (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate floodplain management involving multiple jurisdictions. (e.g., create consensus requiring no adverse impact)
Floodplain Management	-	Codify use of most restrictive standard where conflicts exist	Revise local standards to codify this requirement and address adverse impact
Floodplain Management	-	Drainage component is not part of certificate of compliance (In Ector County there is no review of any building or development permit, no component for flood mitigation)	Counties should have the option to be empowered to enforce drainage requirements within the requirements for a certificate of compliance
Flood Mitigation Planning	-	Improve flood mitigation planning coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation planning involving multiple jurisdictions.
Flood Mitigation Implementation	-	Improve flood mitigation implementation coordination with other jurisdictions to facilitate (TxDOT, IBWC, TPW, RRC, TCEQ, Private Entities)	Coordinate regional protocols to facilitate flood mitigation implementation involving multiple jurisdictions.
Flood Mitigation Implementation	-	Coordinate with State Historic Preservation Office to develop acceptable mitigation practices for the Upper Rio Grande Flood Planning region outside of El Paso County	Develop regional procedures for accelerating compliance, reducing delays in projects due to interaction with the historic preservation office.

Table 8.7 Fundraising Recommendations (Flood Planning Area Outside of El Paso County)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Flood Mitigation Planning	-	Collect appropriate data to present a complete plan to obtain HUD funds for flood planning. Prepare documentation for post-disasters	Increase coordination between City-County-and HUD to develop procedures and databases which meet HUDs requirements
Floodplain Management	-	Lack of fees for County Drainage	Provide regional support to interested counties to investigate feasibility of forming a county stormwater utility
Flood Mitigation Implementation	-	Small community/ low population counties have a disadvantage in obtaining FEMA post-disaster flood mitigation funding due to $3M damage threshold. Low property values and limited infrastructure at risk disqualify small communities/ low population counties from grant eligibility.	RFPG to convey recommendation to FEMA to change thresholds to address small city disadvantage in grant funding
Flood Mitigation Implementation	-	HUD CDBG grant application success for small communities/ low population counties is inhibited by a lack of local resources	Convey recommendation to HUD to set aside a fixed percentage of grant funding to address small community/ low population county needs; or by adding ranking points favoring small communities/ low population counties
Flood Mitigation Implementation	-	TWDB Flood Infrastructure Fund grant application success is limited by the lack of local resources and technical expertise within small communities to assemble technical requirements of the application	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for grant preparation
Flood Mitigation Implementation	-	Lack of regional assistance to available resources to apply for funds identifying funding sources	Create an online resource so that regions have assistance to apply for funds and identifying funding sources

Table 8.8 Other Recommendations (Flood Planning Area Outside of El Paso County)

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Floodplain Management	FMS13	Need for resources to join/ maintain NFIP	Plan solution for lack of staff resources within areas with small populations, but with significant risk.
Floodplain Management	FMS8	Certification of Cibolo Creek Levees in Presidio County	Support certification of this levee by City of Presidio
Floodplain Management	-	Small communities lack resources for these services/ resources needed for floodplain management: funding for badly needed new floodplain maps, training of staff in NFIP requirements, development and technical oversight of local drainage design criteria for new development, education of local populace in importance of floodplain management.	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for these issues; staff position could be potentially funded by additional TWDB RFP allocations; RFPG to request TWDB support in development of web portals to facilitate communication, relevant data collection/ tracking of queries, and document network of available support.
Floodplain Management	-	Low population counties lack resources for these services/ resources needed for floodplain management: funding for badly needed new floodplain maps, training of staff in NFIP requirements, education of local populace in importance of floodplain management, support in developing a stormwater utility.	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for these issues; staff position could be potentially funded by additional TWDB RFP allocations; RFPG to request TWDB support in development of web portals to facilitate communication, relevant data collection/ tracking of queries, and document network of available support.
Floodplain Management	-	Coordinate with TxDOT to get clarity on maintenance at specific locations within jurisdictions	Create an MOU to clarify maintenance responsibilities at specified crossings
Flood Mitigation Planning	FMS6	Flooding in Presidio County	Binational Planning to Address Rio Conchos flooding

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Flood Mitigation Planning	-	Small communities lack resources for these services/ resources needed for flood mitigation planning: funding for strategic growth plan essential for planning future drainage infrastructure, training of staff in FEMA disaster programs (e.g., post-disaster Public Assistance), funding for storm water master planning, education of local populace in importance of storm water master planning.	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for these issues; staff position could be potentially funded by additional TWDB RFP allocations; RFPG to request TWDB support in development of web portals to facilitate communication, relevant data collection/ tracking of queries, and document network of available support.
Flood Mitigation Planning	-	Need updated maps and funding to have updated master drainage plans	Funding needed to provide updated floodplain maps.
Flood Mitigation Planning	-	No systematic data collection post-flood event (high water marks, damages)	Initiate and maintain a State-created repository for post flood data needed to refine local flood risk assessments
Flood Mitigation Implementation	-	Low population counties lack resources for these services/ resources needed for flood mitigation implementation: training in USACE Section 404 permitting of channel maintenance, training in selection of grant opportunities across the full spectrum of available grants, technical support for the associated grant application data requirements and processes, education of local populace in importance of implementation of priority flood mitigation actions.	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for these issues; staff position could be potentially funded by additional TWDB RFP allocations; RFPG to request TWDB support in development of web portals to facilitate communication, relevant data collection/ tracking of queries, and document network of available support.

Flood Mitigation Category	Related FME/FMS	Need to address	Recommendation
Flood Mitigation Implementation	-	Small communities lack resources for these services/ resources needed for flood mitigation implementation: training in USACE Section 404 permitting of channel maintenance, training in selection of grant opportunities across the full spectrum of available grants, technical support for the associated grant application data requirements and processes, education of local populace in importance of implementation of priority flood mitigation actions.	Region to take action to create a partial staff position to provide a regional resource within the RFPG to assist small communities/ low population counties in seeking support for these issues; staff position could be potentially funded by additional TWDB RFP allocations; RFPG to request TWDB support in development of web portals to facilitate communication, relevant data collection/ tracking of queries, and document network of available support.
Floodplain Management	-	Coordinate phasing of grading plan/other permit approvals with flood risk	Provide guidance on order of permit approvals to ensure continuity of drainage protection

Chapter 9:
Flood Infrastructure Financing Analysis

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Appendices

9. Flood Infrastructure Financing Analysis

The Region 14 RFPG has recommended a total of 58 flood mitigation actions to address flood risk across the planning region. Combined, these flood mitigation actions are anticipated to cost $160.3 million to implement. The summary of recommended flood mitigation by action type are summarized in **Table 9.1**, below.

Table 9.1 Total Cost of Recommended Flood Mitigation Actions

Flood Mitigation Action Type	Number of Recommended Actions	Anticipated Total Cost of Implementation
FME	22	$7,510,000
FMP	14	$149,205,280
FMS	22	$3,586,100
Total	58	$160,301,380

TWDB requires that each RFPG assess and report on how local sponsors propose to finance recommended FMEs, FMSs, and FMPs. To determine the capabilities of the local sponsors to finance the projects, the RFPG conducted a survey for local sponsors to determine the funding needs of local sponsors and propose what role the state should have in financing the recommended FMEs, FMSs, and FMPs. **Section 9.1** presents an overview of common sources of funding for flood mitigation planning, projects, and other management efforts. The methodology and results of the financing survey are presented in **Section 9.2**.

9.1 Sources of Funding for Flood Management Activities

Stormwater infrastructure and floodplain management activities are historically underfunded programs compared to other infrastructure types, and this is a continued challenge that local entities documented in written and verbal communications throughout the planning process. Lack of local funding was indicated as a leading cause of inadequate or deficient drainage infrastructure faced by municipalities. Given the challenges of funding flood management activities, local sponsors will likely be required to use a combination of funding sources to implement flood mitigation actions, including local, state, and federal sources. This section discusses some of the most common avenues of generating local funding and overviews various state and federal financial assistance programs available to entities for flood management. **Table 9.2** summarizes the local, state, and federal funding opportunities that may be available for flood management activities and characterizes each by the following three key parameters: (1) which state and federal agencies are involved, if applicable; (2) whether each funding opportunity offers grants, loans, or both; and (3) whether each funding opportunity is regularly occurring or is only available after a disaster.

