



Llano and San Saba County Hazard Mitigation Action Plan 2023 Update



Volume I

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TETRA TECH

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Section 1 Introduction

1.1 Purpose

Llano County, San Saba County, and its participating jurisdictions (the Planning Area) have prepared this multi-hazard mitigation plan to better protect the residents and property throughout the Planning Area from the effects of hazard events. This plan demonstrates the Planning Area's commitment to reducing risk from hazards, increasing resilience overall, and provides a tool to help decision makers integrate mitigation in their day-to-day processes. This plan was also developed to position the Planning Area for eligibility of pre- and post-disaster Federal Emergency Management Agency (FEMA) grants, including Hazard Mitigation Assistance grant programs (HMA), which include Hazard Mitigation Grant Program (HMGP), Building Resilient Infrastructure and Communities (BRIC), and Flood Mitigation Assistance (FMA). This plan also aligns with the planning elements of the National Flood Insurance Program's Community Rating System (CRS) which provides for lower flood

insurance premiums in CRS communities.

1.2 Background

A Hazard Mitigation Action Plan (HMAP) is a living document that communities use to reduce their vulnerability to hazards. It forms the foundation for a community's long-term strategy to reduce disaster losses and creates a framework for decision making to reduce damages to lives, property, and the economy from future disasters. Examples of mitigation projects include home acquisitions or elevations to remove structures from high-risk areas, upgrades to critical public facilities, and infrastructure improvements. Ultimately, these actions reduce vulnerability, and communities are able to recover more quickly from disasters. The Planning Area has demonstrated its commitment to reducing disaster losses by initially developing its HMAP in 2016 and updating information upon which to base a successful mitigation strategy to reduce the impacts of natural disasters and to increase the resiliency of the Planning Area.

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), which requires local governmental agencies to develop and update their HMP every five years, this plan serves as the 2023 update to the 2016 Llano County Hazard Mitigation Plan and the 2016 San Saba County Hazard Mitigation Plan. During the course of the planning process, the entire plan was updated with a focus on examining changes in vulnerability due to hazard events, reviewing capabilities and how they implement hazard mitigation, and reviewing the mitigation strategy and identifying new initiatives to increase overall resiliency in the Planning Area.

Hazard Mitigation is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.

FEMA defines a **Hazard Mitigation Plan** as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.

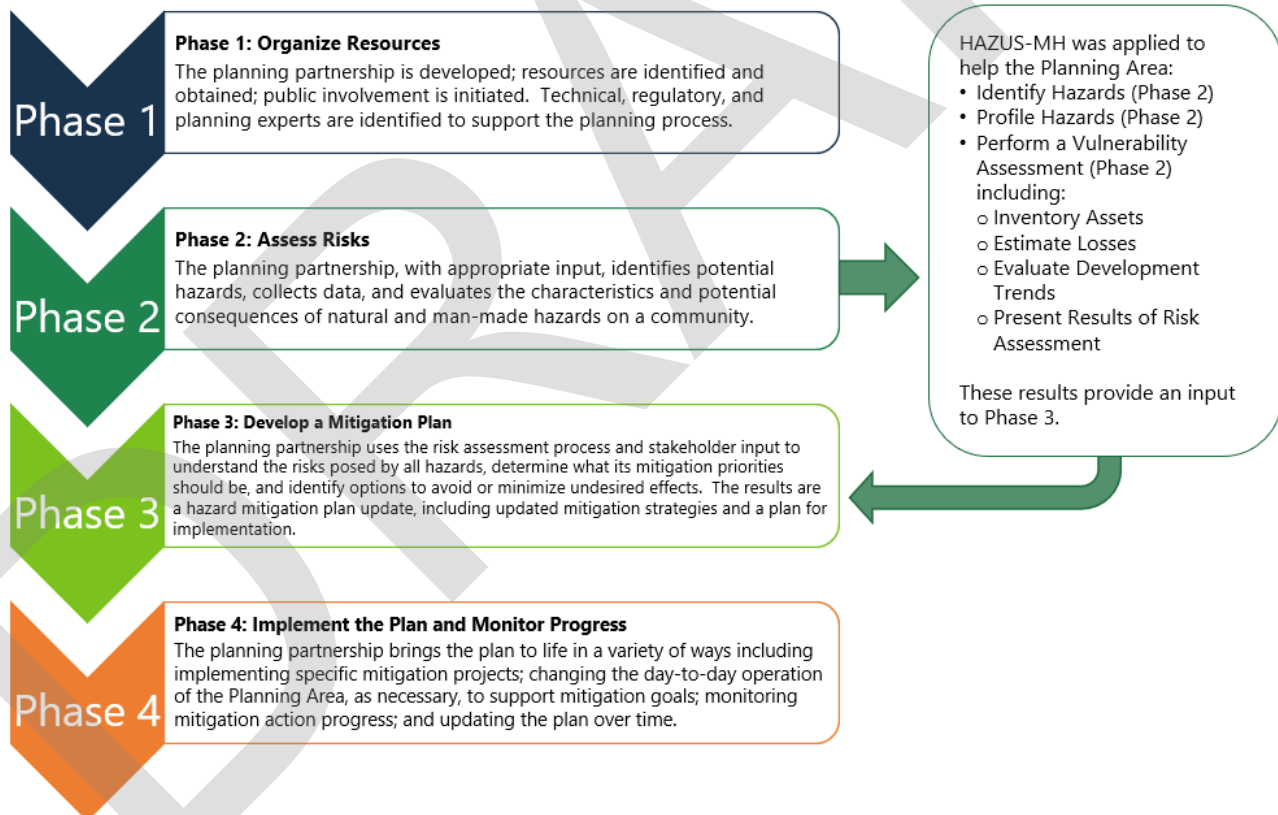
1.3 Plan Organization

The Llano and San Saba County Hazard Mitigation Action Plan 2023 Update is organized as a two-volume plan and is in alignment with the TDEM planning requirements, the 2013 FEMA Local Mitigation Planning Handbook, and the FEMA Local Mitigation Plan Review Tool.

Volume I provides information on the overall planning process and hazard profiling and vulnerability assessments, which serves as a basis for understanding risk and identifying mitigation actions. As such, Volume I is intended for use as a resource for ongoing mitigation analysis.

Volume II provides an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; identifies vulnerabilities to hazards; documents mitigation plan integration with other planning efforts; records status of past mitigation actions; and presents an individualized mitigation strategy. The annexes are intended to provide a useful resource for each jurisdiction for implementation of mitigation projects and future grant opportunities, as well as a place for each jurisdiction to record and maintain their local aspect of the multi-jurisdictional plan.

Figure 1-1. Llano and San Saba County Hazard Mitigation Planning Process



Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of the planning process and layout of the plan.

- Section 2:** Planning Process: Description of the HMP methodology and development process; Steering Committee, Planning Committee, Planning Partnership, and stakeholder involvement efforts; and a description of how this HMP will be incorporated into existing programs.
- Section 3:** County Profile: Overview of the Planning Area, including: (1) physical setting, (2) land use, (3) land use trends, (4) population and demographics, (5) general building stock and (6) critical facilities and lifelines.
- Section 4:** Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety, health, general building stock, critical facilities, the economy); description of the status of local data; and planned steps to improve local data to support mitigation planning.
- Section 5:** Capability Assessment: A summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the Planning Area.
- Section 6:** Mitigation Strategy: This section provides information regarding the mitigation goals and objectives in response to priority hazards of concern and the process by which Planning Area mitigation strategies have been developed or updated.
- Section 7:** Plan Maintenance: System established to continue to monitor, evaluate, maintain, and update the HMAP.

Volume II of this plan includes the following sections:

- Section 8:** Planning Partnership: Description of the Planning Partnership, their responsibilities, and description of jurisdictional annexes.
- Section 9:** Annexes: Jurisdiction-specific annexes for Llano County and San Saba County containing their hazards of concern, hazard ranking, capability assessment, mitigation actions, action prioritization specific only to Llano County and San Saba County, progress on prior mitigation activities (as applicable), and a discussion of prior local hazard mitigation plan integration into local planning processes.

Appendices include the following:

- Appendix A:** Plan Adoption: Resolutions from Llano and San Saba Counties and all participating jurisdiction included as each formally adopts the HMP update.
- Appendix B:** Participation Documentation: Matrix to give a broad overview of who attended meetings and when input was provided to the HMP update and additional worksheets submitted during workshops conducted throughout the planning process.
- Appendix C:** Meeting Documentation: Agendas, attendance sheets, minutes, and other documentation (as available and applicable) of planning meetings convened during the development of the plan.
- Appendix D:** Public and Stakeholder Outreach Documentation: Documentation of the public and stakeholder outreach effort including webpages, informational materials, public and stakeholder meetings

and presentations, surveys, and other methods used to receive and incorporate public and stakeholder comment and input to the plan process.

- Appendix E:** Mitigation Strategy Supplementary Data: Documentation of the broad range of actions identified during the mitigation process; types of mitigation actions; the mitigation catalog developed using jurisdiction input and potential mitigation funding sources.
- Appendix F:** Plan Maintenance Tools: Examples of plan review tools and templates available to support annual plan review.
- Appendix G:** Linkage Procedures: Includes steps non-participating local governments and other local jurisdictions such as Fire Districts, Utility Districts, School Districts, and any other eligible local government as defined in 44 CFR 201.2 within the planning area can join this plan as a participating jurisdiction and to ultimately achieve approved status.
- Appendix H:** Critical Facilities: Includes a full list of critical facilities identified for the update of the HMP. Due to the sensitive nature of the information, critical facility details have been redacted.

1.4 The Plan Update – What is Different?

The 2023 update builds on the previous plan and includes the following changes and enhancements:

- Updated data and tools provided for a more detailed and accurate risk assessment. The risk assessment was prepared to better support future grant applications by providing risk and vulnerability information that would directly support the measurement of “cost-effectiveness” required under FEMA mitigation grant programs.
- The plan identified implementable actions, with enough information to serve as the basis for policy and funding decisions and represent measurable impacts on resiliency and mitigation progress. Strategies provide direction, but actions are fundable under grant programs.
- Each participating jurisdiction has their own jurisdictional annex in the plan, found in Volume II, Section 9.

It should be noted that due to the limitations on participation posed by the pandemic and the strains on time and resources for many local governments and other community organizations from 2020 to present, participation of stakeholders at the municipal level was limited. In accordance with FEMA guiding principles for inclusive participation at various levels, the planning team will place a high priority on an expanded effort on stakeholder participation with local planning committees in future plan updates.

Table 1-1 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 1-1. Llano County Plan Changes Crosswalk

44 CFR Requirement	2016 HMP	2023 Updated Plan
<i>Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:</i>	The 2016 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved the following:	Building upon the success of the 2016 plan, the 2023 planning effort deployed the same public engagement methodology. The plan

44 CFR Requirement	2016 HMP	2023 Updated Plan
(1) <i>An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;</i> (2) <i>An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and non-profit interests to be involved in the planning process; and</i> (3) <i>Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.</i>	• Key department personnel formed a Steering Committee for the plan. • All Planning Partnership meetings were open to the public. • A website was created on Llano County's domain to keep the public informed of the planning process and how to get involved. • Use of a public participation survey. • Press releases were distributed as key milestones were achieved and proper to each public meeting. • Stakeholders were identified and coordinated with throughout the process. • Draft plan deliverables were made available on the County and multiple City websites, local libraries, and City Hall's. • A variety of existing studies, plans, reports, and technical information were reviewed as part of the planning process.	included the following enhancements: • Adjacent communities, along with the County, were invited to participate in the planning meetings. • The 2023 plan includes San Saba County and its jurisdictions. • Social media was utilized to engage the public. As with the 2016 plan, the 2023 planning process identified key stakeholders and coordinated with them throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.
<i>§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.</i>	The 2016 plan included a risk assessment of hazards of concern. The risk assessment included frequency of return, approximate annualized losses, a description of general vulnerability, climate change impacts, secondary hazards, critical facilities and infrastructure, discussion on vulnerabilities, and future development trends.	The 2023 plan update includes a comprehensive update to the risk assessment. The flood hazard was expanded to include stormwater flooding (or flooding outside of the floodplain). New and updated hazards of concern were included. Jurisdiction-specific risk assessment results are summarized in Section 4 (Risk Assessment) and in each jurisdictional annex (Section 9).
<i>§201.6(c)(2)(i): [The risk assessment] shall include a) description of the ... location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.</i>	The 2016 plan presented a risk assessment of each hazard of concern. Each section included the following: • General background • Hazard profile • Past events • Location • Frequency	A similar but adjusted format, using new and updated data, was used for the 2023 plan update. Each hazard profile includes information for both Llano and San Saba County. Each section of the risk assessment includes the following: • Hazard profile, including hazard description and types, maps of extent and location, previous

44 CFR Requirement	2016 HMP	2023 Updated Plan
	• Severity • Warning time • Secondary hazards • Climate change impacts • Exposure • Vulnerability • Future trends in development • Scenario • Issues	occurrences, and probability of future events. • Climate change impacts on future probability. • Vulnerability assessment including impact on life, safety, and health, general building stock, critical facilities, and the economy, as well as future changes that could impact vulnerability. The vulnerability assessment also includes changes in vulnerability since the 2016 plan.
<i>§201.6(c)(2)(ii): [The risk assessment] shall include a] description of the jurisdiction’s vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.</i>	Vulnerability was assessed for all hazards of concern. Each hazard of concern included a summary of assets exposed to the hazard (people/parcels annualized losses and expected damage to critical facilities and the environment).	A robust vulnerability assessment was conducted for the 2023 plan update, using new and updated asset and hazard data. Volume 1, Section 4.3 summarizes the planning area’s vulnerability for each hazard of concern. The jurisdictional annexes (Section 9) include a summary table of impacts on both Planning Partners.
<i>§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged by floods.</i>	A summary of NFIP insured properties identified as repetitive loss and severe repetitive loss locations was included in the plan.	A summary of NFIP insured properties identified as repetitive loss and severe repetitive loss locations was included in the plan.
<i>Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.</i>	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Planning Partnership defined “critical facilities” for the planning area, and these were inventoried by exposure.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). In addition, critical facilities considered lifelines in accordance with FEMA’s definition were identified.
<i>Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.</i>	Loss estimates were generated for all hazards of concern by using readily available information.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). Estimated potential losses are reported in both Volume 1 Section 4.3 and Volume II Section 9 for each jurisdiction.
<i>Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation</i>	There is a summary of future trends in development in each hazard profile.	A spatial analysis using identified growth areas, and potential new development identified by jurisdictions was conducted to determine if located in hazard areas.

44 CFR Requirement	2016 HMP	2023 Updated Plan
<i>options can be considered in future land use decisions.</i>		These results were reported to all participants and summarized in their annexes to discuss mitigation measures. In Volume I, Section 4.3, projected changes in population and development are discussed in each hazard section and how these projected changes may lead to increased vulnerability, or plans/regulations/ordinances in place to implement mitigation to protect the development.
<i>§201.6(c)(3):[The plan shall include a mitigation strategy that provides the jurisdiction’s blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.]</i>	The 2016 plan contained goals, objectives, and actions. The identified actions covered multiple hazards, goals, and objectives.	The Planning Partnership reviewed and updated the goals and objectives. A mitigation strategy workshop with associated tools and guidance on problem statement development was deployed to inform the identification of mitigation actions. Actions that were completed or no longer considered to be feasible were removed. The balance of the actions was carried over to the 2023 plan, and in some cases, new actions were added to the action plan.
<i>Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.</i>	The Planning Partnership identified goals and objectives targeted specifically for this hazard mitigation plan. These planning components supported the actions identified in the plan.	The Planning Partnership reviewed and updated the goals and objectives. Several new objectives were identified to align with updated Planning Area priorities.
<i>Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.</i>	For each identified hazard, mitigation strategies were developed and prioritized using mitigation action worksheets. The mitigation actions were displayed in a table, separated by jurisdiction.	For the 2023 update, a mitigation catalog was developed to provide a comprehensive range of specific mitigation actions to be considered. A table with the analysis of mitigation actions by type and hazard was used in jurisdictional annexes to the plan. Mitigation action worksheets with an alternative project evaluation were prepared for FEMA-eligible projects.
<i>Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction’s participation in the National Flood Insurance Program, and continued compliance with the program’s requirements, as appropriate.</i>	The County identified an action to place flood insurance materials/mortgage lending mandates in libraries	For the 2023 update, each jurisdictional annex includes a description on how each jurisdiction participates and implements the NFIP.

44 CFR Requirement	2016 HMP	2023 Updated Plan
<i>Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.</i>	Each of the actions in this were prioritized based on FEMA's STAPLEE criteria, which includes consideration of the social, technical, administrative, political, legal, economic, and environmental factors necessary for the implementation of each action.	A revised methodology based on the STAPLEE criteria and using new and updated data was used for the 2023 plan update. The 14 criteria were used to evaluate each potential mitigation action. The evaluation included a qualitative benefits and cost review. The results of the evaluation were used to identify the actions to include in the plan and assist with the prioritization.
<i>Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.</i>	The 2016 plan details a plan maintenance strategy stating that the plan will be revised and maintained as required.	The 2023 plan details a plan maintenance strategy similar to that of the initial plan. However, the 2023 plan maintenance strategy includes the use of the BATool SM which will enable municipal and county representatives to directly access mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation.
<i>Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.</i>	The 2016 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2023 plan details recommendations for incorporating the plan into other planning mechanisms such as the following: • Comprehensive/Master Plan. • Emergency Response Plan/ Emergency Operations Plan. • Capital Improvement Programs. • Municipal Code.
<i>Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.</i>	The 2016 plan details a strategy for continuing public involvement.	The 2016 plan maintenance strategy was carried over to the 2023 plan.
<i>Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council).</i>	Llano County and all the Planning Partners have adopted the plan.	The 2023 plan achieves DMA compliance for Llano and San Saba Counties. Resolutions for each Planning Partner adopting the plan can be found in Appendix A of this volume.

Section 2 Planning Process

2.1 Introduction

This section includes a description of the planning process used to update the 2018 Llano and San Saba County Hazard Mitigation Action Plan (HMAP), including how it was prepared, who was involved in the process, and how the public was involved. To ensure that the plan meets the requirements of the DMA 2000 and that the planning process would have the broad and effective support of the participating jurisdictions, regional and local stakeholders, and the public, an approach to the planning process and plan documentation was developed to achieve the following goals:

- The HMAP is multi-jurisdictional and considers natural and human-caused hazards facing the Planning Area, thereby satisfying the natural hazards mitigation planning requirements specified in the DMA 2000.
- Llano County and San Saba County are the plan participants.
- The HMAP was developed following the process outlined by the DMA 2000, FEMA regulations, and prevailing FEMA and TDEM guidance. Following this process ensures all the requirements are met and support HMP review.

The Llano/San Saba HMP update was written using the best available information obtained from a wide variety of sources. Throughout the HMAP update process, a concerted effort was made to gather information from local and regional agencies and staff, as well as stakeholders, federal and state agencies, and the residents of the Planning Area. The HMAP Planning Team solicited information from local agencies and individuals with specific knowledge of certain hazards and past historical events, as well as considering planning and zoning codes, ordinances, and other recent planning decisions. The hazard mitigation strategies identified in this HMP have been developed through an extensive planning process involving local, county, and regional agencies, Planning Area residents, and stakeholders.

This section describes the mitigation planning process, including (1) Organization of the Planning Process; (2) Stakeholder Outreach and Involvement; (3) Public Participation; (4) Incorporation of Existing Data, Plans, and Technical Information; (5) Integration with Existing Planning Mechanisms and Programs; and (6) Continued Public Involvement.

2.2 Organization of the Planning Process

Many parties supported the preparation of this HMAP update: County officials, municipal officials, the Planning Team, stakeholders, and the planning consultant. This planning process does not represent the start of hazard risk management in the Planning Area; rather it is part of an ongoing process that various state, county, and local agencies, and individuals have continued to embrace. A summary of the past and ongoing mitigation efforts is provided in Section 6 (Mitigation Strategy), as well as in Volume II Section 9 (Jurisdictional Annexes), to give a historical perspective of the Planning Area and local activities implemented to reduce vulnerability to hazards.

This section of the HMP identifies how the planning process was organized with the many “Planning Partners” involved and outlines the major activities that were conducted in the development of this HMP update.



2.2.1 Organization of the Planning Team

A contract planning consultant (Tetra Tech, Inc. referred herein as Tetra Tech) was selected to guide Llano/San Saba through the HMP update process. A contract between Tetra Tech and Llano County was executed in July 2022. Specifically, Tetra Tech, the contract consultant, was tasked with the following:

- Assisting with the organization of the Core Planning Team and Planning Team.
- Assisting with the development and implementation of a public and stakeholder outreach program.
- Data collection.
- Facilitation and attendance at meetings (Core Planning Team, Planning Team, stakeholder, public and other).
- Review and update of the hazards of concern, hazard profiling and risk assessment.
- Assistance with the review and update of mitigation planning goals and objectives.
- Assistance with the review of past mitigation strategies progress.
- Assistance with the screening of mitigation actions and the identification of appropriate actions.
- Assistance with the prioritization of mitigation actions.
- Authoring of the draft and final plan documents.

To facilitate plan development, Llano County developed a Planning Team to provide guidance and direction to the HMP update effort and to ensure the resulting document will be embraced both politically and by the constituency within the planning area (Llano County and San Saba County) (Table 2-1). Specifically, the Planning Team was charged with the following:

- Attending and participating in Planning Team meetings.
- Represent their jurisdiction throughout the planning process and assure participation expectations are met by their jurisdiction.
- Support and promote the public involvement process.
- Assisting with the development and completion of certain planning elements, including:
 - Reviewing and updating the hazards of concern.
 - Developing a public and stakeholder outreach program.
 - Assuring that the data and information used in the plan update process are the best available.
 - Reviewing and updating the hazard mitigation goals.
 - Report on progress of mitigation actions identified in prior or existing HMPs, as applicable.
 - Identifying and screening of appropriate mitigation strategies and activities.
- Reviewing and commenting on plan documents prior to submission to TDEM and FEMA.
- Adopt, implement, and maintain the plan update.

Table 2-1. Llano/San Saba County Hazard Mitigation Planning Team

Name	Title	Organization	Steering Committee Member	Planning Team Member
Linda Raschke	Commissioner	Llano County	Yes	Yes
Gilbert Bennett	EMC	Llano County	Yes	Yes
Cheryl Keep	Grants Administrator	Llano County	Yes	Yes
Cristy Vaught	Floodplain Administrator	Llano County	Yes	Yes
Byron Theodosis	Judge	San Saba County	No	Yes

Name	Title	Organization	Steering Committee Member	Planning Team Member
Lois VanBeck	Treasurer	San Saba County	No	Yes
Marsha Hardy	EMC	San Saba County	No	Yes
Brent Batla	Fire Chief	City of Horseshoe Bay	No	Yes
Kelli Tudyk	Mayor	City of Llano	No	Yes
Frank Pearce	Mayor Pro-Tem	City of Richland Springs	No	Yes
Johnie Reeves	Mayor	City of Richland Springs	No	Yes
John Bauer	Police Chief	City of San Saba	No	Yes
Michael Wadsworth	Inspector	City of San Saba	No	Yes
Scott Edmonson	Manager	City of San Saba	No	Yes
Scott Glaze	Public Works	City of San Saba	No	Yes
Chellie Stewart	Mayor	City of Sunrise Beach	No	Yes
Dan Gower	Fire Chief	City of Sunrise Beach	No	Yes
Laurie Brock	Police Chief	City of Sunrise Beach	No	Yes
Angela Thomas	Manager	Llano Co MUD #1 Blue Lake	No	Yes
Jamie Payne	Assistant Superintendent	Llano ISD	No	Yes
Chris Perry		Richard Springs Water	No	Yes
Chad Ashworth	Police Chief	Richland Springs ISD	No	Yes
James Womack	Superintendent	Richland Springs ISD	No	Yes
Rhonda Wyatt	Principal	Richland Springs ISD	No	Yes
Deana Sealy		Richland Springs Special UD	No	Yes
Buck Gilcrease	Superintendent	San Saba ISD	No	Yes
Jennifer Bordner	Superintendent	Cherokee ISD	No	Yes

Appendix B (Participation Matrix) identifies those individuals who represented the planning partners during this planning effort and indicates how they contributed to the planning process.

2.2.2 Planning Activities

Members of the Planning Team, as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards; assess risks; review existing inventories of and identify new critical facilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the Planning Team and Planning Team had the opportunity to review the draft plan and supported interaction with other stakeholders and assisted with public involvement efforts.

A summary of Planning Team meetings held, and key milestones met during the development of the HMP update is included in Table 2-2 that also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (e.g., agendas, sign-in sheets, meeting notes) are in Appendix C (Meeting Documentation). Table 2-2 identifies only the formal meetings held during plan development and does not reflect all planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, there was a great deal of communication between Llano County, committee members, and the contract consultant through individual local meetings, electronic mail (email), and by phone.

Table 2-2. Summary of Mitigation Planning Activities / Efforts

Date	DMA 2000 Requirement	Description of Activity	Participants
July 27, 2022	2	<u>Pre-Kick Off Meeting with Llano County:</u> Plan timing and administration, data needs and sharing, hazards of concern, dates, and next steps	County EMC, County Grants Administrator, Tetra Tech
August 19, 2022	2	<u>Steering Committee Meeting #1:</u> Introduce Steering Committee to the HMP update process, discuss mitigation planning, project organization, roles and responsibilities, data collection, hazards of concern, and schedule of the plan.	County Grant Administrator, County Emergency Manager, County Development Services Department Administrator, County 911 Coordinator/GIS, Tetra Tech
August 24, 2022	2, 4a	<u>Planning Partnership Meeting #1:</u> Introduce Planning Partnership to the HMP update process, discuss mitigation planning, project organization, roles and responsibilities, data collection, hazards of concern, and schedule of plan.	County Grant Administrator, County Emergency Manager, County Development Services Department Administrator, County 911 Coordinator/GIS, Richland Springs Police Chief, Richland Springs ISD Superintendent, City of San Saba CEO, Sunrise Beach VFD, Sunrise Beach Police Chief, City of Horseshoe Bay Fire Marshal, San Saba County staff, Llano County staff, Llano County Judge, Tetra Tech
October 13, 2022	2, 3a, 3b, 3c, 3d, 3e	<u>Steering Committee Meeting #2:</u> Welcome and Introductions, In-Kind Tracking, Project Schedule and Status Review, Hazards of Concern Review, Confirmation of Goals and Objectives, Next Steps	County Grant Administrator, County Emergency Manager, County Development Services Department Administrator, Tetra Tech
November 10, 2022	2, 4a, 4b	<u>Risk Ranking Meeting:</u> In-Kind Tracking, Project Overview and Status, Risk Assessment Overview, Review Calculated Hazard Ranking.	County Grants Administrator, City of Richland Springs, Sunrise Beach VFD, Tetra Tech
January 26, 2023	2	<u>Draft Plan Review Presentation:</u> Overview of entire plan and sections; confirmed plan maintenance schedule	Llano County Grant Administrator, San Saba County Emergency Management Coordinator, Sunrise Beach Police Chief, Sunrise Beach Fire Chief, City of Horseshoe Bay Fire Chief, Richland Springs Staff and Mayor, Llano County MUD #1, Tetra Tech
February 6, 2023	1b, 2	Draft HMP posted to public project website; all plan participants were notified and asked to assist with the public outreach including social media. Neighboring communities and stakeholders were notified of the posting as well.	Public and Stakeholders
February 21, 2023	2	HMP submitted to TDEM and FEMA Region VI	TDEM, FEMA Region VI

Date	DMA 2000 Requirement	Description of Activity	Participants
Upon plan approval by FEMA	1a	Plan adoption by resolution by the governing bodies of all participating jurisdictions	All Plan Participants

Note: All activities/efforts were conducted during the National Emergency response to the COVID-19 pandemic.

TBD = to be determined.

Each number in column 2 identifies specific DMA 2000 requirements, as follows:

1a – Prerequisite – Adoption by the Local Governing Body

1b – Public Participation

2 – Planning Process – Documentation of the Planning Process

3a – Risk Assessment – Identifying Hazards

3b – Risk Assessment – Profiling Hazard Events

3c – Risk Assessment – Assessing Vulnerability: Identifying Assets

3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses

3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends

4a – Mitigation Strategy – Local Hazard Mitigation Goals

4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures

4c – Mitigation Strategy – Implementation of Mitigation Measures

5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan

5b – Plan Maintenance Procedures – Implementation through Existing Programs

5c – Plan Maintenance Procedures – Continued Public Involvement

2.3 Stakeholder Outreach and Involvement

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the HMP, including all Planning Partners. Diligent efforts were made to assure broad regional, county, and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Planning Team. Stakeholder outreach was performed early on, and continually throughout the planning process. This HMP update includes information and input provided by these stakeholders where appropriate, as identified in the references.

This subsection discusses the various stakeholders that were invited to participate in the development of this HMP update, and how these stakeholders participated and contributed. This summary listing cannot possibly represent the total of stakeholders that were aware of and/or contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many Planning Partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process:

- All Planning Team meetings were open to the public and advertised via the Planning Area’s HMP website (<https://www.llanocountytxhmp.com/>).
- The Planning Team was provided outreach materials to post on their websites, social media platforms, and distribute printed materials.
- Distributed a stakeholder survey and neighbor survey to provide input regarding vulnerabilities, capabilities, and mitigation projects.
- Posted draft plan on the Llano County HMP website and advertised using social media platforms.
- Email correspondence to regional stakeholders and neighboring communities to review the draft HMP and provide input.

2.3.1 Federal, State, and County Agencies

The following describes the various departments and agencies that were involved during the planning process.

Federal Agencies

Please see Appendix B (Participation Documentation) for further details regarding federal agency participation. All responses to the stakeholder surveys may be found in Appendix D (Outreach).

FEMA Region VI: Provided updated planning guidance and conducted plan review.

Information regarding hazard identification and the risk assessment for this plan update were requested and received or incorporated by reference from the following agencies and organizations:

- National Climatic Data Center (NCDC)
- National Hurricane Center (NHC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Storm Prediction Center (SPC)
- U.S. Army Corps of Engineers (USACE)
- U.S. Census Bureau
- U.S. Department of Agriculture (USDA)
- U.S. Department of Health and Human Services
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)

State Agencies

Please see Appendix B (Participation Documentation) for further details regarding state agency participation. All responses to the surveys may be found in Appendix D (Outreach).

Texas Division of Emergency Management (TDEM): Administered the planning grant; provided updated planning guidance; provided review of the draft HMP update.

Planning Area Agencies and Departments

Several planning area agencies and departments were represented on the Planning Team and involved in the HMP update planning process. Appendix B (Participation Matrix) provides further details regarding regional and local stakeholder agencies. All responses to the stakeholder surveys are in Appendix D (Outreach). Refer to Section 5 (Capability Assessment) for details on each department and their roles during the HMP update and their overall responsibilities in the planning area.

- Llano County Commissioners Court
- Llano County Development Services
- Llano County Emergency Management
- Llano County Grants Administration
- Llano Independent School District
- Llano County Municipal Utility District #1 Blue Lake
- San Saba County Court
- San Saba County Emergency Management

- San Saba Independent School District
- San Saba County Treasurer
- Cherokee Independent School District
- City of Horseshoe Bay Fire Department
- City of Llano Administration
- City of Llano Code Enforcement Department
- City of Richland Springs Administration
- City of Richland Springs Independent School District
- City of Richland Springs Police Department
- City of Richland Springs Special Utility District
- City of Richland Springs Water Supply
- City of San Saba Code Enforcement
- City of San Saba Manager and Administration
- City of San Saba Police Department
- City of San Saba Public Works
- City of Sunrise Beach Administration
- City of Sunrise Beach Fire Department
- City of Sunrise Beach Police Department

2.3.2 Regional and Local Stakeholders

All Planning Team meetings were announced on the Llano HMP project website and posted on social media to invite residents and stakeholders. In addition, Planning Team representatives emailed regional and local stakeholders requesting their participation in stakeholder sector-specific surveys to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. Refer to Appendix C (Participation Documentation) for further details regarding regional and local stakeholder agency attendance at meetings and Appendix D for additional details on the public and stakeholder outreach, including responses received to the surveys.

Academia

Schools, universities, and other academia institutions were invited to attend planning process meetings and asked to complete the stakeholder survey. The following provided input during the process:

- Central Texas College
- Cherokee Independent School District
- Llano Independent School District
- Richland Springs Independent School District
- San Saba Independent School District

Business, Commercial, and Non-Profit Interests

The following business and commercial industries in the planning area were invited to take the stakeholder survey and provide input to the planning process:

- San Saba Economic Development Corporation
- Llano County Development Services

Emergency Services

Local emergency service providers (police, fire, and EMS) were invited to take the stakeholder survey and provide input to the planning process including the following:

- City of Llano Fire Department
- City of Llano Police Department
- City of San Saba Police Department
- Horseshoe Bay OEM
- Horseshoe Bay Police Department
- Lake Buchanan VFD
- Llano County ESD #1 – Llano
- Llano County ESD #1 – Horseshoe Bay
- Llano County ESD #2 – Lake Buchanan
- Llano County ESD #4 – Oakridge
- Llano County ESD #5 – Sunrise Beach
- Llano County OEM
- Llano County Sheriff's Department
- San Saba County OEM
- Sunrise Beach Village Fire Department
- Sunrise Beach Village Police Department
- Texas Division of Emergency Management (TDEM)
- Tow VFD

Healthcare

Healthcare facilities and providers located in the planning area were invited to take the stakeholder survey and provide input to the planning process, including:

- Hamilton Hospital
- Hill Country Direct Care
- Llano County Hospital Authority Board
- Llano County Indigent Health Care
- MidCoast Medical Center – Central

Transportation

County and local highway and public works departments were notified of the stakeholder survey and invited to provide input on the draft HMP, including the following:

- City of Llano Public Works Department
- City of Horseshoe Bay Public Works Department
- City of San Saba Public Works Department
- Llano County Road and Bridge Department
- San Saba County Department of Public Works
- San Saba Streets Department
- Texas DOT

Utilities

Utility providers in the planning area were invited to take the stakeholder survey and provide input to the planning process, including the following:

- Blue Lake MUD
- Deerhaven WCID
- Hickory Underground Water Conservation District No. 1
- Horseshoe Bay Utility Department
- Horseshoe Bay Water & Wastewater Plant
- Llano Water/Wastewater Department
- Kingsland MUD
- San Saba Sanitation and Recycling
- San Saba Waste/Wastewater Department

County and Adjacent Municipalities

Llano and San Saba Counties have made efforts to keep the counties and surrounding municipalities apprised of the project, invited to take the stakeholder survey, and allowed the opportunity to provide input to this planning process, including the following:

- Brown County Emergency Management
- Burnet County Office of Emergency Management
- Gillespie County Floodplain and Sanitation
- Lampasas County Office of Emergency Management
- Mason County Road and Bridge Department
- Mills County Office of Emergency Management

2.3.3 Stakeholder Survey Summary

The following provides a summary of the results and feedback received by stakeholders who completed the survey. Feedback was reviewed by the Planning Team and integrated where appropriate in the plan.

Stakeholder Survey

The stakeholder survey was designed to help identify general needs for hazard mitigation and resiliency within Llano and San Saba Counties from their perspective, as well as to identify specific projects that may be included in the mitigation plan. It was distributed to identified stakeholders, including the various county and municipal departments and agencies in the county. As of January 17, 2023, twenty stakeholders completed the survey, representing the following sectors: academic/research, business/commerce, emergency services, hospitals/medical, transportation, public works, and utilities.

The majority of respondents stated the buildings/facilities/structures they have worked in and/or are responsible for have not been impacted by a hazard (50%). Those that experienced damage stated that the structures damage due to winter weather, heavy rains, and flooding. When asked what areas are most vulnerable to hazards in the Planning Area, answers included low lying area, specifically those near rivers and other bodies of water.

The respondents stated that they have the following plans in place: Emergency Operations Plan (58.82%), Business Continuity Plan (5.88%), and Continuity of Operations Plan (17.65%). 11.76% selected they have no plans in place while 29.41% said they are unsure if there are any plans.

Neighbor Survey

The neighbor survey was sent to the surrounding municipalities and counties of Llano and San Saba Counties due to their proximity to and because effects of hazard events that impact the Planning Area would be similar to that of their neighbors. As of January 17, 2023, no responses have been received.

2.4 Public Participation – Public Involvement

In order to facilitate better coordination and communication between the Planning Team and citizens and to involve the public in the planning process, it was determined that meeting dates/locations will be made available to the public via the Llano HMAP website (<https://www.llanocountytxhmp.com/>) and social media; and the draft HMAP available on the Llano HMAP website. The participating partners also feel that community input on the HMAP will increase the likelihood of hazard mitigation becoming one of the standard considerations in the evolution and growth of the Planning Area.

The Planning Team has made the following efforts toward public participation in the development and review of the HMP:

- A dedicated website was created for this project (<https://www.llanocountytxhmp.com/>). The website went live in August 2022 and was continuously updated throughout the planning process. The public website contains a project overview, meeting announcements, draft documents for review and comment, and a link to the public and stakeholder surveys.
- All hazard mitigation Planning Team meetings that were open to the public were advertised on the Llano HMAP website and various social media accounts (Facebook and Twitter). Additional examples of municipal outreach are presented in Appendix D.
- An online natural hazards preparedness public survey was developed to gauge household preparedness that may impact the Planning Area and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asked quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs. The questionnaire also asked several demographic questions to help analyze trends. The questionnaire was available on the public website from September 2022 to January 2023, and further advertised on additional Planning Team websites and on printed materials. Responses were collected and provided back to plan participants for consideration in the mitigation action development (35 responses in total). Appendix D summarizes public input received through the website, the online survey, and other sources.
 - Results from the natural hazards preparedness survey were used to inform the action plans of the Planning Partners. To address the most requested types of projects that residents wanted local and county agencies to be doing, many Planning Partners included actions to improve and strengthen infrastructure, improve the damage resistance of utilities, buy out flood prone properties, improve protective structures, and provide greater control over development in high hazard areas.

- All plan participants were encouraged to post links to the project webpage and citizen survey. In addition, all participants were requested to advertise the availability of the project website, citizen survey and stakeholder surveys via local homepage links, and other available public announcement methods (e.g., Facebook, Twitter, email blasts). Refer to Appendix D which highlights these local efforts.
- Residents within the Planning Area were provided opportunity to comment on the draft HMP before submittal to FEMA. The HMP was posted on the HMP public website on February 6, 2023 for review. All Planning Team participants were requested to assist with advertising the plan was posted via their websites and social media. Public comments received through February 20, 2023 were distributed to Planning Team for their consideration.
- Additional examples of public outreach efforts, and results of surveys distributed, are presented in Appendix D (Public and Stakeholder Outreach Documentation).

2.4.1 Public Survey Responses

Demographically, survey respondents were from the City of Horseshoe Bay, City of Llano, City of Richland Springs, City of San Saba, City of Sunrise Beach, Village of Buchanan Lake, among others. The majority of survey participants have lived in their house for over 10 years (63%) and own their house (90%). The most common (53%) age of respondents were over the age of 61; about 26.67% were in the age range of 51 to 60. Residents were asked the ways in which they receive their information concerning a natural disaster. The majority of respondents rely on social media (82.86%) and mass notification systems (74.29%) to receive information concerning natural disasters. Roughly three-quarters of respondents (71.43%) receive information through the internet and just about half (48.57%) receive information through radio news.

Survey respondents were asked how concerned they were about 17 different hazards, on a scale of not concerned to extremely concerned. Respondents were most concerned (reporting “concerned”, “very concerned”, or “extremely concerned”) about severe winter storms, extreme temperatures (hot/cold), drought, and severe weather.

About 91.43% of respondents’ properties are not located in the floodplain, with 8.57% within a floodplain. Of the respondents in the floodplain, 9.09% do not have flood insurance and 6.06% do have flood insurance. Of the residents whose properties are located outside of the floodplain, 14.71% have flood insure and 64.71% do not. Residents were then asked what types of projects they believe local, county, state, or federal government agencies could be doing in order to reduce the damage and disruption of disasters in the Planning Area including:

- (33.33%) Retrofit and strengthen essential facilities such as police, schools, and hospitals
- (53.33%) Retrofit infrastructure, such as elevating roadways and improving drainage systems
- (76.67%) Work on improving the damage resistance of utilities (electricity, communications, water/wastewater facilities etc.)
- (20.00%) Install or improve protective structures, such as floodwalls, levees, bulkheads, and firebreaks
- (36.67%) Enhance stream maintenance programs/projects
- (46.67%) Replace inadequate or vulnerable bridges and causeways
- (16.67%) Strengthen codes, ordinances and plans to require higher hazard risk management standards and/or provide greater control over development in high hazard areas
- (16.67%) Buyout flood prone properties and maintain as open space

- (46.67%) Inform property owners of ways they can mitigate damage to their properties
- (40.00%) Improve access to information about hazard risks and high-hazard areas
- (36.67%) Assist vulnerable property owners with securing funding to mitigate their properties
- (30.00%) Create a stream gage and weather monitoring program to provide more accurate data and warnings

2.5 Incorporation of Existing Plans, Studies, Reports, and Technical Information

The Llano and San Saba County HMAP strives to use the best available technical information, plans, studies, and reports throughout the plan process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development, and prioritization of county and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments is presented in the County Profile (Section 3). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, is presented in the Risk Assessment, specifically in Section 4.1 Methodology and Tools, as well as throughout the hazard profiles in Section 4.3 (Hazard Profiles). Further, the source of technical data and information used may be found within the References section.

Plans, reports, and other technical information were identified and provided directly by the Planning Team, and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. The Planning Team was tasked with updating the inventory of their Planning and Regulatory capabilities in Section 9 (Annexes) and providing relevant planning and regulatory documents, as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify the following:

- Existing local and regional capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the mitigation strategies.
- Mitigation-related goals or objectives considered in the review and update of the overall Goals and Objectives in Section 6 (Mitigation Strategy).
- Proposed, in-progress, or potential mitigation projects, actions, and initiatives to be incorporated into the updated County and local mitigation strategies.