Table 9.2 Sources of Funding for Flood Management Activities in Texas

<table>
<tr><th>Source</th><th>Federal Agency</th><th>State Agency</th><th>Program Name</th><th>Grant (G)</th><th>Loan (L)</th><th>Post-Disaster (D)</th></tr>
<tr><td rowspan="20">Federal</td><td rowspan="2">EPA</td><td>TCEQ/ TSSWCB</td><td>Nonpoint Source Grant Program 319(h) (NPS)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TWDB</td><td>Clean Water State Revolving Fund (CWSRF)</td><td>G[1]</td><td>L</td><td>-</td></tr>
<tr><td rowspan="8">FEMA</td><td></td><td>Cooperating Technical Partners (CTP)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TBD</td><td>Safeguarding Tomorrow through Ongoing Risk Mitigation Program (STORM)</td><td>-</td><td>L</td><td>-</td></tr>
<tr><td>TCEQ</td><td>Rehabilitation of High Hazard Potential Dam Program (HHPD)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TDEM</td><td>Building Resilient Infrastructure and Communities (BRIC)[2]</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TDEM</td><td>Hazard Mitigation Grant Program (HMGP)</td><td>G</td><td>-</td><td>D</td></tr>
<tr><td>TDEM</td><td>Public Assistance (PA)</td><td>G</td><td>-</td><td>D</td></tr>
<tr><td>TWDB</td><td>Flood Mitigation Assistance Program (FMA)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td rowspan="4">HUD</td><td>GLO</td><td>Community Development Block Grant-Disaster Recovery (CDBG-DR)</td><td>G</td><td>-</td><td>D</td></tr>
<tr><td>GLO/ TDEM</td><td>Community Development Block Grant-Local Hazard Mitigation Plan Program (LHMPP)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>GLO</td><td>Community Development Block Grant-Mitigation (CDBG-MIT)</td><td>G</td><td>-</td><td>D</td></tr>
<tr><td>TDA</td><td>Texas Community Development Block Grant (TxCDBG) Program for Rural Texas</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">NRCS</td><td></td><td>Emergency Watershed Protection Program (EWP)</td><td>G</td><td>-</td><td>D</td></tr>
<tr><td></td><td>Watershed and Flood Prevention Operations Program (WFPO)</td><td>G</td><td>L</td><td>-</td></tr>
<tr><td></td><td>Watershed Rehabilitation Program (REHAB)</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">USACE</td><td></td><td>Continuing Authorities Program (CAP)[3]</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td>Partnerships with USACE, funded through WRDA or other legislative vehicles[3]</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="6">State</td><td rowspan="6">N/A</td><td>TWDB</td><td>Flood Infrastructure Fund (FIF)</td><td>G</td><td>L</td><td>-</td></tr>
<tr><td>TWDB</td><td>Texas Water Development Fund (DFund)</td><td>G</td><td>L</td><td>-</td></tr>
<tr><td>TWDB</td><td>Rural Water Assistance Fund (RWAF)</td><td>-</td><td>L</td><td>-</td></tr>
<tr><td>TSSWCB</td><td>Structural Dam Repair Grant Program</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TSSWCB</td><td>Flood Control Operation and Maintenance (O&M) Grant Program</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td>TSSWCB</td><td>Flood Control Dam Infrastructure Projects - Supplemental Funding</td><td>G</td><td>-</td><td>-</td></tr>
<tr><td rowspan="5">Local</td><td colspan="2" rowspan="5">Not Applicable</td><td>General Fund</td><td colspan="3" rowspan="5">Not Applicable</td></tr>
<tr><td>Stormwater or Drainage Utility Fee</td></tr>
<tr><td>Tax Applications</td></tr>
<tr><td>Bonds</td></tr>
<tr><td>Special-Purpose Districts</td></tr>
</table>

[1] The CWSRF program offers principal forgiveness, which is similar to grant funding.
[2] At the time of this report, Texas projects may see limited success with BRIC applications, given that the state has not adopted the latest building codes. This status may change in the future.
[3] Opportunities to partner with USACE are not considered grant or loan opportunities, but shared participation projects where USACE performs planning work and shares in the cost of construction.

9.1.1 Local Funding

The communities in Region 14 are primarily rural and less impacted by urban development, as described in **Chapter 1** of this RFP. The total population in the region is just over 1 million. Of the counties in this region, El Paso County has a population greater than 900,000 people, three others (Pecos, Reeves, and Ward counties) have populations greater than 10,000, and the remaining 19 counties have populations of less than 10,000. The vast majority (89%) of the population in Region 14 reside in El Paso County. In addition, the western part of the region is highly vulnerable overall with typical Social Vulnerability Index (SVI) values of 0.8 or greater.

Some of the communities in Region 14 have dedicated or regular funding sources for stormwater infrastructure or flood management activities; however, as the majority of the communities in this region tend to be rural and socioeconomically disadvantaged, many communities do not. These communities face an uphill battle to fund community initiatives and improvement projects.

Entities that do have sources of local funding generally rely on the following: general funds, dedicated revenues in the form of stormwater or drainage utility fees, tax applications, and bonds. These funding sources are typically not sufficient to fully fund a community’s total need. Entities indicated that the local match percentage they would expect to supply for future funding opportunities for flood management activities would range from 5% to 50% of the total funding need, including both cash and in-kind services. Each potential local funding source presents its own unique challenges and considerations, described in the following sections.

9.1.1.1 General Fund

A community’s general fund revenue stems from sales, property, and other taxes and is typically the primary fund used by a governmental entity to support most of its departments and services such as police, fire, parks, trash collection, and local government administration. Due to the high demands on this fund for many local needs, there is often not a significant amount available for funding flood projects out of the general fund. Similarly, general funds are not dedicated for flood management activities but are instead allocated on a case-by-case basis. General funds are commonly used to fund flood management activities in Region 14.

9.1.1.2 Stormwater or Drainage Utility Fee

Dedicated fees such as stormwater or drainage fees are an increasingly popular tool for local flood-related funding. Municipalities can establish a stormwater utility (sometimes called a drainage utility), which is a legal mechanism used to generate revenue to finance a city’s cost to provide stormwater services. To provide these services, municipalities assess fees to users of the stormwater utility system. Multiple entities in Region 14 indicated using utility fees to fund flood management activities.

It is important to note that while Texas municipalities have the authority to implement utility fees for stormwater and drainage, the State Legislature has not granted that same authority to counties.

Impact fees, which are necessitated by and collected from new development to cover a portion of expenses to expand stormwater systems, can also be used as a source of local funding for flood-related efforts. None of the entities in Region 14 indicated via the survey that they use impact fees to fund drainage projects.

9.1.1.3 Tax Applications

Tax applications include sales and property taxes, sales tax reallocations, and special tax districts, including Tax Increment Financing (TIF). Taxes are not a dedicated source of funding for stormwater and increasing taxes or diverting revenue away from other programs is generally not politically popular. Special tax districts can be a useful financing method to allow local governments to invest in public infrastructure improvements in areas that are expected to develop by diverting future tax revenue from these areas to pay for the cost of improvements. This mechanism localizes the cost to fund projects to the area receiving the benefit; however, it relies on the development in the district to occur as expected in order to finance the project and also diverts future tax revenue away from other programs or needs that may arise. Multiple entities in Region 14 indicated using tax notes to fund flood management activities.

9.1.1.4 Bonds

Municipalities and counties also have the option to issue debt through bonds which are typically paid back using any of the previously mentioned local revenue raising mechanisms. There are several types of applicable bonds, including general obligation bonds, revenue bonds, or certificates of obligation. Multiple entities in Region 14 indicated that they would use bonds to fund flood management activities.

Revenue bonds typically are not used to finance drainage infrastructure, since they are used to finance municipal projects that generate revenue (which is not typical of drainage infrastructure) that is then used to make payments to bond holders.

In addition to revenue bonds, general obligation bonds and certificates of obligation can provide alternate sources of funding. Between these two alternatives, general obligation bonds are more common. While these bonds typically have a high bond rating and low interest rates, there are a handful of constraints. First, different city programs are typically competing with each other for funding through a given bond program. Second, debt obligations contribute to a lack of flexibility in future financing applications. Lastly, general obligation bonds require voter approval.

Certificates of obligation, conversely, do not require voter approval and can therefore provide flexibility when projects need to be funded quickly. However, they can be controversial and unpopular when not used in emergency applications. Like general obligation bonds, they contribute to a community’s debt obligations and may impact future funding decisions.

9.1.1.5 Special-Purpose Districts and Other Local and Regional Entities

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

There may be opportunities to create special-purpose districts in the region as future growth occurs for the purposes of generating revenue from district taxes and fees. Funding avenues for other types of local and regional entities, such as river authorities, are not discussed in this Chapter. These special-purpose districts and other local and regional entities may represent potential future funding sources for Region 14, as no survey respondents indicated using special-purpose districts to fund flood management activities.

9.1.2 State Funding

The availability of local funding for flood management activities is generally much lower than the need, leading communities to seek out and apply for state and federal financial assistance programs. Today, communities have a broader range of state funding sources and programs available due to new grant and loan programs that did not exist five years ago.

There are two primary state agencies currently involved in providing state funding for flood projects: the TWDB and the TSSWCB. State and federal financial assistance programs discussed herein are not directly available to homeowners nor the general public. Local governments apply on behalf of their communities to receive and implement funding for flood projects in their jurisdiction.

9.1.2.1 Texas Water Development Board (TWDB)

The TWDB has three state-funded programs for flood management activities.

The TWDB's Flood Infrastructure Fund (FIF) was 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. Only projects included in the most recently adopted State Flood Plan will be eligible for funding from the FIF. FMEs, FMSs, and FMPs recommended in this RFP will be included in the overall State Flood Plan and will therefore be eligible for funding.

The TWDB also manages the Texas Water Development Fund (DFund) program, which is a state-funded, streamlined loan program that provides financing for several types of infrastructure projects to eligible political subdivisions. This program enables the TWDB to fund projects with multiple eligible components (water supply, wastewater, or flood control) in one loan at low market rates. Financial assistance for flood management activities may include structural and nonstructural projects, planning efforts, and flood warning systems.

The Rural Water Assistance Fund (RWAF) assists small rural utilities to obtain low-cost financing for water and wastewater projects in the form of tax-exempt equivalent interest rate loans with long-term finance options. Rural political subdivisions are eligible, which include water supply corporations, districts, and municipalities serving populations for 10,000 or less, and counties in which no urban area has a population exceeding 50,000. Several Region 14 municipalities and counties may be eligible for this funding source. Financial assistance for flood management activities may include planning, design, and construction for pumping facilities, storage reservoirs, acquiring groundwater and surface water rights, and collection systems, among others.

9.1.2.2 Texas State Soil & Water Conservation Board (TSSWCB)

The TSSWCB has three state-funded programs specifically for flood control dams.

The O&M Grant Program is a grant program for local Soil and Water Conservation Districts (SWCD) and certain co-sponsors of flood control dams. This program reimburses SWCDs 90% of the cost of an eligible operation and maintenance activity as defined by the program rules; the remaining 10% must be paid with non-state funding.

The Flood Control Dam Infrastructure Projects - Supplemental Funding Program was created and funded in 2019 by the Texas Legislature. Grants are provided to local sponsors of flood control dams, including SWCDs, to fund the repair and rehabilitation of the flood control structures, to ensure dams meet safety criteria to adequately protect lives downstream.

The Flood Control Structural Repair Grant Program provides state grant funds to provide 95% of the cost of allowable repair activities and up to 98.25% of the cost of dam upgrade projects on dams constructed by the US Department of Agriculture Natural Resources Conservation Service (NRCS). The program includes match funding for federal projects through the Dam Rehabilitation Program and the Emergency Watershed Protection Program of the Texas NRCS.

9.1.3 Federal Funding

Federal funding currently accounts for a large share of total available funding for flood projects throughout the state, as federal funding programs offer greater access and availability to large funding amounts from the federal government as appropriated by Congress. There are 18 federal funding programs discussed in this section, administered by several federal agencies and organizations. The funding for these programs originates from the federal government; however, for 13 of the 18 funding programs, a state agency partner plays a key role in management of the program, including assembling and submitting state application packages and administering federally awarded grant funding. Each federal funding opportunity is unique in its eligible applicants, eligible project types, requirements, and application and award timelines. The federal funding opportunities are discussed below by federal agency.

9.1.3.1 Environmental Protection Agency (EPA)

The EPA has two federal funding programs for flood management activities.

The Nonpoint Source (NPS) Grant Program Section 319(h) provides funds to prevent or reduce urban and non-agricultural nonpoint source pollution. The program funds are primarily for implementing watershed protection plans, but may also be used for education and outreach, projects to protect unimpaired waters, and management measures to address NPS pollution. Projects that implement Municipal Separate Storm Sewer System (MS4) permit requirements are not eligible for funding. The NPS Grant Program is administered in Texas by the Texas Commission on Environmental Quality (TCEQ) and the TSSWCB.

The Clean Water State Revolving Fund (CWSRF) provides financial assistance in the form of loans with subsidized interest rates and opportunities for partial principal forgiveness for planning, acquisition, design, and construction of wastewater, reuse, and stormwater mitigation infrastructure projects. Projects can be structural or non-structural. Low Impact Development (LID) projects are also eligible. The CWSRF is administered in Texas by the TWDB.

9.1.3.2 Federal Emergency Management Agency (FEMA)

FEMA has seven federal funding programs for flood management activities.

The Cooperating Technical Partners (CTP) Program is an effort launched by FEMA in 1999 to increase local involvement in developing and maintain up-to-date Flood Insurance Rate Maps (FIRMs), Flood Insurance Study (FIS) reports, and associated geospatial data in support of FEMA's National Flood Insurance Program (NFIP). 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.

Safeguarding Tomorrow through Ongoing Risk Mitigation (STORM) is a new revolving loan program enacted through federal legislation in 2021 to provide sustainable funding for hazard mitigation projects, including water, infrastructure, and disaster recovery projects. The program is designed to provide capitalization grants to states to establish revolving loan funds for hazard mitigation projects. In November 2021, the Infrastructure Investment and Jobs Act (IIJA) appropriated $500 million in funds to the STORM program, or $100 million per year for five years. At the time of the publication of this RFP, the STORM program is not yet operational and has not yet been implemented in Texas.

The Rehabilitation of High Hazard Potential Dam (HHPD) Grant Program, 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% state or local share.

The Building Resilient Infrastructure and Communities (BRIC) is a new pre-disaster funding program implemented in 2020 that replaces FEMA's previously longstanding Pre-Disaster Mitigation Grant Program. The program supports states, local communities, tribes, and territories as they undertake hazard mitigation projects to reduce the risks they face from disasters and natural hazards. Funding is typically a 75% federal grant with a 25% local match. However, eligible small, impoverished communities and U.S. island territories may be funded through a 90% or 100% federal grant, respectively. BRIC is administered in Texas by the Texas Division of Emergency Management (TDEM).

Under the Hazard Mitigation Grant Program (HMGP), FEMA provides funding to state, local, tribal, and territorial governments so they can rebuild from a recent disaster in a way that reduces, or mitigates, future disaster losses in their communities. Funding is typically a 75% federal grant with a 25% local match. While the program is associated with Presidential Disaster Declarations, the HMGP is not a disaster relief program for individual disaster victims or a recovery program that funds repairs to public property damaged during a disaster. The key purpose of the HMGP is to ensure that the community's opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a federally declared disaster. The HMGP program is administered in Texas by TDEM.