The following local regulations, codes, ordinances, and plans were reviewed during this process to develop mitigation planning goals, objectives, and strategies that are consistent across local and regional planning and regulatory mechanisms to accomplish complementary and mutually supportive strategies:

- Master/Comprehensive Plans
- Building Codes
- Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Site Plan Requirements
- Stormwater Management Plans
- Emergency Management and Response Plans

- Land Use and Open Space Plans
- Capital Plans
- State of Texas Hazard Mitigation Plan (2018)
- San Saba County Hazard Mitigation Plan Update (2016)
- Llano County Hazard Mitigation Plan Update (2016)

2.6 Integration With Existing Planning Mechanisms and Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the Planning Area there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those mechanisms.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the Planning Area. Within each annex in Section 9, the Counties, Cities, and entities identified how they integrate hazard risk management into their existing planning, regulatory, and operational/administrative framework (integration capabilities) and how they intend to promote this integration (integration actions). In addition, as noted above, a summary of the plan reviews indicating relevant goals and mitigation actions is provided in Appendix E. This information provided input to identify integration of mitigation concepts into the operations of the Planning Area.

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7 (Plan Maintenance).

2.7 Continued Public Involvement

The Counties of Llano and San Saba are committed to the continued involvement of the public in the hazard mitigation process. This HMAP update will be made available for review on the HMAP public website. Each jurisdiction's elected official shall be responsible for receiving, tracking, and filing public comments regarding this HMAP update. Further details regarding continued public involvement are provided in Section 7 (Plan Maintenance).

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the annual plan evaluation meeting (refer to Section 7 – Plan Maintenance) and posted on the public website at <https://www.llanocountytxhmp.com/>.

The public will have an opportunity to comment on the HMAP update as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator (currently Cheryl Kepp, Llano County Grants Administrator) is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update as appropriate; however, members of the Planning Team will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the HMP.

After completion of this HMAP update, implementation and ongoing maintenance will continue to be a function of the Planning Team. The Planning Team will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan will be publicized annually after the HMP Committee's annual evaluation and posted on the public web site.

Llano County has identified the following as the ongoing HMP Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this HMP update. Contact information is:

Contact Name	Mailing Address	Email Address	Phone Number
Cheryl Kepp, Grant Administrator	801 Ford Street, Llano, Texas 78643	ckepp@co.llano.tx.us	325-247-7756
Gilbert Bennett, Emergency Management Coordinator	100 W Sandstone St, Ste 200A, Llano, Texas 78643	gbennett@co.llano.tx.us	325-247-2039

Section 3 County Profile

3.1 General Information

3.1.1 Llano County

The word “llano” means “plain” in Spanish. The City of Llano was founded in 1855 on the Llano River and Llano County was established in 1856. Much of the following section was summarized from the Handbook of Texas Online (Speck 2010).

The first settlers of the area were the Tonkawa Indians. European explorers arrived in the region in approximately 1535. Spanish explorer Alvar Nunez Cabeza de Vaca led an expedition to explore the region. The Tonkawa Indians were displaced by the Apache Indians and in turn the Apache were displaced by the Comanche Indians. Settlers did not arrive in this area until the mid-1800s; before this time, the area was known as the West Texas Frontier-Indian Territory. The first European settlers arrived in 1845 after a treaty with the Comanche Indians, which allowed for settlement. The last battle between the settlers and the Comanche Indians occurred in 1873. Once the threat of Indian attacks passed, the area attracted ranchers, shops, and industrial work.

Through the 1870s, the local town (which later became the City of Llano) acted as a frontier trading center, with a handful of log buildings that housed business establishments, a post office, and a few homes. During the 1880s, a number of new enterprises serving the County’s farmers and ranchers were established. In 1892, a fire destroyed the County Courthouse. The present courthouse was completed and occupied in 1893 and is listed in the National Register of Historic Places. Other historic buildings in Llano County include Badu Building, Red Top Jail, and Southern Hotel.

Iron deposits discovered at Iron Mountain, in the northwest portion of the County, attracted capital from Dallas and from northern states. Llano County experienced a boom between 1886 and 1893. The boom period faded because the County’s mineral resources didn’t exist in commercially exploitable concentrations. Farming, ranching, and the granite industry remained the foundations of the economy in the 20th century.

3.1.2 San Saba County

San Saba County was organized from Bexar County in 1856 and the majority of this section was summarized from the *Handbook of Texas Online* (Greene 1995). The County was named for the San Saba River. The Tonkawa, Apache, Caddoan, and Comanche Indian tribes inhabited the area at different times. Comanche and Lipan Apaches continued to live in the San Saba County area into the eighteenth and nineteenth centuries, often coming into conflict with Spanish missionaries, United States military forces, and Anglo-American settlers. The original surveys of present San Saba County indicate that the first land grants of a league each along the San Saba River were given to Spanish grantees. The earliest known record of Anglo-Americans in San Saba County was in December 1828 with a group from Austin’s colony. A part of the County was included in one of the grants ceded to Stephen F. Austin under the Mexican empresario system. Early permanent settlers settled at Wallace, Richland, and Cherokee Creeks in the fall of 1854. The present site of the City of San Saba was selected for the County seat. Chappel, settled during the 1850s, was San Saba County’s first town. During the Civil War, the citizens of San Saba County supported the Confederacy.



The years between 1860 and 1920 marked a period of growth for San Saba County. During the 1880s, lawlessness became a problem, and the County experienced a period of "mob rule." In response, citizens formed an anti-mob organization. However, factions developed within the organization, and by 1896, the competing groups were conducting what amounted to open warfare. After a number of men were killed, the Texas Rangers were dispatched to the area, and order was eventually restored. By 1920, the population was 10,045. During this period, agriculture in San Saba County flourished. The number of farms, cattle, and sheep grew. Wheat and oats originally emerged as primary crops and peaches were produced in significant numbers after 1900. Pecans, already in natural abundance, also emerged as an important crop, largely because of the work of Edmund E. Riesen. Riesen is credited for laying the groundwork for the pecan industry that led San Saba County to proclaim itself Pecan Capital of the World (San Saba County 2013).

Difficult agricultural conditions in the 1920s, followed by the Great Depression, affected farming in the County. Although the number of farms increased, the overall value decreased, when half of the County farms were worked by tenants. The record-breaking flood of the San Saba River in July 1938 caused destruction throughout the County. A prolonged drought from 1953 to 1956 did extensive harm to the agricultural economy. Between 1950 and 1959 the number of farms decreased to only 784.

The first newspaper in West Texas was the San Saba County News, which was founded on January 1, 1873. The paper continued operating into the twentieth century, and in 1960 it merged with the San Saba Star. It was still being published as the San Saba News and Star into the late 1980s.

In 1886, the Santa Fe Railroad completed a line that came within 21 miles of the Town of San Saba, but it was 25 years before railroad officials were convinced that San Saba's level of agricultural production merited the extension of the line to the County seat. Not until 1911 was the Lometa-Eden branch of the Santa Fe build across the County. The County's progress in the area of highway construction was equally slow; it was the last county in Texas to have its roads paved. In 1982, San Saba had one railroad branch line used for freight; 755 miles of public roads; and one airport, the San Saba County Municipal Airport.

The economy of San Saba County became more diversified in the late 1980s. The manufacturing base remained small, constituting only seven percent of the business sector. Sixteen percent of the labor force was employed in wholesale and retail trade, and almost twenty-five percent in agribusiness, forestry, fishing, or mining. The industries with the most employment were agribusiness, stone quarrying, and tourism. Tourism showed the highest rate of growth. The County has a variety of recreational opportunities and is a popular deer hunting area (JSW & Associates, Halff Associates, Tetra Tech 2016).

3.2 Major Past Hazard Events

Presidential disaster declarations are issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. No specific dollar loss threshold has been established for these declarations. A presidential disaster declaration puts operationalizes federal recovery programs to assist disaster victims, businesses, and public entities. Programs can be matched by state programs. Review of presidential disaster declarations helps establish the probability of reoccurrence for each hazard and identify targets for risk reduction. Table 3-1 shows FEMA disaster declarations that have included Llano County between 2001 and February 2021. Table 3-2 shows FEMA disaster declarations that have included San Saba County between 2001 and February 2021.



Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Still, many natural hazard events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern. More detailed event tables can be found in the individual hazard profile sections.

Table 3-1. History of Hazard Events in Llano County, Texas

Disaster Number	Declaration Date	Event Date	Incident Type	County Included	Title
DM-4586-TX	02/19/2021	02/11/2021-02/21/2021	Severe Winter Storm	Yes	Texas Severe Winter Storm
EM-3554-TX	02/14/2021	02/11/2021 - 02/21/2021	Severe Winter Storm	Yes	Texas Severe Winter Storm
DR-4485-TX	03/25/2020	01/20/2020 - Continuing	Pandemic	Yes	COVID-19 Pandemic
EM-3458-TX	03/13/2020	01/20/2020 - Continuing	Pandemic	Yes	COVID-19 Pandemic
DR-4416-TX	02/25/2019	09/10/2018 – 11/2/2018	Flood	Yes	Texas Severe Storms and Flooding
EM-3284-TX	03/14/2008	03/14/2008 – 09/01/2008	Wildfire	Yes	Texas Wildfires
DR-1709-TX	06/29/2007	06/16/2007 – 08/03/2007	Severe Weather	Yes	Texas Severe Storms, Tornadoes, and Flooding
DR-1624-TX	01/11/2006	11/27/2005 – 05/14/2006	Wildfire	Yes	Texas Extreme Wildfire Threat
DR-1606-TX	09/24/2005	09/23/2005 – 10/14/2005	Hurricane	Yes	Texas Hurricane Rita
EM-3261-TX	09/21/2005	09/20/2005 – 10/14/2005	Hurricane	Yes	Texas Hurricane Rita
EM-3216-TX	09/02/2005	08/29/2005 – 10/01/2005	Hurricane	Yes	Texas Hurricane Katrina

Source: FEMA 2022

Table 3-2. History of Hazard Events in San Saba County, Texas

Disaster Number	Declaration Date	Event Date	Incident Type	County Included	Title
DM-4586-TX	02/19/2021	02/11/2021-02/21/2021	Severe Winter Storm	Yes	Texas Severe Winter Storm
EM-3554-TX	02/14/2021	02/11/2021 - 02/21/2021	Severe Winter Storm	Yes	Texas Severe Winter Storm
DR-4485-TX	03/25/2020	01/20/2020 - Continuing	Pandemic	Yes	COVID-19 Pandemic
EM-3458-TX	03/13/2020	01/20/2020 - Continuing	Pandemic	Yes	COVID-19 Pandemic
DR-4416-TX	02/25/2019	09/10/2018 – 11/2/2018	Flood	Yes	Texas Severe Storms and Flooding
DR-1999-TX	07/01/2011	04/06/2011 – 08/29/2011	Wildfire	Yes	Texas Wildfires

Disaster Number	Declaration Date	Event Date	Incident Type	County Included	Title
EM-3284-TX	03/14/2008	03/14/2008 – 09/01/2008	Wildfire	Yes	Texas Wildfires
DR-1709-TX	06/29/2007	06/16/2007 – 08/03/2007	Severe Weather	Yes	Texas Severe Storms, Tornadoes, and Flooding
DR-1624-TX	01/11/2006	11/27/2005 – 05/14/2006	Wildfire	Yes	Texas Extreme Wildfire Threat
DR-1606-TX	09/24/2005	09/23/2005 – 10/14/2005	Hurricane	Yes	Texas Hurricane Rita
EM-3261-TX	09/21/2005	09/20/2005 – 10/14/2005	Hurricane	Yes	Texas Hurricane Rita
EM-3216-TX	09/02/2005	08/29/2005 – 10/01/2005	Hurricane	Yes	Texas Hurricane Katrina
DR-1425-TX	07/04/2002	06/29/2022 – 07/31/2022	Severe Weather	Yes	Texas Severe Storms and Flooding

Source: FEMA 2022

3.3 Physical Setting

This section presents the physical setting of the County, including land use/land cover, location, climate, hydrography and hydrology, topography, and geology.

3.3.1 Location

Llano County

Llano County covers approximately 966 square miles and is located in central Texas. The County was named for the Llano River, which crosses through the center of the County. The Llano River and the Colorado River (which flows along the eastern border of the County) contribute to Lake Buchanan, Inks Lake, and Lake Lyndon B. Johnson, which are all partially located within the County.

The City of Llano is the largest city and holds the County seat for Llano County. Other incorporated communities include Bluffton, Buchanan Dam, Castell, Click, Horseshoe Bay, Kingsland, Sunrise Beach Village, Tow, and Valley Spring. As of the 2020 US Census, Llano County had a population of 21,243, a 10.1-percent increase from the 2010 population (U.S. Census Bureau 2020). The County has one hospital, Scott and White Llano Hospital, located in the City of Llano.

Llano County is primarily rural and undeveloped land dedicated to ranching. Most of its economy comes from tourism, ranch trading centers, and vineyards. Llano County is a leading deer-hunting county in Texas, which results in most of the County's tourism. Other tourist attractions include Enchanted Rock, the Bluebonnet Festival, and the Hill Country Wine Trail. The County is also a popular place for retirement (Llano County HMP 2016).

San Saba County

San Saba County covers 1,138 square miles of which all is land except for 3 square miles of water. It is located on the Edwards Plateau in the central part of Texas. The San Saba River bisects the County from southwest to northeast and joins the Colorado River on the eastern border. The San Saba River is a typical Hill Country river consisting of clear water that flows through limestone bluffs and hills. Primary streams include Richland, Wallace, Simpson, Rough, Wilbarger, Brady, and Cherokee Creeks. The City of San Saba is the largest city and holds the



County seat for San Saba County. As of the 2010 U.S. Census, San Saba County had a population of 6,131. The County does not have any hospitals.

The major livestock are beef cattle, sheep, and goats. Many ranchers lease their ranches for deer hunting. The main crops are grain sorghum, small grains, and improved pasture. Pecans are produced in native groves mostly along the Colorado and San Saba Rivers. Soil and water are important natural resources in the County. Most people earn their living from the land and the Colorado and San Saba Rivers provide water for livestock and irrigation.

Limestone, sand, and gravel are other natural resources in the County. Limestone is used as building material and some is crushed for roadbed material (JSW & Associates, Halff Associates, Tetra Tech 2016).

3.3.2 Topography and Geology

Llano County

Texas is broadly divided into four regions by physical geography features such as landforms, climate, and vegetation. Llano County lies entirely in the Llano Basin which is located near the center of Texas. It forms an egg-shaped area south of the North Central Plains and east of the Balcones Escarpment. The terrain can be described as rolling and hilly. The Llano Basin is made up of granite, an extremely hard rock that is formed when molten rock cools slowly under the earth's surface.

Llano County has an incredibly unique geology. Llanite is a rare type of brown rhyolite porphyry with sky blue quartz crystals and rusty-pink microcline feldspar that is found only in Llano County. There are five primary types of bedrock within the County. They are granite, gneiss, schist, limestone, and sandstone. The age of the bedrock ranges from Precambrian (1.3 billion years old) to Ordovician (425 million years old). Llano County has several granite quarries; vermiculite and marble are also mined. The pink granite used to build the State of Texas Capitol building in Austin came from the Llano Basin. Enchanted Rock, a designated state natural area and popular tourist destination, is located in southern Llano County (Llano County HMP, 2016).

The soils of Llano County range from sandy-to-sandy loam. The elevation of this subregion ranges between 800 and 2,000 feet above sea level. Precipitation averages about 28 inches per year, and the growing season lasts about 230 days. The vegetation is made up of mesquite, live oak, and post oak trees, and short grasses. Pecan and oak trees often grow in low areas and along streams. Llano County is within the Llano and Buchanan-Lyndon watersheds and the County is bisected from west to east by the Llano River. The other significant river is the Colorado River. Figure 67 shows the Texas natural regions with Llano County highlighted (Llano County HMP, 2016).

San Saba County

Texas is broadly divided into four regions by physical geography features such as landforms, climate, and vegetation. San Saba County is in central Texas. The County is roughly triangular. In most areas, the topography is undulating to hilly and generally slopes to the southeast. The elevation ranges from 1,100 to 1,800 feet above sea level (JSW & Associates, Halff Associates, Tetra Tech 2016). It lies in three major land resource areas. The majority of the County is within the Edwards Plateau, with remaining portions in the North Central Plains and a sliver in the Texas Central Basin.

The soils in much of the Southern part of San Saba County are within the Edwards Plateau, which formed on mesas and plateaus of erosion-resistant limestone containing canyons, limestone ridges and hills, and gently sloping

valley floors. The Tarrant, Lozier, Ector, Langtry, Brackett, Eckrant, and Real soils are shallow to limestone and differ in texture, mineralogy, and organic matter content.

The North Central Plains soils of San Saba County, located in the Northern half of the County, formed on a dissected plateau with narrow, steep-sided valleys carved by generally southeastward flowing streams. The sedimentary rocks that make up the region are of the Pennsylvanian age and include sandstone, siltstone, or claystone, which occur on gently sloping to steep, broad ridges and plains.

The small portion of Southwestern San Saba County which exists in the Texas Central Basin has soils that formed on an erosional surface of outcropping Precambrian igneous and metamorphic rocks and sedimentary rocks of Cambrian and Cretaceous age. The landscape is dominated by hills of granite, gneiss, and schist that are incised by southeastward-flowing rivers. Shallow Keese soils formed over granite and gneiss on gently sloping to steep hillslopes. Moderately deep Ligon soils formed in schist and gneiss on gently sloping, broad, convex ridges (USDA, NRCS 2008).

3.3.3 Hydrography and Hydrology

Llano County

The dominant water body in Llano County is the Colorado River which forms the County's eastern border and flows north to south. Lake Buchanan, Inks Lake, and Lake Lyndon B. Johnson are found along the river. Numerous creeks and rivers flow into the Colorado River, generally flowing west to east. Llano County is comprised of three HUC-8 sub-basins:

- The Austin Travis-Lakes drains 1240.8 square miles. The primary flooding source is the Colorado River.
- The Buchanan-Lyndon B. Johnson Lakes drains 1270.0 square miles. The primary flooding source is the Colorado River.
- The Llano basin drains 2,613.4 square miles. The primary flooding source is the Llano River (FEMA 2021).

San Saba County

The dominant water body in San Saba County is the Colorado River which forms the County's northeastern border and flows northwest to southeast. The San Saba watershed is the dominant watershed in the County, draining the center of the County to the southwestern border of the County (SNOFLO 2022).

3.3.4 Climate

Llano County

Llano County has a humid, subtropical climate, with hot summer days and generally mild winters. Temperatures range from 84°F in the summer to 46°F in the winter. The Southern Regional Climate Center reports data from the City of Llano weather station in Llano County.

Precipitation is highest during June, July, and August. The average annual precipitation is 26.79 inches. Severe thunderstorms occur mostly in the spring. Llano County received 6,221 cloud-to-ground lightning strikes and 34,843 cloud-to-cloud lightning strikes in 2019 (Earth Networks 2020).

San Saba County

San Saba County is hot in summer but cool in winter when an occasional surge of cold air causes a sharp drop in otherwise mild temperatures. Average temperatures range from 95.8 degrees Fahrenheit (°F) in the summer to

33.9°F in the winter. The Western Regional Climate Center reports data from the City of San Saba weather station in San Saba County.

Rainfall is uniformly distributed throughout the year, reaching a slight peak in spring. Snowfalls are infrequent. Precipitation is highest in May. The average annual precipitation is 26.92 inches. Severe thunderstorms occur mostly in the spring (Western Regional Climate Center 2022). According to the Earth Network’s 2020 US Lightning Report, Texas is the state with the most lightning in 2020. Texas also led the United States in 2020 for the total number of lightning pulses (63,683,799), which includes cloud-to-cloud and cloud-to-ground lightning pulses, and total thunder days (278) (Earth Networks 2020). San Saba County received 7,589 cloud-to-ground lightning strikes and 37,592 cloud-to-cloud lightning strikes in 2019 (Earth Networks 2020).

3.3.5 Land Use and Land Cover

Llano County

Table 3-3. Land Use Breakdowns for Llano County

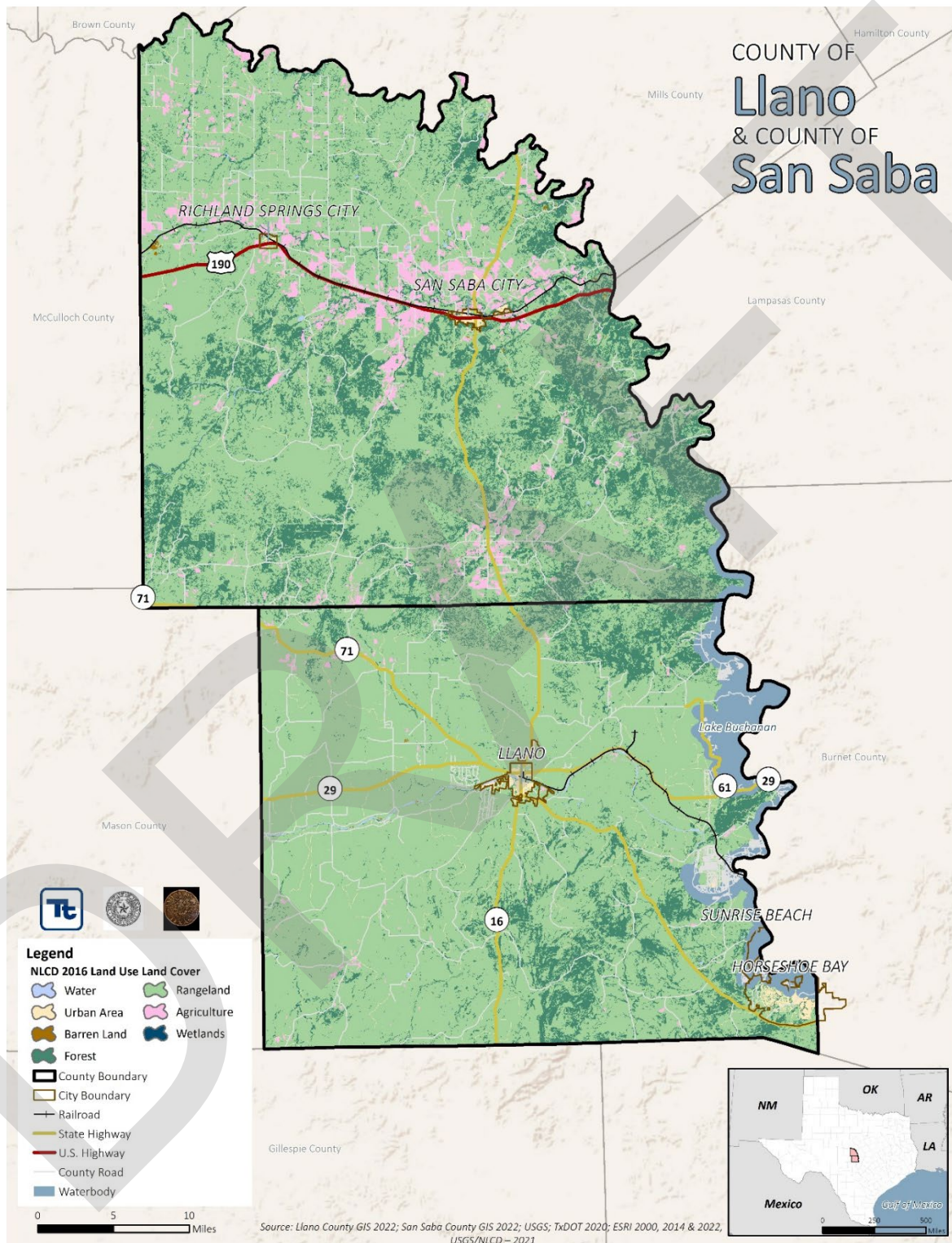
Land Use Category	2011 Data		2016 Data		2019 Data	
	Acreage	Percent of County	Acreage	Percent of County	Acreage	Percent of County

San Saba County

Table 3-4. Land Use Breakdowns for San Saba County

Land Use Category	2011 Data		2016 Data		2019 Data	
	Acreage	Percent of County	Acreage	Percent of County	Acreage	Percent of County

Figure 3-1. Land Use in Llano County, Texas and San Saba County, Texas



3.4 Population and Demographics

Llano County

According to the 2020 Decennial Census, Llano County had a population of 21,243 people which represents an increase from the 2010 U.S. Census population of 19,301 people. Table 3-5 presents the population statistics for Llano County based on the 2020 U.S. Census data.

Table 3-5. Recent Population by Jurisdiction in Llano County

Llano Jurisdiction	Population (2020 Decennial)	
	Total	Percent of County Total
Horseshoe Bay (C)	4,257	20.0%
Sunrise Beach (C)	739	3.5%
Llano (C)	3,325	15.7%
Unincorporated Llano County	12,922	60.8%
Llano County (Total)	21,243	100.0%

Source: U.S. Census 2020

Notes: (C) = City

San Saba County

According to the 2020 Decennial Census, San Saba County had a population of 5,730 people which represents a decrease from the 2010 U.S. Census population of 6,131 people. Table 3-6 presents the population statistics for San Saba County based on the 2020 U.S. Census data.

Table 3-6. Recent Population by Jurisdiction in San Saba County

San Saba Jurisdiction	Population (2020 Decennial)	
	Total	Percent of County Total
Richland Springs (T)	244	4.3%
San Saba (C)	3,117	54.4%
Unincorporated San Saba County	2,369	41.3%
San Saba County (Total)	5,730	100.0%

Source: U.S. Census 2020

Notes: (C) = City

3.4.1 Population and Demographic Trends

This section discusses population trends to use as a basis for estimating future changes that could result from the seasonal character of the population and significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to consider and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

Llano County

According to the U.S. Census Bureau, the 2010 population for Llano County was 19,301 persons, which is a 13.2-percent increase from the 2000 Census population of 17,044. Over the last 50 years, from 1970 to 2020, the

County has seen notable population growth. The largest increase in absolute terms and in percentage was between 1990 and 2000.

Table 3-7. Llano County Population Trends, 1970 to 2020

Year	Population	Change in Population	Percent (%) Population Change
2020	21,243	1,942	10.1
2010	19,301	2,257	13.2
2000	17,044	5,360	46.2
1990	11,684	1,561	15.4
1980	10,123	3,144	45.0
1970	6,979	-	-

Source: Texas Demographic Center n.d.

The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050 (Texas Demographic Center n.d.).

San Saba County

According to the U.S. Census Bureau, the 2010 population for San Saba County was 6,131 persons, which is a 0.89-percent decrease from the 2000 Census population of 6,186. Over the last 50 years, from 1970 to 2020, the County has seen relatively stable population. In fact, the population in 1970 was 5,540 persons, only 190 persons fewer than the 5,730 persons in San Saba County today – a 6.6-percent change in population.

Table 3-8. San Saba County Population Trends, 1970 to 2020

Year	Population	Change in Population	Percent (%) Population Change
2020	5,730	401	-6.6
2010	6,131	55	-0.89
2000	6,186	808	15.02
1990	5,378	451	7.7
1980	5,829	289	5.2
1970	5,540	-	-

Source: Texas Demographic Center n.d.

The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show projected decline between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

3.4.2 Vulnerable Populations

DMA 2000 requires that HMPs consider socially vulnerable populations. These populations can be more susceptible to hazard events, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For the purposes of this study, vulnerable populations shall include (1) the elderly (persons aged 65 and over) and (2) those living in low-income households.

It is noted that the Census data for household income provided in HAZUS includes two ranges (\$0-10,000 and \$10,000-\$20,000/year) that were totaled to provide the “low-income” data used in this study. This does not correspond exactly with the “poverty” thresholds established by the 2019 U.S. Census Bureau, which identifies households with three adults and no children with an annual household income below \$19,998 per year, or households with two adults and one child with an annual household income below \$17,622 per year as “low income” for this region. This difference is not believed to be significant for the purposes of this planning effort.

Llano County

The 2020 American Community Survey data identified approximately 1,612 people in Llano County living below the poverty line. This represents nearly 7.6 percent of the population. Though this is a decrease from 2,661 in 2012, the proportion of individuals in poverty has declined by 39.4-percent since 2012.



Table 3-9. Llano County Vulnerable Population Statistics

Llano Jurisdiction	Population (2020 Decennial)		American Community 5-year Estimates 2020 Population									
	Total	Percent of County Total	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking Households	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Horseshoe Bay (C)	4,257	20.0%	2,221	52.2%	93	2.2%	0	0.0%	928	21.8%	156	3.7%
Sunrise Beach (C)	739	3.5%	383	51.8%	16	2.2%	0	0.0%	176	23.8%	30	4.1%
Llano (C)	3,325	15.7%	691	20.8%	314	9.4%	12	0.4%	719	21.6%	531	16.0%
Unincorporated Llano County	12,922	60.8%	4,680	36.2%	414	3.2%	56	0.4%	3,490	27.0%	895	6.9%
Llano County (Total)	21,243	100.0%	7,975	37.5%	837	3.9%	68	0.3%	5,313	25.0%	1,612	7.6%

Source: U.S. Census 2020

Notes: (C) = City

San Saba County

The 2020 American Community Survey data identified approximately 714 people in San Saba County living below the poverty line. This represents nearly 12.5 percent of the population and decrease from 1,032 persons in 2012; the proportion of individuals in poverty has declined by approximately 31-percent since 2012.

Table 3-10. San Saba County Vulnerable Population Statistics

San Saba Jurisdiction	Population (2020 Decennial)		American Community 5-year Estimates 2020 Population									
	Total	Percent of County Total	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking Households	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Richland Springs (T)	244	4.3%	62	0.0%	14	0.0%	0	0.0%	58	0.0%	41	0.0%
San Saba (C)	3,117	54.4%	588	18.9%	191	6.1%	86	2.8%	405	13.0%	510	16.4%
Unincorporated San Saba County	2,369	41.3%	757	0.0%	107	0.0%	9	0.0%	519	0.0%	163	0.0%
San Saba County (Total)	5,730	100.0%	1,407	10.3%	312	3.3%	95	1.5%	982	7.1%	714	8.9%

Data Sources: Census 2020

Notes: (C) = City, (T) = Town



Income

Llano County

The 2020 American Community Survey 5-Year Estimates provides that the median household income in Llano County was \$58,941. The U.S. Census Bureau identifies households with two adults and one child with an annual household income below \$17,622 per year as *low income* (U. S. Census 2021). The 2020 American Community Survey 5-Year Estimates indicates that nearly 7.6 percent of persons are below the poverty level within the County.

San Saba County

The 2020 American Community Survey 5-Year Estimates provides that the median household income in San Saba County was \$45,169. The U.S. Census Bureau identifies households with two adults and one child with an annual household income below \$17,622 per year as *low income* (U. S. Census 2021). The 2020 American Community Survey 5-Year Estimates indicates that nearly 12.5 percent of persons are below the poverty level within the County.

Physically or Mentally Disabled

Llano County

According to the Centers for Disease Control, “A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions) (CDC 2020).” Cognitive impairments can increase the level of difficulty that individuals might face during an emergency and reduce an individual’s capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability can face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2020 American Community Survey, 5,313 persons or 25 percent of residents in Llano County are living with a disability.

San Saba County

According to the Centers for Disease Control, “A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions) (CDC 2020).” Cognitive impairments can increase the level of difficulty that individuals might face during an emergency and reduce an individual’s capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability can face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2020 American Community Survey, 982 persons or approximately 17 percent of residents in San Saba County are living with a disability.

Non-English Speakers

Llano County

Individuals who are not fluent or working proficiency in English are vulnerable because they can have difficulty with understanding information being conveyed to them. Cultural differences also can add complexity to how information is being conveyed to populations with limited proficiency of English (CDC 2021). According to the 2020 American Community Survey, 6.6-percent of the County’s population over the age of 5 primarily speaks a language other than English at home. Approximately, 1.5-percent of the population over the age of 5 speaks limited English.

San Saba County

Individuals who are not fluent or working proficiency in English are vulnerable because they can have difficulty with understanding information being conveyed to them. Cultural differences also can add complexity to how information is being conveyed to populations with limited proficiency of English (CDC 2021). According to the 2020 American Community Survey, 20-percent of the County's population over the age of 5 primarily speaks a language other than English at home. Approximately, 7.2-percent of the population over the age of 5 speaks limited English.

3.4.3 General Building Stock

Llano County

For this Plan, the default general building stock in Hazus v5.1 was used to develop the general building stock inventory for Llano and San Saba Counties at the aggregate level, incorporating 2010 Census data with 2018 RS Means replacement cost values. For the purposes of this plan, there are approximately 13,604 structures identified through Census data. These structures account for a replacement cost value of approximately \$4.2 billion (structure and contents). Table 3-11 presents building and improvement values in the County.

Table 3-11. Number of Buildings and Improvement Value in Llano County

Jurisdiction	Count	All Occupancies Total Replacement Cost Value (Structure + Contents)
Horseshoe Bay (C)	2,174	\$921,317,000
Sunrise Beach (C)	909	\$345,382,000
Llano (C)	1,733	\$564,332,000
Unincorporated Llano County	8,788	\$2,408,418,000
Llano County (Total)	13,604	\$4,239,449,000

Data Sources: Census 2010, Census 2020

Notes: (C) = City, (T) = Town, (V) = Village

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or under estimated.

San Saba County

For this Plan, the default general building stock in Hazus v5.1 was used to develop the general building stock inventory for Llano and San Saba Counties at the aggregate level, incorporating 2010 Census data with 2018 RS Means replacement cost values. For the purposes of this plan, there are approximately 3,343 structures identified through Census data. These structures account for a replacement cost value of approximately \$957.5 million (structure and contents). Table 3-12 presents building and improvement values in the County.

Table 3-12. Number of Buildings and Improvement Value in San Saba County

Jurisdiction	Count	All Occupancies Total Replacement Cost Value (Structure + Contents)
Richland Springs (T)	213	\$66,306,000
San Saba (C)	1,311	\$410,811,000
Unincorporated San Saba County	1,819	\$480,386,000
San Saba County (Total)	3,343	\$957,503,000

Data Sources: Census 2010, Census 2020

Notes: (C) = City, (T) = Town, (V) = Village



This Hazard Mitigation Plan provides a general overview of population, land use, and types of development occurring within the study areas. An understanding of these development trends can assist in planning for further development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

3.4.4 Land Use Trends

Llano County

While Llano County does not have a comprehensive plan to cite land use trends, patterns emerge from the statistics in this plan. **The amount of urban land has been increasing over the past decade, while the amount of barren land, forest land, and wetland has decreased.** While the number of farms has increased significantly, the workforce in the County is predominantly in the accommodation and food services sectors. The aging population is also a trend that may impact land use in the County.

Economy

The U.S. Census Bureau's Economic Census provides an annual series of sub-national economic data by industry covering the majority of the country's economic activity. According to the 2020 Llano County Economic Census, the retail trade sector has the largest number of establishments, while the accommodation and food services sector has the largest number of employees. The accommodation and food services sector comprises the highest payroll.

Table 3-13. 2017 Economic Census for Llano County, Texas

Sector	Number of Establishments	Number of employees	Annual payroll (\$1,000)
Utilities	D	20-99	D
Manufacturing	16	63	3,720
Wholesale trade	13	217	10,217
Retail trade	67	597	14,876
Transportation and warehousing	5	21	789
Information	7	16	482
Finance and insurance	30	165	7,744
Real estate and rental and leasing	22	62	1,712
Professional, scientific, and technical services	39	147	6,042
Professional, scientific, and technical services (establishments subject to federal income tax)	39	147	6,042
Administrative and support and waste management and remediation services	22	101	3,357
Educational services	D	0-19	D
Educational services (establishments subject to federal income tax)	D	0-19	D
Educational services (establishments exempt from federal income tax)	-	-	-
Health care and social assistance	49	624	21,154
Health care and social assistance (establishments subject to federal income tax)	37	392	11,101

Sector	Number of Establishments	Number of employees	Annual payroll (\$1,000)
Health care and social assistance (establishments exempt from federal income tax)	12	232	10,053
Arts, entertainment, and recreation	6	41	1,184
Arts, entertainment, and recreation (establishments subject to federal income tax)	D	20-99	D
Arts, entertainment, and recreation (establishments exempt from federal income tax)	-	-	-
Accommodation and food services	48	1,145	28,069
Other services (except public administration)	25	84	2,234
Other services (except public administration) (establishments subject to federal income tax)	18	70	1,845
Other services (except public administration) (establishments exempt from federal income tax)	7	14	389
Total (does not include withheld data or range of numbers)	462	4,138	131,010

Source: U.S. Census, Economic Census 2017

D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals.

Agriculture

Farmland plays a smaller role in Llano County than in does in many other counties in Texas. The US Department of Agriculture produces a Census of Agriculture that tracks agricultural data on the County level. In Llano County, the number of farms has increased by 13-percent since 2012, while the acreage of farms has decreased only 1-percent during the same time to just over 523,000 acres of land for farming. Cattle, calves, hay, grains, sheep, goats, and layers make up the main sales for farms in the County. Llano County's agriculture products generate more than \$15.7 million in sales each year, but farms operate at a net loss (USDA 2017).

Corridors and Gateways

The majority of corridors in Llano County are State Highways, including State Highways 16, 29, 71, and 261; other main roads include "Farm-to-Market" or "Ranch-to-Market" roads RM-152, RM-2241, and RM-2323, which are State or County roads that connect rural or agricultural areas to nearby market towns. State Highway 16 is a North-South corridor which is located through the center of Llano County; this State Highway extends from the Texas-Mexico border, through Llano City, and up to Wichita Falls. State Highway 29 is another Texas DoT maintained highway that extends West-to-East from Menard County, through Llano City, and to Circleville in Williamson County. State Highway 71, an East-West highway, spans 253 miles, entering Llano County near Field Creek and exiting to the Southeast, just below Horseshoe Bay. State Highway 261 borders Lake Buchanan in Llano County, beginning at the bend just after Bluffton and continuing around the lake until merging with State Highway 29 at Buchanan Dam. RM-152 is a Ranch-to-Market road, running from Llano City in the East until it intersects US Highway 87 to the West in Mason County. RM-2241, a Ranch-to-Market road, begins just outside of Llano City off of State Highway 29. RM-2241 continues Northwest through Lone Grove and Bluffton up to Tow. RM-2323, also a Ranch-to-Market road, begins South of Llano City off of State Highway 16, and continues Southwest into Gillespie County until it intersects with US Highway 87.

San Saba County

While San Saba County does not have a comprehensive plan to cite land use trends, patterns emerge from the statistics in this plan. **The amount of urban land has been increasing over the past decade, while the amount of**



barren land, forest land, and wetland has decreased. While the amount of agricultural land has increased slightly, the workforce in the County is predominantly in the retail, accommodations and food services, and healthcare sectors. The aging population is also a trend that may impact land use in the County.

Economy

The U.S. Census Bureau's Economic Census provides an annual series of sub-national economic data by industry covering the majority of the country's economic activity. According to the 2017 San Saba County Economic Census, the retail sector has the largest number of establishments, while the accommodation and food services sector has the largest number of employees. The healthcare and social assistance industry comprises the highest payroll.

Table 3-14. 2017 Economic Census for San Saba County, Texas

Sector	Number of Establishments	Number of employees	Annual payroll (\$1,000)
Utilities	-	-	-
Manufacturing	9	41	1,864
Wholesale trade	8	46	2,109
Retail trade	32	158	3,476
Transportation and warehousing	11	36	1,526
Information	-	-	-
Finance and insurance	5	27	1,277
Real estate and rental and leasing	-	-	-
Professional, scientific, and technical services	11	32	978
Professional, scientific, and technical services (establishments subject to federal income tax)	11	32	978
Administrative and support and waste management and remediation services	3	12	348
Educational services	-	-	-
Educational services (establishments subject to federal income tax)	-	-	-
Educational services (establishments exempt from federal income tax)	-	-	-
Health care and social assistance	12	126	4,123
Health care and social assistance (establishments subject to federal income tax)	6	20-99	D
Health care and social assistance (establishments exempt from federal income tax)	6	20-99	D
Arts, entertainment, and recreation	-	-	-
Arts, entertainment, and recreation (establishments subject to federal income tax)	-	-	-
Arts, entertainment, and recreation (establishments exempt from federal income tax)	-	-	-
Accommodation and food services	D	100-249	D
Other services (except public administration)	D	20-99	D
Other services (except public administration) (establishments subject to federal income tax)	7	19	451

Sector	Number of Establishments	Number of employees	Annual payroll (\$1,000)
Other services (except public administration) (establishments exempt from federal income tax)	-	-	-
Total (does not include withheld data or range of numbers)	121	529	17,130

Source: U.S. Census, Economic Census 2017

D = Withheld to avoid disclosing data for individual companies; data are included in higher level totals.

Agriculture

Farmland plays a smaller role in San Saba County than in does in many other counties in Texas. The US Department of Agriculture produces a Census of Agriculture that tracks agricultural data on the County level. In San Saba County, the number of farms has increased by 4-percent since 2012 but the acreage of farms has decreased 2-percent during the same time to just over 660,000 acres of land for farming. Cattle, calves, sheep, goats, fruits, tree nuts, berries, grain, oilseeds, dry beans, and dry peas make up the main sales for farms in the County. San Saba County's agriculture products generate more than \$35.8 million in sales each year (USDA 2017).

Corridors and Gateways

The majority of corridors in San Saba County are "Farm-to-Market" or "Ranch-to-Market" roads, which are State or County roads that connect rural or agricultural areas to nearby market towns. FM-500 is a Texas Department of Transportation (DoT) maintained roadway that runs North-to-South from FM-45 just outside of Skeeterville to San Saba City. RM-501 is another Texas DoT maintained highway that extends from State Highway 71 in Pontotoc, Mason County to FM-850 near Bend, San Saba County. FM-45, a county road in the Northwest corner of the County, connects Richland Springs, San Saba County from US-190 to US-377 in Brownwood, Brown County. State Highway 16 is a North-South corridor which is located through the eastern portion of San Saba County; this State Highway extends from the Texas-Mexico border, through San Saba City, and up to Wichita Falls. US-190 begins in Louisiana and continues to Western Texas, passing directly through San Saba County.

3.4.5 Population Trends

Llano County

Llano County has grown significantly in recent years. Between 2010 and 2020 alone, the estimated population has increased from 19,301 residents to 21,243 residents, a 10.1 percent increase. The County has grown steadily since 1970, adding between 10 and 16 percent to its population every decade, with a few years of larger percentages of growth, such as 45 percent from 1970 to 1980 and 46.2 percent from 1990 to 2000. The County's median age increased from 32.5 years in 2000 to 38.7 years in 2020.

As the County has grown, it has also aged and change composition. In 2000, those 65+ years of age represented the plurality of residents. As of 2020, those 65+ years of age represent the plurality. Whereas the population share of those aged 5 to 19 years has remained relatively constant, the share of residents between the ages of 35 and 49 years has increased from 12.5 percent to 18 percent during the same time. The County has also diversified racially and ethnically, with the share of Hispanic/Latino residents increasing by 6.2 percent from 2000 to 2020 (USA Facts 2022).

San Saba County

San Saba County has had rotating increases and decreases in population throughout the years but has remained mostly stagnant in its growth since 1970. The 1980 Census has the population estimate at 5,829, an increase of



5.2 percent, followed by a 7.7 percent decrease from 1980 to 1990. The year 2000 saw a Census estimated population of 6,186, a 16.5 percent increase from 1990's population estimate of 5,578. However, between 2010 and 2020, the estimated population decreased from 6,131 residents to 5,730 residents, a 6.6 percent decrease. Despite these incremental changes, the overall population change from 1970 to 2020 is just 3.4 percent, or an increase of about 190 persons. The County's median age increased from 39.4 years in 2000 to 42.4 years in 2020.

As the County has grown, it has also aged and change composition. In 2000, those between the ages of 5 and 19 years old represented the plurality of residents. As of 2020, those 65+ years of age represent the plurality. Whereas the population share of those between 0 to 4 and 50 to 64 have remained relatively constant, the share of residents between the ages of 20 to 34 years has increased from 12.4 percent to 21.4 percent during the same time. The County has also diversified racially and ethnically, with the share of Hispanic/Latino residents increasing by 9.8 percent from 2000 to 2020 (USA Facts 2022).

3.4.6 Future Growth and Development

Llano County

The municipal Planning Partners have adopted plans that govern land use decision and policy making in their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the planning area.

It is the goal that all municipal Planning Partners will incorporate this hazard mitigation plan update in their comprehensive plans (if applicable) by reference. This will help ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. None of the Planning Partners has formally tracked the impacts of changes in development over the last five years and how these changes in development were influenced by the risk associated with natural hazards in the County or the communities. As part of this hazard mitigation plan update, Llano County and the Cities of Horseshoe Bay, Llano, and Sunrise Beach Village are now equipped with the knowledge and the tools to track and implement changes to the plan during their annual reviews and 5-year updates to reflect development changes. However, it should be noted that the mitigation actions developed and prioritized through the mitigation action ranking process reflect the current development conditions and applicable policies (JSW & Associates, Halff Associates, Tetra Tech 2016).

San Saba County

The municipal Planning Partners have adopted plans that govern land use decision and policy making in their jurisdictions. Decisions on land use will be governed by these programs. This plan will work together with these programs to support wise land use in the future by providing vital information on the risk associated with natural hazards in the planning area.

It is the goal that all municipal Planning Partners will incorporate this hazard mitigation plan update in their comprehensive plans (if applicable) by reference. This will help ensure that future development trends can be established with the benefits of the information on risk and vulnerability to natural hazards identified in this plan. San Saba County consists primarily of agricultural land, forest land, and grassland/prairie (JSW & Associates, Halff Associates, Tetra Tech 2016).

3.5 Lifelines and Critical Facilities

Critical infrastructure and facilities are those that are essential to the health and welfare of the population. These facilities are especially important after any hazard event. Critical facilities are those that maintain essential and emergency functions and are typically defined to include police and fire stations, schools, and emergency operations centers. Critical infrastructure can include the roads and bridges that provide ingress and egress and allow emergency vehicles access to those in need and the utilities that provide water, electricity, and communication services to the community. Also included are Tier II facilities (hazardous materials) and rail yards; rail lines hold or carry significant amounts of hazardous materials with a potential to impact public health and welfare in a hazard event.

Beginning in 2017, FEMA developed a new construct to increase effectiveness for disaster operations and position response to catastrophic incidents. This construct, known as “community lifelines”, represents the most fundamental services in the community that, when stabilized, enable all other aspects of society. Following a disaster event, intervention is required to stabilize community lifelines. Lifelines are divided into seven categories which include:

- Safety and Security
- Food, Water, Shelter
- Health and Medical
- Energy (Power and Fuel)
- Communications
- Transportation
- Hazardous Materials

To facilitate consistency with the National Response Framework, FEMA Strategic Plan, and guidance for the Building Resilient Infrastructure and Communities grant program, critical facilities in Llano and San Saba Counties are discussed in terms of lifelines.

A comprehensive inventory of critical facilities and lifelines in Llano and San Saba Counties was developed from various sources including input from the Steering Committee and Planning Partnership. The inventory of critical facilities presented in this section represents the current state of this effort at the time of publication of the HMP and was used for the risk assessment in Section 4 (Risk Assessment). Table 3-15 summarizes the number of critical facilities, by category, in Llano County. Table 3-16 summarizes the number of community lifelines, by category, in Llano County. Table 3-17 summarizes the number of critical facilities, by category, in San Saba County. Table 3-18 summarizes the number of community lifelines, by category, in San Saba County.

Critical Facilities are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous material facilities, and essential facilities

Essential facilities are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the County risk assessments, this category was defined to include police, fire, EMS, schools/colleges, shelters, senior facilities, and medical facilities.

Lifelines enable the continuous operation of critical business and government functions and are essential to human health and safety or economic security.

Table 3-15. Critical Facilities in the Planning Area, Llano County

Facility Type	City of Horseshoe Bay	City of Llano	City of Sunrise Beach	Unincorporated or Other	Total
Airport	0	1	0	0	1
Airport Runway	0	1	0	0	1
Bridge (Highway)	0	11	2	146	159
Bridge (Railway)	0	1	0	15	16
Child Care Facility	0	2	0	4	6
Church	0	1	0	1	2
City Hall	0	1	1	1	3
Communication Facility	0	3	0	2	5
Courthouse	0	0	0	1	1
Dam	0	2	0	10	12
DOT	0	0	0	1	1
Electric Power Facility	0	0	0	1	1
Electric Substation	0	1	1	2	4
EOC	0	1	0	1	2
Fire Station	0	1	1	5	7
Gas Facility	0	9	0	14	23
Government Facility	0	0	0	1	1
Grocery Store	0	5	0	3	8
Hazardous Material Facility	0	1	0	6	7
Medical Care	0	9	0	5	14
Police Station	0	1	1	4	6
Potable Water Facility	0	0	1	0	1
Potable Water Treatment Plant	0	0	0	1	1
Primary Education Facility	0	2	0	1	3
Secondary Education Facility	0	2	0	0	2
Wastewater Lift Station	0	0	0	2	2
Wastewater Treatment Plant	0	0	0	4	4
Total	0	55	7	231	293

Source: Llano County GIS 2022, Hazus v5.1, Texas A&M 2022

Table 3-16. Community Lifelines in the Planning Area, Llano County

Facility Type	City of Horseshoe Bay	City of Llano	City of Sunrise Beach	Unincorporated or Other	Total
Communication	0	4	0	2	6
Energy	0	10	1	17	28

Facility Type	City of Horseshoe Bay	City of Llano	City of Sunrise Beach	Unincorporated or Other	Total
Food, Water, Shelter	0	6	1	11	18
Hazardous Materials	0	1	0	6	7
Health and Medical	0	9	0	5	14
Safety and Security	0	10	3	25	38
Transportation	0	13	2	161	176
Total	0	53	7	227	287

Source: Llano County GIS 2022, Hazus v5.1, Texas A&M 2022

Table 3-17. Critical Facilities in the Planning Area, San Saba County

Facility Type	Town of Richland Springs	City of San Saba	Unincorporated or Other	Total
Airport	0	1	0	1
Bridge (Highway)	1	1	92	94
Bridge (Railway)	0	1	15	16
Communication Facility	0	2	0	2
EOC	0	1	0	1
Fire Station	1	1	2	4
Government Facility	1	0	1	2
Police Station	0	2	0	2
Primary Education Facility	0	2	0	2
Secondary Education Facility	1	1	2	4
Wastewater Treatment Plant	1	0	1	2
Total	5	12	113	130

Source: Llano County GIS 2022, Hazus v5.1, Texas A&M 2022

Table 3-18. Community Lifelines in the Planning Area, San Saba County

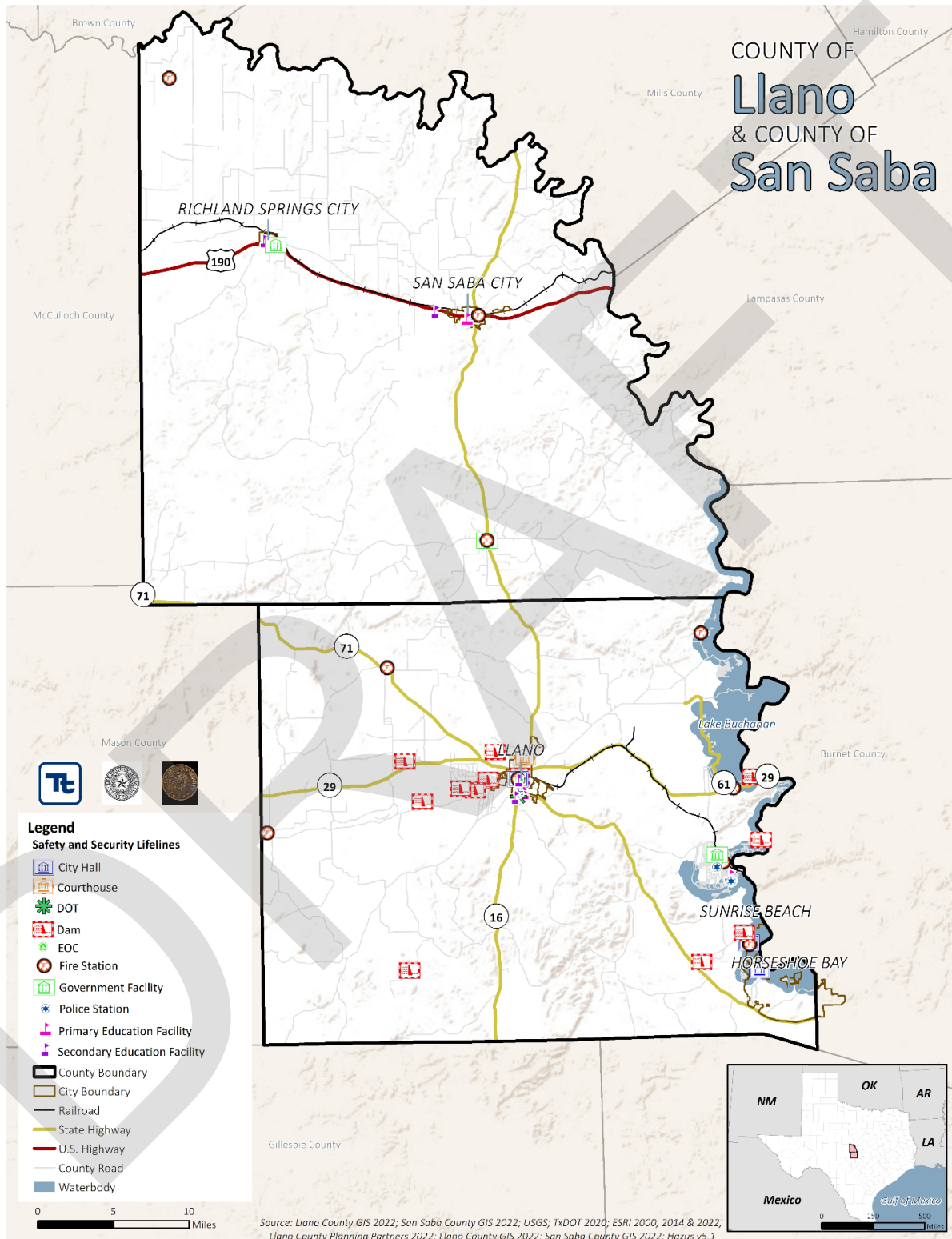
Facility Type	Town of Richland Springs	City of San Saba	Unincorporated or Other	San Saba County Total
Communication	0	2	0	2
Food, Water, Shelter	1	0	1	2
Safety and Security	3	7	5	15
Transportation	1	2	107	111
Total	5	11	113	130

Source: Llano County GIS 2022, Hazus v5.1, Texas A&M 2022

3.5.1 Safety and Security

This section provides information on Safety and Security lifelines. Components of this lifeline category include law enforcement/security, fire services, search and rescue services, government services, and community safety (e.g., dams). There are 36 safety and security lifelines in Llano County and 20 safety and security lifelines in San Saba County. Figure 3-2 shows the location of these facilities.

Figure 3-2. Safety and Security Lifelines in Llano County, Texas and San Saba County, Texas



3.5.2 Food, Water, and Shelter Lifelines

Food, Water, and Shelter lifelines include facilities pertaining to food supply (distribution facilities, programs, and supply chain), water supply (including both potable and wastewater systems), shelter (housing and hotels), and agricultural facilities. Figure 3-3 shows the location of these facilities in the Planning Area.

3.5.3 Health and Medical Lifelines

Health and medical lifelines include medical care (e.g., hospitals, pharmacies, long-term care facilities), patient movement (e.g., EMS), fatality management, public health, and medical supply chain. Figure 3-4 shows the location of these facilities in the Planning Area.

3.5.4 Energy (Power and Fuel) Lifelines

The energy (power and fuel) lifeline includes facilities pertaining to the power grid and fuel supplies. Figure 3-5 shows the location of these facilities in the Planning Area.

3.5.5 Communication Lifelines

Communication lifelines include facilities pertaining to infrastructure, alerts/warnings/messages, 911 and dispatch, responder communications, and finance. Figure 3-6 illustrates the communication facilities in the Planning Area.

3.5.6 Transportation Lifelines

Transportation lifelines include facilities pertaining to highway/roadway, mass transit, railway, aviation, and maritime. Major highways in the County include Interstate 45 and State Highways 3, 6, 87, and 146. Major highways in the County include Interstate 190, State Highway 16, Farm-to-Market Roads FM-45, FM-500, and RM-501, a Ranch-to-Market Road (San Saba Central Appraisal District n.d.). Figure 3-7 illustrates the transportation lifelines in the Planning Area.

3.5.7 Hazardous Materials Lifelines

The hazardous material lifeline includes facilities pertaining to facilities containing hazardous materials and HAZMAT/pollutants/containments. There are six hazardous material lifelines in Llano County and no Superfund sites. Meanwhile in San Saba County, there are no hazardous materials lifelines or Superfund sites.

Llano County

HAZMAT Facilities

A Superfund site consists of land in the United States that has been contaminated by hazardous waste and identified by the U.S. Environmental Protection Agency (EPA) as a candidate for cleanup because it poses a risk to human health or the environment. These sites are placed on the National Priorities List (NPL), the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide EPA in determining which sites warrant further investigation.

Abandoned hazardous waste sites placed on the federal NPL include those that EPA has determined present *a significant risk to human health or the environment*, with the sites being eligible for remediation under the Superfund Trust Fund Program. As of 2022, Llano County hosts no hazardous sites in the federal Superfund Program that are listed as on the NPL (US EPA 2022).

San Saba County

A Superfund site consists of land in the United States that has been contaminated by hazardous waste and identified by the U.S. Environmental Protection Agency (EPA) as a candidate for cleanup because it poses a risk to human health or the environment. These sites are placed on the National Priorities List (NPL), the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide EPA in determining which sites warrant further investigation.

Abandoned hazardous waste sites placed on the federal NPL include those that EPA has determined present *a significant risk to human health or the environment*, with the sites being eligible for remediation under the Superfund Trust Fund Program. As of 2022, San Saba County hosts no hazardous sites in the federal Superfund Program that are listed as on the NPL (US EPA 2022).

Figure 3-3. Food, Water, and Shelter Lifelines in Llano County, Texas and San Saba County, Texas

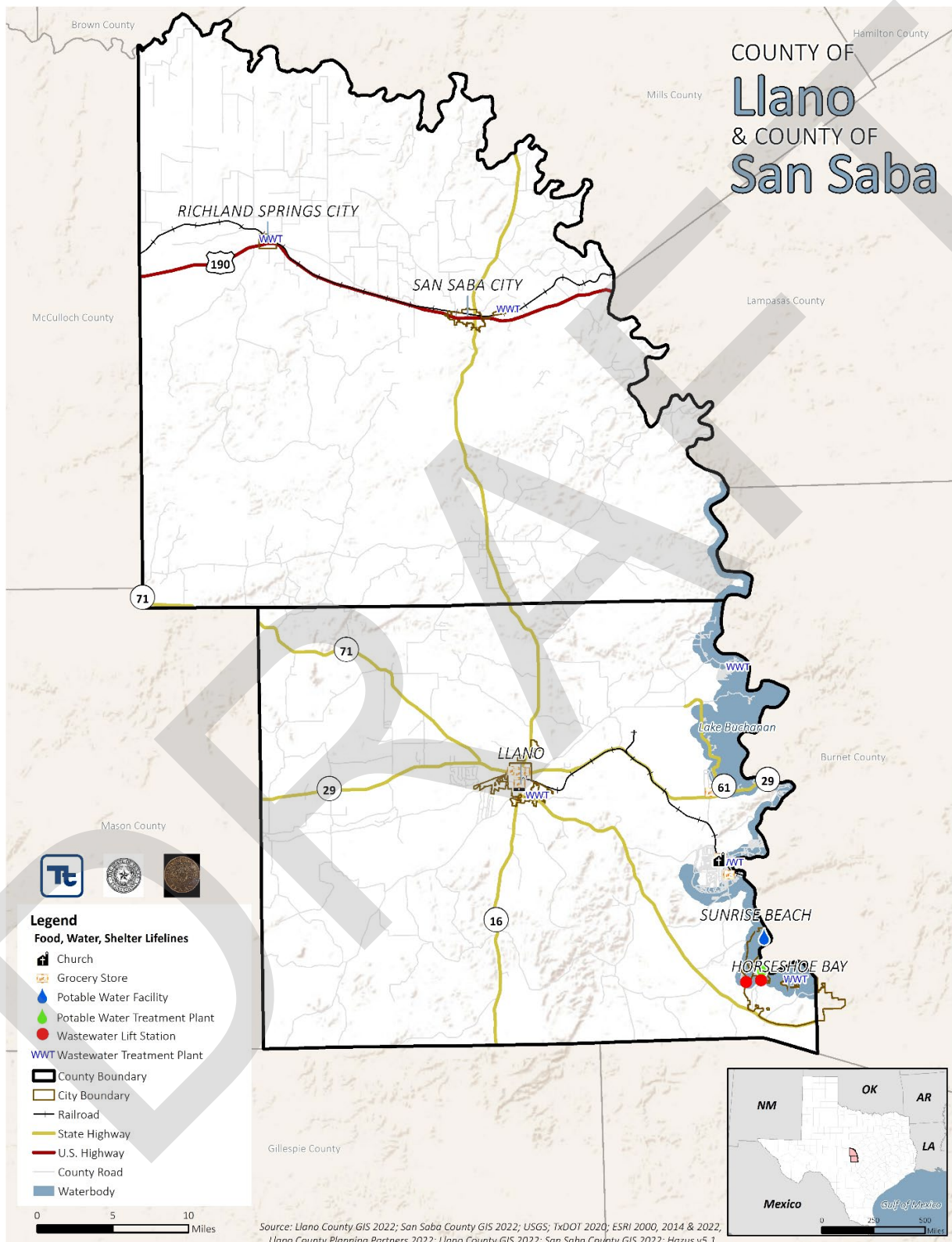


Figure 3-4. Health and Medical Lifelines in Llano County, Texas and San Saba County, Texas

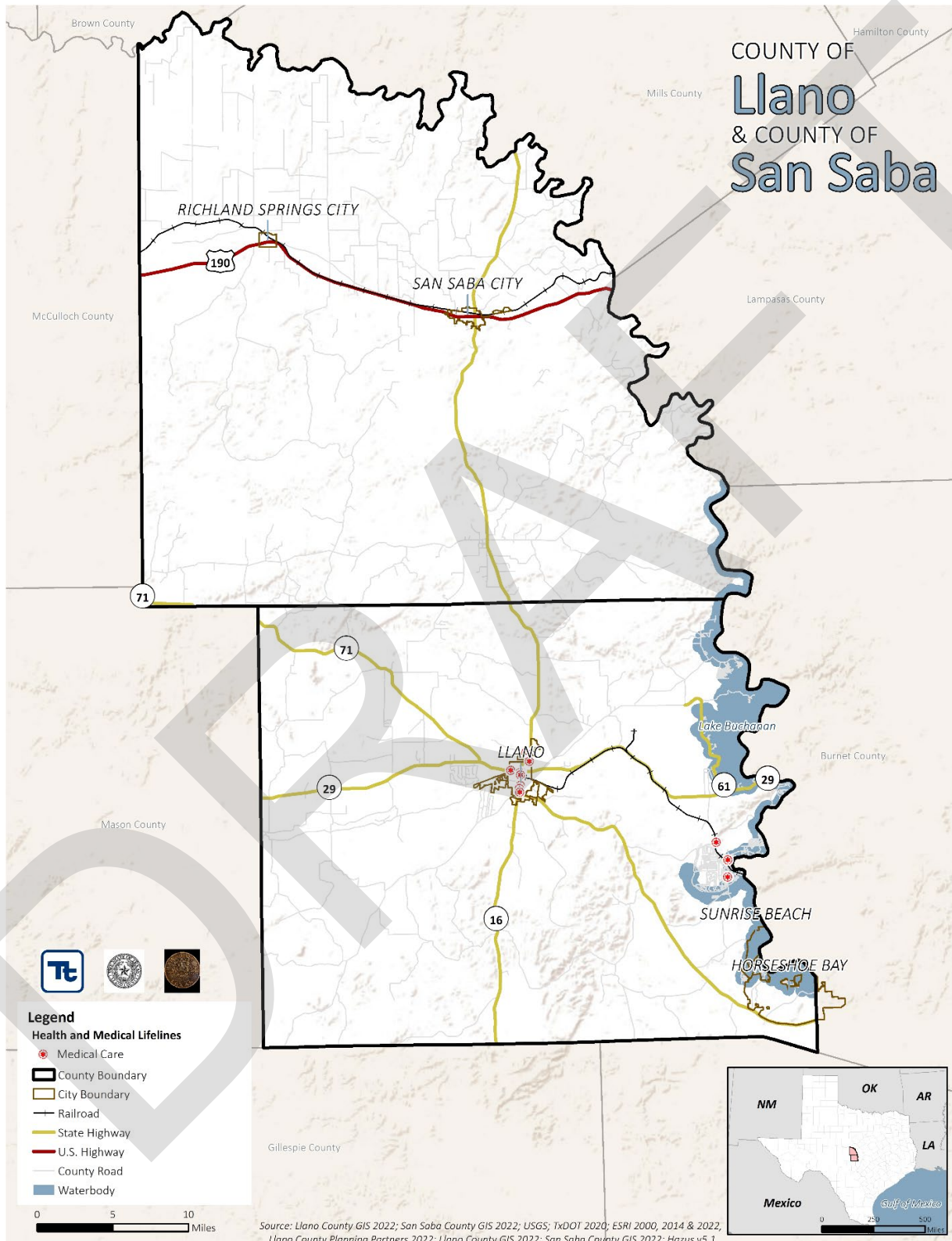


Figure 3-5. Energy Lifelines in Llano County, Texas and San Saba County, Texas

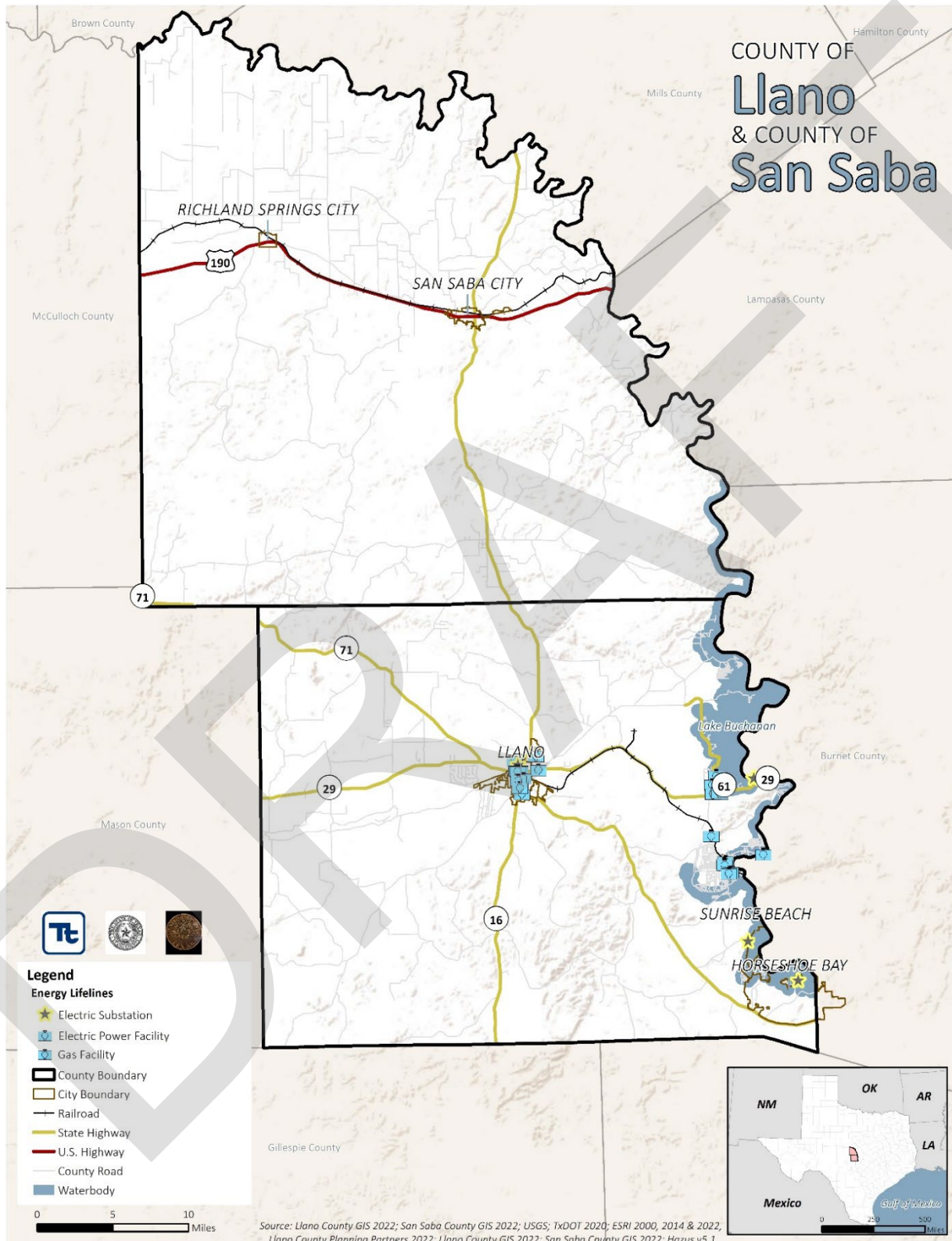


Figure 3-6. Communications Lifelines in Llano County, Texas and San Saba County, Texas

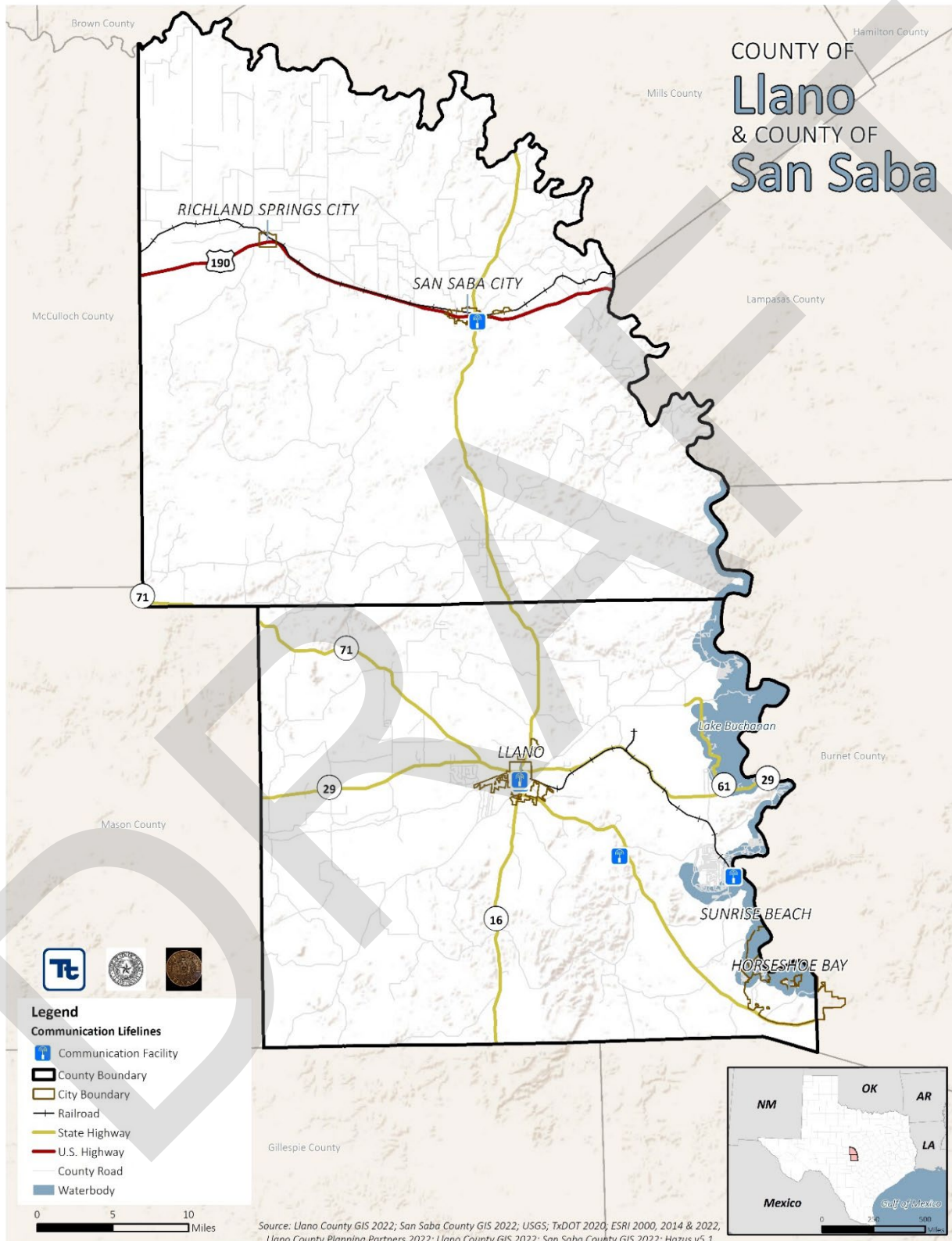
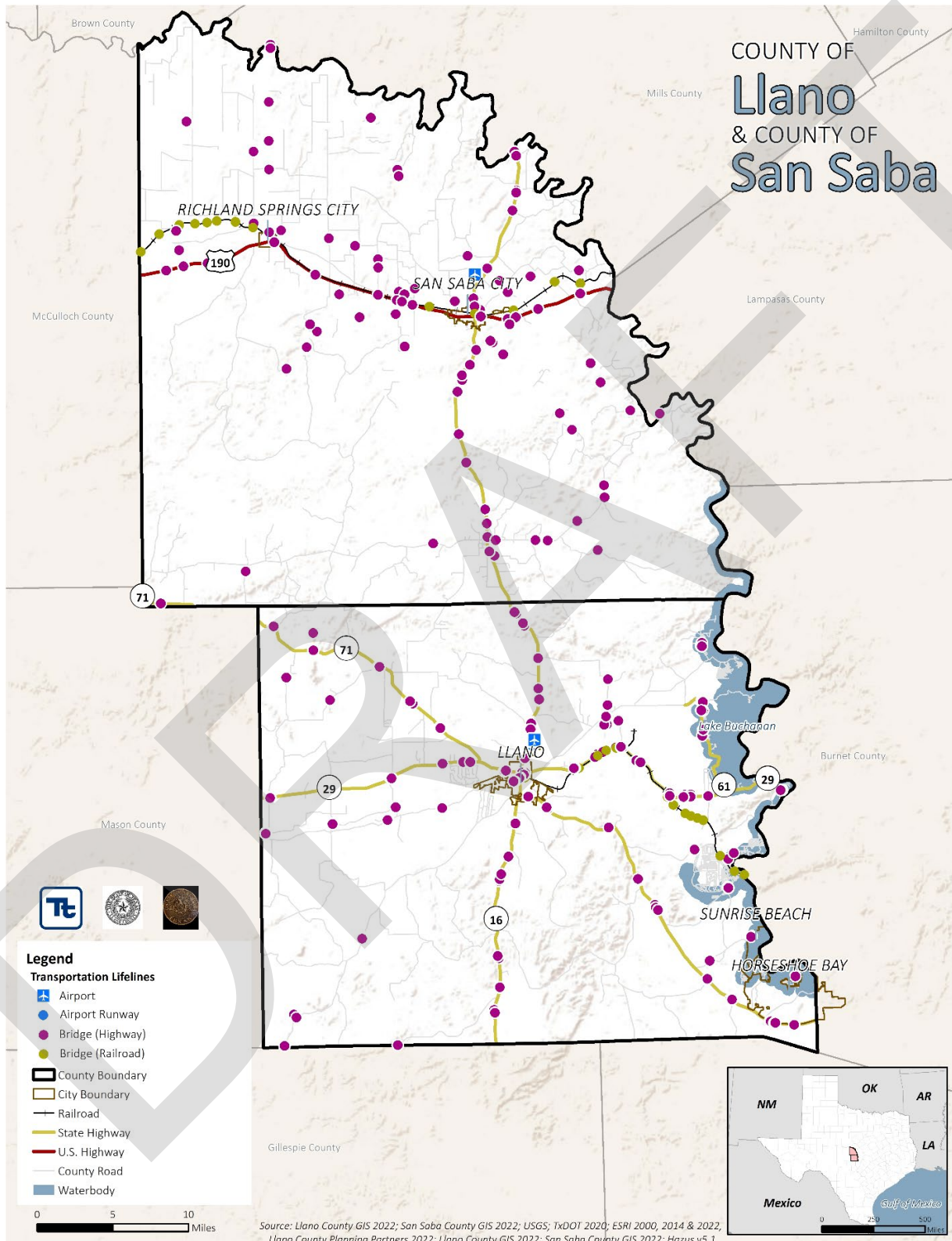


Figure 3-7. Transportation Lifelines in Llano County, Texas and San Saba County, Texas



Section 4 Risk Assessment

4.1 Methodology and Tools

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- Hazard identification—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- Exposure identification—Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- Vulnerability identification and loss estimation—Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)).

To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

The following describes the methodology and tools used to conduct the risk assessment for the Llano and San Saba County Hazard Mitigation Action Plan 2023 update.

4.1.1 Risk Assessment Tools

Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

Hazus

In 1997, FEMA developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Level of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

4.1.2 Risk Assessment Approach

The risk assessments in this plan describe the risks associated with each hazard of concern identified. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
 - Geographic areas most affected by the hazard
 - Event frequency estimates
 - Severity estimates
 - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as GIS and FEMA's hazard-modeling program Hazus were used for this assessment for the earthquake, flood, and hurricane hazards. Outputs similar to those from Hazus were generated for other hazards, using data generated through GIS.

Earthquake

A probabilistic assessment was conducted for Llano and San Saba County for the 100-year and 500-year mean return periods (MRPs) through a Level 2 analysis in Hazus v5.1 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historic earthquakes and inferred faults, locations, and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census tract.

As noted in the Hazus Earthquake User Manual, *“Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that uncertainties are inherent in any estimation methodology, even with state-of-the-art techniques. Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems that have been constructed over a range of years under diverse seismic design codes. There are a variety of components that contribute to transportation and utility system damage estimations. These components can have differing seismic resistance.”* (FEMA 2020). However, Hazus’ potential loss estimates are acceptable for the purposes of this HMP.

Ground shaking is the primary cause of earthquake damage to man-made structures and soft soils **amplify** ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reductions Program (NEHRP) has developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. Class D and E NEHRP soils are the two classes most susceptible to amplified ground motion during an earthquake. If NEHRP data is not available for a project area, Hazus defaults all soil types to Class D. Other default assumptions used in the Hazus model include the following: groundwater was set at a depth of five (5) feet and each mean return period event was set to a magnitude 7.0 earthquake.

Although damages are estimated by Hazus at the census tract level, results were presented at the municipal level. Since there are multiple census tracts that contain more than one jurisdiction, an area analysis was used to extract the percent of each tract that falls within individual jurisdictions. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Damage estimates are calculated for losses to buildings (structural and non-structural) and contents; structural losses include load carrying components of the structure, and non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boilers, etc.

Expansive Soils

Best available data was used to assess Llano and San Saba County’s vulnerability to expansive soils. To help understand the geographic distribution of expansive soils, USDA’s Natural Resources Conservation Service’s 2022 soil data for Llano and San Saba County was referenced. Soils with linear extensibility greater than or equal to 6-percent were selected as expansive soils. Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from expansive soils, the County’s assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from expansive soils.

Flood

The 1-percent and 0.2-percent chance flood events were examined to evaluate Llano and San Saba County's risk and vulnerability to the flood hazard.

The effective Llano County FEMA Digital Flood Insurance Rate Map (DFIRM) dated January 29, 2021, and 2021 cursory fluvial floodplain data from the Texas Water Development Board was used to evaluate potential future losses caused by the 1-percent and 0.2-percent annual chance flood events. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.

The riverine flood risk areas for the 1-percent and 0.2-percent annual chance flood events were published on the FEMA map service center in January 2021. The effective flood data for Llano County was processed into a depth grid using a 2018 USGS 1-meter resolution Digital Elevation Model (DEM).

The FEMA map service center did not have effective DFIRM data available for San Saba County. Therefore, the 2021 cursory floodplain dataset published by the Texas Water Development Board was considered best available data for this HMP update. The fluvial floodplain depth grid data incorporates Texas Water Development Board LiDAR data and NOAA Atlas 14 rainfall data mapped to a 3-meter resolution and converted into feet. More information about this product can be found here: [Overview of Cursory Floodplain Dataset](#).

These depth grids were integrated into the Hazus v5.1 riverine flood models used to estimate potential losses for the 1-percent annual chance flood event.

A Level 2 Hazus riverine flood analysis was performed. Updated critical facilities were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS). Default general building stock data was used from the Hazus model to assess building loss and population displacement. Once updated with the critical facility data, the Hazus riverine flood model was run to estimate potential losses in Llano and San Saba County for the 1-percent annual chance flood event. Hazus calculated the estimated potential losses to the population (default 2010 U.S. Census data), potential damages to the general building stock, and potential damages to critical facility inventories based on the depth grids generated and the default Hazus damage functions in the flood model. Furthermore, building losses, social impacts, and debris were estimated by Hazus at the census block level. These results were presented at the municipal level. Since there are multiple census blocks that contain more than one jurisdiction, an area analysis was used to extract the percent of each jurisdiction within each block. The percentage was multiplied against the results calculated for each block and summed for each municipality.

Hurricane

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Llano and San Saba County for the 100-year and 500-year mean return period events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with the County. Hazus contains data on historic hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the municipal level. Since there are multiple census tracts that contain more than one jurisdiction, a density analysis

was used to extract the percent of each jurisdiction within each tract. The percentage was multiplied against the results calculated for each tract and summed for each municipality.

Land Subsidence

Best available data was used to assess Llano and San Saba County's vulnerability to land subsidence. Llano and San Saba County assessed the land subsidence hazard area using 2017 geologic data created by USGS. Areas of karst carbonate rock were extracted to represent the land subsidence hazard area. Asset data (population, building stock, and critical facilities) were used to support an evaluation of assets at risk to potential impacts and losses associated with this hazard. To determine what assets are at risk to landslide events, available and appropriate GIS data were overlaid with the hazard area.

Landslide

Best available data was used to assess Llano and San Saba County's vulnerability to landslide events. Llano and San Saba County assessed the landslide hazard area using the 2018 1-meter digital elevation model (DEM) created by USGS. The 1-meter DEM was used to determine areas where land area is sloping greater than 25-percent grade. Asset data (population, building stock, and critical facilities) were used to support an evaluation of assets at risk to potential impacts and losses associated with this hazard. To determine what assets are at risk to landslide events, available and appropriate GIS data were overlaid with the hazard area.

Wildfire

The 2022 wildfire threat hazard area obtained through Texas A&M Forest Service was referenced to delineate wildfire hazard areas. Wildfire threat was measured by the Texas A&M Forest Service using the Wildland Fire Susceptibility Index (WFSI), which is defined as the likelihood of an acre burning. This data is derived at a 30-meter resolution.

Asset data (population, building stock, critical facilities, and new development) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are at risk to impacts from wildfires, the County's assets were overlaid with the hazard area. Assets with their centroid located within the wildfire hazard areas were totaled to estimate the number of persons, buildings, and facilities at risk to impacts from wildfire events.

All Other Assessed Hazards

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: dam failure; drought; extreme temperature; pandemic, health, and safety; severe weather; and winter weather.

4.1.3 Sources of Data Used in Hazus Modeling and Exposure Analyses

Llano and San Saba County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Llano and San Saba County assessed exposure vulnerability of the following types of assets: population, buildings, and critical facilities/infrastructure. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

Building and Cost Data

The default general building stock data within Hazus v5.1 was used to assess building exposure and losses for Llano and San Saba County. The general building stock is analyzed at the aggregate Census Block and Census Tract levels and incorporates 2010 Census data with 2018 RS Means replacement cost values. The occupancy classes available in Hazus were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities and Lifelines

The 2023 HMP critical facility inventory, which includes essential facilities, utilities, government offices, transportation features and user-defined facilities was updated by the Planning Partnership. The update involved a review for accuracy, additions, or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Population

Llano and San Saba County used the total population statistics from the 2020 Decennial Census data and 2016-2020 American Community Survey (ACS) 5-year estimate to estimate the exposure and potential impacts to the County's population in place of the 2010 U.S. Census block estimates. Borough and township populations were extracted directly from the Census Bureau and ACS. Population counts at the jurisdictional level were averaged among the total number of residential properties for each dasymetric Census Block within the County to estimate the population distribution at the aggregate Census Block level. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

As discussed in Section 3.0 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Vulnerable populations in Llano and San Saba County included in the risk assessment are children, elderly, and people living in low-income households.

Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Earthquake**—Hazus earthquake probabilistic data were used for the analysis of this hazard.
- **Flood**—The FEMA 2021 effective Digital Flood Insurance Rate Map (DFIRM) 2021 cursory fluvial floodplain data from the Texas Water Development Board was used to delineate the riverine flood hazard areas to estimate potential losses. Using the DFIRM floodplain boundaries and base flood elevation information, and the USGS 1-meter digital elevation model data, flood depth grids were generated and integrated into the Hazus model.
- **Hurricane**—Hazus hurricane probabilistic data were used for the analysis of this hazard.

Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:



- **Expansive Soils**—2022 USDA’s Natural Resources Conservation Service’s soil data for soil types with a linear extensibility >6%
- **Land Subsidence**—2017 USGS geologic data for areas of karst carbonate rock
- **Landslide**—2018 USGS 1-meter digital elevation model (DEM) where slopes >25% grade
- **Wildfire**—2022 Texas A&M Forest Service wildfire threat hazard area

No GIS format datasets appropriate for an exposure analysis were identified for the following hazards: dam failure; drought; extreme temperature; pandemic, health, and safety; severe weather; and winter weather.

Data Source Summary

Table 4.1-1 summarizes the data sources used for the risk assessment for this plan.

Table 4.1-1. Data Source Summary

Data	Source	Date	Format
Population Data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2010/2020; 2016-2020	Digital (GIS) Format; CSV
Building Inventory	Hazus v5.1	2010/2018	Digital (GIS) Format
Critical Facilities	Llano and San Saba County; Hazus v5.1	2022	Digital (GIS) Format
Digitized Effective FIRM Data	FEMA	2021	Digital (GIS) Format
Digital Elevation Model	USGS	2018	Digital (GIS) Format
Fluvial Flood Depth Grids	Texas Water Development Board	2021	Digital (GIS) Format
Expansive Soils	USDA	2022	Digital (GIS) Format
Land Subsidence	USGS	2017	Digital (GIS) Format
Landslide (Steep Slopes)	USGS	2018	Digital (GIS) Format
Wildfire	Texas A&M Forest Service	2022	Digital (GIS) Format

Notes: FEMA – Federal Emergency Management Agency; USDA – United States Department of Agriculture; USGS – United States Geological Survey

4.1.4 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents has to prepare for a specific hazard event.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Llano and San Saba County will collect additional data to assist in estimating potential losses associated with other hazards.

Section 4 Risk Assessment

4.2 Identification of Hazards of Concern

To provide a strong foundation for mitigation actions considered in Sections 6 (Mitigation Strategy), the Planning Team focused on considering a full range of hazards that could impact the area and then identified and ranked those hazards that presented the greatest concern. The hazard of concern identification process incorporated input from the Planning Team; review of the State of Texas Hazard Mitigation Plan (2019); review of the 2016 Llano and San Saba Counties HMP; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural (not manmade) hazards and the perceived vulnerability of the study area's assets to them. Table 4.2-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation. Specific hazards not identified as a hazard of concern for the Planning Area will not be further discussed in detail.

4.2.1 Changes from the 2016 Hazard Mitigation Plan

Since the development of the last plan, hazards and disasters not assessed in the prior plan have occurred in the Planning Area. These hazards were identified by stakeholders as areas to address in the plan. One hazard is new to San Saba but was present in Llano's 2016 plan. A few hazards were renamed, and some were pulled out of combined sections to be stand-alone sections.

- The prior plan did not address Disease Outbreak as a hazard of concern. Beginning in March 2020, the Planning Area was hit with the COVID-19 pandemic along with the rest of the world.
- The prior plan only addressed extreme heat in combination with drought. The update addressed extreme temperatures as its own section which includes extreme cold as well.
- The prior plan addressed Lightning, Hail and Wind as a hazard of concern. The Planning Team agreed to break these hazards into their own sections and include an overarching Severe Weather hazard profile.
- The prior plan addressed Expansive Soils, Earthquake, and Land Subsidence as individual hazards. The Planning Team agreed to break these hazards into their own sections and include an overarching Geological hazard profile.
- The 2023 Llano and San Saba Hazard Mitigation Plan Update includes best available data throughout the plan to present an updated understanding the Planning Area's risk.

4.2.2 Hazard Groupings

As per the 2016 Llano and San Saba HMPs, the Planning Team maintained the grouping of hazards based on the similarity of hazard events, typical concurrence or impacts, consideration of how hazards have been grouped in FEMA guidance documents (*FEMA 386-2 Understanding Your Risks, Identifying Hazards and Estimating Losses; Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy; Local Mitigation Planning Handbook*), and consideration of hazard grouping in the State of Texas HMP.



The Dam Failure profile addresses dam/levee failures that may impact the Planning Area.



The *Drought* hazard profile specifically addresses drought events that occurred in the Planning Area.

The *Extreme Temperature* hazard profile specifically addresses periods of extreme heat and cold that occurred in the Planning Area.

The *Flood* hazard includes riverine, flash flooding, and stormwater flooding. Inclusion of the various forms of flooding is consistent with that used in FEMA's *Multi-Hazard Identification and Risk Assessment* guidance.

The *Geologic* profile addresses expansive soils, land subsidence, and earthquakes that may impact the Planning Area.

The *Hurricane and Tropical Storm* profile addresses hurricanes and tropical storms that occurred in or impacted the Planning Area.

The *Severe Weather* hazard profile addresses lightning, wind events, tornadoes, and thunderstorms.

The *Pandemic/Health and Safety* hazard profile addresses diseases with the potential to impact the Planning Area, including the novel coronavirus (COVID-19), West Nile Virus, and Influenza.

The *Wildfire* profile addresses wildfire events that may impact the Planning Area.

The *Winter Weather* profile includes heavy snow, blizzards, and ice storms. This grouping is consistent with the State of Texas HMP.

Table 4.2-1. Identification of Hazards of Concern for the Planning Area

Hazard	Description
Dam Failure	- The 2018 State of Texas HMP includes dam/levee failure as a hazard of concern for the State. - According to the National Inventory of Dams, there are 40 dams in San Saba County. None of them have hazard classifications. - According to the National Inventory of Dams, there are 10 dams in Llano County. None of them have hazard classifications (Times, n.d.). - There have been no reported dam or levee incidents in the Planning Area. - Dam and levee failure was identified as a hazard of concern for the Planning Area.
Pandemic/Health and Safety	- The Planning Areas have experienced two separate public health events since 2003. These include West Nile Virus and COVID-19. - At the time of this plan's writing, COVID-19 continues to impact public health both locally and globally.
Drought	- Llano and San Saba Counties both had one FEMA drought declaration in 1993. - Both Llano and San Saba Counties have experienced numerous droughts since 2018 according to the NCEI database. - Due to the history of occurrence and the impacts drought can have, drought was identified as a hazard of concern for the Planning Area.
Expansive Soils	- Expansive soils are common throughout Texas because Texas has a lot of soils with clay that have a high swelling potential and move and change depending on water ground level. - There is no FEMA declared disaster, however, expanding soils have led to extensive damages that have destroyed building foundations.

Hazard	Description
	Expansive soils was identified as a hazard of concern for the Planning Area and incorporated into the Geological Hazards hazard profile.
Extreme Temperature	- Extreme heat was identified as a hazard of concern in the State of Texas HMP. - Llano and San Saba Counties were identified in a total of three extreme temperature events since 2018. - Llano and San Saba Counties has experienced extreme heat events and will continue to experience them in the future. In addition, the Planning Team identified extreme cold as a hazard of concern. Therefore, extreme heat and cold (extreme temperature) was identified as a hazard of concern for the Planning Area.
Flood	- Riverine flooding was identified as a hazard of concern in the 2018 State of Texas Hazard Mitigation Plan. 14 flood events have been identified as occurring in the Planning Area since 1954. The flood events have resulted in three FEMA disaster declarations. - Based on the history of events and losses, flooding was identified as a hazard of concern for the Planning Area.
Land Subsidence	- Land Subsidence was identified as a hazard of concern in the 2018 Texas State Hazard Mitigation Plan. - Llano and San Saba Counties were not subject to a land subsidence-related major disaster/emergency declaration - Land Subsidence was identified as a hazard of concern for the Planning Area and incorporated into the Geological Hazards hazard profile.
Hurricane & Tropical Storm	- Hurricanes and tropical storms were identified as a hazard of concern in the 2018 State Hazard Mitigation Plan. - Llano and San Saba Counties was included 3 hurricane-related FEMA major disaster and emergency declarations and have led to flooding recorded by the NCEI database. - Based on history of occurrences and losses, the hazard was identified as a hazard of concern for the Planning Area.
Lightning	- Lightning was identified as a hazard of concern in the 2018 State Hazard Mitigation Plan. - Lightning is a somewhat frequent occurrence in the Planning Area. - The hazard was identified as a hazard on concern for the Planning Area and incorporated into the Severe Weather hazard profile.
Tornado	- The Texas State Hazard Mitigation Plan identified tornadoes as a state hazard of concern. - Llano and San Saba Counties have not been included in any tornado specific-related FEMA disaster declarations. - The hazard was identified as a hazard on concern for the Planning Area and incorporated into the Severe Weather hazard profile.
Wildfire	- The Texas State Hazard Mitigation Plan identified wildfires as a state hazard of concern. - Llano and San Saba have experienced a sufficient number of fires in the planning area; San Saba has experienced 7 FEMA fire declarations, three of which were wildfires and Llano has experienced 3 FEMA fire declarations, one of which was a wildfire. - The wildfire hazard was identified as a hazard of concern for the Planning Area.
Winter Weather	- Winter weather was identified as a hazard of concern in the State Hazard Mitigation Plan. - Two recorded FEMA events have occurred in 2021 that spanned both counties. - The hazard was identified as a hazard of concern for the Planning Area.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.1 Dam Failure

The following section provides the hazard profile and vulnerability assessment for the dam failure hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

A dam failure is defined as systematic failure of dam structure resulting in the uncontrolled release of water, often resulting in floods that could exceed the 100-year flood plain boundaries. A dam failure could cause mass fatalities and extensive structural damage if populated and/or industrial areas are located near or downstream of the dam structure.

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

Dam failure is a collapse or breach in a dam. While most dams have storage volumes small enough that failures have little or no repercussions, dams with large storage amounts can cause significant downstream flooding. Dam failures in the United States typically occur from any one or combination of the following:

- Overtopping of the primary dam structure, which accounts for 34-percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30-percent of all dam failures.
- Failure due to piping and seepage accounts for 20-percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10-percent of all failures (Llano County 2016).

The remaining 6-percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results from other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage (Llano County 2016).

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

Location

The majority of dams and lakes in Texas are used for water supply. Dams also provide benefits such as irrigation for agriculture, hydropower, flood control, maintenance of lake levels, and recreation. However, despite the benefits and importance of dams to our public works infrastructure, many safety issues exist for dams as with any complex infrastructure; the most serious threat is dam failure.

There are ten total dams located in Llano County. 50-percent of the dams in all of Llano County and participating are State-Regulated Dams. 100-percent of the dams are High Hazard Potential Dams with an EAP. There are 40 total dams located within San Saba County. 70-percent of the dams in all of San Saba County and participating jurisdictions are State-Regulated Dams. 67-percent of the dams are High Hazard Potential Dams with an EAP (USACE 2022). Table 4.3.1-1 and Table 4.3.1-2 shows the number documented dams in Llano County and San Saba County, respectively. There was no data available to identify the hazard ranking of the dams in both Llano and San Saba County based on the information provided.

Table 4.3.1-1. Dams in Llano County and Participating Communities

Name	Ownership Type	Max Storage (Acre-Feet)	Hazard Class	Emergency Action Plan (EAP) Prepared
Barry Dam	Private	60.0	N/A	Not Required
Freight Development Lake Dam	Private	1,008	N/A	Not Required
Gary Cooper Dam	Private	115.0	N/A	Not Required
Horseshoe Bay West Dam C	Private	31.0	N/A	Yes
Kingsland Lake Dam	Private	22.0	N/A	Yes
Llano City Lake Dam	Local Government	383.0	N/A	Not Required
Llano Park Dam	Local Government	317.0	N/A	Not Required
Moss Dam 2	Private	128.0	N/A	Not Required
Ratliff Dam	Private	435.0	N/A	Not Required
Slator Ranch Dam 3	Private	126.0	N/A	Not Required

Source: USACE 2022

Notes: N/A Not Available

Table 4.3.1-2. Dams in San Saba County and Participating Communities

Name	Ownership Type	Max Storage (Acre-Feet)	Hazard Class	Emergency Action Plan (EAP) Prepared
Barfield Lake Dam	Private	106.0	N/A	Not Required
Childress Lake Dam	Private	314.0	N/A	Not Required
Deep Creek Ranch Dam	Private	126.0	N/A	Not Required
Dyer Lake Dam	Private	152.0	N/A	Not Required
Gardner Dam A	Private	113.0	N/A	Not Required
Gardner Pond Dam	Private	94.0	N/A	Not Required
Lake Margery Dam	Private	1,215.0	N/A	Yes
Lower San Saba River WS SCS Site 10 Dam	Local Government	1,300.0	N/A	Not Required

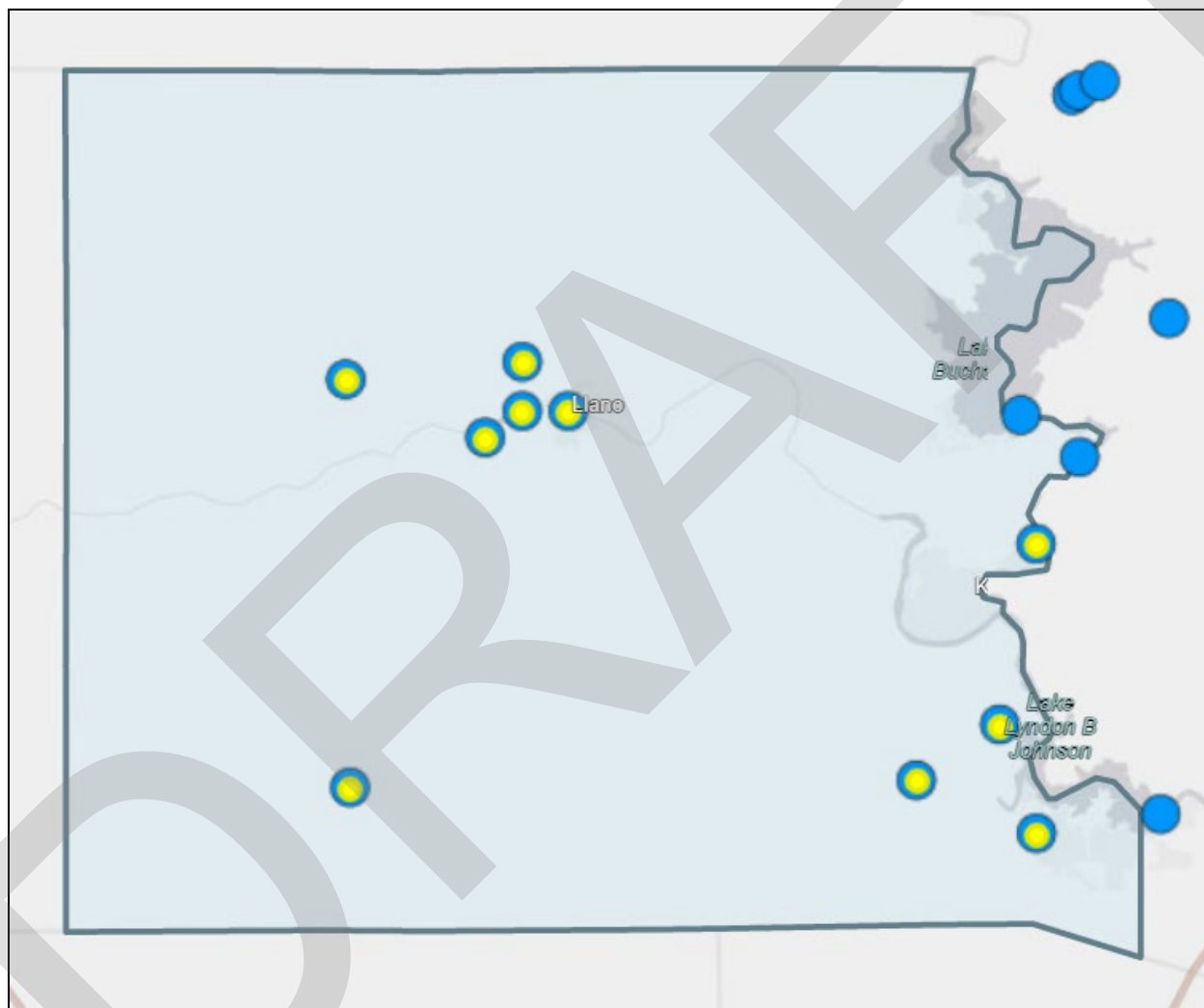
Name	Ownership Type	Max Storage (Acre-Feet)	Hazard Class	Emergency Action Plan (EAP) Prepared
Lower San Saba River WS SCS Site 11 Dam	Local Government	1,793.0	N/A	No
Lower San Saba River WS SCS Site 12 Dam	Local Government	1,242.0	N/A	No
Lower San Saba River WS SCS Site 13a Dam	Local Government	4,269.0	N/A	Yes
Lower San Saba River WS SCS Site 14a Dam	Local Government	4,185.0	N/A	Yes
Lower San Saba River WS SCS Site 15 Dam	Local Government	1,037.0	N/A	Not Required
Lower San Saba River WS SCS Site 16 Dam	Local Government	1,632.0	N/A	Not Required
Lower San Saba River WS SCS Site 2 Dam	Local Government	4,846.0	N/A	Not Required
Lower San Saba River WS SCS Site 3 Dam	Local Government	2,106.0	N/A	Not Required
Lower San Saba River WS SCS Site 4 Dam	Local Government	2,319.0	N/A	Not Required
Lower San Saba River WS SCS Site 5 Dam	Local Government	1,099.0	N/A	Yes
Lower San Saba River WS SCS Site 6 Dam	Local Government	1,107.0	N/A	Not Required
Lower San Saba River WS SCS Site 7 Dam	Local Government	2,392.0	N/A	Not Required
Lower San Saba River WS SCS Site 8 Dam	Local Government	696.0	N/A	Not Required
Lower San Saba River WS SCS Site 9 Dam	Local Government	1,004.0	N/A	Not Required
Mcdaniel Lake Dam	Private	286.0	N/A	Not Required
Mill Pond Dam	Local Government	32.0	N/A	Yes
Miller Dam	Private	384.0	N/A	Not Required
Ratliff Lake Dam	Private	158.0	N/A	Not Required
Se Laterals WS SCS Site 1 Dam	Local Government	1,710.0	N/A	Not Required
Se Laterals WS SCS Site 2 Dam	Local Government	665.0	N/A	Not Required
Se Laterals WS SCS Site 3 Dam	Local Government	647.0	N/A	Yes
Se Laterals WS SCS Site 4 Dam	Local Government	530.0	N/A	Not Required
Se Laterals WS SCS Site 5 Dam	Local Government	562.0	N/A	Not Required
Se Laterals WS SCS Site 6 Dam	Local Government	560.0	N/A	Not Required
Se Laterals WS SCS Site 7 Dam	Local Government	1,051.0	N/A	Not Required
Se Laterals WS SCS Site 8 Dam	Local Government	5,899.0	N/A	Not required
Se Laterals WS SCS Site 9 Dam	Local Government	602.0	N/A	Not Required
Sofge Bates Lake No 1 Dam	Private	212.0	N/A	Not Required
Sofge Bates Lake No 2 Dam	Private	109.0	N/A	Not Required

Name	Ownership Type	Max Storage (Acre-Feet)	Hazard Class	Emergency Action Plan (EAP) Prepared
Southeast Laterals WS SCS Site 8a-1 Dam	Local Government	2,020.0	N/A	Yes
William Harlow Lake Dam	Private	645	N/A	Not Required
Wilson Lake Dam	Private	378.0	N/A	Not Required

Source: USACE 2022

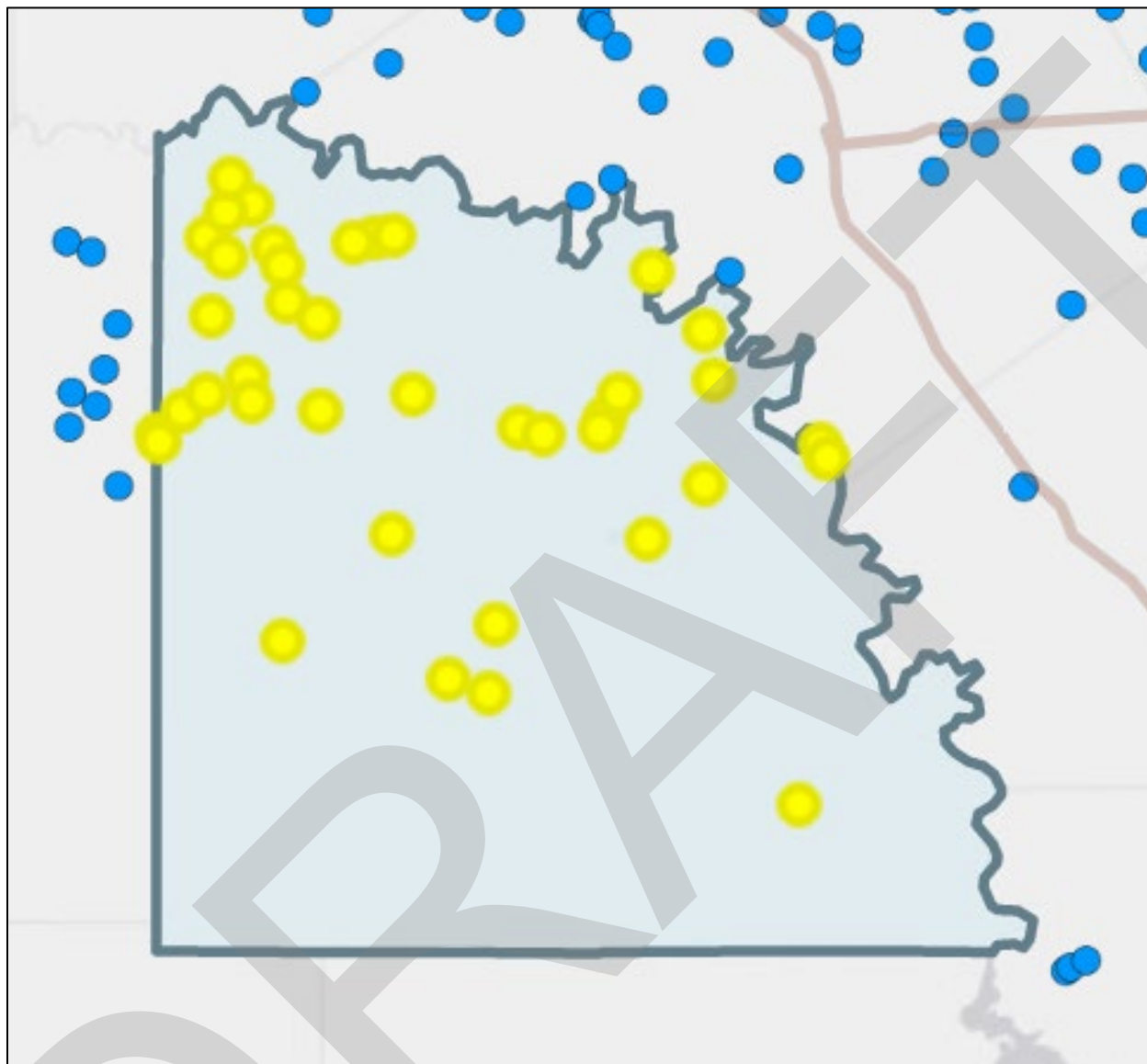
Notes: N/A Not Available

Figure 4.3.1-1. Locations of Dams in Llano County



Source: USACE 2022

Figure 4.3.1-2. Locations of Dams in San Saba County



Source: USACE 2022

The areas of the participating communities most likely to be impacted by a dam failure are the Kingsland area through the City of Sunrise Beach Village to Horseshoe Bay and along the Colorado River. Llano County could be impacted by several high-hazard dams that are located outside of the County. If a failure of one of these high-hazard dams occurred, it could result in loss of life. Other high-hazard dams are located outside of the planning area and their drainages enter Llano County either by direct drainage through parts of the County or by inflow into the Colorado River or Llano River upstream from Llano County.

The areas of San Saba County and the City of San Saba most likely to be impacted by a dam failure are the downstream areas of the City of San Saba along the San Saba River and the Richland Springs Creek Community along Richland Springs Creek. San Saba County could be impacted by several high-hazard dams that are located outside of the planning area. If a failure of one of these high-hazard dams occurred, it could result in loss of life. Other high-hazard dams are located outside of the County and their drainages enter San Saba County either by

direct drainage through parts of the County or by inflow into the San Saba River or Richland Springs Creek upstream from McCulloch County. Dams upstream and outside of the planning area that may affect the unincorporated area include Brady Dam and Richards Park Dam. These dams are approximately 25- and 20-miles upstream Brady Creek from San Saba County. Both dams are in McCulloch County. However there have not been any dam breaches immediately upstream of or within the City of San Saba, thus the overall chance of this occurring is minimal, and therefore classified as ‘No Exposure’.

Overall, dam failure impacts in Llano County would likely be rare and limited to Llano County and the participating communities.

Extent

The extent or magnitude of a dam failure event can be measured in terms of the classification of the dam. Additionally, there are two factors that influence the potential severity of a full or partial dam failure are: (1) the amount of water impounded; and (2) the density, type, and value of development and infrastructure located downstream (Association of State Dam Safety Officials 2020). The following classification system is used by the USACE for the hazard potential of dams.

- **Low Hazard Potential Dams** are dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner’s property.
- **Significant Hazard Potential Dams** where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential Dams** are dams where failure or mis-operation will probably cause loss of human life (USACE 2022).

Worst-Case Scenario

While the probability of a dam failure is low, a worst-case scenario would be a hurricane or tropical storm that would stall over the Planning Area, causing the dam to breach, impacting areas that are supposed to be protected. If a dam failure were to occur, properties protected by the structure could see standing water and minor injuries, but loss of life is not expected.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were not included in any disaster (DR) or emergency (EM) declarations for dam failure-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2018 and 2022, Llano and/or San Saba County were included in no dam failure-related agricultural disaster declarations.

Previous Events

Although the hazard ranking for Llano County is high, the County has not recorded a dam failure or levee failure event in the last 100 years (Llano County 2016). San Saba County has not recorded a dam failure or levee failure in the last 100 years. According to FEMA and USDA, between 2018 and 2022 there have been no recorded dam or levee failure events for Llano County or San Saba County. For events prior to 2018, refer to Appendix I (Supplementary Data).

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of dam failure events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2016 Llano and San Saba County HMPs were used to identify the number of dam failure events that occurred between 1950 and 2022. Table 4.3.1-3 presents the probability of future events for the dam/levee failure in Llano and San Saba County.

Table 4.3.1-3. Probability of Future Dam Failure Events

Hazard Type	Number of Occurrences Between 2017 and 2022	% Chance of Occurring in Any Given Year
Dam Failure	0	0
Levee Failure	0	0

Sources: NOAA NCEI 2022; State of Texas 2018; Llano County 2016; San Saba County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all dam failure events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for dam failure in the Planning Area is considered 'rare'.

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of dam failure (Centers for Climate and Energy Solutions n.d.).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The locations in the Planning Area that are downstream of a dam are vulnerable to the dam failure hazard. The following text evaluates and estimates the potential impact of the dam failure hazard in Llano County and San Saba County as a whole.

Impact on Life, Health, and Safety

The impact of dam failure on life, health, and safety is dependent on several factors such as the class of dam, the area that the dam is protecting, the location of the dam, and the proximity of structures, infrastructure, and critical facilities to the dam structure. The United States Army Corp of Engineers (USACE) classifies dams based on the

potential hazard to the downstream area resulting from failure or mis-operation of the dam or facilities. Please refer to Table 4.3.1-4 below.

Table 4.3.1-4. USACE Hazard Potential Classifications for Dams

Hazard Category (a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

Sources: FEMA 2004

- Notes:
- Categories are assigned to overall projects, not individual structures at a project.
 - Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.
 - Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.
 - Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.
 - Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Dam failure impacts depend on several factors including severity of the event and whether or not adequate warning time is provided to residents. The population living in or near the inundation areas are considered exposed to the hazard. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event); the degree of that impact varies and is not strictly measurable.

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly, young and individuals with disabilities, access or functional needs who may be unable to get themselves out of the inundation area. The vulnerable population also includes individuals who would not have adequate warning from the emergency warning system (e.g., television or radio); this would include residents and visitors. The population adversely affected by a dam failure may also include those beyond the disaster area that rely on the dam for providing potable water.

Floods created from a dam failure and their aftermath present numerous threats to public health and safety including exposure to unsafe food, contaminated drinking and washing water, mosquitoes, animals, mold, and mildew. For more detailed descriptions of these and additional threats to public health and safety, refer to Section 4.3.5 (Flood). Current loss estimation models such as Hazus are not equipped to measure public health impacts such as these. The best preparation for these effects includes awareness that they can occur, education of the public on prevention, and planning to deal with them during responses to dam failure events.

Impact on General Building Stock

Vulnerable properties are those within the dam failure inundation area. These properties would experience the largest, most destructive surge of water. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads, and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Impact on Critical Facilities

Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues and significant disruption to travel, including all roads, railroads, and bridges in areas in and around the dam. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines in the inundation zone could also be vulnerable. If phone lines were lost, significant communication issues may occur in the planning area due to limited cell phone reception in many areas. In addition, emergency response would be hindered due to the loss of transportation routes as well as some protective-function facilities located in the inundation zone. Recovery time to restore many critical functions after an event may be lengthy, as wastewater, potable water, and other community facilities are located in the dam inundation zone.

Impact on Economy

Severe flooding that follows an event like a dam failure can cause extensive structural damage and withhold essential services. The cost to recover from flood damages after a surge will vary depending on the hazard risk of each dam. Severe flooding that follows an event like a dam failure can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities can become temporarily out of operation. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.5 (Flood).

Dam failure events can significantly impact the local and regional economy. Similar to flooding, losses include, but are not limited to, damages to buildings and infrastructure, agricultural losses, business interruption and impacts on tax base. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation.

Impact on the Environment

The environmental impacts of a dam failure can include significant water-quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals may get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth in Llano County and San Saba County could be potentially impacted by the dam failure hazard because these areas are exposed and vulnerable. Areas downstream of dams are the most vulnerable to losses; therefore, any development in these areas will be more susceptible to dam failure impacts.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

Increases in population in dam failure inundation areas will result in increased risk to life to the dam failure hazard.

Climate Change

An increasing average annual temperature will directly impact the atmospheric moisture potential. The probability of expanding atmospheric moisture leads to an increasing amount of rainfall during storm events. The increased potential volume of rainfall will directly lead to an increasing pressure placed on levee systems during future riverine flood events (State of Texas HMP 2018).

Change of Vulnerability Since 2016 HMP

Overall, Llano County and San Saba County's vulnerability has not changed. Each county will continue to be exposed and vulnerable to dam failure events, especially those located within or near downstream inundation zones. Because of the sensitive nature of the dam failure inundation zones, potential losses have not been quantified and presented in this plan. To estimate potential losses to population, buildings, critical facilities and infrastructure, inundation areas and depths of flooding may be used to generate depth grids. Hazus may be used to estimate potential losses for Llano County and San Saba County and participating municipalities in future HMP updates.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.2 Drought

The following section provides the hazard profile and vulnerability assessment for the drought hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Drought is the consequence of a natural reduction in the amount of precipitation expected for a given area or region over an extended period of time, usually a season or more in length. Drought can occur anywhere in the state of Texas.

Drought is a normal phase in the climatic cycle of most geographical areas. According to the National Drought Mitigation Center, drought originates from a deficiency of precipitation over an extended period, usually a season or more. This results in a water shortage for some activity, group, or environmental sector. Drought is the result of a significant decrease in water supply relative to what is “normal” in a given location. Unlike most disasters, drought normally occur slowly but last a long time. There are four generally accepted operational definitions of drought:

- **Meteorological drought** is an expression of precipitation’s departure from normal over some period of time. Meteorological measurements are the first indicators of drought. Definitions are usually region-specific and based on an understanding of regional climatology. A definition of drought developed in one part of the world may not apply to another, given the wide range of meteorological definitions.
- **Agricultural drought** occurs when there is not enough soil moisture to meet the needs of a particular crop at a particular time. Agricultural drought happens after meteorological drought but before hydrological drought. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological drought** refers to deficiencies in surface and subsurface water supplies. It is measured as stream flow and as lake, reservoir, and groundwater levels. There is a time lag between lack of rain and the volume of water in streams, rivers, lakes, and reservoirs, so hydrological measurements are not the earliest indicators of drought. After precipitation has been reduced or deficient over an extended period of time, this shortage is reflected in declining surface and subsurface water levels. Water supply is controlled not only by precipitation, but also by other factors, including evaporation (which is increased by higher-than-normal heat and winds), transpiration (the use of water by plants), and human use.
- **Socioeconomic drought** occurs when a physical water shortage starts to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with the supply and demand of an economic good.

Location

A drought occurs on a regional scale; therefore, the entire Planning Area is vulnerable and at risk. Droughts can occur at any time and have the potential to directly or indirectly impact every person in the Planning Area, as well as the local economy.

Extent

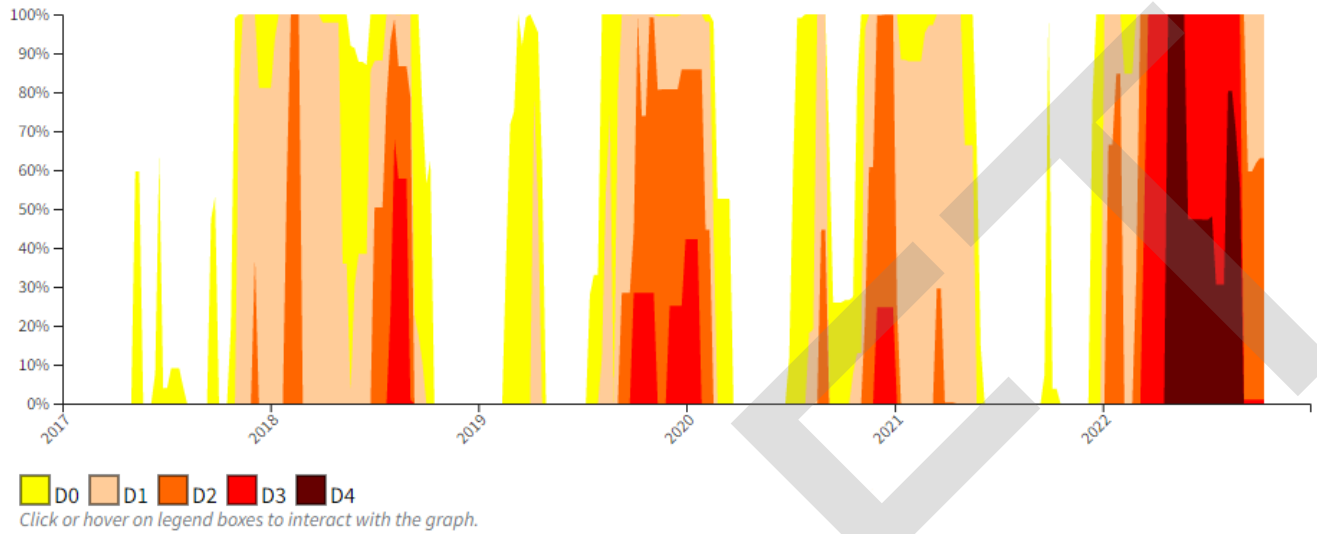
The severity of a drought depends on the degree of moisture deficiency, the duration of the event, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential (University of Nevada, Reno Extension College of Agriculture, Biotechnology & Natural Resources n.d.).

The following description of drought measures comes from a NOAA's National Integrated Drought Information System. It explains the measures of drought from the United States Drought Monitor (USDM) from 2017 to 2022 for Llano and San Saba County's, shown in the graphic below.

The USDM's drought intensity scale is composed of five different levels:

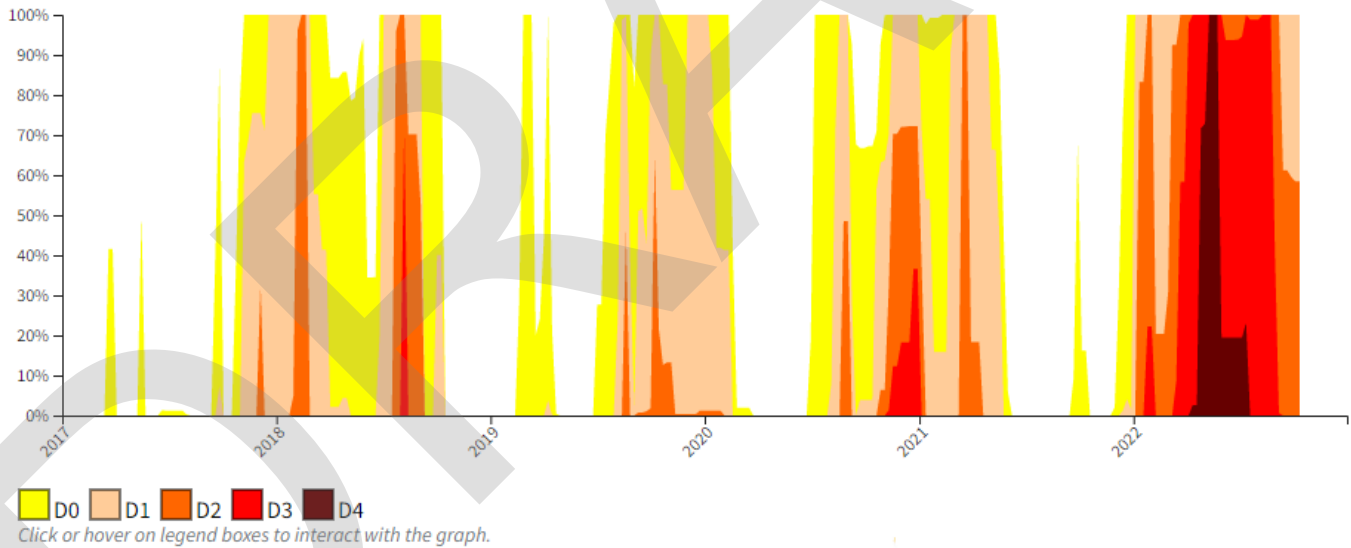
- D0, abnormally dry, corresponds to an area experiencing short-term dryness that is typical with the onset of drought. This type of dryness can slow crop growth and elevate fire risk to above average. This level also refers to areas coming out of drought, which have lingering water deficits and pastures or crops that have not fully recovered.
- D1, moderate drought, corresponds to an area where damage to crops and pastures can be expected and where fire risk is high, while stream, reservoir, or well levels are low.
- D2, severe drought, corresponds to an area where crop or pasture losses are likely, fire risk is very high, water shortages are common, and water restrictions are typically voluntary or mandated.
- D3, extreme drought, corresponds to an area where major crop and pasture losses are common, fire risk is extreme, and widespread water shortages can be expected requiring usage restrictions.
- D4, exceptional drought, corresponds to an area experiencing extraordinary and widespread crop and pasture losses, fire risk, and water shortages that result in water emergencies (NOAA 2022).

Figure 4.3.2-1. Historical Drought Conditions for Llano County



Source: NOAA 2022

Figure 4.3.2-2. Historical Drought Conditions for San Saba County



Source: NOAA 2022

Worst-Case Scenario

A multi-year drought with a Palmer Drought Category of D4 (exceptional drought) that impacts the Planning Area is the worst-case scenario for the Planning Area. If another severe drought occurs before these systems have a chance to recover, it could exacerbate the stress already placed on existing Planning Area water resources. Severe droughts can also lead to crop and livestock losses, impacting the food supply and economy.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were not included in any disaster (DR) or emergency (EM) declarations for drought-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Llano and/or San Saba County were included in 10 drought-related agricultural disaster declarations. These declarations are identified in Table 4.3.2-2.