The Public Assistance (PA) Program provides supplemental grants to state, tribal, territorial, and local governments, and certain types of private non-profits following a declared disaster so communities can quickly respond to and recover through actions such as debris removal, life-saving emergency protective measures, and restoring public infrastructure. Funding cost share levels are determined for each disaster and the local match requirement is typically between 10% and 25%. In Texas, the FEMA PA program is administered by TDEM.

The Flood Mitigation Assistance (FMA) Grant is a nationally competitive program that provides funding to states, local communities, federally recognized tribes, and territories. 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% federal grant with a 25% local match. Projects mitigating Repetitive Loss and Severe Repetitive Loss properties may be funded through a 90% or 100% federal grant, respectively. FMA is administered in Texas by the TWDB.

9.1.3.3 US Department of Housing and Urban Development (HUD)

The US Department of Housing and Urban Development has four federal funding programs for flood management activities.

Following a major disaster, Congress may appropriate funds to HUD under the Community Development Block Grant-Disaster Recovery (CDBG-DR) Program when there are significant unmet needs for long-term recovery. Appropriations for CDBG-DR are frequently very large, and the program provides 100% grants in most cases. The special federal appropriation provides funds to the most impacted and distressed areas for disaster relief, long-term recovery, restoration of infrastructure, housing, and economic revitalization. The CDBG-DR program is administered in Texas by the Texas General Land Office (GLO).

The Community Development Block Grant-Local Hazard Mitigation Plans (LHMPP) Program assists entities by providing grants to develop or update local hazard mitigation plans. It can also be used to provide cost share for hazard mitigation planning activities funded through other federal sources. LHMPP funds are administered by HUD through the CDBG-MIT program, described below, and are implemented by the GLO and/or TDEM, depending on the activity being funded.

The Community Development Block Grant-Mitigation (CDBG-MIT) Program allows eligible grantees to use assistance in areas impacted by recent disasters to carry out strategic and high-impact activities to mitigate disaster risks. The primary feature differentiating CDBG-MIT from CDBG-DR is that, unlike CDBG-DR, which funds recovery from a recent disaster to restore damaged services, systems, and infrastructure, CDBG-MIT funds are intended to support mitigation efforts to rebuild in ways that will lessen the impact of future disasters. CDBG-MIT defines such mitigation activities as those that increase resilience to disasters or reduce or eliminate the long-term risk of loss of life, injury, damage to and loss of property, and suffering or hardship resulting from the disaster. The CDBG-MIT program is administered in Texas by the GLO.

The Community Development Block Grant (TxCDBG) Program for Rural Texas 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 expanding economic opportunities principally for persons of low- to moderate-income. Funds can be used for public facilities such as water and wastewater infrastructure, street and drainage improvements, and housing. The TxCDBG program is administered by the Texas Department of Agriculture (TDA).

9.1.3.4 US Department of Agriculture Natural Resources Conservation Service (NRCS)

The US Department of Agriculture's Natural Resources Conservation Service has three federal funding programs for flood management activities.

The Emergency Watershed Protection (EWP) Program is a federal emergency recovery grant program that 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 EWP Program does not require an official disaster declaration for program assistance to begin and can include projects like removing debris from stream channels, road culverts, and bridges; reshaping and protecting eroded stream banks; and repairing damaged or destroyed facilities.

The Watershed Protection and Flood Prevention Operations (WFPO) Program offers grants and loans to help federal, state, local and tribal governments protect and restore watersheds up to 250,000 acres. Funding can be used to prevent erosion, floodwater, and sediment damage; to further the conservation development, use and disposal of water; and to further the conservation and proper use of land in authorized watersheds. The program requires public sponsorship and that at least 20% of project benefits be directly related to agriculture, including rural communities.

Lastly, the Watershed Rehabilitation (REHAB) Program offers grants to help local sponsors rehabilitate aging dams that are reaching the end of their design lives and/or no longer meet federal or state standards. The program targets rehabilitation projects that address critical public health and safety concerns. Costs associated with additional or new water supply storage purposes may be added to the rehabilitation project and cost-shared with REHAB funds. Local cost share is typically 35% of the total construction cost.

9.1.3.5 US Army Corps of Engineers (USACE)

The USACE works with non-federal partners (states, tribes, counties, or local governments) throughout the country to investigate water resources and related land problems and opportunities and, if warranted, develop civil works projects that would otherwise be beyond the sole capability of the non-federal partners. Partnerships are typically initiated or requested by the local community to their local USACE District office. Before any project or study can begin, USACE determines whether there is an existing authority under which the project could be considered, such as the Continuing Authorities Program (CAP), or whether Congress must establish study or project authority and appropriate specific funding for the activity.

New study or project authorizations are typically provided through periodic **Water Resource Development Acts (WRDA)** or via another legislative vehicle. Congress will not provide project authorization until a completed feasibility study results in a recommendation to Congress of a water resources project, conveyed via a Report of the Chief of Engineers (Chief's Report) or Report of the Director of Civil Works (Director's Report). Opportunities to partner with USACE are not considered grant or loan opportunities, but rather are shared participation projects where USACE performs planning work and shares in the cost of construction with the non-federal sponsor. Additionally, USACE has other technical assistance opportunities, including Floodplain Management Services and the **Planning Assistance to States Program,** that are available to local entities.

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. A few examples of special appropriations from the federal government that can be used to fund flood-related activities are discussed below.

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. The Coronavirus State and Local Fiscal Recovery Funds (SLFRF) Program, a part of ARPA, delivers $350 billion directly to state, local, and tribal governments across the country. Some of the authorized uses include improving stormwater facilities and infrastructure. Although not a direct appropriation to local governments like ARPA, the 2021 Infrastructure Investment and Jobs Act (IIJA), also called the Bipartisan Infrastructure Law (BIL), authorizes over $1 trillion for infrastructure spending across the U.S. and provides for a significant infusion of resources over the next several years into existing federal financial assistance programs as well as creating new programs. In April 2022, the Biden Administration issued a Bipartisan Infrastructure Law Rural Playbook as a "roadmap for delivering opportunity and investments in rural America."

9.1.4 Barriers to Funding

Local entities encounter barriers to accessing or seeking funding sources for flood management activities, including lack of knowledge of funding sources, lack of expertise to apply for funding, and lack of local funds available for match requirements. As opposed to some other types of infrastructure, flood projects do not typically generate revenue and many entities do not have steady revenue streams to fund flood projects, as discussed in **Section 9.1.1**. Consequently, entities struggle to generate funds for local match requirements or loan repayment. Multiple of the entities responding to the survey indicated that their financial capacity to provide local match funds for a given project would be 10% or less, including cash and in-kind services. Complex or burdensome application or program requirements, as well as prolonged implementation timelines also act as barriers to entities being equipped to access state and federal financial assistance. Of those entities able to overcome those barriers, apply for funding, and generate local resources for match requirements, the competitiveness of state and federal grant/loan funding opportunities still leave many local entities without the resources they need to address flood risks.

9.2 Flood Infrastructure Financing Survey

To assist local entities with acquiring funding for the flood mitigation actions identified in this plan, the Upper Rio Grande Flood Planning Group developed a Flood Infrastructure Financing (FIF) survey for potential local sponsors to gain an understanding of the funding needs in the region and to characterize what role the RFPG proposes for the state in financing the recommended FME, FMS, and FMP action types.

9.2.1 Survey Methodology

The FIF survey was a short, 9-question online survey with a table listing each flood mitigation action for which an entity was identified as a sponsor or co-sponsor in the RFP and instructing the respondent to indicate which funding sources, if any, had been identified to complete the mitigation action. The survey included a link to a SharePoint folder that contained project summary spreadsheets for each flood mitigation action listed in the plan as a resource for sponsors. A copy of the questions from the Funding Survey sent to sponsors of FMEs, FMPs, and FMSs is included in **Appendix 9A**.

The survey was sent via email to community representatives from 29 entities on a rolling basis between the dates of June 15, 2022 and July 4, 2022 requesting responses between June 27, 2022 and July 15, 2022. The contact list was compiled from various sources, including contact information collected through the initial flood planning survey for community officials and available online data. At least one point of contact was able to be identified from each community. A summary of the entities contacted for the FIF survey is provided in **Table 9.3**.