Previous Events

For this 2023 HMP update, known drought events that impacted the Planning Area between 2017 and 2022 are discussed below. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.2-1. Drought Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
January 30, 2018 – January 31, 2018	Drought			After several months with less than normal rainfall Burnet and Llano Counties fell into severe drought (Stage D2) during January. Both counties enacted outdoor burn bans. Lake Buchanan, on the border between the two counties, was 4.6 feet below conservation pool level at the end of the month. No property or crop damages were reported.
February 01, 2018 – February 27, 2018	Drought			A heavy rain event on the 20-21 dropped one to four inches of rain over Llano and Burnet Counties and this was enough to move them out of severe drought category. No property or crop damages were reported.
June 01, 2018 – June 30, 2018	Drought			Most of the Hill Country and Rio Grande Plains region received less than 25% of normal precipitation during the month of June. Drought conditions worsened across South Central Texas with Kinney and Maverick Counties entering

				exceptional drought category (Stage D4), Dimmit, Uvalde, Real, Val Verde, and Zavala moving into extreme category (D3), and Bandera, Comal, Edwards, Frio, Gillespie, Kendall, Kerr, and Llano in severe category (D2). Of these counties Dimmit, Edwards, Frio, Gillespie, Kerr, Kinney, Llano, Maverick, Val Verde, and Zavala had outdoor burn bans in effect at the end of the month. The main effects of the drought conditions were hydrological. The seven-day stream flow averages for the Rio Grande, Pecos, Nueces, Guadalupe, and Colorado Rivers were below normal (10-24%) at the end of the month. Lake Amistad was 32.9 feet below Conservation Pool level, Medina Lake was 24.9 feet below, Canyon Lake was 5.1 feet below, and Lake Buchanan was 6.2 below. The Edwards Aquifer was 5.1 feet below average and 3.0 feet below the 2017 level. Fredericksburg was in Stage 3 water restrictions, New Braunfels was in Stage 2, and Uvalde was in Stage 1. No property or crop damages were reported.
June 19, 2018	Drought	USDA S4380	Llano, San Saba	Drought
July 01, 2018 – July 31, 2018	Drought			July was a mixed bag as far as the drought was concerned. Parts of South-Central Texas had enough rain to improve a category while several others received little rain and the drought worsened. Kinney (Extreme D3), Maverick (D3), and Val Verde (Severe D2) Counties saw improvement while Gillespie (D3), Llano (D3), Blanco (D2), and Burnet (D2) got worse. Dimmit County remained in Extreme (D3) and Edwards and Kerr Counties remained in Severe (D2). Fire danger at the end of the month was moderate. All the counties in D2 or worse drought had outdoor burn bans in effect. The seven-day stream flow averages for the Pecos, Frio, Upper Guadalupe, and the Upper Colorado Rivers were much below normal (< 10%). The Rio

				Grande, Devils, and Nueces basins were below normal (10-24%). Lake Amistad was 35.2 feet below Conservation Pool elevation and Lake Buchanan was 8.5 feet below. The Edwards Aquifer was 16.1 feet below normal and 17.6 feet below the 2017 level. Llano was in Stage 5 water restrictions, Fredericksburg was in Stage 3, and Uvalde and Kerrville were in Stage 1. No property or crop damages were reported.
July 31, 2018	Drought	USDA S4375	Llano, San Saba	Drought
August 01, 2018 – August 31, 2018	Drought			A large part of South-Central Texas received 50% or less of normal rain in August. This led to worsening drought conditions in Maverick (Exceptional D4), Zavala (D4), Caldwell (Severe D2), Comal (D2), Guadalupe (D2), Hays (D2), Kendall (D2), Real (D2), and Williamson (D2) Counties. Gillespie, Kinney, Llano, and Uvalde Counties remained in Extreme (D3) drought and Blanco, Burnet, Edwards, Kerr, and Val Verde were still in D2. Dimmit (D2) County saw some improvement. Fire danger at the end of the month was moderate. All the counties in D2 or worse drought had outdoor burn bans in effect. The seven-day stream flow averages for the Pecos, Frio, Upper Guadalupe, and the Upper Colorado Rivers were much below normal (< 10%). The Rio Grande, Devils, and Nueces basins were below normal (10-24%). Llano was in Stage 5 water restrictions, Fredericksburg was in Stage 3, and Uvalde and Kerrville were in Stage 1. No property or crop damages were reported.
September 01, 2018 – September 11, 2018	Drought			After a month of record setting rain in some places and nearly all of South-Central Texas receiving at least 150% of normal all of our counties were in less than Severe (D2) drought at the end of the month. Severe category drought ended in Blanco, Burnet, Caldwell, Comal, Dimmit, Edwards, Gillespie, Guadalupe, Hays, Kendall, Kerr, Kinney, Llano, Maverick, Real,



				Uvalde, Val Verde, Williamson, and Zavala Counties. No property or crop damages were reported.
September 01, 2019 – September 30, 2019	Drought			Most of South-Central Texas received less than 50% of normal precipitation during July, August, and September, and a large part of the region had less than 25%. This resulted in drought conditions setting in. Atascosa, Bexar, De Witt, Gonzales, Guadalupe, Hays, Karnes, Kendall, Lee, Medina, Travis, Uvalde, and Val Verde Counties went into Severe (D2) drought. Comal, Frio, Kinney, Llano, Maverick, Williamson, and Wilson Counties went into Extreme (D3) drought. Zavala County remained in D2 and Dimmit County in D3. Stage 2 water restrictions were instituted in parts of Guadalupe and Hays Counties. Stage 1 restrictions were in place in Atascosa, Bexar, Comal, Karnes, Kendall, Llano, Medina, Travis, Uvalde, and Williamson Counties and voluntary restrictions were encouraged in Bastrop, Dimmit, Gonzales, Lee, Val Verde, Wilson, and Zavala. Burn bans were in place in all the affected counties except Williamson and Uvalde. Texas A&M Agrilife reported rangelands were dry with very short soil moisture levels. Livestock were in fair condition and supplemental feeding continued. Lake Amistad was 32.2 feet below Conservation Pool Level. No property or crop damages were reported.
September 10, 2019	Drought	USDA S4577	Llano, San Saba	Drought
September 24, 2019	Drought	USDA S4543	Llano	Drought
October 01, 2019	Drought	USDA S4552	Llano, San Saba	Drought
October 01, 2019 – October 31, 2019	Drought			Nearly all of South-Central Texas had less than normal rainfall during October. Much of the northwestern part of the area had less than 50% of normal. This put Bandera, Bastrop, Blanco, Burnet, Caldwell, Edwards, Fayette, Lavaca, and Real Counties into Severe Drought (D2) and Uvalde and Zavala Counties into Extreme

				Drought (D3). De Witt, Gonzales, Guadalupe, Hays, Karnes, Kendall, Lee, Travis, and Val Verde remained in D2 and Kinney, Llano, and Maverick in D3. There was enough rain in Comal, Dimmit, Frio, Williamson, and Wilson Counties to improve conditions from D3 to D2. Burn bans were in effect for all of the counties in D2 or worse drought except Uvalde, Comal, Guadalupe, Gonzales, De Witt, Lavaca, Williamson, Bastrop, Lee, and Burnet. Lake Amistad was at 50% of conservation storage and Lake Georgetown was at 65%. The Llano, Pedernales, Upper Colorado, San Gabriel, Nueces, Frio, and Navidad Rivers had below normal streamflow and the Atascosa River had a new record low streamflow. Larger Public Water Systems in Bandera, Bastrop, Blanco, Burnet, Caldwell, Comal, Dimmit, Fayette, Gonzales, Hays, Karnes, Kendall, Llano, Travis, Uvalde, Val Verde, Williamson, Wilson, and Zavala Counties were in Voluntary or Stage 1 water restrictions. Systems in Guadalupe and Real Counties were in Stage 2 and some smaller Public Water Systems across the region were in Stage 2 or Stage 3. The Texas A&M AgriLife Texas Crop and Weather Report stated Ranchers around the district were still culling herds due to drought conditions despite some improvement. Cattle market prices were low due to the high numbers of livestock for sale. The district in this case includes Maverick, Zavala, Dimmit, and Frio Counties. No property or crop damages were reported.
October 08, 2019	Drought	USDA S4596	Llano	Drought
November 01, 2019	Drought	USDA S4654	Llano, San Saba	Drought
November 01, 2019 – November 30, 2019	Drought			Most of South-Central Texas received only 50% or less of normal precipitation during November and drought conditions remained unchanged across much of the northern and western parts of the

				region. Kinney, Llano, Uvalde, and Zavala Counties stayed in Extreme Drought (D3) and Bandera, Blanco, Burnet, Karnes, Kendall, Real, and Val Verde Counties stayed in Severe Drought (D2) conditions. There was enough rain in Maverick County to improve conditions from D3 to D2. Larger public water systems in Real County were in Stage 2 water restrictions. In Bandera, Blanco, Burnet, Karnes, Kendall, and Llano there were Stage 1 restrictions and in Val Verde and Zavala there were voluntary restrictions. Area reservoirs were beginning to drop with the most significant impact at Lake Amistad which was 31.1 feet below Conservation Pool level. Of the counties in D2 or worse drought Blanco, Karnes, Kendall, Kinney, Maverick, Real, Val Verde, and Zavala had burn bans if effect. The Texas A&M Agrilife Texas Crop and Weather Report pointed out that livestock were in fair condition and producers continued with supplemental feeding. No property or crop damages were reported.
December 01, 2019 – December 31, 2019	Drought			December was another dry month with nearly all of South-Central Texas seeing 50% or less of normal precipitation. Most of Kinney, Maverick, Uvalde, Zavala, and Dimmit Counties had 10% or less of normal. With this lack of rain, the drought status was unchanged across the region. Kinney, Llano, Uvalde, and Zavala Counties remained in Extreme Drought (D3) and Bandera, Blanco, Burnet, Karnes, Kendall, Maverick, Real, and Val Verde Counties stayed in Severe Drought (D2). Larger public water systems in Real County were in Stage 2 water restrictions. In Bandera, Blanco, Burnet, Karnes, Kendall, and Llano there were Stage 1 restrictions and in Val Verde and Zavala there were voluntary restrictions. Area reservoirs were beginning to drop

				with the most significant impact at Lake Amistad which was 31.1 feet below Conservation Pool level. Of the counties in D2 or worse drought Karnes, Kendall, Kinney, Maverick, Real, Uvalde, Val Verde, and Zavala had burn bans in effect. No property or crop damages were reported.
January 01, 2020 – January 31, 2020	Drought			There were three precipitation regimes over South Central Texas in January. The area east of Hwy 281 received between 75% and 125% of normal. The area west of Hwy 281 and north of Hwy 90 received between 125% and 300% of normal. The area west of Hwy 281 and south of Hwy 90 received less than 50%. This led to some improvement and some worsening of drought conditions. Maverick County went from Severe (D2) Drought to Extreme (D3) Drought. Atascosa, Caldwell, Comal, De Witt, Dimmit, Frio, Gonzales, Guadalupe, Hays, Williamson, and Wilson Counties moved from no drought to Severe (D2). Kinney, Llano, and Uvalde Counties improved from D3 to D2. Zavala stayed in D3, and Blanco, Burnet, Karnes, and Val Verde stayed in D2. Of the counties in D2 or worse drought Atascosa, Dimmit, Frio, Karnes, Kinney, Maverick, Uvalde, Val Verde, and Zavala had burn bans in place. Larger public water systems in Blanco, Burnet, Karnes, and Llano Counties were in Stage 1 water restrictions and in Val Verde and Zavala there were voluntary restrictions. No property or crop damages were reported.
February 01, 2020 – February 18, 2020	Drought			The northern half of South-Central Texas had above normal precipitation during February. Parts of this region received 125% to 200% of normal. This led to Blanco, Burnet, Comal, Hays, Llano, and Williamson Counties improving to better than Severe (D2) drought category. No property or crop damages were reported.

August 01, 2020 – August 31, 2020	Drought			The U.S. Drought Monitor placed a large portion of West Central Texas in a Severe Drought for the month of August. A period of very hot temperatures and below normal rainfall amounts led to a flash drought across a large part of West Central Texas. These hot temperatures resulted in numerous grass fires. According to the Texas Crop Report, dryland cotton across the northern Edwards Plateau and northwest Hill Country continued to show signs of stress where moisture had been inadequate. Also, some ranchers, in this region, had to provide supplemental feed to their livestock because of the lack of grasses. The U.S. Drought Monitor placed a portion of San Saba County into the severe drought category. No property or crop damages were reported.
November 01, 2020	Drought	USDA S4924	Llano, San Saba	Drought
November 01, 2020 – November 20, 2020	Drought			November was another month of mostly below normal rainfall across South Central Texas. Most of the northern half of the area had less than 50% of normal with some places in the northwest having less than 10%. In most of our counties the drought worsened during the month. Bandera, Comal, Gillespie, Kendall, and Kerr Counties entered Extreme (D3) Drought. Bastrop, Bexar, Blanco, Burnet, Caldwell, Edwards, Guadalupe, Hays, Kinney, Lee, Llano, Real, Travis, Val Verde, and Williamson ended the month in Severe (D2) Drought. Uvalde and Zavala remained in D3, and Dimmit, Frio, and Maverick stayed in D2. Medina County with near normal rain actually improved from D3 to D2. Public water systems across the region had instituted some level of water restrictions. The Pecos, Frio, Nueces, Medina, and lower Guadalupe river basins reported much below normal seven-day stream flows at the end of the month. The upper and middle

				Guadalupe, San Antonio, Blanco, San Marcos. Brazos, and Colorado river basins reported below normal seven-day flows. Reservoirs in the drought areas were below normal with Lake Amistad 44 feet below normal. All of the counties in D2 or worse drought had outdoor burn bans in effect except Burnet, Kerr, and Bastrop. No property or crop damages were reported.
November 01, 2020 – November 20, 2020	Drought			The month of November featured an extended period of dry weather, above normal temperatures and well below normal rainfall. According to the U.S. Drought Monitor, the drought became severe over a large part of West Central Texas by the middle of November, especially south of Interstate 20. The drought was exceptional in portions of McCulloch and Mason Counties. According to the Agrilife Texas Crop and Weather Report, the area from Barnhart to San Saba and north across I20, needed moisture. Wheat and oat fields were progressing slowly. Stock tank levels remained very low. Cotton harvest continued with below average yields reported. Pecan harvest was mixed with some reporting low yields and others reporting fair to good yields. Feeder cattle prices were mostly steady at local auctions with steer prices up \$10-15 per hundredweight. South of Barnhart to San Saba across I10, Trace amounts of rain were reported, but more rain was needed. Spring wheat planting began with oats and rye coming along nicely. Livestock conditions were good with supplemental feeding. Wildlife were in fair condition. U.S. Drought Monitor placed a large part of San Saba County in a severe drought category by November 17. The extreme southwest part of the county was in an exceptional drought. No property or crop damages were reported.

December 01, 2020 – December 31, 2020	Drought			The drought continued over most of South-Central Texas in December. Most of the area had less than normal precipitation during the month. Drought conditions worsened from Severe (D2) to Extreme (D3) in Caldwell, Guadalupe, Kinney, Val Verde, and Williamson Counties and from Moderate (D1) to D2 in Fayette County. Bandera, Comal, Gillespie, Kendall, Kerr, Uvalde, and Zavala Counties remained in D3 and Bastrop, Bexar, Blanco, Burnet, Dimmit, Edwards, Frio, Hays, Lee, Llano, Maverick, Medina, Real, and Travis remained in D2. Large public water systems in Austin, Del Rio, Fredericksburg, Kerrville, New Braunfels, San Antonio, San Marcos, and Uvalde had some level of water restrictions. Most area reservoirs were below Conservation Pool level. Lake Amistad was 43.3 feet below, Medina Lake 32.2 feet, and Lake Travis 21.8 feet. Outdoor burn bans were in effect in Bandera, Bexar, Dimmit, Edwards, Frio, Kendall, Kinney, Maverick, Medina, Real, Val Verde, and Zavala Counties. No property or crop damages were reported.
December 01, 2020 – December 31, 2020	Drought			Lack of rainfall has caused the drought to continue to expand and worsen in December. According to the Texas Ag Report from Agrilife, small-grain growth slowed due to drought, and insect pests increased. Livestock looked fair to poor due to the lack of grazing. Supplemental feeding of livestock increased. U.S. Drought monitor placed San Saba County in severe drought across the extreme western part of the county and severe drought in the middle part of the county. No property or crop damages were reported.
December 22, 2020	Drought	USDA S4902	San Saba	Drought
January 01, 2021 – January 31, 2021	Drought			Most of South-Central Texas received enough rain to bring drought relief in January. Bastrop, Blanco, Burnet,

				Caldwell, Edwards, Fayette, Gillespie, Guadalupe, Hays, Kendall, Kerr, Kinney, Lee, Llano, Maverick, Real, Travis, Val Verde, and Williamson Counties all improved to better than Severe (D2) Drought. No property or crop damages were reported.
November 01, 2021	Drought	USDA S5158	Llano, San Saba	Drought
January 01, 2022 – January 31, 2022	Drought			Most of west central Texas experienced an intensifying drought during January. The US Drought Monitor indicated severe to extreme drought conditions across San Saba County during January. No property or crop damages were reported.
January 01, 2022 – January 31, 2022	Drought		Llano	Most of the western half of South-Central Texas received less than 25% of normal precipitation during January and the north central part of the area had less than 75% of normal. The lack of rainfall led to Severe (D2) Drought conditions developing in Atascosa, Bandera, Blanco, Burnet, Frio, Gillespie, Kendall, Kerr, Kinney, Llano, Medina, Real, Uvalde, and Zavala Counties. Dimmit County worsened from Severe to Extreme (D3) and Edwards, Maverick, and Val Verde remained in D2. At the end of the month, the seven-day streamflow for rivers in the region were below to much below normal. The Edwards Aquifer was 4.6 feet below normal. Area reservoirs were below normal. Lake Amistad was 48 feet below normal, and Medina Lake was 47.3 feet below normal. Of the counties in D2 or worse drought Atascosa, Blanco, Burnet, Dimmit, Frio, Kendall, Kinney, Llano, Maverick, Val Verde, and Zavala had outdoor burn bans in effect. No property or crop damages were reported.
February 01, 2022 – February 28, 2022	Drought			Another month of below normal precipitation left much of South-Central Texas in Severe (D2) or worse drought conditions. Dimmit County stayed in Extreme (D3) drought and Atascosa, Bandera, Blanco, Burnet,

			Edwards, Frio, Gillespie, Kendall, Kerr, Kinney, Llano, Maverick, Medina, Real, Uvalde, Val Verde, and Zavala Counties remained in D2. The 7-day average streamflow at the end of the month was Much Below normal on the Frio, Medina, San Antonio, Upper Guadalupe, Pedernales, and Llano Rivers. It was Below normal on the Nueces River. Fredericksburg was in Stage 3 water restrictions. The Edwards Aquifer was 9.6 feet below normal. Area lakes and reservoirs were below normal with Lake Amistad 48.3 feet below and Medina Lake 48.1 feet below. Atascosa, Blanco, Dimmit, Frio, Kendall, Kinney, Llano, Maverick, Uvalde, Val Verde, and Zavala Counties had outdoor burn bans in effect. No property or crop damages were reported.
March 01, 2022 – March 31, 2022	Drought		The dry conditions rolled on through March resulting in severe to extreme drought conditions across much of the area. The U.S. Drought Monitor indicated severe to extreme drought conditions across San Saba County during March. No property or crop damages were reported.
March 01, 2022 – March 31, 2022	Drought		Nearly all of South-Central Texas had below normal precipitation during the month and the area west of a line from Burnet to San Antonio and Pleasanton had less than 25% of normal. This worsened the drought across the region. Dimmit County ended the month in Exceptional (D4) drought category. Atascosa, Bandera, Blanco, Burnet, Edwards, Frio, Gillespie, Kendall, Kerr, Kinney, Llano, Maverick, Medina, Real, Uvalde, Val Verde, and Zavala Counties moved into Extreme (D3) drought. Bexar, Comal, De Witt, Gonzales, Guadalupe, Karnes, and Wilson entered Severe (D2) drought. Fredericksburg was in Stage 3 water restrictions and San Antonio and New Braunfels were in Stage 1. The Edwards Aquifer was 15.4 feet below normal at the end of the

				month. Area reservoirs were down with Lake Amistad 51.3 feet below conservation pool level and Medina Lake 51.6 feet below. The only counties in D2 or worse drought without a burn ban in effect at the end of the month were Bexar, Edwards, and Kerr. No property or crop damages were reported.
April 01, 2022 – April 30, 2022	Drought			The drought persisted across much of west central Texas during April. Most areas reported severe to extreme conditions. The US Drought Monitor indicated extreme to exceptional drought conditions across San Saba County during April. No property or crop damages were reported.
April 01, 2022 – April 30, 2022	Drought			Most of South-Central Texas had another dry month in April with all but a few spots receiving less than normal rainfall. This led to a worsening of drought conditions for Atascosa, Bandera, Burnet, Gillespie, Llano, Medina, Real, and Uvalde Counties all of which went from Extreme (D3) drought to Exceptional (D4) drought conditions. Bexar, Karnes, and Wilson Counties went from Severe (D2) drought to D3 drought. Lavaca County went into D2 drought. Blanco, Edwards, Frio, Kendall, Kerr, Kinney, Maverick, and Zavala Counties remained in D3. Comal, De Witt, Gonzales, and Guadalupe Counties remained in D2. Near normal rain moved Dimmit County from D4 to D3 and above normal precipitation moved Val Verde County from D3 to D2. All public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some the larger services had the following: Fredericksburg Stage 3, New Braunfels Stage 2, San Antonio Stage 2, Del Rio Stage 1, Kerrville Stage 1, and Pleasanton Stage 1. The Edwards Aquifer was 19.6 feet below normal at the end of the month. Area reservoirs were generally below normal



				conservation pool levels with Lake Amistad 55.7 feet below normal and Medina Lake 56.5 feet below normal. All the counties in D2 or worse drought had outdoor burn bans in effect except Uvalde, Gonzales, and Lavaca. The 7-day streamflow at the end of the month was well below normal on the rivers across the northern part of South-Central Texas and below normal across the southern part of the area. No property or crop damages were reported.
May 01, 2022 – May 31, 2022	Drought			May was another dry month across most of South-Central Texas which exacerbated the ongoing drought. In Blanco, Karnes, Kendall, and Kerr Counties the drought worsened to Exceptional (D4) drought. Hays and Williamson Counties moved into Severe (D2) drought for the first time. Bandera, Gillespie, Medina, Real, and Uvalde remained in D4. Bexar, Edwards, Frio, Kinney, Maverick, Wilson, and Zavala stayed in Extreme (D3) drought. Comal, De Witt, Gonzales, Guadalupe, Lavaca, and Val Verde remained in D2. There were a few small areas that had above normal rainfall and the drought category improved. Atascosa, Burnet, and Llano improved from D4 to D3. Dimmit improved from D3 to D2. All public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some the larger systems had the following: Fredericksburg Stage 3, New Braunfels Stage 2, San Antonio Stage 2, San Marcos Stage 2, Austin Stage 1, Del Rio Stage 1, Kerrville Stage 1, and Pleasanton Stage 1. The Edwards Aquifer was 26.4 feet below normal. Area reservoirs were below normal Conservation Pool level. Lake Amistad was 58.0 feet below normal; Medina Lake was 61.5 feet below normal, and Lake Travis was 28.5 feet below normal. Rivers across the region were below or much below

				normal seven-day streamflow at the end of the month. All the counties in D2 or worse drought had outdoor burn bans in effect at the end of the month. No property or crop damages were reported.
May 01, 2022 – May 31, 2022	Drought			The drought continued and intensified across much of the area, besides Crockett County, during the month of May. The US Drought Monitor indicated mainly exceptional drought conditions across San Saba County during the month of May. No property or crop damages were reported.
June 01, 2022 – June 30, 2022	Drought			June was another month with below normal precipitation across South Central Texas and the drought continued to worsen. Atascosa and Edwards Counties moved from Extreme (D3) to Exceptional (D4) drought. Comal, De Witt, Gonzales, and Guadalupe moved from Severe (D2) to D3. Caldwell, Lee, and Travis moved into D2. Bandera, Blanco, Gillespie, Karnes, Kendall, Kerr, Medina, Real, and Uvalde remained in D4. Bexar, Burnet, Frio, Kinney, Llano, Maverick, Wilson, and Zavala remained in D3. Dimmit, Hays, Lavaca, Val Verde, and Williamson remained in D2. All public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some the larger services had the following: Fredericksburg Stage 3, New Braunfels Stage 3, San Antonio Stage 2, San Marcos Stage 2, Austin Stage 1, Del Rio Stage 1, Kerrville Stage 1, and Pleasanton Stage 1. The Edwards Aquifer dropped 1.9 feet and was 28.3 feet below normal. Area reservoirs continued to fall farther below normal conservation pool levels. Lake Amistad fell 4.5 feet to 62.5 feet below normal; Medina Lake was down 4.7 feet to 66.2 below normal, and Lake Travis dropped 2.5 feet to 31.0 feet below normal. All the counties in D2 or worse drought had outdoor burn bans

				in effect. The 7-day average streamflow on the Upper Guadalupe River was near the all-time low. All the other rivers in the region were below to much below normal. No property or crop damages were reported.
June 01, 2022 – June 30, 2022	Drought			The drought persisted across much of West Central Texas during the month of June. The US Drought Monitor indicated severe/exceptional drought conditions across San Saba County during the month of June. No property or crop damages were reported.
July 01, 2022 – July 31, 2022	Drought			The drought intensified across much of west central Texas during July. The US Drought Monitor indicated extreme/exceptional drought conditions across San Saba County during the month of July. No property or crop damages were reported.
July 01, 2022 – July 31, 2022	Drought			July was another month with below normal precipitation across nearly all of South-Central Texas and the drought continued to worsen. Bexar, Gonzales, Guadalupe, Karnes, Kinney, Maverick, Uvalde, Wilson, and Zavala Counties moved from Extreme (D3) to Exceptional (D4) drought. Caldwell, Dimmit, Hays, Lavaca, Lee, Travis, and Williamson moved from Severe (D2) to D3. Bastrop and Fayette moved into D2. Atascosa, Bandera, Blanco, Gillespie, Kendall, Kerr, Medina, and Real remained in D4. Burnet, Comal, De Witt, Frio, and Llano remained in D3. Val Verde remained in D2. Edwards County which had some areas get above normal rainfall improved from D4 to D3. All public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some the larger services had the following: Fredericksburg Stage 3, New Braunfels Stage 3, San Antonio Stage 2, San Marcos Stage 2, Austin Stage 1, Del Rio Stage 1, Kerrville Stage 1, and Pleasanton Stage 1. Georgetown declared Stage 2 this month, and Hutto declared Stage 3.

				The Edwards Aquifer dropped 1.3 feet and was 27.2 feet below normal. Area reservoirs continued to fall farther below normal conservation pool levels. Lake Amistad fell 1.4 feet to 63.9 feet below normal; Medina Lake was down 5.3 feet to 71.5 below normal, and Lake Travis dropped 3.5 feet to 34.5 feet below normal. All the counties in D2 or worse drought had outdoor burn bans in effect. The 7-day average streamflow on the Upper Guadalupe River was near the all-time low. All the other rivers in the region were below to much below normal. No property or crop damages were reported.
August 01, 2022 – August 31, 2022	Drought			Several heavy rain episodes during August led to above normal precipitation across South Central Texas. Much of the western half of the area received three to four times their normal. The result was improvement on the drought in all but two counties. The central part of the area had the least rain and Comal County was the only county that saw the drought worsen from Extreme (D3) category to Exceptional (D4) category. Next door Hays County remained in D3. All other counties saw improvement. Bandera, Gillespie, Gonzales, Kerr, Kinney, Maverick, Real, Uvalde, and Wilson improved from D4 to Severe (D2) category. Bexar, Blanco, Guadalupe, Kendall, and Medina improved from D4 to D3. Burnet, Caldwell, Llano, and Williamson improved from D3 to D2. Of the counties in D2 or worse drought Maverick, Kerr, Bandera, Medina, Bexar, Comal, Hays, and Wilson had outdoor burn bans in effect at the end of the month. The 7-day average streamflow on the Nueces River was normal (25%-75%), the Frio River was much below normal (<10%), the Medina River was below normal (10%-24%), the San Antonio River was normal, the upper Guadalupe River was much below

				normal, the lower Guadalupe River was below normal, the upper Colorado River was normal to below normal, and the lower Colorado River was below to much below (<10%) normal. The Edwards Aquifer rose 4.2 feet but was still 27.2 feet below normal. Lake Amistad rose 9.8 feet but was still 54.1 feet below normal conservation pool level. Medina Lake dropped 4.2 feet and was 75.7 feet below normal and Lake Travis fell 1.7 feet to 36.2 feet below normal. Most public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some of the larger services had the following: Fredericksburg Stage 3, New Braunfels Stage 1, San Antonio Stage 2, San Marcos Stage 2, Austin Stage 1, Kerrville Stage 1, and Georgetown Stage 2. No property or crop damages were reported.
August 01, 2022 – August 31, 2022	Drought			The drought intensified across west central Texas during the month of August. The extreme/exceptional conditions expanded to cover 79 percent of the area. The US Drought Monitor indicated extreme drought conditions across San Saba County during the month of August. No property or crop damages were reported.
September 01, 2022 – September 30, 2022	Drought			After beneficial rain in August, dry weather returned in September. Most of South-Central Texas had below normal precipitation and drought conditions worsened or remained the same. Guadalupe and Hays Counties worsened from Extreme (D3) category to Exceptional (D4) category. Bandera and Caldwell went from Severe (D2) category to D3. Bastrop, Fayette, Lavaca, and Travis worsened to D2. Comal remained in D4. Bexar, Blanco, Kendall, and Medina stayed in D3. Burnet, Gillespie, Gonzales, Kerr, Kinney, Llano, Maverick, Real, Uvalde, Williamson, and Wilson remained in D2. Of the counties in D2 or worse

				drought Comal, Hays, Bexar, Blanco, Caldwell, Medina, Fayette, Maverick, Travis, and Wilson had outdoor burn bans in effect. At the end of the month the 7-day average streamflow was much below (<10%) normal on the Frio River, below (10%-24%) normal on the Medina River, below normal on the San Antonio River, much below normal on the Guadalupe River, normal to below normal on the upper Colorado River, and much below normal on the lower Colorado. The Edwards Aquifer dropped 3.6 feet and was 32.2 feet below normal at the end of the month. Area reservoirs continued to lose water. Medina Lake was down 1.1 feet to 76.8 feet below conservation pool level, and Lake Travis was down 2.0 feet to 38.2 feet below conservation level. Lake Amistad rose 12.6 feet during the month due to rainfall in Mexico but was still 41.5 feet below conservation level. Most public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some the larger services had the following: New Braunfels Stage 1, San Antonio Stage 2, Austin Stage 1, and Kerrville Stage 1. No property or crop damages were reported.
September 01, 2022 – September 30, 2022	Drought			The drought weakened across west central Texas during the month of September. The US Drought Monitor indicated moderate/severe drought conditions across San Saba County during the month of September. No property or crop damages were reported.
October 01, 2022 – October 31, 2022	Drought			The drought remained across much of west central Texas during the month of October. The US Drought Monitor indicated moderate/severe drought conditions across San Saba County during the month of October. No property or crop damages were reported.

October 01, 2022 – October 31, 2022	Drought			Rainfall was a bit of a mixed bag in October. A swath of the central part of the area had 10-50% of normal. The area along the Rio Grande had 100-200% of normal. The rest of the area was in between. There was enough rainfall in Bandera County for that county to improve from Extreme (D3) drought to Severe (D2) drought. Lack of rain worsened the drought from D2 to D3 in Fayette and Gonzales Counties. All other counties remained where they were in September. Comal, Guadalupe, and Hays stayed in Exceptional (D4) drought. Bexar, Blanco, Caldwell, Kendall, and Medina remained in D3. Bastrop, Burnet, Gillespie, Kerr, Kinney, Lavaca, Llano, Real, Travis, Uvalde, Williamson, and Wilson stayed in D2. Of the counties in D2 or worse drought Comal, Guadalupe, Hays, Bexar, Blanco, Caldwell, Fayette, Gonzales, Kendall, Medina, Burnet, Gillespie, Llano, Travis, and Wilson had outdoor burn bans in effect at the end of the month. The 7-day average streamflow at the end of the month was normal (25%-75%) to below normal (10%-24%) on the Nueces River, much below normal (<10%) on the Frio River, below normal (10%-24%) on the Medina River, below normal (10%-24%) on the San Antonio River, much below normal (<10%) on the upper and lower Guadalupe River, and normal (25%-75%) to below normal (10%-24%) on the upper Colorado River. Area reservoirs were below normal pool level. Lake Amistad rose 4.5 feet but was still 37.0 feet below normal. Medina Lake decreased 1.2 feet to 78.0 feet below normal and Lake Travis dropped 2.4 feet to 40.6 feet below normal. The Edwards Aquifer rose 2.3 feet but was 33.2 feet below average. Most public water systems encouraged at least voluntary water restrictions, and many had mandatory restrictions in effect. Some of the larger services had the following: New

				Braunfels Stage 1, San Antonio Stage 2, Austin Stage 1, and Kerrville Stage 1. No property or crop damages were reported.

Sources: NOAA 2023; USDA 2023; FEMA 2023

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drought events for the County. Information from NOAA-NCEI storm events database and the 2018 State of Texas HMP were used to identify the number of drought events that occurred between 1950 and 2022. Table 4.3.2-2 presents the probability of future events for the dam/levee failure in Herkimer County.

Table 4.3.2-2. Probability of Future Drought Events

Hazard Type	Number of Occurrences Between 2017 and 2022	% Chance of Occurring in Any Given Year
Drought	47	65.27%

Sources: NOAA 2023; TDEM 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all drought events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for drought in the Planning Area is considered ‘occasional’.

Climate Change Projections

The climate of Texas is changing. Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as droughts. While predicting changes of drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2016).

With a warmer climate, droughts can become more frequent, more severe, and longer lasting. According to the National Climate Assessment, variable precipitation and rising temperatures are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in water survey quality. Future warming will add to the stress on water supplies and impact the availability of water supply (USGCRP 2018).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the drought hazard; therefore, all assets within Llano County and San Saba County (population, structures, critical facilities, and lifelines), as described in Section 3 (County Profile), are potentially vulnerable to a drought event. The following text evaluates and estimates the potential impact of the drought hazard in Llano County and San Saba County as a whole.

Impact on Life, Health, and Safety

The entire population of Llano County and San Saba County is vulnerable to drought events (2020 Census: 21,243 in Llano County, 5,730 in San Saba County). Drought conditions can affect public health and safety, including reduced local firefighting capabilities, health problems related to low water flows and poor water quality, and health problems related to dust. If droughts are severe enough, these health problems can lead to loss of human life.

Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources, the infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions. Some drought-related health effects are short term, while others can be long term (CDC 2012).

Impact on General Building Stock

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can have significant impacts on other types of property such as landscaped areas and economically important natural resources.

Impact on Critical Facilities

Water supply facilities may be affected by drought events. However, a majority of the critical facilities defined for this plan will continue to be operational during a drought.

Impact on Economy

Drought causes the most significant economic impacts on industries that use water or depend on water for their business, most notably agriculture and related sectors, power plants, and oil refineries. In addition to losses in yields in crop and livestock production, drought is associated with increased insect infestations, plant diseases, and wind erosion. Drought can lead to other losses because so many sectors interconnected. This can lead to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue. Prices for food, energy, and other products may also increase as supplies decrease.

According to the 2017 Census of Agriculture, Llano County has 523,436 acres of farmland, resulting in a \$15.7 million market value of products sold (USDA 2017). Saba County has 660,016 acres of farmland, resulting in a \$35.8 million market value of products sold (USDA 2017).

According to the 2018 State of Texas HMP, between 1996 and 2016, Llano County experienced drought-related losses (property plus crop losses) ranging between \$143 million and \$3.1 billion. San Saba County did not experience drought-related losses (TDEM 2018).

Impact on the Environment

Drought can impact the environment because it can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2000). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods

because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the drought hazard because the entire Planning Area is exposed and vulnerable to droughts. Future growth and development could impact the amount of potable water available due to a drain on the available water resources. An increased drain on water resources would not only impact the Planning Area's population, but it would also exacerbate impacts to other areas of the Planning Area as discussed above, including agriculture and recreational facilities.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

With an increase in population, the demand for water supply will increase. During a drought, the amount of water needed might not be available. This might require reallocation of water resources to meet demands during a drought. If needed, the counties can pass special ordinances regulating the amount of water consumed and used during periods of drought to conserve water.

Climate Change

Climate change has the potential to impact the number of and the severity of droughts. An increased incidence of drought might impact availability of water supplies, primarily placing an increased stress on the population. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, could increase and threaten structures. If a wildfire were to occur during a drought, emergency services might face complications from a water shortage depending on their water source, and critical water-related service sectors might need to adjust management practices and actively manage resources. Increased incidence of drought increases the potential for impacts on the local economy, including the production of agricultural products.

Change of Vulnerability Since 2016 HMP

Since the 2016 HMP, Llano County has grown in population, while San Saba County has decreased in population. Overall, Llano County and San Saba County will continue to be exposed and vulnerable to drought events.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.3 Extreme Temperatures

The following section provides the hazard profile and vulnerability assessment for the extreme temperatures hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Extreme Heat

Extreme heat events are defined by the U.S. Environmental Protection Agency (EPA) as “summertime weather that is substantially hotter or more humid than average for a location at that time of year” (US EPA 2016). Criteria that define an extreme heat event may differ among jurisdictions and in the same jurisdiction depending on the time of year.

The summer months in Texas are frequently affected by extreme heat hazards. Persistent domes of high pressure establish themselves, which set up hot and dry conditions. This high pressure prevents other weather features such as cool fronts or rain events from moving into the area and providing necessary relief. Daily high temperatures range into the upper 90s and low 100s. When combined with moderate to high relative humidity levels, the heat index moves into dangerous levels, and a heat index of 105°F is considered the level where many people begin to experience extreme discomfort or physical distress (Llano County 2016).

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. What constitutes as extreme cold varies in different parts of the country. In the southern United States, near freezing temperatures are considered extreme cold. Freezing temperatures can cause severe damage to citrus fruit crops and other vegetation. Pipes may freeze and burst in homes that are poorly insulated or without heat (NWS n.d.).

Extreme cold often accompanies a winter storm or is left in its wake. It is most likely to occur in the winter months of December, January, and February. Prolonged exposure to the cold can cause frostbite or hypothermia and can become life-threatening. Infants and the elderly are most susceptible. Pipes may freeze and burst in homes or buildings that are poorly insulated or without heat. Extreme cold can disrupt or impair communications facilities (Llano County 2016) (San Saba County 2016).

Location

Extreme Heat

All of the state is vulnerable to extreme heat. In addition, large metropolitan areas, such as Dallas/Fort Worth and Houston may experience extreme heat since they have an abundance of concrete which absorbs and then radiates solar energy. This effect is known as urban heat island and can be dangerous to those without air conditioners (State of Texas 2018).

The record highs for Texas occurs during May through October. Llano County experiences an average of 13 100°F-and-above days during these months according to data recorded by the National Weather Service between 1900 and 2014. San Saba County experiences an average of 17 days with temperatures 100°F or above during these months, according to data recorded by the National Weather Service between 1900 and 2014.

The entire planning area is at risk to extreme heat events; however, these events may be exacerbated in urban areas, where reduced air flow, reduced vegetation, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding rural (Llano County and San Saba Unincorporated Areas) or less urbanized areas. This phenomenon is known as urban heat island effect. This can happen in the City of Llano, Horseshoe Bay, and Sunrise Beach Village in Llano County and in the City of San Saba and Richland Springs in San Saba County (Llano County 2016) (San Saba County 2016).

Extreme Cold

Extreme cold can happen anywhere in the state, although its levels can range extensively. In the panhandle extreme cold means days below zero Fahrenheit while in the Rio Grande Valley it means reaching temperatures below freezing (State of Texas 2018).

The record lows for Texas occurs during October through March. The average first freeze in the HMP update area usually occurs late November to early December and the last freeze late February to early March according to data recorded by the National Weather Service.

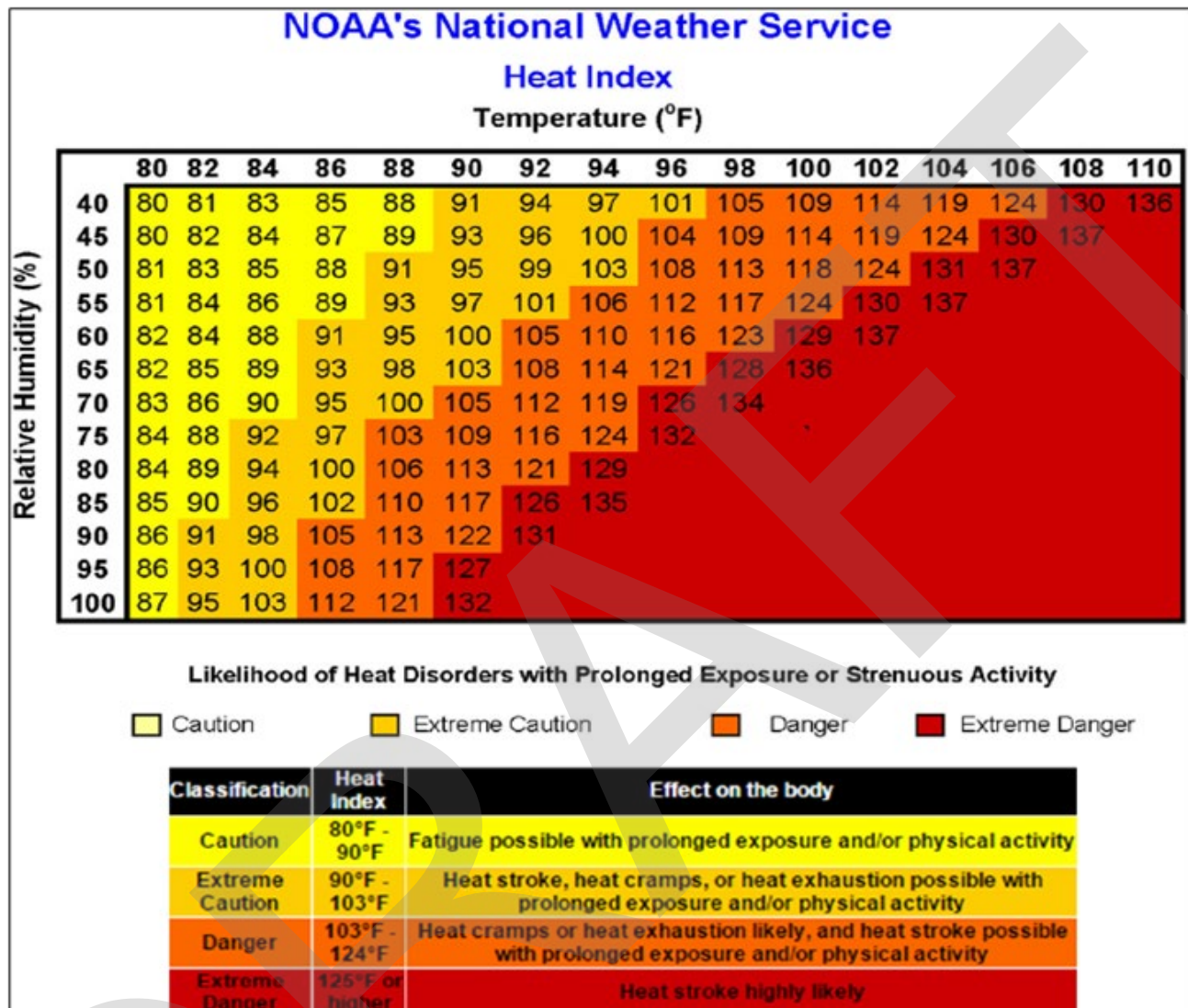
All participating communities in the project area do not experience extreme cold temperature events consistently, but the events can affect the HMP update area (Llano County 2016) (San Saba County 2016).

Extent

Extreme Heat

The extent of extreme heat temperatures generally is measured through the Heat Index. Heat index tables (see Figure 4.3.3-1) are commonly used to provide information about how hot it feels, which is based on the interactions between several meteorological conditions. Since heat index values were devised for shady, light wind conditions, exposure to full sunshine can increase heat index values by up to 15 degrees Fahrenheit (°F). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous. Extreme heat is defined as a combination of very high temperatures and, usually, exceptionally humid conditions. When persisting over a period of time, it is called a heat wave (State of Texas 2018).

Figure 4.3.3-1. NOAA's National Weather Service Heat Index Table (°F)



Source: NOAA National Weather Service

Each National Weather Service office issues some or all of the following heat-related products as conditions warrant (Table 4.3.3-1):

Table 4.3.3-1. National Weather Service Alerts for Extreme Heat

Alert	Criteria
Excessive Heat Warning—Take Action!	An Excessive Heat Warning is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you don't take precautions immediately when conditions are extreme, you may become seriously ill or even die.