Where no response was received by the deadline, it was assumed that the action would need 100% funding from the state. Similarly, some respondents did not indicate whether or not they would be able to provide a match or what funding source would be used; in those cases, it was assumed the action would need 100% funding from the state.

Table 9.3 Region 14 Entities Contacted for FIF Survey

County or Municipality	Date Survey Sent	Date Response Requested	Response Received?
Brewster County	July 4, 2022	July 15, 2022	No
City of Alpine	July 1, 2022	July 8, 2022	Yes
City of Kermit	June 15, 2022	June 27, 2022	No
City of Marfa	June 15, 2022 July 1, 2022	June 27, 2022 July 8, 2022	Yes

County or Municipality	Date Survey Sent	Date Response Requested	Response Received?
City of Monahans	June 15, 2022 July 1, 2022 July 4, 2022	June 27, 2022 July 8, 2022 July 15, 2022	Yes
City of Ozona	June 15, 2022	June 27, 2022	No
City of Pecos	June 15, 2022	June 27, 2022	No
City of Presidio	July 1, 2022	July 8, 2022	Yes
City of San Elizario	June 15, 2022	June 27, 2022	Yes
City of Socorro	June 15, 2022	June 27, 2022	Yes
City of Sonora	June 15, 2022	June 27, 2022	No
Crocket County WCID	July 1, 2022	July 8, 2022	No
Dona Ana County	July 4, 2022	July 15, 2022	No
El Paso County	June 15, 2022 July 1, 2022	June 27, 2022 July 8, 2022	Yes
El Paso Water	June 15, 2022	June 27, 2022	Yes
EPCWID #1	June 15, 2022 July 1, 2022	June 27, 2022 July 8, 2022	Yes
Fort Hancock WCID	July 4, 2022	July 15, 2022	No
Fort Stockton	June 15, 2022	June 27, 2022	No
Hudspeth County	June 15, 2022	June 27, 2022	Yes
Hudspeth County CRD1	July 1, 2022	July 8, 2022	Yes
National Park Service	July 4, 2022	July 15, 2022	No
Pecos County	July 1, 2022 July 4, 2022	July 8, 2022 July 15, 2022	No
Presidio County	July 1, 2022	July 8, 2022	No
Reeves County	July 4, 2022	July 15, 2022	No
Rio Grande Joint Ventures	July 4, 2022	July 15, 2022	No
Texas Department of Transportation	July 1, 2022	July 8, 2022	No
Texas General Land Office	July 1, 2022	July 8, 2022	No
US Army Corps of Engineers	July 1, 2022	July 8, 2022	No
US IBWC	July 1, 2022	July 8, 2022	No

9.2.2 Survey Results

Table 9B in **Appendix 9B** presents the results of the Sponsor Financing survey for each FME, FMS, and FMP. Of the 29 entities contacted, 11 responded to the survey, an overall response rate of 37.9%.

While the overall response rate appears low, there is significant interest and continued participation demonstrated by major regional stakeholders. The entities that responded to the survey are listed as sponsors for a combined 46 of the 58 flood mitigation actions (79%) accounting for $156.5 million (97.6%) of the total implementation cost needed. As a result, even with a low overall response rate, the information received provides a representative picture of total funding needs across the basin.

Of the 11 entities that responded to the survey, the likely sources of funding indicated to implement flood management activities included general or dedicated revenues, bonds, tax notes, or utility fees. Just under half (5 of 11) of the respondents had not applied for grant funding in the past five years (one respondent left this blank). Of the remaining six respondents that had applied for grant funding, three had been successful in receiving a grant and loan, one had been unsuccessful, one had received an invitation for a full application but decided not to pursue the project, and one application was still under further review.

The communities in Region 14 have demonstrated a strong commitment to funding regional flood management activities. El Paso County, for instance, issued two certificates of obligation in the amounts of $1.61 million and $20.7 million to finance construction of detention ponds, channel improvements, and flood mitigation projects throughout the county. El Paso County is also seeking a $2.37 million loan from the TWDB for similar improvements. Similarly, EPWater authorized the issuance of $25 million to pay off a line of credit used for Capital Improvement Program drainage projects for fiscal year (FY) 2022-23 and issued revenue bonds in 2022 for $9.49 million to pay for flood mitigation actions. In total, the drainage capital improvement projects undertaken by EPWater for FY 2022-23 will be $70 million.

9.3 Proposed Role of State in Financing

Overall, there is an estimated $155.7 million needed to implement the recommended FMEs, FMSs, and FMPs in this RFP beyond what is anticipated to be funded by local sponsors. This figure represents 97% of the total cost of the flood mitigation actions identified in this plan. There may be other sources of funding available through other local, state, and federal programs outlined previously in this section, or future revenue sources, but these have not been acquired to date for the actions listed in the RFP.

This estimate does not represent the amount of funding needed to mitigate all risks in the region nor to solve known regional flooding problems in their totality. Rather, this estimate only represents the funding needs for the specific, identified studies, strategies, and projects in this cycle of regional flood planning. Future cycles of regional flood planning will continue to identify more projects and studies needed to further flood mitigation efforts in the Upper Rio Grande Flood Planning Group (Region 14).

For planning purposes, the RFPG recommends using this figure to estimate the need for funding from the state. While certain entities may choose to adjust their expenditure priorities or find ways to generate additional revenue for drainage projects, the RFPG anticipates that a significant gap will remain between the cost to implement the RFP and the funding that can be generated by local jurisdictions. The RFPG also recognizes that it is unlikely, if not impossible, for enough money to be appropriated to the FIF to be able to fill the funding gap across the region and the state as a whole.

The RFPG recommends that the TWDB utilize the information generated by these RFPs to assist entities with identifying and leveraging existing funding sources that are available for FMPs, such as by providing assistance to small and underserved communities with grant funding applications and simplifying and streamlining TWBD program and application requirements, when possible. This RFP also provides recommendations to help identify other potential revenue-raising opportunities for flood mitigation in the state, as can be found in **Chapter 8.**

Chapter 10: Public Participation and Plan Adoption

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10. Public Participation and Plan Adoption

This chapter summarizes the role of the Upper Rio Grande RFPG in the flood planning process and the various public participation, information, and outreach activities conducted by the RFPG during the development of the RFP. These activities demonstrate the RFPG's commitment to engaging with the public and other flood planning stakeholders and providing as many opportunities as possible for public input.

The chapter also describes the flood plan adoption process, including information on the submittal of the Draft RFP, the required public hearing, addressing public comments, and the adoption of the Final RFP.

10.1 RFPG Organization and Role in Flood Planning Process

The Upper Rio Grande RFPG is one of the 15 RFPGs formed by the TWDB on October 1, 2020, as a result of the passage of Texas Senate Bill 8 in 2019, which established the state and regional flood planning process. The RFPG's role and functions are defined in Texas Water Code (TWC) Chapter 16 and in Title 31 of the TAC Chapters 361 and 362. Among these functions, the Upper Rio Grande RFPG's primary responsibility is to identify and manage flood risks across the region to reduce the impacts of flooding to life, property, and infrastructure.

Voting members within the Upper Rio Grande RFPG represent ten interest groups (shown in **Table 10.1**), while non-voting members represent state agencies or other neighboring regional planning groups (shown in **Table 10.2**). All RFPG members are recognized for their important contributions to the 2023 Upper Rio Grande Regional Flood Plan.