Excessive Heat Watches—Be Prepared!	Heat watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. A Watch is used when the risk of a heat wave has increased but its occurrence and timing is still uncertain.
Heat Advisory—Take Action!	A Heat Advisory is issued within 12 hours of the onset of extremely dangerous heat conditions. The general rule of thumb for this Advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you don't take precautions, you may become seriously ill or even die.
Excessive Heat Outlooks—Be Aware!	The outlooks are issued when the potential exists for an excessive heat event in the next 3-7 days. An Outlook provides information to those who need considerable lead-time to prepare for the event.

Source: NWS n.d.

Worst-Case Scenario

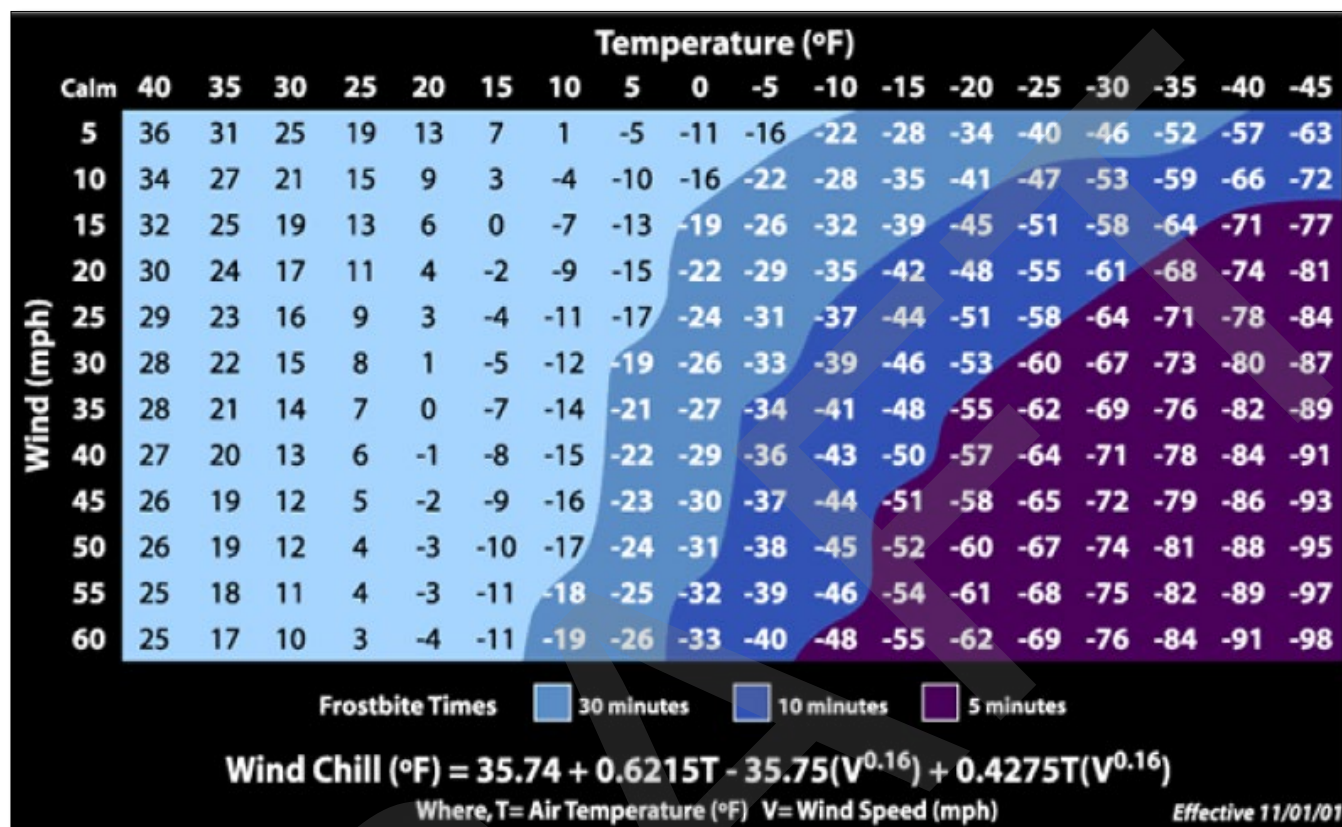
An extreme multi-year drought with extreme heat conditions could impact the region with little warning. Combinations of low precipitation and unusually high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the planning area, increasing the need for water. Surrounding communities, also in drought and extreme heat conditions, could increase their demand for water supplies relied upon by the planning partnership, causing social and political conflicts. If such conditions persisted for several years, the economy of both Llano County and San Saba County could experience setbacks, especially in water dependent industries. The following are extreme heat-related issues:

- Identification and development of alternative water supplies.
- Utilization of groundwater recharge techniques to stabilize the groundwater supply.
- The probability of increased drought frequencies and durations due to climate change.
- The promotion of active water conservation even during non-drought periods.
- Increasing vulnerability to drought over time as demand for water from different sectors increases.
- The effects of climate change may result in an increase in frequency of extreme heat events.
- The effects of recent droughts have exposed the vulnerability of the planning areas economy to drought events.
- Environmental and erosion control impact analysis for transportation projects.
- Wildlife habitat management for landowners.
- Human health impacts from droughts and extreme heat.
- Monitoring and evaluating risks to power supply and water rights.
- Development of mitigation- or response-based state drought plans.

Extreme Cold

In 2001, the NWS implemented an updated wind chill temperature index (see Figure 4.3.3-2). This index describes the relative discomfort or danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature (NOAA 2022).

Figure 4.3.3-2. National Weather Service Wind Chill Chart (°F)



Source: NWS 2019

The NWS provides alerts when Wind Chill indices approach hazardous levels. Table 4.3.3-2 explains these alerts.

Table 4.3.3-2. National Weather Service Alerts for Extreme Cold

Alert	Criteria
Wind Chill Warning – Take Action!	NWS issues a wind chill warning when dangerously cold wind chill values are expected or occurring. If you are in an area with a wind chill warning, avoid going outside during the coldest parts of the day. If you do go outside, dress in layers, cover exposed skin, and make sure at least one other person knows your whereabouts. Update them when you arrive safely at your destination.
Wind Chill Watch – Be Prepared	NWS issues a wind chill watch when dangerously cold wind chill values are possible. As with a warning, adjust your plans to avoid being outside during the coldest parts of the day. Make sure your car has at least a half a tank of gas and update your winter survival kit.
Wind Chill Advisory – Be Aware	NWS issues a wind chill advisory when seasonably cold wind chill values, but not extremely cold values are expected or occurring. Be sure you and your loved one's dress appropriately and cover exposed skin when venturing outdoors.

Source: NWS n.d.

The most significant secondary hazards associated with extreme cold temperatures occur after a severe winter storm when there are falling and downed trees, landslides, and downed power lines. Heavy rain and icy conditions

can overwhelm both natural and manmade drainage systems, causing overflow and property destruction. Landslides occur when the soil on slopes becomes oversaturated and fails. Additionally, the storms may result in closed highways and blocked roads. It is not unusual for motorists and residents to become stranded. Annually, icy conditions and frozen pipes cause damage to residences and businesses. Late season winter events will typically cause some plant and crop damage (Llano County 2016) (San Saba County 2016).

Worst-Case Scenario

Primarily, the extreme cold faced in Llano and San Saba Counties is coupled with severe winter weather. A worst-case event would involve prolonged high winds during a winter storm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Important issues associated with a winter storm in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to winter weather, particularly freezing temperatures, high winds, and ice.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- Future efforts should be made to identify populations at risk and determine special needs during a winter storm event

Previous Occurrences and Losses

Extreme Heat

During 2011, Texas experienced the hottest summer in U.S. history with an average temperature of 86.8°F. Llano County experienced over 90 100°F-and-above days in 2011, while San Saba County experienced 77 100°F-and-above days (Llano County 2016) (San Saba County 2016).

Even though the NOAA storm events database reports only limited past events for extreme heat, the local participating communities in this HMP update report that extreme heat days do occur a few days in the year during the summer months (NOAA 2022).

Extreme Cold

The record lows for Texas occurs during October through March. The average first freeze in the HMP update area usually occurs late November to early December and the last freeze late February to early March according to data recorded by the National Weather Service.

In January 1940, Llano County experienced the coldest month on record with mean temperature of about 38.6°F. The coldest recorded winter for the area was in 1979, with a mean temperature of about 46.2°F (Llano County 2016). Similarly, the San Saba County area experienced the coldest month on record in January 1940 as well, with a mean temperature of 38.1°F. The coldest recorded winter for the area was in 1978, with a mean temperature of about 43.1°F (San Saba County 2016).

All participating communities in the project area do not experience extreme cold temperature events consistently, but the events can affect the HMP update area (Llano County 2016) (San Saba County 2016).

FEMA Disaster Declarations

Between 1954 and 2022, Llano County and San Saba County were included in no disaster (DR) or emergency (EM) declarations for extreme heat-related events. Between 1954 and 2022, Llano County and San Saba County were



included in two disaster (DR) or emergency (EM) declarations for extreme cold-related events; the two declarations, FEMA DR-4586 and FEMA-3554-EM, were for the same event, Winter Storm Uri.

Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Llano County and San Saba County were not included in extreme heat-related agricultural disaster declarations. Between 2012 and 2022, Llano County and San Saba County were not included in extreme cold-related agricultural disaster declarations (USDA FSA 2022).

Previous Events

For this 2023 HMP update, known extreme heat events that impacted the Planning Area between 2017 and 2022 are discussed below. The National Climatic Data Center lists two extreme heat events that impacted Llano County, one in July 2018 and the second in July 2020. For both events, there were no declarations from FEMA or the USDA. San Saba County did not have any extreme heat related events occur between 2017 and 2022. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.3- 3. Extreme Temperature Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
July 19, 2018	Excessive Heat	N/A	N/A	Strong high pressure settled over South Central Texas, and temperatures soared to record levels. The heat wave started on the 19th in Burnet, Frio, Llano, Medina, Travis, and Williamson Counties with high temperatures reaching 105 and higher. The hot temperatures spread across the region, reaching their greatest extent on the 23rd when 22 counties reached extreme heat criteria.
July 13, 2020	Excessive Heat	N/A	N/A	Temperatures exceeded 105 degrees across Atascosa, Bastrop, Bexar, Burnet, Caldwell, De Witt, Fayette, Gillespie, Gonzales, Guadalupe, Hays, Kerr, Lee, Llano, Medina, Travis, and Uvalde Counties.
February 14, 2021	Severe Winter Storm	FEMA DR-4586, FEMA-3554-EM	Yes, Llano County and San Saba County	A series of weather systems brought several rounds of winter weather to South and West Central Texas from February 11 through February 18. The second round came on the 13th and

			14th with cold air still in place in the low levels, another upper-level shortwave trough moved across Texas providing lift for precipitation. The deeper atmosphere had warm air above the cold leading to a second round of freezing rain. The third round of winter weather was initiated by another upper-level shortwave trough on the 14th and 15th. This system brought cooler air above the boundary layer and turned precipitation to snow. Most of the area had only snow, but there were also short periods of freezing rain in a few places. In addition to the snow, bitterly cold air and breezy winds combined to bring extreme wind chill values on the 15th.

Sources: NOAA 2022; USDA FSA 2022; FEMA 2022; San Saba County 2016; Llano County 2016

Notes: Llano County was affected by the two excessive heat events listed in the above table. San Saba County was not impacted by any heat-related events between the years 2017-2022. No declarations were issued by FEMA or the USDA for either County.

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of extreme heat and cold events for the project area. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2016 Llano HMP and the 2016 San Saba County HMP were used to identify the number of extreme heat and cold events that occurred between 1950 and 2022. Table 4.3.3-4 presents the probability of future events for extreme temperatures in Llano County; Table 4.3.4-5 presents the probability of future events for extreme temperatures in San Saba County.

Table 4.3.3-4. Probability of Future Extreme Temperature Events, Llano County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Excessive Heat	2	2.7%
Heat	0	0%
Extreme Cold / Wind Chill	1	0.01%
Cold / Wind Chill	0	0%

Sources: NOAA 2022; State of Texas 2018; Llano County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all Extreme Heat events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Table 4.3.3-5. Probability of Future Extreme Temperature Events, San Saba County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Excessive Heat	0	0%

Heat	0	0%
Extreme Cold / Wind Chill	1	0.01%
Cold / Wind Chill	2	0.02%

Sources: NOAA 2022; State of Texas 2018; San Saba County 2016

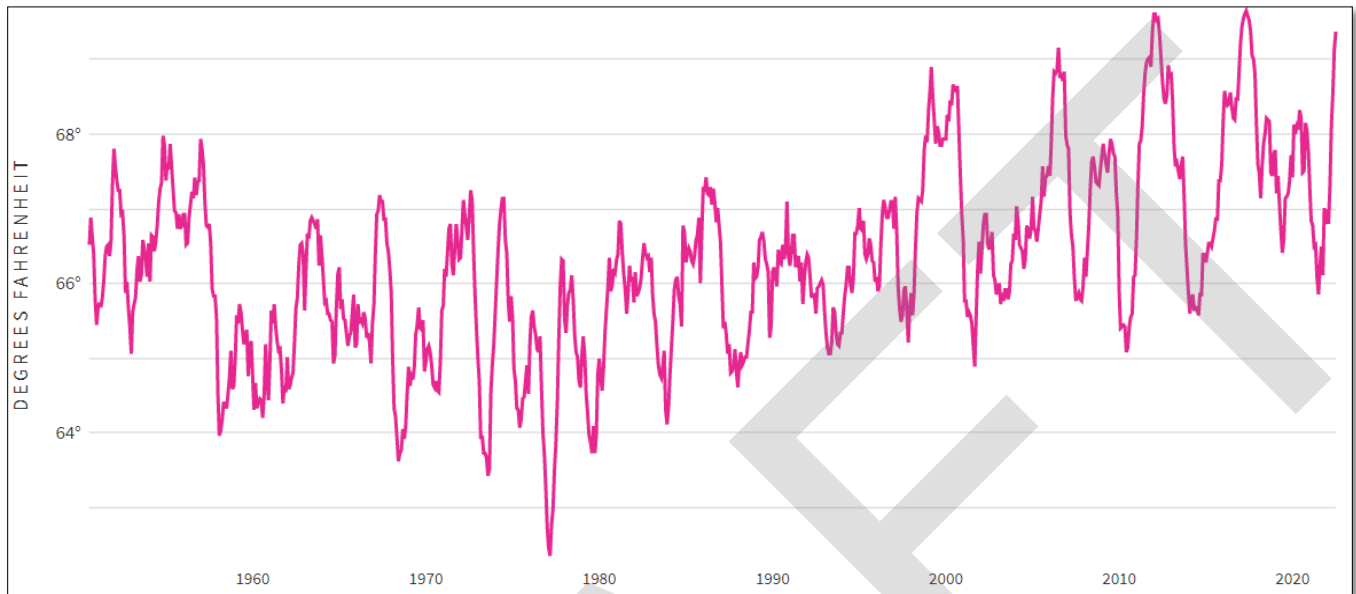
Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all Extreme Heat events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for extreme temperatures in the Planning Area is considered ‘frequent’.

Climate Change Projections

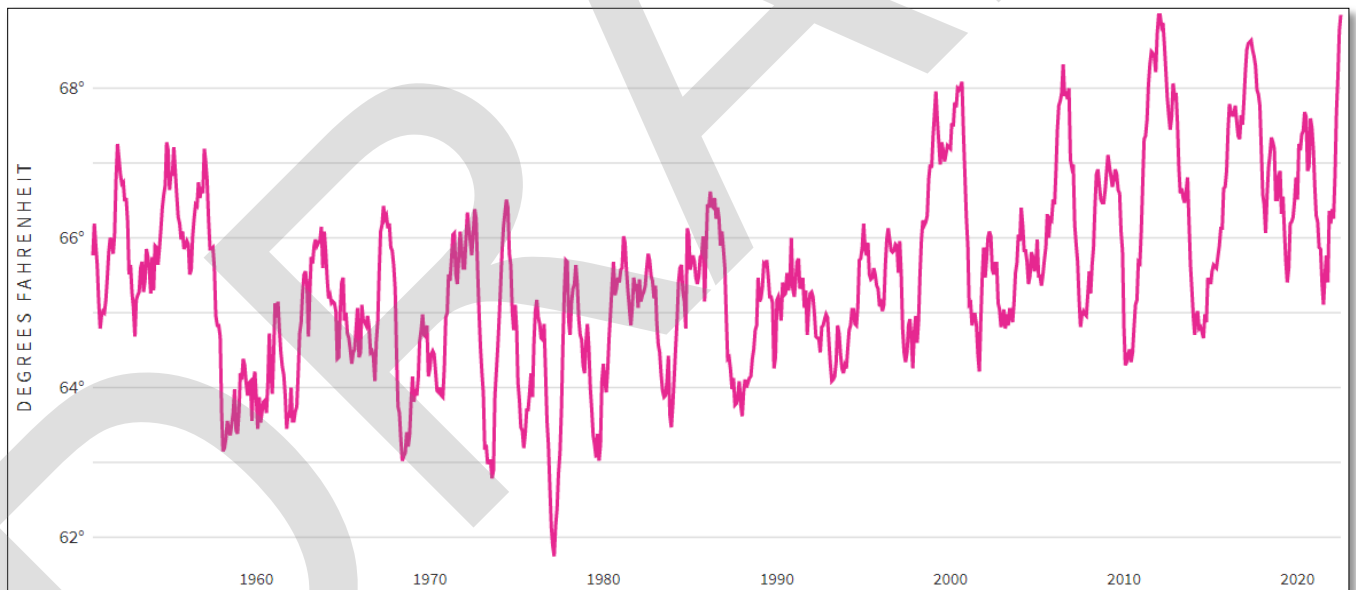
Temperature trends in the project area, like the rest of the globe, are increasing. Between September 1950 to August 2022, the 12-month average temperature in Llano County increased 2.8°F; from September 1950 to August 2022, the 12-month average temperature was 66.3°F (see Figure 4.3.4-3) (USA Facts, NCEI 2022). Similarly, between September 1950 to August 2022 the 12-month average temperature in San Saba County increased 3.2°F; from September 1950 to August 2022, the 12-month average temperature was 65.5°F (see Figure 4.3.4-4) (USA Facts, NCEI 2022).

Figure 4.3.3-3. 12-month temperature averages in Llano County, Sept. 1950 – Aug. 2022



Source: USA Facts, NCEI

Figure 4.3.3-4. 12-month temperature averages in San Saba County, Sept. 1950 – Aug. 2022



Source: USA Facts, NCEI

Extreme heat has always been prevalent in Texas. Unusually hot summer temperatures have become more common across the contiguous 48 states in recent decades, extreme heat events (heat waves) have become more frequent and intense, and these trends are expected to continue. As a result, the risk of heat-related deaths and illness is also expected to increase. Death rates can also change, however, as people acclimate to higher temperatures and as communities strengthen their heat response plans and take other steps to continue to adapt (US EPA 2022).

Extreme cold temperatures have become more prevalent in Texas in recent years. However, extreme cold waves are likely to decrease as winter temperatures increase in the future. This winter warming is expected to reduce the number of direct cold-related deaths, but the decrease is projected to be smaller than increases in heat-related deaths in most regions. This is because some of the factors that lead to higher death rates in the winter are not particularly sensitive to climate change, because extreme heat has a more immediate and direct effect on death rates than extreme cold, and because the solutions to protect against cold exposure (such as staying indoors, wearing more clothing, turning on the heat) are more widely accessible than protection against extreme heat. Cold-related death rates can change as communities strengthen their cold weather plans and take other steps to protect vulnerable people during cold winter months (US EPA 2022).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the extreme temperature hazard. The following text evaluates and estimates the potential impact of the extreme temperature hazard in Llano County and San Saba County as a whole.

Impact on Life, Health, and Safety

The entire population of Llano County (21,243) and San Saba County (5,730) is exposed to the extreme temperature hazard. Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention, populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals with chronic medical conditions (e.g., heart disease, high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC 2007). The number of people vulnerable to extreme temperatures are presented in Table 4.3.4-6.

Table 4.3.3-6. Vulnerable Populations in the Llano County

Llano Jurisdiction	Population (2020 Decennial)		American Community 5-year Estimates 2020 Population									
	Total	Percent of County Total	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking Households	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Horseshoe Bay (C)	4,257	20.0%	2,221	52.2%	93	2.2%	0	0.0%	928	21.8%	156	3.7%
Sunrise Beach (C)	3,325	15.7%	691	20.8%	314	9.4%	12	0.4%	719	21.6%	531	16.0%
Llano (C)	739	3.5%	383	51.8%	16	2.2%	0	0.0%	176	23.8%	30	4.1%
Unincorporated Llano County	12,922	60.8%	4,680	36.2%	414	3.2%	56	0.4%	3,490	27.0%	895	6.9%
Llano County (Total)	21,243	100.0%	7,975	37.5%	837	3.9%	68	0.3%	5,313	25.0%	1,612	7.6%

Source: U.S. Census 2020

Notes: (C) = City, (T) = Town

Table 4.3.3-7. Vulnerable Populations in the San Saba County

San Saba Jurisdiction	Population (2020 Decennial)		American Community 5-year Estimates 2020 Population									
	Total	Percent of County Total	Over 65	Percent of Jurisdiction Total	Under 5	Percent of Jurisdiction Total	Non-English Speaking Households	Percent of Jurisdiction Total	Disability	Percent of Jurisdiction Total	Poverty Level	Percent of Jurisdiction Total
Richland Springs (T)	244	4.3%	62	0.0%	14	0.0%	0	0.0%	58	0.0%	41	0.0%
San Saba (C)	3,117	54.4%	588	18.9%	191	6.1%	86	2.8%	405	13.0%	510	16.4%
Unincorporated San Saba County	2,369	41.3%	757	0.0%	107	0.0%	9	0.0%	519	0.0%	163	0.0%
San Saba County (Total)	5,730	100.0%	1,407	10.3%	312	3.3%	95	1.5%	982	7.1%	714	8.9%

Source: U.S. Census 2020

Notes: (C) = City, (T) = Town



Exposure to extreme temperature can pose a number of health risks to individuals. Table 4.3.3-8 and Table 4.3.3-9 identify different health hazards related to extreme heat and extreme cold conditions.

Table 4.3.3-8. Health Effects of Extreme Heat

Health Hazard	Symptoms
Sunburn	Redness and pain. In severe cases: swelling of skin, blisters, fevers, and headaches
Dehydration	Excessive thirst, dry lips, and slightly dry mucous membranes
Heat Cramps	Painful spasms, usually in muscles of legs and abdomen, and possible heavy sweating
Heat Exhaustion	Heavy sweating; weakness; cold, pale and clammy skin; weak pulse; possible fainting and vomiting
Heat Stroke	High body temperature (104°F or higher), hot and dry skin, rapid and strong pulse, and possible coma

Source: CDC 2016

Table 4.3.3-9. Health Effects of Extreme Cold

Health Hazard	Symptoms
Wind Chill	Wind chill is not the actual temperature but rather how wind and cold feel on exposed skin. As the wind increases, heat is carried away from the body at an accelerated rate, driving down the body temperature. Animals are also affected by wind chill; however, cars, plants and other objects are not.
Frostbite	Frostbite is damage to body tissue caused by extreme cold. A wind chill of -20°F will cause frostbite in just 30 minutes. Frostbite causes a loss of feeling and a white or pale appearance in extremities, such as fingers, toes, ear lobes or the tip of the nose. If symptoms are detected, get medical help immediately! If you must wait for help, slowly re-warm affected areas. However, if the person is also showing signs of hypothermia, warm the body core before the extremities.
Hypothermia	Hypothermia is a condition brought on when the body temperature drops to less than 95°F. It can kill. For those who survive, there are likely to be lasting kidney, liver and pancreas problems. Warning signs include uncontrollable shivering, memory loss, disorientation, incoherence, slurred speech, drowsiness and apparent exhaustion.

Source: CDC 2007

Meteorologists can accurately forecast extreme heat and cold event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions, and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All the building stock in the Planning Area is exposed to the extreme temperature hazard. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles, as well as increasing vulnerability to home fires. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities can have inadequate capabilities to withstand extreme temperatures.

Due to the expansive nature of soils in this area, extreme heat could pose foundation issues. The lack of air conditioning in businesses and homes can exacerbate existing health conditions, particularly in senior citizens (Llano County 2016) (San Saba County 2016).

Impact on Critical Facilities

All critical facilities in the Planning Area are exposed to the extreme temperature hazard. Impacts to critical facilities are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as brownouts, due to increased usage from air conditioners and other energy-intensive appliances. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure.

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business-owners can be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills, or business interruption due to power failure (i.e., loss of electricity, telecommunications).

Impact on the Environment

Extreme temperature events can have a major impact on the environment. For example, freezing and warming weather patterns create changes in natural processes. An excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS 2020). Extreme heat events can have particularly negative impacts on aquatic systems, contributing to fish kills, aquatic plant die offs, and increased likelihood of harmful algal blooms.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

The ability of new development to withstand extreme temperature impacts can be enhanced through land use practices and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially replace open land and vegetation. Transformation of pervious surfaces (including vegetation) to impervious surfaces causes an island of higher temperatures.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba

County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.). Increases in population will increase the exposure to the extreme temperature hazard.

Climate Change

As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency; the shift in temperatures could also result in hotter extreme heat events. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses, such as heatstroke and cardiovascular and kidney disease. Additionally, as temperatures rise, more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat.

Change of Vulnerability Since 2016 HMP

Overall, the vulnerability to the extreme temperature hazard since the 2016 HMP remains unchanged.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.4 Flood

The following section provides the hazard profile and vulnerability assessment for the flood hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from:

- The overflow of stream banks
- The unusual and rapid accumulation of runoff of surface waters from any source
- Mudflows or the sudden collapse of shoreline land

Flooding results when the flow of water is greater than the normal carrying capacity of the stream channel. Rate of rise, magnitude (or peak discharge), duration, and frequency of floods are a function of specific physiographic characteristics. Generally, the rise in water surface elevation is quite rapid on small (and steep gradient) streams and slow in large (and flat sloped) streams.

The causes of floods relate directly to the accumulation of water from precipitation, or the failure of man-made structures, such as dams or levees. Floods caused by precipitation are further classified as coming from: rain in a general storm system, rain in a localized intense thunderstorm, melting snow, and ice.

Floods may also be caused by structural or hydrologic failures of dams or levees. A hydrologic failure occurs when the volume of water behind the dam or levee exceeds the structure's capacity resulting in overtopping. Structural failure arises when the physical stability of the dam or levee is compromised due to age, poor construction and maintenance, seismic activity, rodent tunneling, or myriad other causes. For more information on dam failure, refer to Section 4.3.1.

Texas has the most flash flood deaths of any state in the country and while San Saba lies just north of the "Flash Flood Alley" area of Texas, a portion of Llano County is within the region (see Figure 4.3.4- 1). The terrain in the "Flash Flood Alley" area is punctuated by a large number of limestone or granite rocks and boulders and a thin layer of topsoil, which makes the region very dry and prone to flash flooding. Other factors contributing to flash floods in the area include its location between the Rocky Mountains and the moisture laden Gulf of Mexico. As weather systems stall and dissipate over Texas, and they drop intense rains over small areas. In the past, Llano and San Saba Counties have had significant seasonal floods along the Colorado and Llano Rivers; however, these floods have been greatly reduced by the construction of large reservoirs along the Colorado River. This has also helped to reduce the impacts of seasonal floods in the planning area.

Figure 4.3.4-1 Flash Flood Alley in Texas



Source: San Antonio River Authority 2022

The potential for flooding can change and increase through various land use changes and changes to land surface. A change in environment can create localized flooding problems inside and outside of natural floodplains by altering or confining watersheds or natural drainage channels. These changes are commonly created by human activities (e.g., development). These changes can also be created by other events such as wildfires. Wildfires create hydrophobic soils, a hardening or “glazing” of the earth’s surface that prevents rainfall from being absorbed into the ground, thereby increasing runoff, erosion, and downstream sedimentation of channels (Llano County 2016) (San Saba County 2016).

Riverine Flooding

Though local in the immediate impacts, riverine flooding damages are widely dispersed in Texas. The majority of flood-related deaths are caused by people attempting to drive through moving water.

Riverine flood risks are calculated in hydrologic and hydraulic (H&H) studies. These studies yield the most specific and localized risk maps. Hydrologic elements calculate the amount of water that is expected in a given system, either from contributing waterways or from precipitation. Hydraulic elements calculate how the water can be expected to flow through the system based on its capacity to move the water. The engineering process produces estimates at various points along the waterway that make up expected water levels of various probabilities or return periods. H&H studies determine at what volumes waters will overflow the banks of the river systems and what the resultant areas or chance of flooding will be at given return periods.

Federal regulations require houses with their base floor elevation within one foot of the 100-year-floodplain to participate in the National Flood Insurance Program (NFIP). This is a federally subsidized insurance program administered by FEMA in coordination with state and local governments. This program seeks to limit damages through regulation and also to help stabilize real estate markets nationwide. NFIP requires that FEMA develop and maintain maps of nationwide 100-year floodplains prioritized for high-risk areas. The vast majority of Texas is covered by these studies (State of Texas 2018).

Thunderstorm/Flash Flooding

Damaging thunderstorm floods are caused by intense rain over basins of relatively small area. They are characterized by a sudden rise in stream level, short duration, and a relatively small volume of runoff. Because there is little or no warning time, the term “flash flood” is often used to describe thunderstorm floods. Texas is known as the “Flash Flood Alley” and the area along the Balcones Escarpment (from Austin south to San Antonio, then west to Del Rio) is one of the nation's three most flash flood-prone regions. Figure 12-1 and Figure 12-2 show the number of flash floods and storm centers in the HMP update area. Llano County lies in the path of the “Flash Flood Alley,” while San Saba lies just to its North.

Thunderstorm floods occur in every month of the year in Texas but are most common in the spring and summer. The mean annual number of thunderstorm flood days varies from 40 in eastern Texas to 60 in western Texas. Most flash flooding is caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms.

Flash floods can occur within a few minutes or after hours of excessive rainfall. Flash floods can roll boulders, tear out trees, destroy buildings and bridges, and carve out new channels. Rapidly rising water can reach heights of thirty feet or more. Flash flood-producing rains can also trigger catastrophic mudslides. Often there is no warning that flash floods are coming. Hill Country flash floods devastated the river basin and are a major reason why the LCRA located Mansfield Dam and Lake Travis (the flood control components of the Highland Lake chain) upstream of Austin. Flash flooding poses a deadly danger to residents of the Lower Colorado River Basin. Several roads run through low-lying areas that are prone to sudden and frequent flooding during heavy rains. Motorists often attempt to drive through barricaded or flooded roadways. It takes only 18 to 24 inches of water moving across a roadway to carry away most vehicles. Floating cars easily get swept downstream, making rescues difficult and dangerous (Llano County 2016) (San Saba County 2016).

Stormwater Flooding

Stormwater flooding is generated from rain and snowmelt events that flow over land or impervious surfaces, such as paved streets, parking lots, and building rooftops, and does not soak into the ground. The runoff picks up pollutants like trash, chemicals, oils, and dirt/sediment that can harm our rivers, streams, lakes, and coastal waters. Population growth and the development of urban/urbanized areas are major contributors to the number of pollutants in the flood waters as well as the volume and rate from impervious surfaces. Together, they can



cause changes in hydrology and water quality that result in habitat modification and loss, increased flooding, decreased aquatic biological diversity, and increased sedimentation and erosion (US EPA 2022).

During periods of heavy rainfall or snowmelt, some wastewater systems are designed to occasionally overflow and discharge excess untreated sewage directly to nearby streams, rivers, or other water bodies. These discharges are known as combined sewer overflows and are common in many cities nationwide.

Green infrastructure can be used to address stormwater runoff and sewer overflow problems. Green infrastructure works by slowing down the runoff, spreading it out over the land, and slowly soaking it into the ground, or in some cases reusing the water onsite. Green infrastructure is also sometimes referred to as low impact development. These techniques also help to remove pollutants from runoff, but allowing plants to filter out pollutants as the water slowly infiltrates into the ground. Some examples of green infrastructure techniques include rain gardens, pervious pavement, rain barrels, and green roofs (US EPA 2022).

Location

Llano County and the participating communities in this HMP update are located in the Llano and Buchanan-Lyndon watersheds. All streams in the County are either direct or indirect tributaries of the Llano River or the Colorado River. The Llano River runs west to east centrally across the County and drains into the Colorado River. Small creeks in the County that flow into the Llano River include Hickory Creek, Honey Creek, Little Llano River, Pecan Creek, and San Fernando Creek. These streams normally flow year-round, although they may dry up during unusually dry years. Additionally, large irrigation canals (not mapped) also contribute to local flooding (Llano County 2016).

San Saba County lies completely within the Colorado River basin. The Colorado River runs west to southeast in this area along the north and east boundary of the County. Some local waterbodies include the San Saba River, as well as Antelope, Simpson, Richland Springs, Wallace, and Wilbarger Creeks. These streams normally flow year-round, although they may dry up during unusually dry years. Additionally, large irrigation canals (not mapped) also contribute to local flooding (San Saba County 2016).

Run off in Llano County is captured to fill several lakes and reservoirs in the County. The LCRA operates several dams in the area and uses the floodgates to manage floodwaters with the overall goal of reducing downstream flooding. Run off in San Saba County is captured to fill several lakes and reservoirs. The San Saba soil and water conservation districts (SWCD) operates several dams within the County. Some with the highest storage volumes include the Lower San Saba River WS Site 2, 7, and 15 Dams. These dams are used to manage floodwaters with the overall goal of reducing downstream flooding.

In addition to the riverine flooding, the project area also experiences stormwater flooding caused by urbanization, which may increase the run-off potential of an area.

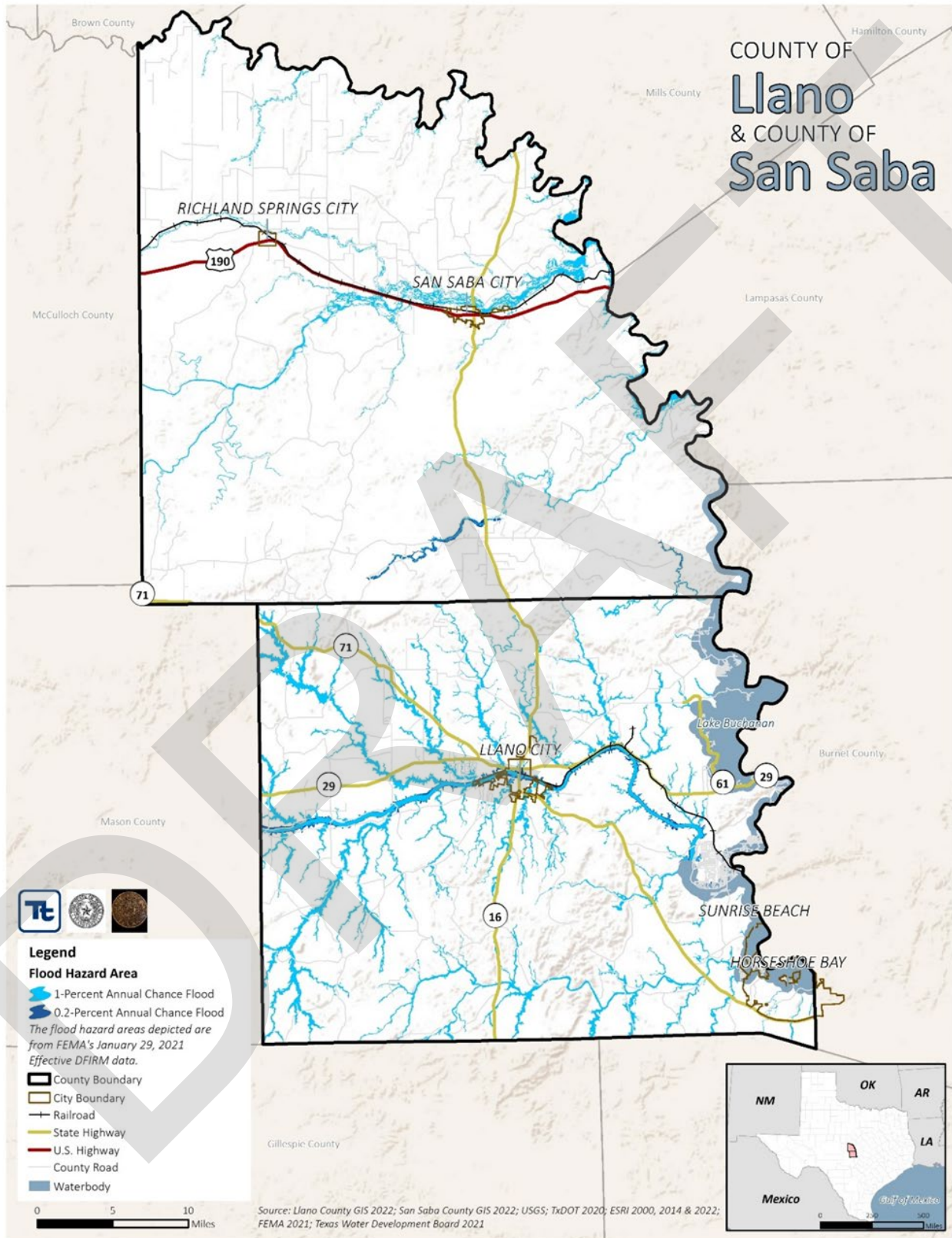
The floodplain boundary extents for most of the creeks, streams, rivers, and lakes in the project area have been mapped by FEMA. The resulting FIRMs provide an official depiction of flood hazard risks and

risk premium zones for each community and for properties located within it. The updated maps in Llano County became effective January 29, 2021 and have been effective in San Saba County since July 2, 1991. However, areas in the southeast corner as well as the north central border of San Saba County have not yet had the flood map boundaries printed. The FIRMs mapped for San Saba County have not yet been remapped as part of the FEMA Map Modernization Program providing Digital Flood Insurance Rate Maps, or DFIRMs. While the FEMA digital

flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Riverine flooding, stormwater flooding, and flood-related losses often do occur outside of delineated SFHAs.

Excluding waterbodies, Llano County has 50,502 acres in the 100-year floodplain and 106,355 acres in 500-year floodplain; San Saba County has 11,408 acres in the 100-year floodplain, and 23,185 acres in the 500-year floodplain (FEMA 2021)(NHD 2022).

Figure 4.3.4-2 Special Flood Hazard Areas for the County of Llano and the County of San Saba



Extent

Intensity of floods is the damage caused by it. It can be characterized by depth of inundation, volume of inundation, velocity of flow and rate of rise of water. The more the depth of water, more will be its volume, velocity, and its damaging capacity. A high rate of rise for water also means less preparation time for people in the area.

Flooding in the HMP update area is mostly caused by slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms. Flash floods can occur within a few minutes or after hours of excessive rainfall. These rain events are most often microbursts, which produce a large amount of rainfall in a short amount of time. Flash floods, by their nature, occur suddenly but usually dissipate within hours. Despite their sudden nature, the NWS is usually able to issue advisories, watches, and warnings in advance of a flood.

Worst-Case Scenario

An intense, short-duration storm could move slowly across the planning area creating significant flash floods with little or no warning. Injuries or fatalities may result if residents are caught off guard by the flood event. Stormwater systems could be overwhelmed, and significant flooding could impact a substantial portion of structures within the planning area. Transportation routes could be cut off due to floodwaters, isolating portions of the planning area. These impacts may last after the floodwater recedes as flash floods in the area have been known to cause extensive damage to roadway infrastructure. Areas that have recently experienced wildfires would contribute to the extent of flooding impacts. The major issues for flooding are the following:

- Flash flooding that occurs with little or no warning will continue to impact the planning area.
- The duration and intensity of storms contributing to flooding issues may increase due to climate change.
- Flooding may be exacerbated by other hazards, such as wildfires.
- Damages resulting from flood may impact tourism, which may have significant impacts on the local economy.
- The promotion of flood insurance as a means of protecting private property owners from the economic impacts of frequent flood events should continue.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and San Saba County were included in one disaster (DR) or emergency (EM) declaration for flood-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Llano and/or San Saba County were not included in flood-related agricultural disaster declarations.



Previous Events

For this 2023 HMP update, known flood events that impacted the Planning Area between 2017 and 2022 are discussed below in Table 4.3.4-1. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.4-1 Flood Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
April 10, 2017	Flash Flood	N/A	N/A	A cold front moved through South Central Texas and generated thunderstorms. Some of these storms produced large hail and heavy rain that led to flash flooding. This storm amounted to \$500,000.00 worth of property damages.
August 7, 2017	Flash Flood	N/A	N/A	A line of thunderstorms formed ahead of a cold front in North Texas and moved southward. This line moved into a very moist airmass and produced heavy rain as it moved slowly across Llano County. It continued to move southward, and convection was enhanced by interaction with an outflow boundary over Bexar County where additional heavy rain developed.
September 10 – November 2, 2018	Severe Storms and Flooding	FEMA-4416-DR	Llano and San Saba Counties	Prolonged and cascading weather impacts from several successive weather patterns, including tropical Atlantic moisture and impacts from Pacific hurricanes, hit Texas from September 10, 2018 through October 28, 2018 causing catastrophic river flooding. Numerous heavy rain events created cascading effects, saturating soils, and preventing sensitive river basins from recovering. Texas experienced historic river flooding along the Llano and Colorado River basins with major flood waves on the Brazos, Trinity, and Nueces Rivers. Catastrophic flooding in the Colorado River basin led to unprecedented releases into the Highland Lakes, necessitating the Lower Colorado River Authority to conduct massive river releases. These releases overwhelmed the city of Austin's water and wastewater treatment plants due to

				the high amounts of silt in the floodwaters and caused a city-wide water crisis.
October 15-16, 2018	Riverine Flood and Flash Flood	N/A	N/A	An upper-level low pressure system remained parked through October 17. This feature interacted with plenty of moisture and resulted in periods of very heavy rain from October 15 through the 17. Widespread flooding developed across the area and many lakes and rivers rose above flood stage and resulted in widespread flooding. Millions of dollars of damage was done to roads and county infrastructure. Johnson Fork Creek rose high enough that it caused some water to overflow onto one of the lanes on Interstate 10. Interstate 10 had to be closed. The Clear Fork on the Brazos River near Fort Griffin rose to 36.18 feet on October 15; The Llano River at Mason rose to 32.89 foot on October 16; Colorado River near San Saba rose to 32.53 feet on October 17; Colorado River near Ballinger rose to 22.97 feet on October 17; and the San Saba River at San Saba rose to 28.54 inches on October 16. This storm caused \$111 million worth of property damages.
July 12, 2021	Flash Flood	N/A	N/A	The combination of abundant tropical moisture, moderate instability and a weak upper-level disturbance produced thunderstorms with heavy rainfall across the Concho Valley and Heartland. A few of the thunderstorms produced flash flooding.

Sources: NOAA 2022; USDA FSA 2022; FEMA 2022; San Saba County 2016; Llano County 2016

Notes: Llano County and San Saba County were affected by several flooding events between 2017 and 2022.

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of flood events for the County. Information from NOAA-NCEI storm events database, the 2019 State of Texas HMP, the 2016 Llano HMP and the 2016 San Saba County HMP were used to identify the number of flood events that occurred between 1950 and 2022. Table 4.3.4-2 presents the probability of future flood events in Llano County; Table 4.3.4-3 presents the probability of future flood events in San Saba County.

Table 4.3.4-2 Probability of Future Flood Events in Llano County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Flash Flood	77	100%
Flood	12	16%

Sources: NOAA 2022; State of Texas 2018; Llano County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all flood events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Table 4.3.4-3 Probability of Future Flood Events in San Saba County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Flash Flood	23	32%
Flood	9	13%

Sources: NOAA 2022; State of Texas 2018; San Saba County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all flood events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Llano County, seasonal flooding on the Llano River and Colorado River have increased over time due to increased rainfall events and weather patterns. In San Saba County, seasonal flooding on the Colorado River and Richland Springs Creek have increased over time due to increased rainfall events and weather patterns (San Saba County 2016).

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for floods in the Planning Area is considered ‘frequent’.

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of flood (Centers for Climate and Energy Solutions n.d.).

High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed

vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 100-year flood may strike more often, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and

regulation of flood protection facilities such as dams, floodways, bypass channels, and levees, as well as the design of local sewers and storm drains (Llano County 2016) (San Saba County 2016).

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted. Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions.

Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The locations in the Planning Area that are located in the 1-percent and 0.2-percent annual chance floodplain are most vulnerable to the flood hazard. The following text evaluates and estimates the potential impact of the flood hazard in the 1-percent and 0.2-percent floodplains.

Impact on Life, Health, and Safety

Impacts of flooding on life, health, and safety depend on several factors including severity of the event and whether adequate warning time is provided to residents. Vulnerable populations are all populations residing or located in the floodplain that are incapable of escaping the area within the required timeframe to reach safety. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by a hazard event (e.g., people are considered at risk if they are traveling in flooded areas, or their access to emergency services is compromised during an event). Flash floods can be localized events that affect areas outside of the floodplain due to localized drainage issues and can directly impact populations and comprise access to emergency services. The degree of that impact varies and is not strictly measurable.

In Llano County, an estimated 1,706 people reside in the 1-percent annual chance event boundary, and 4,490 people within the 0.2-percent annual chance flood boundary. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. Table 4.3.4-4 lists population estimates within flood hazard zones in Llano County.

Table 4.3.4-4 Estimated Population Exposed to the Flood Hazard in Llano County

Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1- percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2- percent Annual Chance Flood Event Hazard Area	Percent of Total
Horseshoe Bay (C)	4,257	252	5.9%	791	18.6%
Sunrise Beach (C)	739	120	16.2%	347	47.0%
Llano (C)	3,325	242	7.3%	765	23.0%
Unincorporated Llano County	12,922	1,092	8.5%	2,587	20.0%
Llano County (Total)	21,243	1,706	8.0%	4,490	21.1%

Source: Hazus v5.1; FEMA 2021; Census 2020

Note: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

In San Saba County, an estimated 132 people reside in the 1-percent annual chance event boundary, and 143 people within the 0.2-percent annual chance flood boundary. These residents may be displaced by the flooding of their homes, requiring them to seek temporary shelter with friends and family or in emergency shelters. Table 4.3.4-5 lists population estimates within flood hazard zones in San Saba County.

Table 4.3.4-5 Estimated Population Exposed to the Flood Hazard in San Saba County

Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Flood Hazard Areas			
		Number of Persons Located in the 1- percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2- percent Annual Chance Flood Event Hazard Area	Percent of Total
Richland Springs (T)	244	2	0.7%	2	0.7%
San Saba (C)	3,117	25	0.8%	25	0.8%
Unincorporated San Saba County	2,369	106	4.5%	117	4.9%
San Saba County (Total)	5,730	132	2.3%	143	2.5%

Source: FEMA 2021; Texas Water Development Board 2021; Census 2020

Note: (C) = City, (T) = Town

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts to their families. The population over age 65 is also more vulnerable because available medical services may be disrupted, and they are more likely to seek or need medical attention that may not be available due to isolation during a flood event. They also may have more difficulty evacuating. Table 4.3.4-6 and Table 4.3.4-7 presents the estimated potential sheltering needs as a result of the 1-percent flood event.

Table 4.3.4-6 Estimated Llano County Population Displaced or Seeking Short-Term Shelter from Flood Events

Llano Jurisdiction	Total Population (2020 Decennial Census)	1-Percent Annual Chance Flood Event	
		Displaced Population*	Persons Seeking Short-Term Sheltering
Horseshoe Bay (C)	4,257	175	39
Sunrise Beach (C)	3,325	113	23
Llano (C)	739	241	31
Unincorporated Llano County	12,922	975	209
Llano County (Total)	21,243	1,505	302

Source: FEMA 2021; Hazus v5.1; Census 2010/2020

Notes: (C) = City, (T) = Town

*The number of displaced persons may overestimate the impacted population located in the 1-percent annual chance flood hazard area due to the limitations of the Hazus model using Census 2010 census block data

Table 4.3.4-7 Estimated San Saba County Population Displaced or Seeking Short-Term Shelter from Flood Events

San Saba Jurisdiction	Total Population (2020 Decennial Census)	1-Percent Annual Chance Flood Event	
		Displaced Population*	Persons Seeking Short-Term Sheltering
Richland Springs (T)	244	318	2
San Saba (C)	3,117	2,574	51
Unincorporated San Saba County	2,369	3,240	87
San Saba County (Total)	5,730	6,131	140

Source: FEMA 2021; Texas Water Development Board 2021; Hazus v5.1; Census 2010/2020

Notes: (C) = City, (T) = Town

*The number of displaced persons may overestimate the impacted population located in the 1-percent annual chance flood hazard area due to the limitations of the Hazus model using Census 2010 census block data

Total numbers of injuries and casualties resulting from typical riverine flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for flash flooding is limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard.

Cascading impacts may also include exposure to pathogens such as mold. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. The degree of impact will vary and is not strictly measurable. Molds can grow in as short a period as 24-48 hours in wet and damaged areas of buildings that have not been properly cleaned. Very small mold spores can easily be inhaled, creating the potential for allergic reactions, asthma episodes, and other respiratory problems. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2021).

Molds and mildews are not the only public health risk associated with flooding. Floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue (CDC 2021)

Current loss estimation models such as Hazus v5.1 cannot measure public health impacts. The best ways to mitigate these impacts are to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Impact on General Building Stock

To assess potential impacts on buildings, exposure (located in the hazard area) of the building stock was examined for the 1-percent and 0.2-percent flood scenarios. Overall, 11-percent of buildings and 11.5-percent of the replacement cost value of buildings in Llano County are exposed to the 1-percent flood scenario. 2.9-percent of buildings and 2.6-percent of the replacement cost value of buildings in San Saba County are exposed to the 1-percent flood scenario. 26.7-percent of buildings and 24.5-percent of the replacement cost value of buildings in Llano County are exposed to the 0.2-percent flood scenario. 3.2 percent of buildings and 2.9 percent of the replacement cost value of buildings in San Saba County are exposed to the 0.2-percent flood scenario.

Hazus v5.1 was used to calculate the projected building stock impacts from the 1-percent flood event. In Llano County, the 1-percent event is anticipated to result in damages to 11 percent of the total replacement cost value of the building stock of the County's . In San Saba County, the 1-percent event is anticipated to result in damages to less than 0.1 percent of the total replacement cost value of the County's building stock. Table 4.3.4-8 through Table 4.3.4-11 summarize these results.

Table 4.3.4-8 Estimated General Building Stock Exposure to a 1-Percent and 0.2-Percent Annual Chance Flood Event in Llano County

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located Within the 1-Percent Annual Chance Flood Hazard Area				Estimated Number and Total Replacement Cost Value of Structures Located Within the 0.2-Percent Annual Chance Flood Hazard Area			
			Number of Buildings Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the 1-percent Annual Chance Flood Event Hazard Area (Haz_RCV)	Percent of Total	Number of Buildings Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the 0.2-percent Annual Chance Flood Event Hazard Area (Haz_RCV)	Percent of Total
Horseshoe Bay (C)	2,174	\$921,317,000	228	10.5%	\$94,642,983	10.3%	632	29.1%	\$271,865,160	29.5%
Sunrise Beach (C)	909	\$345,382,000	183	20.1%	\$68,940,918	20.0%	510	56.1%	\$193,297,404	56.0%
Llano (C)	1,733	\$564,332,000	128	7.4%	\$47,358,862	8.4%	407	23.5%	\$133,367,474	23.6%
Unincorporated Llano County	8,788	\$2,408,418,000	958	10.9%	\$276,242,103	11.5%	2,077	23.6%	\$592,861,416	24.6%
Llano County (Total)	13,604	\$4,239,449,000	1,497	11.0%	\$487,184,866	11.5%	3,626	26.7%	\$1,191,391,455	28.1%

Source: FEMA 2021; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.4-9 Estimated Building Stock Impacts to a 1-Percent Annual Chance Flood Event in Llano County

Jurisdiction	Total Replacement Cost Value (RCV)	All Occupancies	
		Estimated Loss	Percent of Total Replacement Cost Value
Horseshoe Bay (C)	\$921,317,000	228	10.5%
Sunrise Beach (C)	\$345,382,000	183	20.1%
Llano (C)	\$564,332,000	128	7.4%
Unincorporated Llano County	\$2,408,418,000	958	10.9%
Llano County (Total)	\$4,239,449,000	1,497	11.0%

Source: FEMA 2021; Hazus v5.1; Census 2010/2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.



Table 4.3.4-10 Estimated General Building Stock Exposure to a 1-Percent and 0.2-Percent Annual Chance Flood Event in San Saba County

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located Within the 1-Percent Annual Chance Flood Hazard Area				Estimated Number and Total Replacement Cost Value of Structures Located Within the 0.2-Percent Annual Chance Flood Hazard Area			
			Number of Buildings Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the 1-percent Annual Chance Flood Event Hazard Area (Haz_RCV)	Percent of Total	Number of Buildings Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the 0.2-percent Annual Chance Flood Event Hazard Area (Haz_RCV)	Percent of Total
Richland Springs (T)	213	\$66,306,000	1	0.7%	\$427,534	0.6%	1	0.7%	\$427,534	0.6%
San Saba (C)	1,311	\$410,811,000	9	0.7%	\$2,158,751	0.5%	9	0.7%	\$2,158,751	0.5%
Unincorporated San Saba County	1,819	\$480,386,000	85	4.7%	\$22,448,577	4.7%	96	5.3%	\$25,231,364	5.3%
San Saba County (Total)	3,343	\$957,503,000	95	2.9%	\$25,034,862	2.6%	107	3.2%	\$27,817,649	2.9%

Source: FEMA 2021; Texas Water Development Board 2021; Census 2020

Notes: (C) = City, (T) = Town

Table 4.3.4-11 Estimated Building Stock Impacts to a 1-Percent Annual Chance Flood Event in San Saba County

Jurisdiction	Total Replacement Cost Value (RCV)	All Occupancies	
		Estimated Loss	Percent of Total Replacement Cost Value
Richland Springs (T)	\$66,306,000	\$0	0.0%
San Saba (C)	\$410,811,000	\$2,000	0.0%
Unincorporated San Saba County	\$480,386,000	\$0	0.0%
San Saba County (Total)	\$957,503,000	\$2,000	<0.1%

Source: FEMA 2021; Texas Water Development Board 2021; Hazus v5.1; Census 2010/2020

Notes: (C) = City



NFIP

According to data from FEMA, as of October 2022, Llano County has 542 NFIP policies for a total NFIP premium of \$536,514 and \$152,807,000 in coverage. There have been 478 closed paid losses for a value of \$13,054,686.

Table 4.3.4-12 NFIP Statistics for Llano County

Property Type	Policies in Force for All Properties	Premium Value for All Properties	Insurance in Force for All Properties	Number of Closed Paid Losses for All Properties	Value of Closed Paid Losses for All Properties
Single Family	509	\$508,377	\$146,659,200	446	\$12,373,022
2-4 Family	8	\$10,898	\$1,721,800	8	\$248,506
All Other Residential	18	\$10,644	\$3,162,000	9	\$268,631
Non-Residential	7	\$6,595	\$1,264,000	15	\$164,527
Llano County (Total)	542	\$536,514	\$152,807,000	478	\$13,054,686

Source: FEMA 2022

According to data from FEMA, as of October 2022, San Saba County has 15 NFIP policies for a total NFIP premium of \$10,756 and \$2,546,000 in coverage. There have been 8 closed paid losses for a value of \$106,713.

Table 4.3.4-13 NFIP Statistics for San Saba County

Property Type	Policies in Force for All Properties	Premium Value for All Properties	Insurance in Force for All Properties	Number of Closed Paid Losses for All Properties	Value of Closed Paid Losses for All Properties
Single Family	11	\$8,547	\$2,109,600	8	\$106,713
2-4 Family	0	\$0	\$0	0	\$0
All Other Residential	0	\$0	\$0	0	\$0
Non-Residential	4	\$2,209	\$437,000	0	\$0
San Saba County (Total)	15	\$10,756	\$2,546,600	8	\$106,713

Source: FEMA 2022

A property is considered a repetitive loss (RL) property when there are “two or more losses reported which were paid more than \$1,000 for each loss. The two losses must be within 10 years of each other and be at least 10 days apart. Only losses from (sic since) January 1, 1978 that are closed are considered. A severe repetitive loss (SRL) property is defined as a residential property covered under an NFIP flood insurance policy, and satisfying either of conditions 1 and 2, as well as condition 3 (Section 1361A of the National Flood Insurance Act 42 *United States Code* 4102a):

1. “At least four NFIP claim payments for the property (including building and contents) over \$5,000 each have occurred, and the cumulative amount of such claims payments exceeded \$20,000.
2. At least two separate claims payments for the property (building payments only) have occurred, and the cumulative amount of the building portion of such claims exceeded the market value of the building.
3. For either of the above, at least two of the referenced claims must have occurred within any 10-year period and must have occurred more than 10 days apart”

The Flood Mitigation Assistance (FMA) Program has separate definitions for repetitive and severe repetitive loss. According to the FMA program, an RL property, as defined under 42 U.S.C. § 4121(a)(7), is a structure covered by a contract for flood insurance made available under the NFIP that:

1. Has incurred flood-related damage on two occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each flood event; and
2. At the time of the second incidence of flood-related damage, the contract for flood insurance contains Increased Cost of Compliance (ICC) coverage.

According to the FMA program, an SRL property, as defined under 42 U.S.C. § 4104c(h)(3), is a structure that:

1. Is covered under a contract for flood insurance made available under the NFIP; and
2. Has incurred flood-related damage
 - a. For which four or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding \$5,000, and with the cumulative amount of such claims payments exceeding \$20,000, or
 - b. For which at least two separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure

According to the NFIP definition of repetitive loss, Llano County has 13 repetitive loss properties and 1 severe repetitive loss property. According to the FMA definition of repetitive loss, Llano County has four repetitive loss properties and one severe repetitive loss property.

Table 4.3.4-14 Repetitive Loss Statistics for Llano County

Property Type	Number of NFIP Repetitive Loss Properties	Number of NFIP Severe Repetitive Loss Properties	Number of FMA Repetitive Loss Properties	Number of FMA Severe Repetitive Loss Properties
Single Family	12	1	4	1
2-4 Family	0	0	0	0
All Other Residential	0	0	0	0
Non-Residential	1	0	0	0
Llano County (Total)	13	1	4	1

Source: FEMA 2022

According to the NFIP definition of repetitive loss, San Saba County has two repetitive loss properties and no severe repetitive loss properties. According to the FMA definition of repetitive loss, San Saba County has no repetitive loss or severe repetitive loss properties.

Table 4.3.4-15 Repetitive Loss Statistics for San Saba County

Property Type	Number of NFIP Repetitive Loss Properties	Number of NFIP Severe Repetitive Loss Properties	Number of FMA Repetitive Loss Properties	Number of FMA Severe Repetitive Loss Properties
Single Family	2	0	0	0
2-4 Family	0	0	0	0

All Other Residential	0	0	0	0
Non-Residential	0	0	0	0
Llano County (Total)	2	0	0	0

Source: FEMA 2022

Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure within the Planning Area that may be at risk to flooding (riverine, flash/stormwater flooding), and who may be impacted should damage occur. Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the Planning Area to many service providers needing to get to vulnerable populations or to make repairs. Utilities such as overhead power, cable, and phone lines could also be vulnerable due to utility poles damaged by standing water or the surge of moving water. Loss of these utilities could create additional isolation issues for the inundation zones.

Critical facility exposure to the flood hazard was examined. Table 4.3.4-16 and Table 4.3.4-17 summarize these results.

Table 4.3.4-16 Critical Facility Types Located in the 1-Percent and 0.2-Percent Annual Chance Flood Hazard Areas and Damages in Llano County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1-percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2-percent Annual Chance Flood Event Hazard Area
Communications	5	0	2
Energy	28	4	6
Food, Water, Shelter	18	3	3
Hazardous Material	7	1	2
Health and Medical	14	1	1
Safety and Security	38	5	8
Transportation	177	104	110
Llano County (Total)	287	118	132

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021

Table 4.3.4-17 Critical Facility Types Located in the 1-Percent and 0.2-Percent Annual Chance Flood Hazard Areas and Damages in San Saba County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1-percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2-percent Annual Chance Flood Event Hazard Area
Communications	2	0	0
Energy	0	0	0
Food, Water, Shelter	2	1	1

Hazardous Material	0	0	0
Health and Medical	0	0	0
Safety and Security	15	0	0
Transportation	111	43	43
San Saba County (Total)	130	44	44

Source: Llano County GIS 2022; Texas Water Development Board 2021; Hazus v5.1; Texas A&M 2022; FEMA 2021

Note: San Saba County identified critical facilities using a different process than Llano County.

Impact on Economy

Flood events can significantly impact the local and regional economy. This includes but is not limited to general building stock damages and associated tax loss, impacts to utilities and infrastructure, agricultural losses, business interruption, and effects on tourism.

In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the section earlier which discusses direct impacts to buildings in the Planning Area.

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; drinking water and wastewater treatment facilities may be temporarily out of operation.

Debris management may also be a large expense after a flood event. Hazus v5.1 estimates the number of structural debris generated during a flood event. The model breaks down debris into three categories: (1) finishes (dry wall, insulation, etc.); (2) structural (wood, brick, etc.); and (3) foundations (concrete slab and block, rebar, etc.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4.3.4-18 and Table 4.3.4-19 summarize the Hazus v5.1 countywide debris estimates for the 1-percent annual chance flood event in Llano County and San Saba County. Table 4.3.4-20 and Table 4.3.4-21 summarize the estimated losses for the 1-percent annual chance flood event in Llano County and San Saba County. Please note that these tables only estimate structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 4.3.4-18 Estimated Debris Generated from a 1-Percent Chance Annual Flood in Llano County

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Horseshoe Bay (C)	584	506	37	42
Sunrise Beach (C)	806	622	70	114
Llano (C)	2,136	610	739	787
Unincorporated Llano County	15,783	5,177	4,235	6,370
Llano County (Total)	19,309	6,915	5,081	7,313

Source: FEMA 2021; Hazus v5.1; Census 2010/2020

Note: (C) = City

Table 4.3.4-19 Estimated Debris Generated from a 1-Percent Chance Annual Flood in San Saba County

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Horseshoe Bay (C)	584	506	37	42
Sunrise Beach (C)	806	622	70	114
Llano (C)	2,136	610	739	787
Unincorporated Llano County	15,783	5,177	4,235	6,370
Llano County (Total)	19,309	6,915	5,081	7,313

Source: FEMA 2021; Texas Water Development Board 2021; Hazus v5.1; Census 2010/2020

Note: (C) = City

Table 4.3.4-20 Estimated Losses from a 1-Percent Chance Annual Flood in Llano County

Flood Hazard	Inventory Loss	Relocation Loss	Building Loss	Content Loss	Wage Loss	Rental Loss	Income Loss
1-Percent Annual Chance Flood Event	\$350,000	\$21,390,000	\$75,310,000	\$48,990,000	\$16,620,000	\$7,090,000	\$7,170,000

Source: FEMA 2021; Hazus v5.1

Table 4.3.4-21 Estimated Losses from a 1-Percent Chance Annual Flood in San Saba County

Flood Hazard	Inventory Loss	Relocation Loss	Building Loss	Content Loss	Wage Loss	Rental Loss	Income Loss
1-Percent Annual Chance Flood Event	\$0	\$60,000	\$0	\$0	\$180,000	\$10,000	\$30,000

Source: FEMA 2021; Texas Water Development Board 2021; Hazus v5.1

Impact on the Environment

Floodplains serve beneficial and natural functions on ecological, environmental, social, and economic levels. Areas in the floodplain that typically provide these natural functions and benefits are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. Floods, however, can also lead to negative impacts on the environment. Disruption of natural systems and the benefits they provide can have long-term consequences for entire regions. According to FEMA, well-known, water-related functions of floodplains include the following:

- Natural flood and erosion control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce flood peaks
- Reduce sedimentation
- Surface water quality maintenance
- Process organic wastes
- Moderate temperatures of water
- Groundwater recharge
- Filter nutrients and impurities from runoff
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low-surface flows

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be impacted by the flood hazard if located in the floodplain. The Flood Damage Prevention Ordinance regulates not only how land in designated floodplain areas may be used or altered, but the location and types of structures that are permitted in those areas as well as the specifications to which they must build. All structures, including residential and commercial properties, manufactured homes, and the developments of subdivisions are regulated.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

Any increases in population, specifically in the 1-percent annual chance flood hazard area, will increase the overall flood risk in the Planning Area.

Climate Change

Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Climate change may result in changes in the intensity and frequency of hurricanes, leading to more heavy precipitation events.

Change of Vulnerability Since 2016 HMP

The Planning Area continues to be vulnerable to floods. The 2023 update includes the updated flood maps for Llano County. The 2023 update therefore provides more accurate estimated exposure and potential losses due to flooding for the Planning Area.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.5 Geologic Hazards

The following section provides the hazard profile and vulnerability assessment for the geologic hazard in the Planning Area. Geologic hazards in the Planning Area include earthquake, expansive soils, and subsidence. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Earthquake

An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, a volcanic eruption, or by a manmade explosion (FEMA 2013). Most earthquakes occur at the boundaries where the Earth's tectonic plates meet (faults); however, less than 10-percent of earthquakes occur within plate interiors. New York State is in an area where plate interior-related earthquakes occur. As plates continue to move and plate boundaries change over geologic time, weakened boundary regions become part of the interiors of the plates. These zones of weakness within the continents can cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust (Shedlock and Pakiser 1997).

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter (Shedlock and Pakiser 1997). Earthquakes usually occur without warning and their effects can impact areas of great distance from the epicenter.

Expansive soils

Expansive soils are soils that expand when water is added and shrink when they dry out. This continuous change in soil volume can cause structures to move unevenly and crack and roads and sidewalks to buckle. Soils with a high clay content exhibit high expansive properties. Slab on grade construction is the most susceptible to damage from expansive clays.

Subsidence

Land subsidence is the gradual lowering of land-surface elevation. In the Planning Areas, land subsidence is caused by compaction of fine-grained aquifer sediments (silts and clays) below the land surface due to groundwater withdrawals. Removing water from fine-grained aquifer sediments compresses the aquifer leaving less pore space available to store water resulting in the lowering (sinking or settling) of the land-surface. Most compaction that occurs as a result of groundwater withdrawals is irreversible; even if groundwater levels rise, compacted sediments and the associated land-surface lowering would remain (USGS n.d.).

Consequences of land subsidence in the Planning Area include:

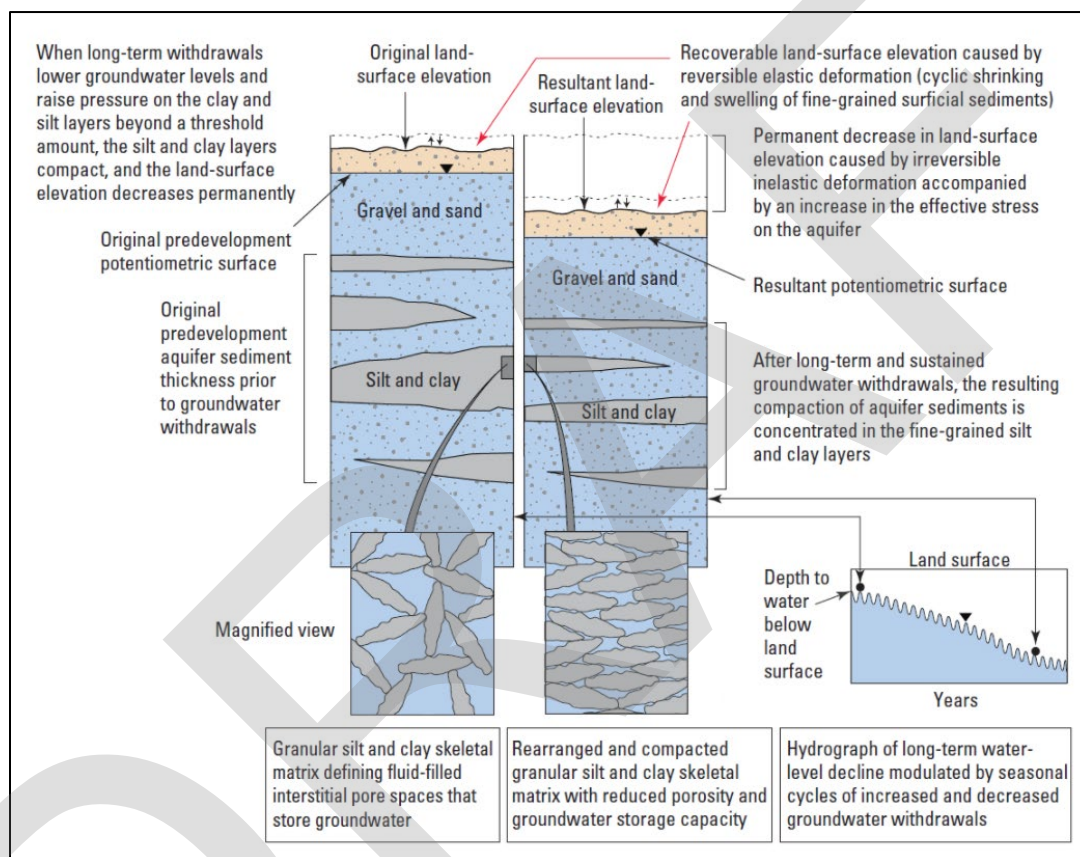
- Reduces the ability to store water in an aquifer



- Partially or completely submerges land
- Collapses water well casings
- Disrupts collector drains and irrigation ditches
- Alters the flow of creeks and bayous which may increase the frequency and severity of flooding
- Damages roadways, bridges, building foundations, and other infrastructure

Figure 4.3.5-1 below illustrates the land subsidence process, wherein soil layers become compacted and unstable due to the loss of groundwater.

Figure 4.3.5-1. The Subsidence Process



Source: USGS n.d.

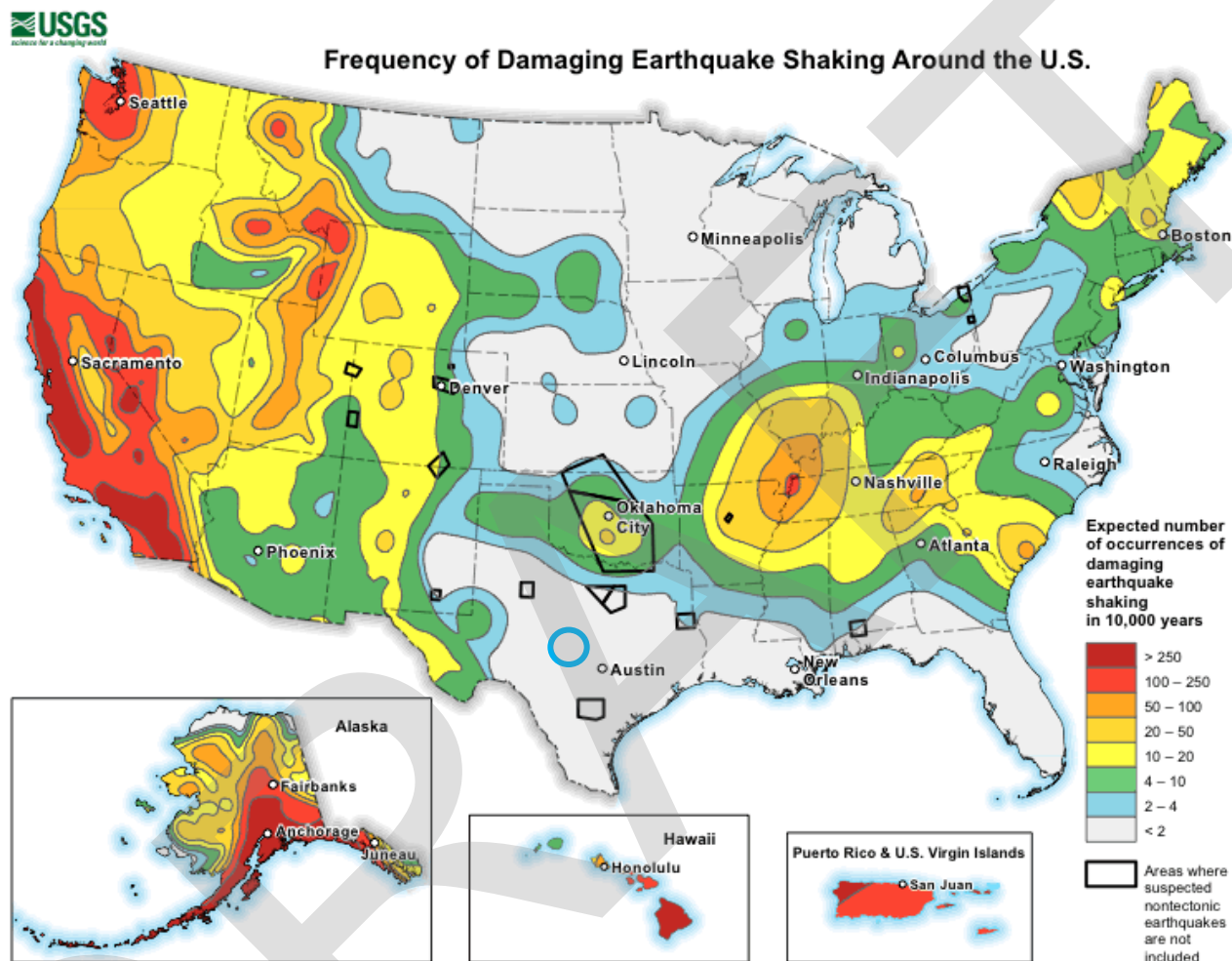
Location

Earthquake

While Texas does face some earthquake hazard, this hazard is very small in comparison to many other states. The biggest threat appears to be from the New Madrid fault system in Missouri, a system powerful enough to pose a risk to the north Texas area. Two regions, near El Paso and in the Panhandle, should expect earthquakes with magnitudes of approximately 5.5 to 6.0 to occur every 50 to 100 years, with even larger earthquakes possible. In Central Texas, the hazard is generally low, but residents should be aware that small earthquakes can occur, including some that are theoretically triggered by oil or gas production. Elsewhere in Texas, earthquakes are

exceedingly rare. However, the hazard level is not zero anywhere in Texas; small earthquakes are possible almost anywhere, and all regions face possible ill effects from very large, distant earthquakes (Llano County 2016).

Figure 4.3.5-2. Frequency of Damaging Earthquake Shaking Around the U.S.



Source: USGS n.d.

Note: The blue circle shows the general location of the Planning Area.

A probabilistic assessment was conducted for the 100- and 500-year mean return periods (MRP) through a Level 2 analysis using the HAZUS-MH, Version 2.2 (HAZUS-MH) probabilistic model to analyze the earthquake hazard for the Planning Area. The Level 2 HAZUS analysis evaluates the statistical likelihood that a specific event will occur and what consequences will occur. A 100-year MRP event is an earthquake with a 1-percent chance that the mapped ground motion levels (PGA) will be exceeded in any given year. For a 500-year MRP, there is a 0.2-percent chance the mapped PGA will be exceeded in any given year.

Figure 4.3.5-3 and Figure 4.3.5-4 illustrate the geographic distribution of PGA (g) across the Planning Area for 100- and 500-year MRP events.

Figure 4.3.5-3. 100-Year Earthquake PGA in the Planning Area

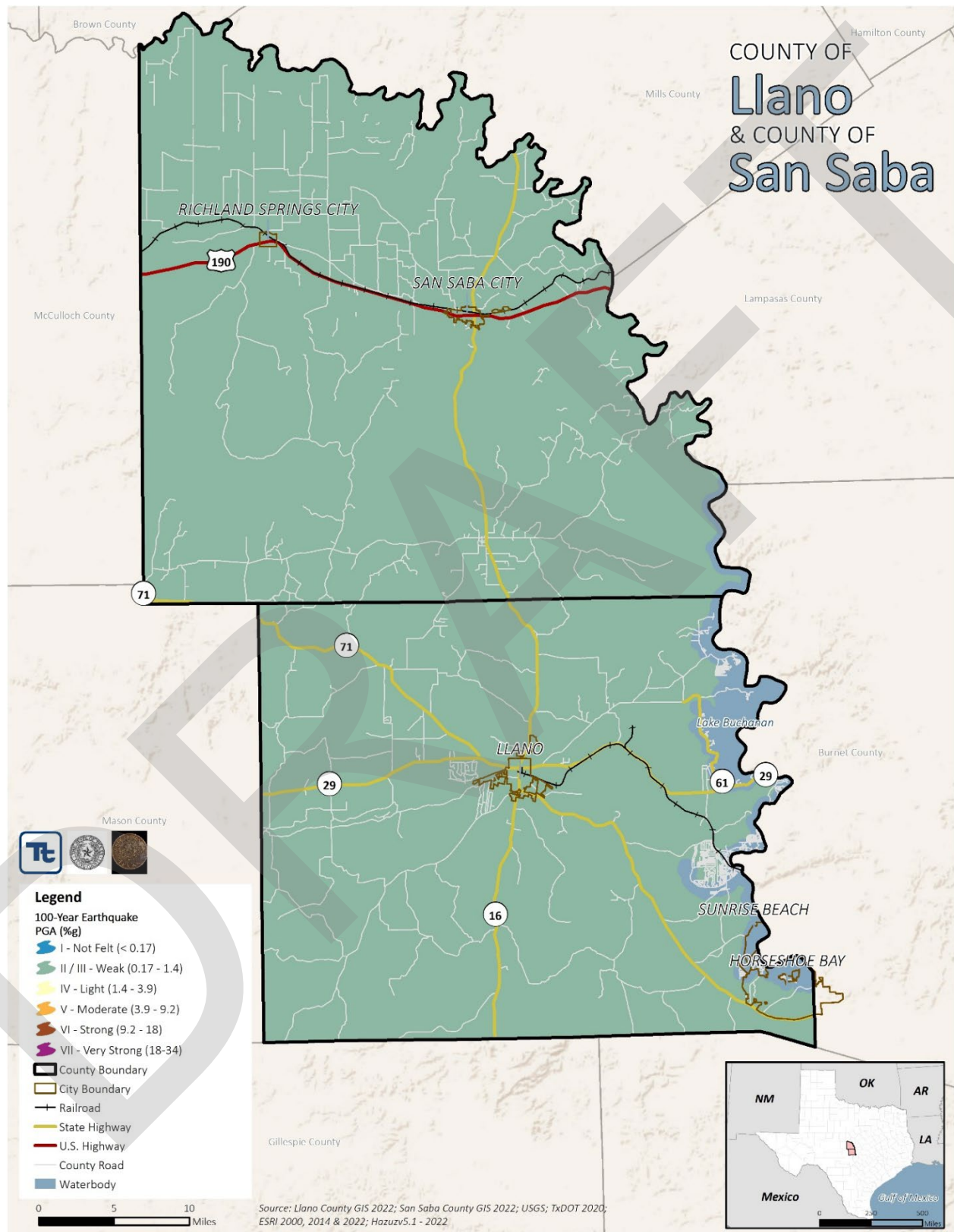
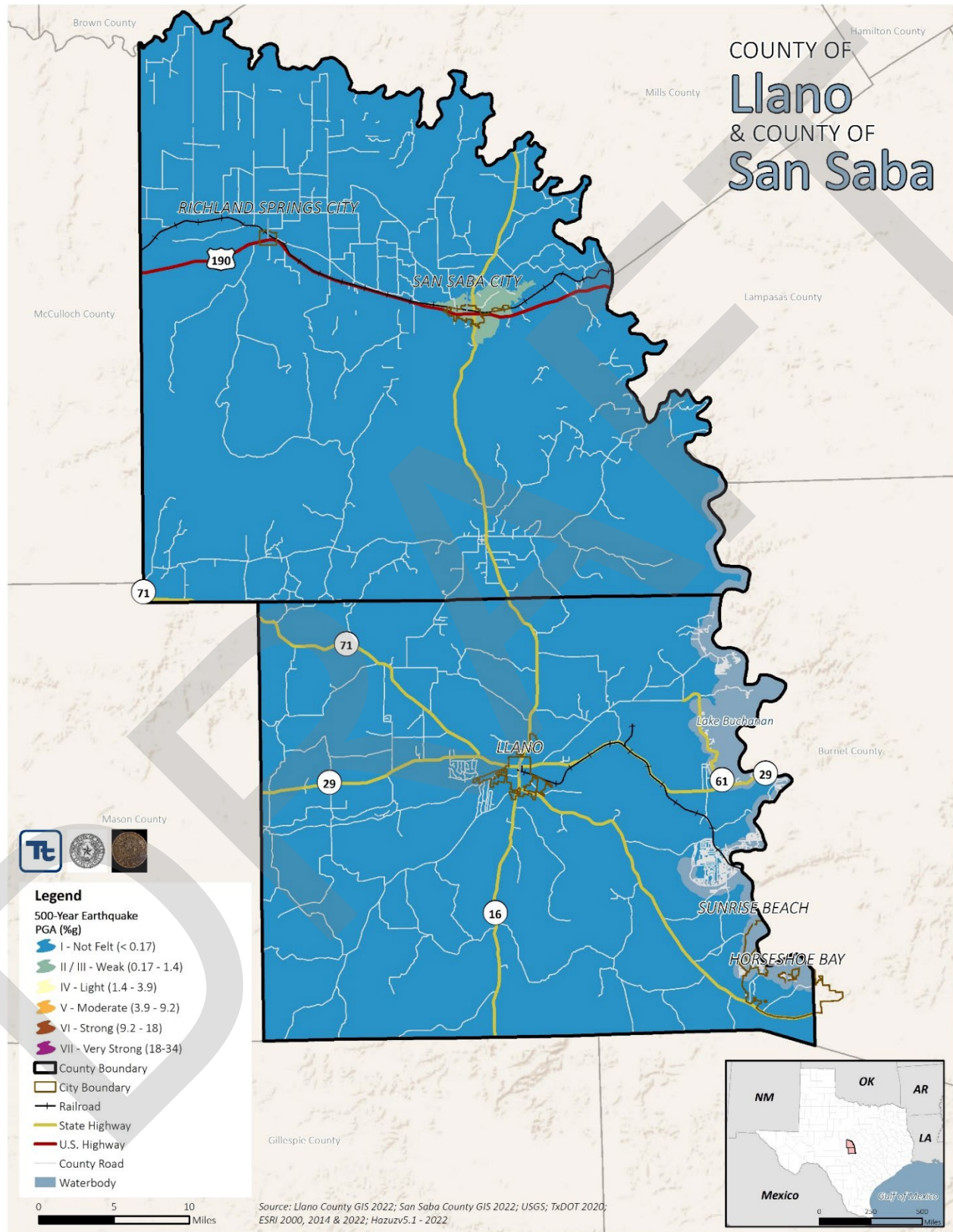
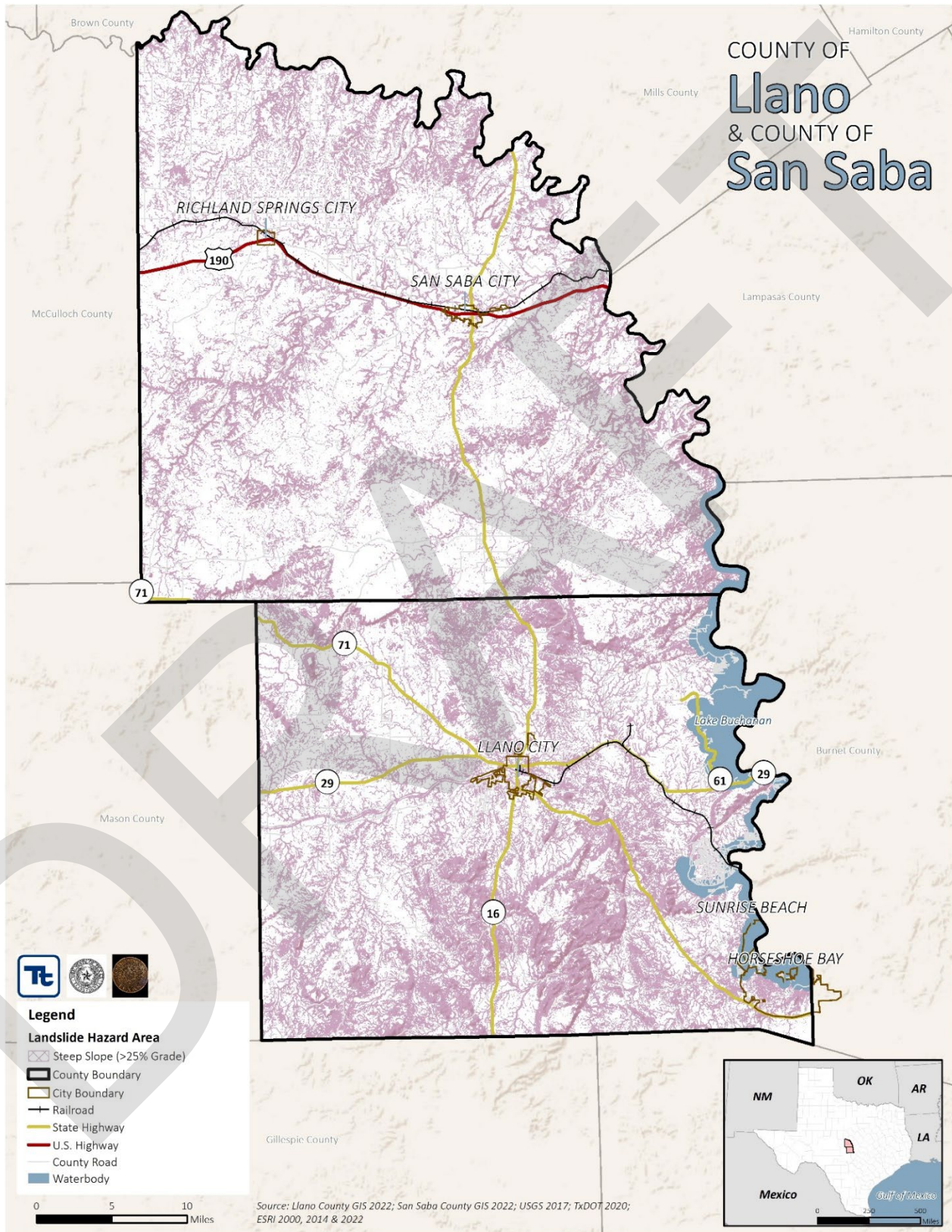


Figure 4.3.5-4. 500-Year Earthquake PGA in the Planning Area



Earthquakes can also trigger landslides. Landslides most commonly occur in areas with steep slopes. For this assessment, areas with slopes with greater than a 25-percent grade were considered to be steep slopes that form the landslide hazard area. Figure 4.3.5-5 displays the areas of Llano County and San Saba County prone to landslides.