Table 10.1 Upper Rio Grande Flood Planning Voting Members

Interest Group	Name	Entity	County	Alternate Member
Agriculture	Dr. Zhuping Sheng	Sheng Engineering PLLC	El Paso	N/A
Counties	Gilbert Saldana, Jr.	El Paso County	El Paso	N/A
Electric generating utilities	Vacant	N/A	N/A	N/A
Environmental Interests	Jeff Bennett	Rio Grande Joint Venture	Brewster	N/A
Industries	Sal Masoud	Del Rio Engineering	El Paso	N/A
Municipalities	Javier Acosta	FXSA	El Paso	N/A
Public	Dave Hall	N/A	El Paso	N/A
Public	Carlos Arturo Velarde Fernandez	Val Verde County	Val Verde	N/A
Small Business	Rene Rodriguez	N/A	El Paso	N/A
Water Districts	Omar L. Martinez	EPCWID #1	El Paso	N/A
Water Utilities	Gisela Dagnino	El Paso Water	El Paso	Enrique Ochoa, Marvin Gomez
Water Utilities	Levi Bryand	LCA, Inc.	Ector	N/A

Table 10.2 Upper Rio Grande Flood Planning Non-Voting Members

Non-Voting Member	Agency/Organization
James Weaver	Texas Parks and Wildlife Department
Judy Lucio	Texas Division of Emergency Management
Larissa Place	Texas Department of Agriculture
Elijah Casas	Texas General Land Office
Richard Bagans	Texas Water Development Board (TWDB)
Anita Keese	Texas Commission on Environmental Quality (TCEQ)
Vanessa Rosales-Herrera	Region 15 Liaison
Delbert Humberson	U.S. International Boundary and Water Commission (IBWC)
Ben Wilde	Texas State Soil and Water Conservation Board (TSSWCB)

Throughout the planning process, the RFPG formed several committees to focus on different aspects of the flood plan and provide recommendations to the overall planning group at general RFPG meetings. These committees included an executive committee and four topic-based subcommittees to examine specific parts of the RFP scope of work as listed below and summarized in **Table 10.3**:

- Subcommittee 1: Evaluation and Recommendations on Floodplain Management Practices/Flood Mitigation and Floodplain Management Goals (Tasks 3A and 3B, Chapter 3), shown in
- Subcommittee 2: Identification & Evaluation of Potential FMPs (Task 4, Chapter 4)
- Subcommittee 3: Identification & Evaluation of Potential FMEs and FMSs (Task 4, Chapter 4)
- Subcommittee 4: Administrative, Regulatory, and Legislative Recommendations (Task 8, Chapter 8)

The four subcommittees were formed by the RFPG on September 7, 2021, and included both voting and non-voting members from the RFPG. Subcommittee members are listed in **Table 10.4** through **Table 10.7**. General RFPG meetings and subcommittee meetings were all held in accordance with Open Meetings Act (OMA) requirements, as described in Section 10.2.2.

Table 10.3 Upper Rio Grande Flood Planning Group Committees

Committee	Number of Meetings
Executive Committee	1
Subcommittee 1 – Evaluation and Recommendations on Floodplain Management Practices/Flood Mitigation and Floodplain Management Goals (Task 3)	4
Subcommittee 2 – Identification & Evaluation of Potential FMPs (Task 4)	6
Subcommittee 3 – Identification & Evaluation of Potential FMEs and FMSs (Task 4)	4
Subcommittee 4 – Administrative, Regulatory, and Legislative Recommendations (Task 8)	3

Table 10.4 Subcommittee 1 Members (Evaluation and Recommendations on Floodplain Management Practices/Flood Mitigation and Floodplain Management Goals, Task 3)

Member	Interest Category	Member Type
Dave Hall, *Subcommittee 1 Chair*	Public	RFPG Voting Member
Carlos Arturo Velarde Fernandez	Public	RFPG Voting Member
Gilbert Saldana, Jr.	Counties	RFPG Voting Member
Gisela Dagnino	Water Utilities	RFPG Voting Member
Javier Acosta	Municipalities	RFPG Voting Member
Levi Bryand	Water Utilities	RFPG Voting Member
Omar L. Martinez	Water Districts	RFPG Voting Member

Table 10.5 Subcommittee 2 Members (Identification & Evaluation of Potential FMPs, Task 4)

Member	Interest Category	Member Type
Javier Acosta, *Subcommittee 2 Chair*	Municipalities	RFPG Voting Member
Carlos Arturo Velarde Fernandez	Public	RFPG Voting Member
Dave Hall	Public	RFPG Voting Member
Gilbert Saldana, Jr.	Counties	RFPG Voting Member
Gisela Dagnino	Water Utilities	RFPG Voting Member
Jeff Bennett	Environmental Interests	RFPG Voting Member
Levi Bryand	Water Utilities	RFPG Voting Member
Omar L. Martinez	Water Districts	RFPG Voting Member
Delbert Humberson	U.S. IBWC	RFPG Non-Voting Member

Table 10.6 Subcommittee 3 Members (Identification & Evaluation of Potential FMEs and FMSs, Task 4)

Member	Interest Category	Member Type
Sal Masoud, *Subcommittee 3 Chair*	Industries	RFPG Voting Member
Gisela Dagnino	Water Utilities	RFPG Voting Member
Jeff Bennett	Environmental Interests	RFPG Voting Member
Levi Bryand	Water Utilities	RFPG Voting Member
Omar L . Martinez	Water Districts	RFPG Voting Member
Delbert Humberson	U.S. IBWC	RFPG Non-Voting Member

Table 10.7 Subcommittee 4 Members (Administrative, Regulatory, and Legislative Recommendations, Task 8)

Member	Interest Category	Member Type
Omar L . Martinez, *Subcommittee 4 Chair*	Water Districts	RFPG Voting Member
Gilbert Saldana, Jr.	Counties	RFPG Voting Member
Gisela Dagnino	Water Utilities	RFPG Voting Member
Levi Bryand	Water Utilities	RFPG Voting Member
Sal Masoud	Industries	RFPG Voting Member
Anita Keese	TCEQ	RFPG Non-Voting Member
Delbert Humberson	U.S. IBWC	RFPG Non-Voting Member

The RFPG represents the interests of stakeholders throughout the flood planning region and functions in support of and in coordination with the TWDB to deliver the draft and final Regional Flood Plans. The RFPG responsibilities are outlined in 31 TAC §361.12 and include the following activities for every planning cycle:

1. Designate a political subdivision as a Planning Group Sponsor – in this planning cycle, the Planning Group sponsor was RGCOG.
2. Select a technical consultant(s) to be procured by the Planning Group Sponsor – in this planning cycle, the technical consultant was AECOM.
3. Hold at least one public meeting, to determine what, if any, additional public notice the RFPG determines is necessary to ensure adequate public notice in its own FPR. This meeting was held on November 5, 2020.
4. Hold public meetings at central locations readily accessible to the public within the FPR to gather general suggestions and recommendations from the public. These meetings are discussed further in Section 10.2.2.
5. Approve the contract(s) and any subsequent amendments thereto between the Planning Group Sponsor and the technical consultant or TWDB Scope(s) of Work or budgets in open

meetings. The original contract was approved and executed on June 11, 2021, and the contract amendment was approved and executed on March 25, 2022.

10.2 Public Information and Engagement

The Upper Rio Grande RFPG encouraged broad, regionwide public participation throughout the flood planning process. All RFPG activities and RFP updates were posted and accessible to the public with opportunities for public feedback. Flood planning stakeholders and the public were engaged throughout the process across several modes of outreach as described in the following section. The RFPG met all requirements under the Texas Open Meetings Act and Public Information Act.

10.2.1 Media Releases and Online Access

Media releases about the flood planning process were produced and distributed to local media organizations across the region. These media releases resulted in an estimated media reach of nearly 3 million through print, digital, and broadcast media stories, targeting the areas of El Paso, Pecos, Presidio, Alpine, Marfa, and Fort Davis. Additional public outreach was conducted by state media outlets.

The Upper Rio Grande RFPG maintains a flood planning website (www.urgfpg.org) with information for the public regarding past and upcoming RFPG meetings, open house events, planning documents, RFPG members, and public comment submission. Interested parties are encouraged to sign up to receive public meeting notices and other flood planning updates by email. Additional information regarding the state flood planning process is also available at the TWDB's flood planning website (www.twdb.texas.gov/flood/planning/index.asp).

10.2.2 Public Meetings

RFPG Meetings

The Upper Rio Grande RFPG held several meetings between November 2020 and January 2023 to discuss relevant RFP topics, conduct pre-planning and administrative activities, receive updates from the technical consultant, and vote on specific measures. All meetings were posted and held in accordance with the Texas Open Meetings Act (OMA) with a copy of all materials presented or discussed available for public inspection prior to and following public meetings.

Due to the COVID-19 pandemic, selected OMA provisions were temporarily suspended by the Office of the Texas Governor, and public meetings were initially held fully online via GoToWebinar and Microsoft Teams. Once these temporary suspensions were lifted, RFPG meetings were conducted in-person at the RGCOG office in El Paso with a virtual option for the convenience and safety of attendees. Public attendance was encouraged, and each meeting included a scheduled time for public comments or questions. In addition, all meetings were recorded and posted online on the RFPG website along with the associated meeting minutes for public access following the meetings. **Table 10.8** provides an overview of all general RFPG meetings conducted during the first planning cycle. Meeting minutes from the RFPG general meetings and subcommittee meetings are provided in **Appendix 10A**.

Table 10.8 Upper Rio Grande Flood Planning Meetings

Meeting Number	Date	Meeting Location	Agenda Highlights
0.1	November 5, 2020	GoToWebinar Virtual Meeting	Pre-Planning Meeting
0.2	January 21, 2021	GoToWebinar Virtual Meeting	Pre-Planning Meeting
0.3	March 16, 2021	GoToWebinar Virtual Meeting	Pre-Planning Meeting
0.5	April 9, 2021	GoToWebinar Virtual Meeting	Executive Committee Meeting
0.5	April 15, 2021	GoToWebinar Virtual Meeting	Pre-Planning Meeting
0.6	May 20, 2021	GoToWebinar Virtual Meeting	Pre-Planning Meeting
1	August 5, 2021	RGCOG, El Paso, TX / Microsoft Teams	Introduction to Consultant Team; Flood Plan Outline; Discussion of Tasks 1-2
2	September 7, 2021	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 1-2; RFPG Approval of Subcommittees 1-4
3	October 15, 2021	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 1-4; Stakeholder Coordination; El Paso Open House Meeting Preview; Updates from Subcommittee 1-3 Meetings
4	November 2, 2021	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 1-4; Stakeholder Coordination Results; El Paso Open House Meeting Recap; Updates from Subcommittee 1 and 3 Meetings
5	November 30, 2021	El RGCOG, Paso, TX / Microsoft Teams	Discussion of Tasks 1-4; RFPG Approval of (1) Recommendations on Floodplain Management Standards, (2) Adoption of Flood Mitigation and Floodplain Management Goals, and (3) Process to Identify and Evaluate Potential FMEs, FMSs, and FMPs
6	December 16, 2021	RGCOG, El Paso, TX / Microsoft Teams	Updates from Subcommittee 2 Meeting; RFPG Adoption of Technical Memo and Authorization of Consultant to submit Technical Memo to TWDB
7	February 2, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 4-5; Pecos and Presidio Open House Meeting Preview; Updates from Subcommittee 2-3 Meetings; RFPG Approval of (1) Refinements to list of Identified FMEs and FMSs and (2) Refinements to FMP Prioritization Method
8	February 28, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 4-5 and 8 focusing on evaluation of FMEs and FMSs; Pecos and Presidio Open House Meeting Recap; RFPG Approval of Technical Memo March 7th Deliverables and Authorization of Consultant to submit Deliverables to TWDB
9	March 15, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 4-5 focusing on evaluations of FMPs
10	April 21, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 4-5 focusing on evaluations of FMEs, FMSs, and FMPs; RFPG Approval of Recommendations for FMPs

Meeting Number	Date	Meeting Location	Agenda Highlights
11	May 25, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion of Tasks 4-5 and 8; RFPG Approval of (1) Recommendations for FMPs and (2) Revision of Flood Mitigation and Floodplain Management Goals
12	June 30, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of Draft RFP Chapters
13	July 13, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of Draft RFP Chapters
14	July 20, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of Draft RFP Chapters; RFPG Approval of (1) Draft RFP Deliverables and Authorization of Consultant to Submit Deliverables to TWDB and (2) Recommendations for FMEs, FMSs, and FMPs
15	July 26, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of Draft RFP Chapters
16	July 28, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of Draft RFP Chapters; RFPG Approval of Chapter 8 Administrative, Regulatory, and Legislative Recommendations
17	September 14, 2022	RGCOG, El Paso, TX / Microsoft Teams	Discussion on potential FMEs to perform during Task 12 RFP amendment phase
18	November 15, 2022	RGCOG, El Paso, TX / Microsoft Teams	Initial discussion of TWDB and public comments on Draft RFP; Discussion of Stakeholder Coordination for Task 12 (FMEs for Amended RFP); RFPG Approval of FMEs to study in Task 12
19	December 6, 2022	RGCOG, El Paso, TX / Microsoft Teams	Review of TWDB/public comments and draft responses to comments on Draft RFP; Discussion of Task 12; RFPG Approval of changes to Task 12 FMEs
20	December 15, 2022	RGCOG, El Paso, TX / Microsoft Teams	RFPG Adoption of Final RFP and Authorization of Consultant to Submit Final Deliverables to TWDB

Open House Meetings and Hearings

In addition to the regular RFPG and committee meetings, several public open house meetings were held throughout the region to facilitate engagement with the public and other flood planning stakeholders. Due to the region's large size, three locations relatively central to the region were identified to host these public open house meetings, including the Cities of El Paso, Pecos, and Presidio.

An initial pre-planning meeting was held in El Paso on July 25, 2021, to receive preliminary feedback from the public on important issues to be considered as part of the RFP. In addition, over the course of the flood planning process, four open house meetings were conducted on the following dates:

- Open House Meeting in El Paso: October 27, 2021
- Open House Meeting in Pecos: February 9, 2022
- Open House Meeting in Presidio: February 10, 2022

- Open House Meeting in El Paso: June 8, 2022

At each of these open house meetings, flood maps from the region were shared to allow community members the opportunity to identify any potential flood risks that had not previously been captured on the maps. Public feedback from these meetings was used during the development of flood prone areas discussed in *Chapter 2 ("Flood Risk Analyses").* These meetings were also utilized to gather general suggestions and recommendations from the public as to issues, provisions, and types of FMSs, FMPs, and FMEs that should be considered for potential inclusion in the first-cycle RFP. The final open house meeting in El Paso was utilized to gather public feedback on the potential recommended FMSs, FMPs, and FMEs discussed in *Chapter 5 ("Evaluation and Recommendation of Flood Solutions").* Public notifications for each open house meeting were advertised in local newspapers and on social media.

A Public Hearing was held in El Paso on September 14, 2022, to receive public feedback on the Draft RFP. Details of this public hearing are included with **Appendix 10C**.

10.2.3 Surveys

The RFPG conducted a stakeholder survey from September to October 2021 to obtain flood-related information from the public and other flood planning stakeholders. The survey was posted on the RFPG website and emailed directly to stakeholders, who were also contacted by the RFPG and technical consultant and encouraged to participate in the survey. In addition to stakeholder-specific questions, the survey included general flood-related questions to solicit feedback from the public related to overall flood experiences and issues of concern. A copy of the survey results is provided for reference in **Appendix 10B**.

In addition, an interactive web map was developed to collect feedback from the public regarding flood prone areas, critical infrastructure or resources, existing infrastructure, and existing or proposed flood mitigation projects. The interactive web map was shared as part of the stakeholder survey and at public open house meetings.

10.2.4 Draft RFP Review and Final Adoption

The Draft RFP was approved by the RFPG on July 20, 2022, and submitted to the TWDB for review. The Draft RFP was released for public review with a 60-day comment period between August 14, 2022, and October 14, 2022. In addition, a Public Hearing was held on September 14, 2022, to receive public comments. Printed copies of the Draft RFP were located in three publicly accessible locations in the region including the cities of El Paso, Pecos, and Presidio. The Draft RFP was also posted to the RFPG website for public review, and public comments were accepted electronically during the public review and comment period.

All comments from the TWDB on the Draft RFP are provided in **Appendix 10D** followed by RFPG responses to these comments. Public comments received during the 60-day comment period are summarized (along with responses) in **Appendix 10E**, including comments from the Rio Grande Council of Governments (RGCOG) and the U.S. Army Corps of Engineers (USACE). During the Public Hearing on September 14, 2022, the RFPG met with members of the public to clarify the purpose and content included in the RFP; however, no additional formal comments requiring changes to the RFP were received from the public during this meeting.

The Final RFP was adopted by the RFPG on December 15, 2022, and submitted to the TWDB along with supporting materials on January 10, 2023. The RFP was submitted in accordance with the contractual, statute, and rule requirements.

10.3 Flood Planning Guidance Principles

The state and regional flood planning process is guided by 39 principles adopted in Title 31 Texas Administrative Code (TAC) §362.3. This RFP conforms with each of these flood planning guidance principles, including the requirement that the plan will not negatively affect any neighboring areas. Specifically, each of the principles are aligned with one or more of the RFP report sections as outlined in **Table 10.9**. In addition, the RFP adequately provides for the preservation of life and property in the region.

Table 10.9 Alignment of RFP with Guidance Principles

Guidance Principle (“The regional and state flood plans: …”)		RFP Section(s)
1	shall be a guide to state, regional, and local flood risk management policy;	Chapter 3, Chapter 8
2	shall be based on the best available science, data, models, and flood risk mapping;	Chapter 1, Chapter 2, Chapter 4/5
3	shall focus on identifying both current and future flood risks, including hazard, exposure, vulnerability and residual risks; selecting achievable flood mitigation goals, as determined by each RFPG for their region; and incorporating strategies and projects to reduce the identified risks accordingly;	Chapter 2, Chapter 3, Chapter 4/5
4	shall, at a minimum, evaluate flood hazard exposure to life and property associated with 0.2 percent annual chance flood event (the 500-year flood) and, in these efforts, shall not be limited to consideration of historic flood events;	Chapter 2
5	shall, when possible and at a minimum, evaluate flood risk to life and property associated with 1.0 percent annual chance flood event (the 100-year flood) and address, through recommended strategies and projects, the flood mitigation goals of the RFPG (per item 2 above) to address flood events associated with a 1.0 percent annual chance flood event (the 100-year flood); and, in these efforts, shall not be limited to consideration of historic flood events;	Chapter 2, Chapter 4/5
6	shall consider the extent to which current floodplain management, land use regulations, and economic development practices increase future flood risks to life and property and consider recommending adoption of floodplain management, land use regulations, and economic development practices to reduce future flood risk;	Chapter 3
7	shall consider future development within the planning region and its potential to impact the benefits of flood management strategies (and associated projects) recommended in the plan;	Chapter 1, Chapter 2
8	shall consider various types of flooding risks that pose a threat to life and property, including, but not limited to, riverine flooding, urban flooding, engineered structure failures, slow rise flooding, ponding, flash flooding, and coastal flooding, including relative sea level change and storm surge;	Chapter 1, Chapter 2
9	shall focus primarily on flood management strategies and projects with a contributing drainage area greater than or equal to 1.0 (one) square miles except in instances of flooding of critical facilities or transportation routes or for other reasons, including levels of risk or project size, determined by the RFPG;	Chapter 4/5

Guidance Principle ("The regional and state flood plans: …")		RFP Section(s)
10	shall consider the potential upstream and downstream effects, including environmental, of potential flood management strategies (and associated projects) on neighboring areas. In recommending strategies, RFPGs shall ensure that no neighboring area is negatively affected by the regional flood plan;	Chapter 4/5, Chapter 6
11	shall include an assessment of existing, major flood mitigation infrastructure and will recommend both new strategies and projects that will further reduce risk, beyond what existing flood strategies and projects were designed to provide, and make recommendations regarding required expenditures to address deferred maintenance on or repairs to existing flood infrastructure;	Chapter 1, Chapter 4/5
12	shall include the estimate of costs and benefits at a level of detail sufficient for RFPGs and sponsors of flood mitigation projects to understand project benefits and, when applicable, compare the relative benefits and costs, including environmental and social benefits and costs, between feasible options;	Chapter 4/5
13	shall provide for the orderly preparation for and response to flood conditions to protect against the loss of life and property and reduce injuries and other flood-related human suffering;	Chapter 7
14	shall provide for an achievable reduction in flood risk at a reasonable cost to protect against the loss of life and property from flooding;	Chapter 4/5
15	shall be supported by state agencies, including the TWDB, General Land Office, Texas Commission on Environmental Quality, Texas State Soil and Water Conservation Board, Texas Parks and Wildlife Department, and the Texas Department of Agriculture, working cooperatively to avoid duplication of effort and to make the best and most efficient use of state and federal resources;	Chapter 10
16	shall include recommended strategies and projects that minimize residual flood risk and provide effective and economical management of flood risk to people, properties, and communities, and associated environmental benefits;	Chapter 4/5
17	shall include strategies and projects that provide for a balance of structural and nonstructural flood mitigation measures, including projects that use nature-based features, that lead to long-term mitigation of flood risk;	Chapter 4/5
18	shall contribute to water supply development where possible;	Chapter 6
19	shall also follow all regional and state water planning guidance principles (31 TAC 358.3) in instances where recommended flood projects also include a water supply component;	Chapter 6
20	shall be based on decision-making that is open to, understandable for, and accountable to the public with full dissemination of planning results except for those matters made confidential by law;	Chapter 10
21	shall be based on established terms of participation that shall be equitable and shall not unduly hinder participation;	Chapter 10
22	shall include flood management strategies and projects recommended by the RFPGs that are based upon identification, analysis, and comparison of all flood management strategies the RFPGs determine to be potentially feasible to meet flood mitigation and floodplain management goals;	Chapter 4/5
23	shall consider land-use and floodplain management policies and approaches that support short- and long-term flood mitigation and floodplain management goals;	Chapter 3
24	shall consider natural systems and beneficial functions of floodplains, including flood peak attenuation and ecosystem services;	Chapter 3, Chapter 4/5
25	shall be consistent with the National Flood Insurance Program (NFIP) and shall not undermine participation in nor the incentives or benefits associated with the NFIP;	Chapter 2, Chapter 3
26	shall emphasize the fundamental importance of floodplain management policies that reduce flood risk;	Chapter 3

Guidance Principle ("The regional and state flood plans: …")		RFP Section(s)
27	shall encourage flood mitigation design approaches that work with, rather than against, natural patterns and conditions of floodplains;	Chapter 3, Chapter 4/5
28	shall not cause long-term impairment to the designated water quality as shown in the state water quality management plan as a result of a recommended flood management strategy or project;	Chapter 6
29	shall be based on identifying common needs, issues, and challenges; achieving efficiencies; fostering cooperative planning with local, state, and federal partners; and resolving conflicts in a fair, equitable, and efficient manner;	Chapter 10
30	shall include recommended strategies and projects that are described in sufficient detail to allow a state agency making a financial or regulatory decision to determine if a proposed action before the state agency is consistent with an approved regional flood plan;	Chapter 4/5
31	shall include ongoing flood projects that are in the planning stage, have been permitted, or are under construction;	Chapter 1
32	shall include legislative recommendations that are considered necessary and desirable to facilitate flood management planning and implementation to protect life and property;	Chapter 8
33	shall be based on coordination of flood management planning, strategies, and mitigation projects with local, regional, state, and federal agencies projects and goals;	Chapter 10
34	shall be in accordance with all existing water rights laws, including but not limited to, Texas statutes and rules, federal statutes and rules, interstate compacts, and international treaties;	Chapter 6
35	shall consider protection of vulnerable populations;	Chapter 2, Chapter 4/5
36	shall consider benefits of flood management strategies to water quality, fish and wildlife, ecosystem function, and recreation, as appropriate;	Chapter 4/5, Chapter 6
37	shall minimize adverse environmental impacts and be in accordance with adopted environmental flow standards;	Chapter 4/5, Chapter 6
38	shall consider how long-term maintenance and operation of flood strategies will be conducted and funded; and	Chapter 9
39	shall consider multi-use opportunities such as green space, parks, water quality, or recreation, portions of which could be funded, constructed, and or maintained by additional, third-party project participants.	Chapter 4/5