Figure 4.3.5-5. Landslide Hazard Area

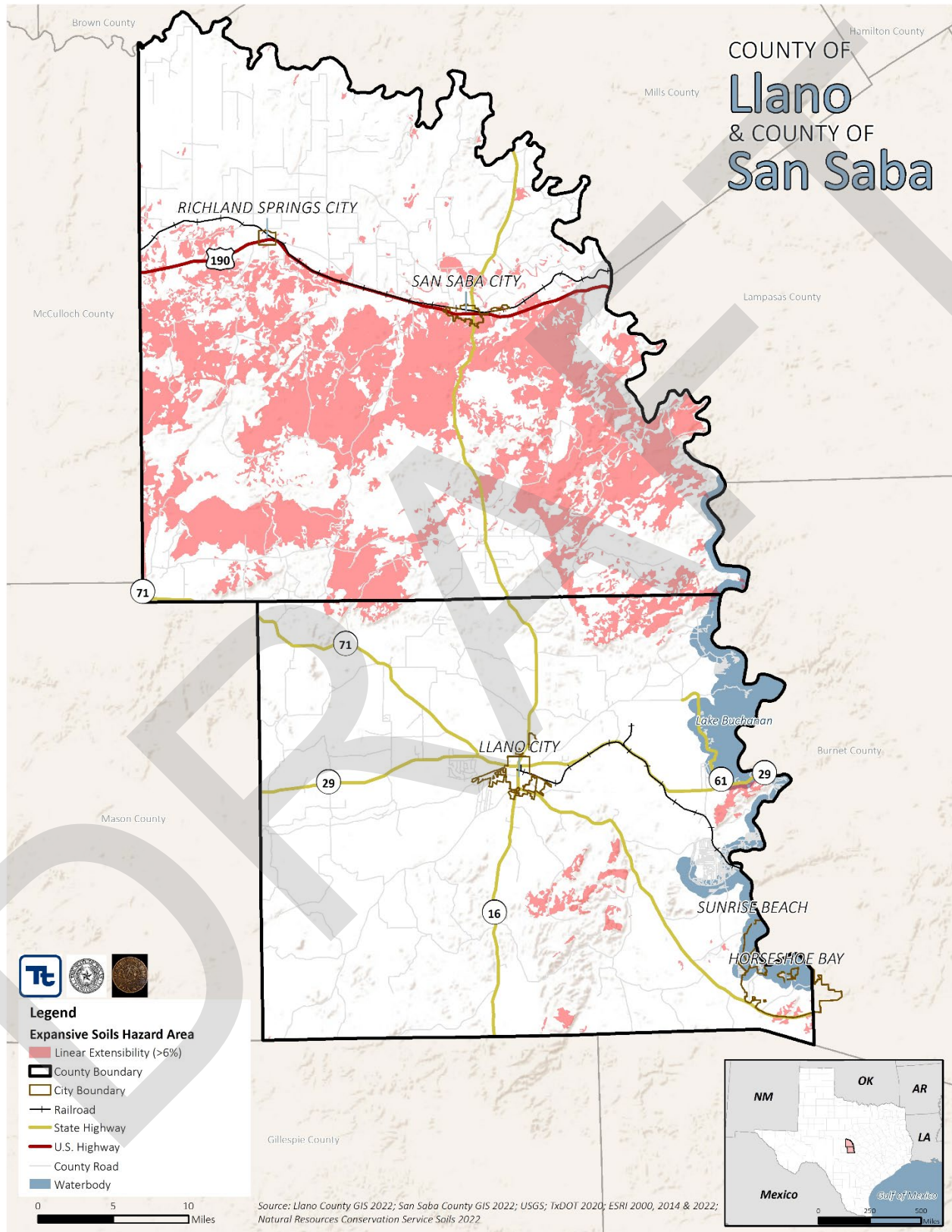


Expansive soils

Damage to buildings and critical infrastructure due to expansive soils can occur throughout the Planning Area. The hazard is most prevalent in areas with clay or sandy soil which are prone to expanding and contracting in periods of heavy precipitation followed by periods of drought.

The predominant soil types in the Planning Area are formed of granite, gneiss, and limestone rock. These soils are stronger and more resilient to expansion and contraction than softer, clay- or sand-dominant soils. Figure 4.3.5-6 below shows the locations with the potential for swelling of soils in the Planning Area. Expansive soils are most common in the southern half of San Saba County.

Figure 4.3.5-6. Location of Potential Swelling from Expansive Soils in the Planning Area

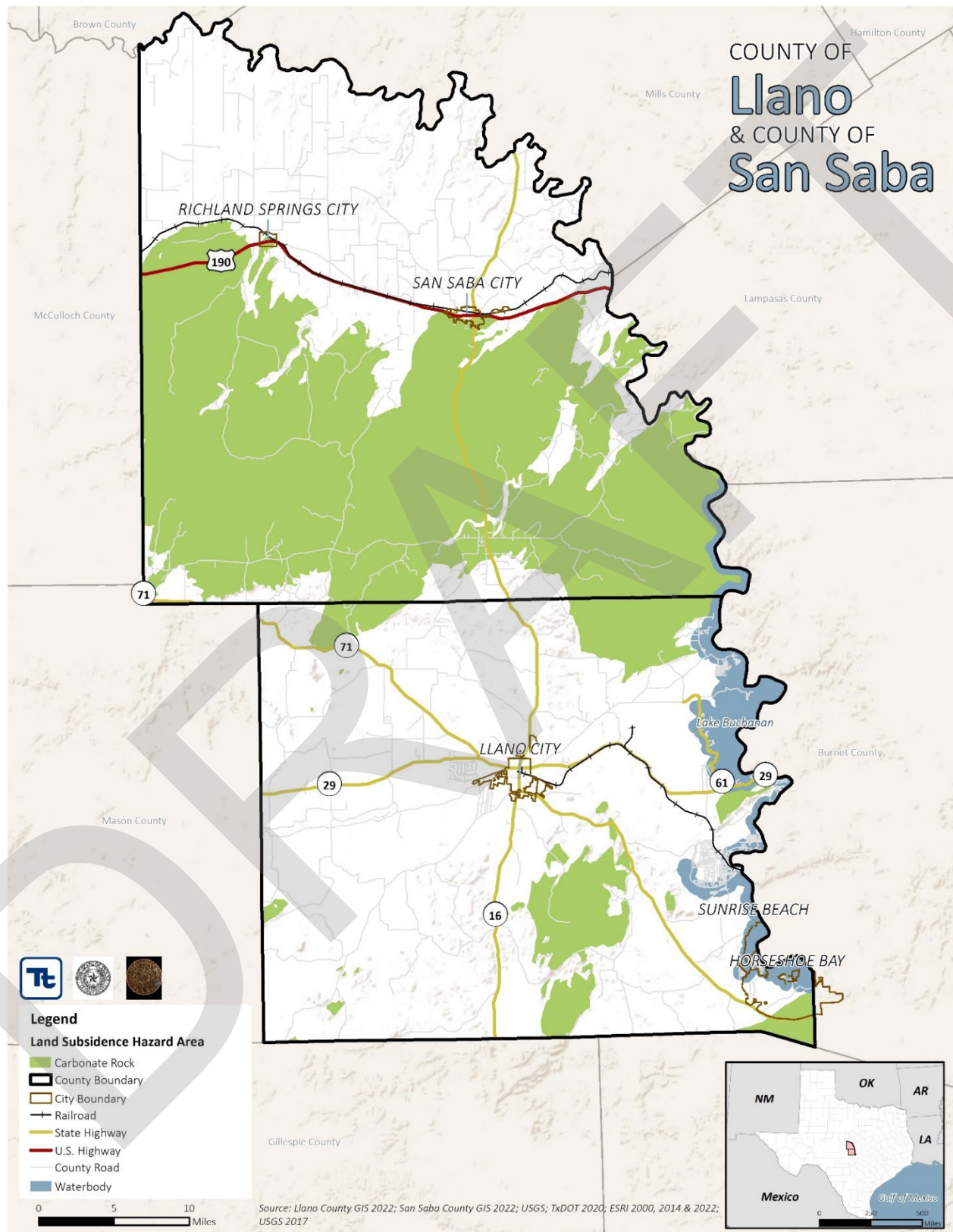


Subsidence

The US Geological Survey (USGS) notes that “subsidence is a global problem and, in the United States, more than 17,000 square miles in 45 States, an area roughly the size of New Hampshire and Vermont combined, have been directly affected by subsidence” (USGS 2018).

To identify areas where subsidence may occur, locations with carbonate rock were mapped. Figure 4.3.5-7 shows the land subsidence hazard area in Llano County and San Saba County. Land subsidence risk is focused in the southern half of San Saba County with small areas in Llano County.

Figure 4.3.5-7. Land Subsidence Hazard Area



Extent

Earthquake

An earthquake's magnitude and intensity are used to describe the severity and size of the event. intensity describes the overall felt severity of shaking during the event and magnitude describes the size at the focus of an earthquake. The earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude was formerly expressed by ratings on the Richter scale. It is now most commonly expressed using the moment magnitude (Mw) scale. This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). The scale is as follows:

- Great Mw > 8
- Major Mw = 7.0 – 7.9
- Strong Mw = 6.0 – 6.9
- Moderate Mw = 5.0 – 5.9
- Light Mw = 4.0 – 4.9
- Minor Mw = 3.0 – 3.9
- Micro Mw = 3.0 – 3.9

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale, as well as the perceived shaking and damage potential for structures, are shown in Table 4.3.5-1. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region. This shaking depends on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A USGS shake map shows the variation of ground shaking in a region immediately following significant earthquakes. Table 4.3.5-1 displays the MMI scale and its relationship to the areas peak ground acceleration.

Table 4.3.5-1. Modified Mercalli Intensity Scale

Mercalli Intensity	Shaking	Description
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibrations are similar to the passing of a truck. Duration estimated.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing automobiles rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII	Very Strong	Felt by all. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Felt by all. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Felt by all. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Felt by all. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

Source: USGS 2014

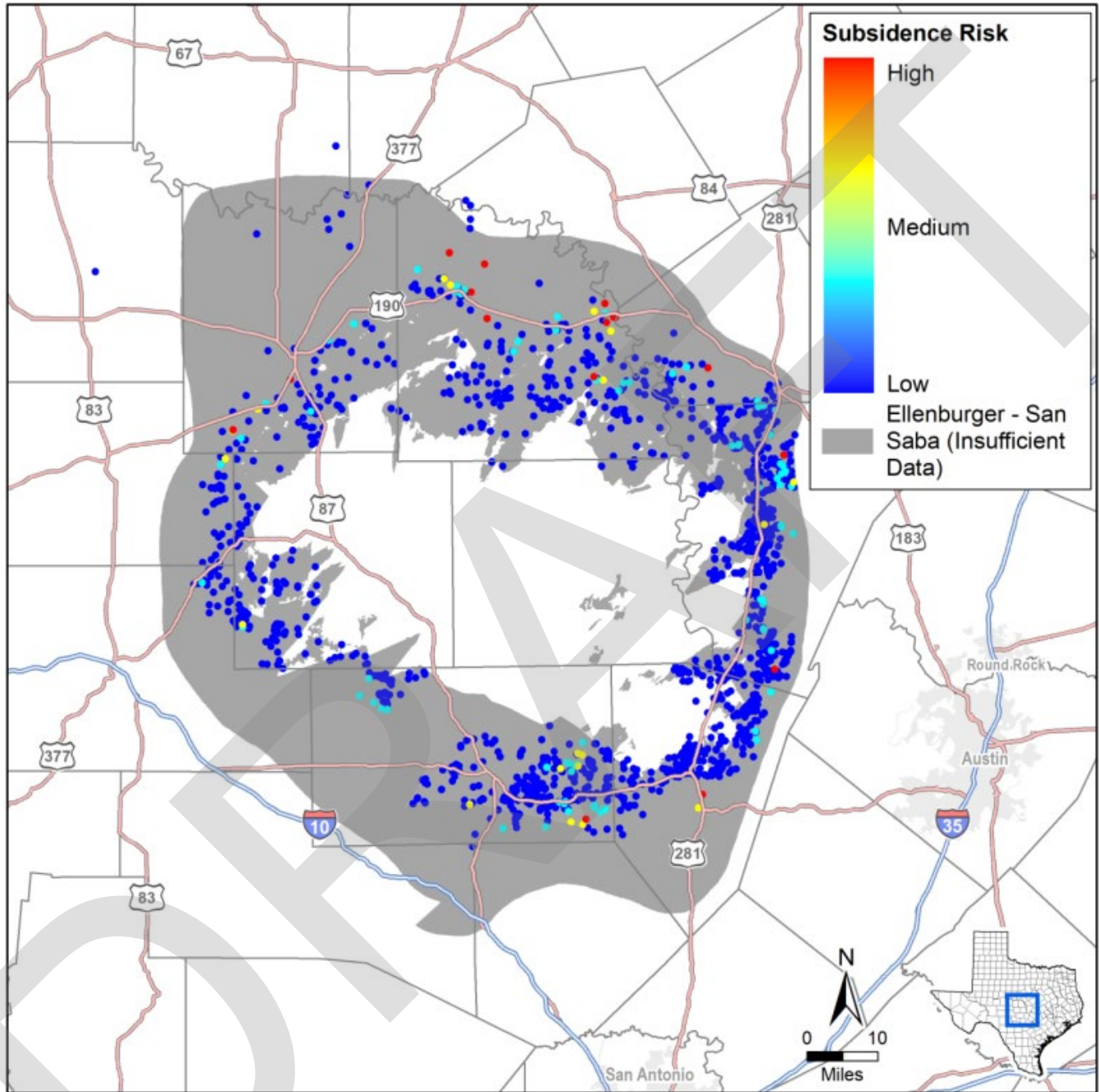
Expansive Soils

The Planning Area is considered to be at low to extremely limited potential of potential swelling. The effects of this hazard can impact a community similarly to those of drought and land subsidence, with the ground shifting and causing structural damage to the built environment. With limited documentation of national datasets addressing expansive soils, however, providing a measure of expansive soil impacts poses a challenge.

Subsidence

The primary cause of land subsidence in the Planning Area is groundwater pumping. The Texas Water Development Board's 2016 report classifies the risk of land subsidence from the Ellenburger-San Saba Aquifer as low, given the thickness of clay in the region's soils and the generally stable water levels within the aquifer (Texas Water Development Board 2016). Figure 4.3.5-8 below maps the risk of land subsidence at various wells throughout the aquifer region.

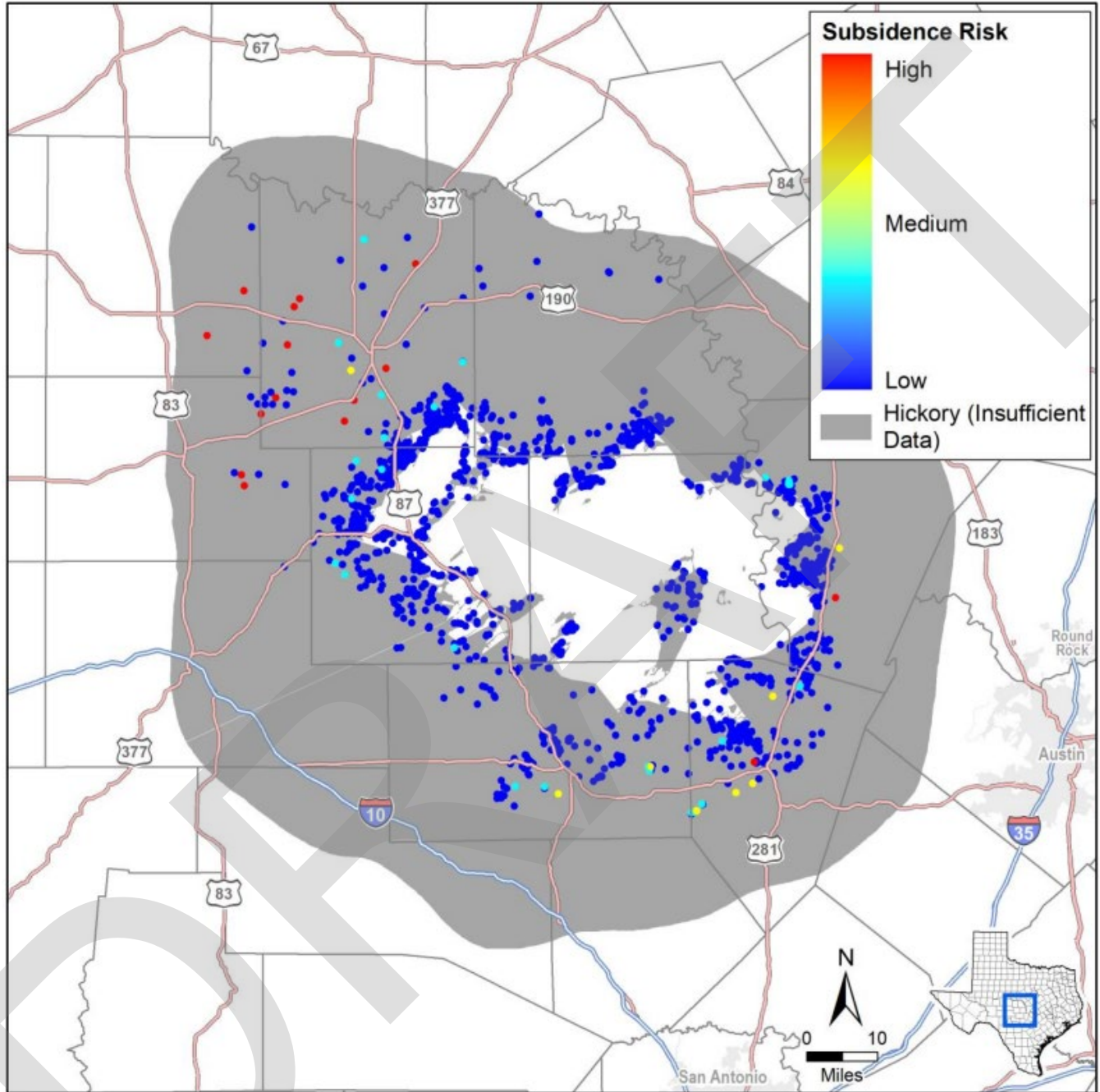
Figure 4.3.5-8. Land Subsidence Risk at Well Locations in the Ellenburger-San Saba Aquifer



Source: Texas Water Development Board

Subsidence risk from the Hickory Aquifer is also low due to the thickness of clay in the region's soils and the generally stable water levels within the aquifer (Texas Water Development Board 2016). Figure 4.3.5-9 below maps the risk of land subsidence at various wells throughout the aquifer region.

Figure 4.3.5-9. Land Subsidence Risk at Well Locations in the Hickory Aquifer



Source: Texas Water Development Board

Worst-Case Scenario

A worst-case scenario for earthquake would be a moderate strength earthquake with a Mercalli Intensity of V. This level event would be felt by nearly everyone in the Planning Area. Some dishes and windows would be broken with unstable objects overturned.

A season of flooding with rapid drying conditions such as in a drought would present a worst-case scenario for the expansive soils hazard. Underground utility pipes, foundations, roadways, and sidewalks would be vulnerable to cracking or buckling, causing damage to the built environment.

A worst-case scenario for land subsidence would be an increase in its rate, causing damage to the built environment. Impacts from this land subsidence would include road closures, damage to infrastructure and buildings, and inaccessible areas that can disrupt emergency response.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were not included in any disaster (DR) or emergency (EM) declarations for geologic hazard-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Llano and/or San Saba County were not included in any geologic-related agricultural disaster declarations.

Previous Events

There is insufficient data on losses from earthquakes, expansive soils, and land subsidence in the Planning Area, and there are no recorded previous occurrences in the FEMA, NCEI, USGS, or USDA databases.

Probability of Future Occurrences

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for geologic events in the Planning Area is considered 'rare'.

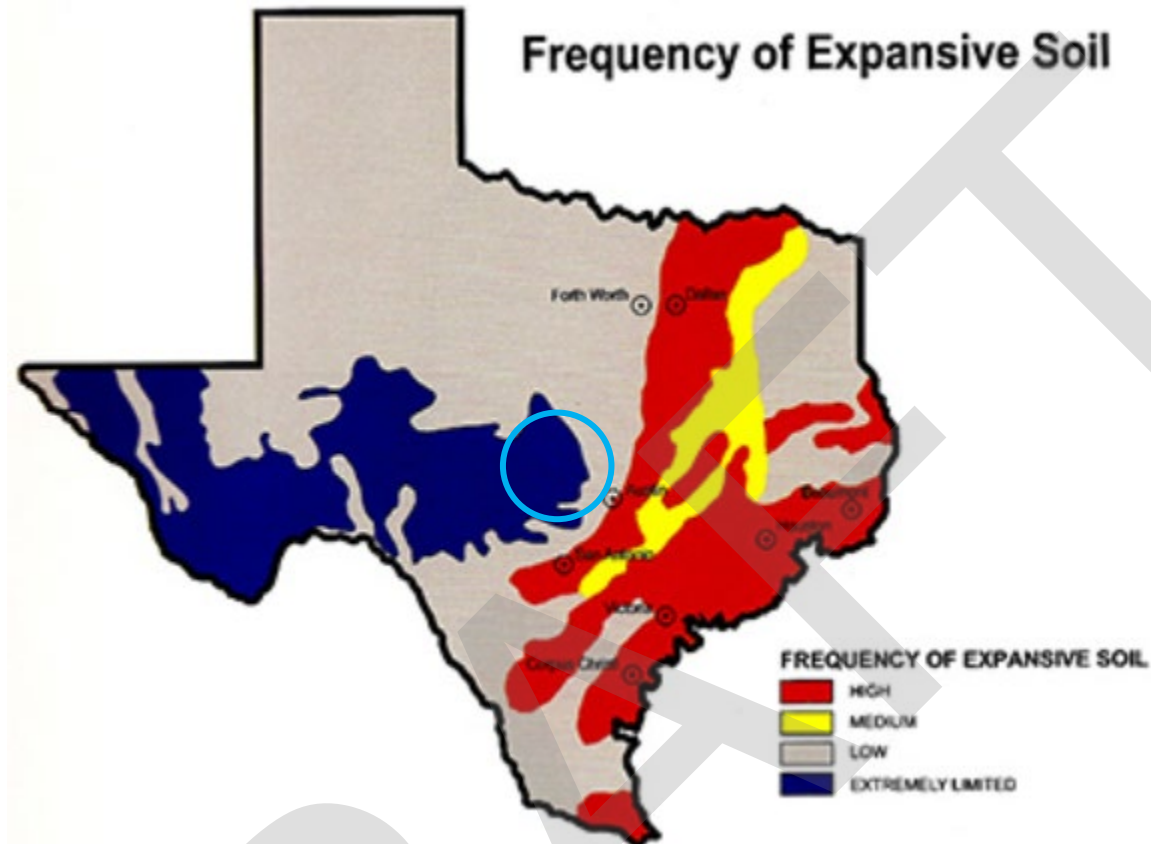
Earthquake

Earthquake hazard maps illustrate the distribution of earthquake shaking levels that have a certain probability of occurring over a given time period. According to the USGS, in 2017 (the date of the most recent analysis), the Planning Area has less than a 0.1-percent annual probability of an occurrence of a damaging earthquake.

Expansive Soils

Despite having areas susceptible to expansive soils, the strong soil types of Llano and San Saba counties, mostly made of granite, gneiss, and limestone rock, limit the planning area's vulnerability to the hazard. Compared to the rest of Central Texas, Llano and San Saba counties are in the 'extremely limited' area for frequency of expandable soils, meaning it is unlikely the hazard will occur at a rapid pace or in the near future. Areas close by, including Travis County to the East and Bear County further South, have high frequencies of expansive soils. See Figure 4.3.5-10 below to view the frequency of expansive soils in the Central Texas corridor.

Figure 4.3.5-10. Frequency of Expansive Soils in the Central Texas Corridor



Source: Tella Firma Foundations 2017

Note: The blue circle shows the general location of the Planning Area.

Subsidence

Subsidence is usually a continual process, slowly progressing over time. Although land subsidence is primarily being seen in the coastal areas of Texas, as the demand for water in central Texas increases, including in Llano and San Saba counties, the aquifers below the region will decrease in volume, causing a gap of space to emerge between the land and the water below the surface. This gap of empty space could cause the land above it to begin to subside. As mentioned, this process is slow paced, and movements will not be rapid.

Climate Change Projections

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Climate change is likely to have significant impacts on the performance of residential buildings constructed on expansive soils. Precipitation and temperature are the primary weather parameters used for determining ground movement (Sun, Li and Zhou 2017). The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. Rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016).

While there is no established connection that climate change increases land subsidence, secondary impacts of climate change such as drought and flood may have a greater impact on areas experiencing land subsidence. As drought levels increase, the need to pump water from aquifers also increases which exacerbates subsidence (Shirzaei and Bürgmann 2018).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the geologic hazard. The following text evaluates and estimates the potential impact of the geologic hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

Earthquake

The impact of an earthquake on life, health, and safety is dependent upon the severity of the event. Risk to public safety and loss of life from an earthquake in the Planning Area is minimal. However, a higher risk would occur in for those inside buildings, due to structural damage, or people walking below building ornamentation and chimneys that may be loose and fall as a result of the earthquake.

A strong correlation exists between structural building damage and the number of injuries and casualties from an earthquake event. Further, the time of day also exposes different sectors of the community to the hazard. For example, Hazus considers the residential occupancy at its maximum at 2:00 a.m., where the educational, commercial, and industrial sectors are at their maximum at 2:00 p.m., and peak commute time is at 5:00 p.m. Whether directly impacted or indirectly impacted, the entire population will be affected to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of utilities could impact populations that suffered no direct damage from an event itself.

Hazus was used to examine potential the impacts from the 100- and 500-year MRP earthquake events in the Planning Area. For each event, there are no expected displaced households or people requiring short-term shelter. No injuries, hospitalizations, or casualties are expected for the 100- or 500-year MRP earthquake events in the Planning Area.

Expansive Soils

The population living in areas of high linear extensibility are considered especially vulnerable to the expansive soils hazard. A quantitative analysis was conducted using expansive soil hazard areas to determine the population living in expansive soils hazard areas. It was found that, while a low percentage of the population of Llano County is located in the expansive soils hazard area, almost a quarter of the population of San Saba County is exposed to this hazard. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by a hazard event (e.g., people are at risk while traveling, people inside of vulnerable buildings, or people whose access emergency services is compromised during an event); the degree of that impact varies and is not strictly measurable.

Table 4.3.5-2. Estimated Population Located in the Expansive Soils Hazard Area in Llano County

Llano Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Expansive Soils Hazard Area	
		Number of Persons	Percent of Total
Horseshoe Bay (C)	4,257	13	0.3%

Sunrise Beach (C)	739	0	0.0%
Llano (C)	3,325	0	0.0%
Unincorporated Llano County	12,922	23	0.2%
Llano County (Total)	21,243	36	0.2%

Source: USDA 2003; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.5-3. Estimated Population Located in the Expansive Soils Hazard Area in San Saba County

San Saba Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Expansive Soils Hazard Area	
		Number of Persons	Percent of Total
Richland Springs (T)	244	1	0.4%
San Saba (C)	3,117	921	29.5%
Unincorporated San Saba County	2,369	425	17.9%
San Saba County (Total)	5,730	1,346	23.5%

Source: USDA 2003; Census 2020

Notes: (C) = City; (T) = Town

Subsidence

Subsidence negatively impacts roadways, buildings, water, and sewer infrastructure which increases safety hazards. The most common problems associated with land subsidence are loss of utilities and power outages which can be life threatening to those dependent on electricity for life support.

The impact of subsidence on life, health, and safety is dependent upon several factors including the severity of the event and the populations access to food, water, and shelter. In addition, residents can also be displaced or require temporary to long-term sheltering depending on viability of utilities.

Most fracking, pumping, or mining is done near communities that are economically disadvantaged, making this population more vulnerable to subsidence. Although the entire population of the Planning Area is exposed to geologic hazards, some populations are more vulnerable. Vulnerable populations include the elderly, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. In general, populations who are reliant on sustained sources of power to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable to geologic hazards.

Table 4.3.5-4. Estimated Population Located in the Subsidence (Carbonate Karst) Hazard Area in Llano County

Llano Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Subsidence (Carbonate Karst) Hazard Area	
		Number of Persons	Percent of Total
Horseshoe Bay (C)	4,257	543	12.8%
Sunrise Beach (C)	739	0	0.0%
Llano (C)	3,325	0	0.0%

Unincorporated Llano County	12,922	159	1.2%
Llano County (Total)	21,243	702	3.3%

Source: USGS 2017; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.5-5. Estimated Population Located in the Subsidence (Carbonate Karst) Hazard Area in San Saba County

San Saba Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located in the Subsidence (Carbonate Karst) Hazard Area	
		Number of Persons	Percent of Total
Richland Springs (T)	244	182	74.5%
San Saba (C)	3,117	1,289	41.4%
Unincorporated San Saba County	2,369	637	26.9%
San Saba County (Total)	5,730	2,109	36.8%

Source: USGS 2017; Census 2020

Notes: (C) = City, (T) = Town

Impact on General Building Stock

Earthquake

The entire Planning Area's general building stock is considered at risk and exposed to this hazard. A building's construction determines how well it can withstand the force of an earthquake. Hazus considers building construction and age of building as part of the analysis. Because a custom general building stock was used for this analysis, the building ages and building types from the inventory were incorporated into the Hazus model. Potential building damage was evaluated by Hazus across the following damage categories (none, slight, moderate, extensive, and complete). Hazus estimates that no building damages are expected for the 100-year and 500-year MRP earthquake event.

Expansive Soils

Soils capable of changes in volume present a hazard to structures built over them and to the pipelines, sewer and water lines buried in them. Houses and one-story commercial buildings are more apt to be damaged by the expansion of swelling clays than are multi-story buildings, which are usually heavy enough to counter swelling pressures. However, if constructed on wet clay, multi-story buildings may also be damaged by clay shrinkage when moisture levels are substantially reduced (Texas Division of Emergency Management 2018).

An estimated 21.7-percent of buildings in San Saba County are located in the expansive soils hazard area.

Table 4.3.5-6. Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils Hazard Area in Llano County

Llano Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total

Horseshoe Bay (C)	2,174	\$921,317,000	8	0.4%	\$3,245,145	0.4%
Sunrise Beach (C)	909	\$345,382,000	0	0.0%	\$0	0.0%
Llano (C)	1,733	\$564,332,000	0	0.0%	\$0	0.0%
Unincorporated Llano County	8,788	\$2,408,418,000	15	0.2%	\$4,183,170	0.2%
Llano County (Total)	13,604	\$4,239,449,000	23	0.2%	\$7,428,316	0.2%

Source: USDA 2003; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.5-7. Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils Hazard Area in San Saba County

San Saba Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Expansive Soils Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Richland Springs (T)	213	\$66,306,000	1	0.3%	\$120,412	0.2%
San Saba (C)	1,311	\$410,811,000	380	29.0%	\$122,890,202	29.9%
Unincorporated San Saba County	1,819	\$480,386,000	320	17.6%	\$84,597,342	17.6%
San Saba County (Total)	3,343	\$957,503,000	701	21.0%	\$207,607,955	21.7%

Source: USDA 2003; Census 2020

Notes: (C) = City, (T) = Town

While all infrastructures in the higher-risk areas are vulnerable, slab-on-grade structures are most likely to suffer damages from expansive soils. In addition, older structures built to less stringent building codes may be more susceptible to damages than new construction. Bridges, highways, streets, and parking lots are especially vulnerable when they are constructed when clays are dry, such as during a drought, and then subsequent soaking rains swell the clay (State of Texas HMP 2018).

Subsidence

Buildings that are located on or near areas that have a higher chance of failing due to subsidence may need to be relocated or reinforced to ensure building stability. Extreme subsidence can crack and break building materials, so building construction plays a major role in the extent of damage resulting from levels of subsidence. Due to differences in construction, residential structures are generally more susceptible to subsidence than commercial and industrial structures, especially homes and buildings that may be built on top of land that has materials being extracted underneath. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings.

Table 4.3.5-8. Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area in Llano County

Llano Jurisdiction	Total Number	Total Replacement	Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area

	of Buildings	Cost Value (RCV)	Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Horseshoe Bay (C)	2,174	\$921,317,000	194	8.9%	\$76,151,461	8.3%
Sunrise Beach (C)	909	\$345,382,000	0	0.0%	\$0	0.0%
Llano (C)	1,733	\$564,332,000	0	0.0%	\$0	0.0%
Unincorporated Llano County	8,788	\$2,408,418,000	133	1.5%	\$37,681,202	1.6%
Llano County (Total)	13,604	\$4,239,449,000	327	2.4%	\$113,832,663	2.7%

Source: USGS 2017; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.5-9. Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area in San Saba County

San Saba Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Richland Springs (T)	213	\$66,306,000	160	75.3%	\$52,310,036	78.9%
San Saba (C)	1,311	\$410,811,000	514	39.2%	\$150,046,862	36.5%
Unincorporated San Saba County	1,819	\$480,386,000	499	27.4%	\$117,810,455	24.5%
San Saba County (Total)	3,343	\$957,503,000	1,173	35.1%	\$320,167,354	33.4%

Source: USGS 2017; Census 2020

Notes: (C) = City, (T) = Town

Impact on Critical Facilities

Earthquake

After considering the general building stock exposed to, and damaged by, 100- and 500-year MRP earthquake events, critical facilities were evaluated. All critical facilities in Llano County and San Saba County are considered exposed and vulnerable to the earthquake hazard. The Hazus model estimates that less than 0.1-percent of critical facilities in the Planning Area will be damaged by the 100- or 500-year MRP earthquake event. Critical facilities are expected to maintain functionality in each event.

Expansive Soils

Expansive soil events may potentially impact critical facilities and lifelines identified within the County. Critical services may not be available if critical facilities or lifelines are directly damaged or transportation routes to access these critical facilities are breached due to expansive soil events. In Llano County, only one lifeline facility is located in the expansive soils hazard area. In San Saba County, 20 lifeline facilities are located in the expansive soils hazard area.

Table 4.3.5-10. Number of Lifelines Located in the Expansive Soils Hazard Area in Llano County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Expansive Soils Hazard Area
Communications	5	1
Energy	28	0
Food, Water, Shelter	18	0
Hazardous Material	7	0
Health and Medical	14	0
Safety and Security	38	0
Transportation	177	0
Llano County (Total)	287	1

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021; USDA 2003

Table 4.3.5-11. Number of Lifelines Located in the Expansive Soils Hazard Area in San Saba County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Expansive Soils Hazard Area
Communications	2	2
Energy	0	0
Food, Water, Shelter	2	0
Hazardous Material	0	0
Health and Medical	0	0
Safety and Security	15	3
Transportation	111	15
San Saba County (Total)	130	20

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021; USDA 2003

Subsidence

Overall, all critical facilities in the Planning Area are vulnerable to being affected by subsidence. Subsidence can destroy roadways and buildings which can affect emergency services getting to a location in a timely manner. Utility infrastructure could suffer damage collapsing land resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Table 4.3.5-12. Number of Lifelines Located in the Subsidence (Carbonate Karst) Hazard Area in Llano County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Subsidence (Carbonate Karst) Hazard Area
Communications	5	0

Energy	28	0
Food, Water, Shelter	18	0
Hazardous Material	7	0
Health and Medical	14	0
Safety and Security	38	0
Transportation	177	3
Llano County (Total)	287	3

Source: USGS 2017

Table 4.3.5-13. Number of Lifelines Located in the Subsidence (Carbonate Karst) Hazard Area in San Saba County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Subsidence (Carbonate Karst) Hazard Area
Communications	2	2
Energy	0	0
Food, Water, Shelter	2	0
Hazardous Material	0	0
Health and Medical	0	0
Safety and Security	15	9
Transportation	111	31
San Saba County (Total)	130	42

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021; USGS 2017

Impact on Economy

Earthquake

Earthquakes also impact the economy, including loss of business function, damage to inventory (buildings, transportation, and utility systems), relocation costs, wage loss, and rental loss due to repair and replacement of buildings. Hazus estimates building-related economic losses, including income losses (wage, rental, relocation, and capital-related losses) and capital stock losses (structural, non-structural, content, and inventory losses). For the 100- and 500-year MRP earthquake events, Hazus estimates no losses due to inventory losses, relocation losses, building and content losses, wages losses, rental losses, or capital-related losses.

Additionally, Hazus estimates volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare for and rapidly and efficiently manage debris removal and disposal. For the 100- and 500-year MRP earthquake events, Hazus does not estimate debris will be generated.

Expansive Soils

Expansive soil events can significantly impact the local and regional economy. Losses include, but are not limited to, damages to buildings and infrastructure, agricultural losses, business interruption, and disruptions in delivery of service.

Subsidence

Subsidence damage to buildings, including residential, commercial, and public buildings, can increase initial construction costs as well as long-term maintenance needs. Impacted roadways and other infrastructure will also need to be replaced and maintained to mitigate risks associated with failing infrastructure. Impacts also include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Business interruption losses include losses associated with the inability to operate a business because of utility failure. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can further impact heating or cooling provision to the populations.

Table 4.3.5-14. Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area in Llano County

Llano Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Horseshoe Bay (C)	2,174	\$921,317,000	194	8.9%	\$76,151,461	8.3%
Sunrise Beach (C)	909	\$345,382,000	0	0.0%	\$0	0.0%
Llano (C)	1,733	\$564,332,000	0	0.0%	\$0	0.0%
Unincorporated Llano County	8,788	\$2,408,418,000	133	1.5%	\$37,681,202	1.6%
Llano County (Total)	13,604	\$4,239,449,000	327	2.4%	\$113,832,663	2.7%

Source: USGS 2017; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.5-15. Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area in San Saba County

San Saba Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Subsidence (Carbonate Karst) Hazard Area			
			Number of Buildings	Percent of Total	Total Replacement Cost Value of Buildings	Percent of Total
Richland Springs (T)	213	\$66,306,000	160	75.3%	\$52,310,036	78.9%
San Saba (C)	1,311	\$410,811,000	514	39.2%	\$150,046,862	36.5%
Unincorporated San Saba County	1,819	\$480,386,000	499	27.4%	\$117,810,455	24.5%
San Saba County (Total)	3,343	\$957,503,000	1,173	35.1%	\$320,167,354	33.4%

Source: USGS 2017; Census 2020

Notes: (C) = City, (T) = Town

Impact on the Environment

Earthquake

According to USGS, earthquakes can cause damage to the surface of the Earth in various forms depending on the magnitude and distribution of the event (USGS 2020). Surface faulting is one of the major seismic components to earthquakes that can create wide ruptures in the ground. Ruptures can have a direct impact on the landscape and natural environment because it can disconnect habitats for miles isolating animal species or tear apart plant roots.

Furthermore, ground failure as a result of soil liquefaction can have an impact on soil pores and retention of water resources (USGS 2020). The greater the seismic activity and liquefaction properties of the soil, the more likely drainage of groundwater can occur which depletes groundwater resources. In areas where there is higher pressure of groundwater retention, the pores can build up more pressure and make soil behave more like a fluid rather than a solid increasing risk of localized flooding and deposition or accumulation of silt.

Expansive Soils

Expansive soils are not expected to have substantial impacts on the environment.

Subsidence

Major environmental impacts from subsidence includes an increased flood risk with more frequent inundation caused by rainfall because of the limited effectiveness of the drainage system. In addition, there can be a change in the gradient of streams, canals, and rivers.

Indirect damages also occur such as a decrease of farmland productivity in areas because freshwater availability has been limited by an increase in saltwater intrusion (resulting from a decreased land elevation). The most common indirect effects are related to changes in relative surface and subsurface water levels (The Groundwater Project 2021).

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

It is anticipated that the human exposure and vulnerability to geologic hazard impacts in newly developed areas will be similar to those that currently exist within the Planning Area. Current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built using lower construction standards.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba

County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14- and 0.25-percent every five years from 2025 to 2035, followed by a projected growth between 0.68- and 3.3-percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51- and 4.3-percent every five years from 2025 to 2050 (Texas Demographic Center n.d.). Changes in the density of population can impact the number of persons exposed to geologic hazards.

Climate Change

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts.

Climate change is likely to have significant impacts on the performance of residential buildings constructed on expansive soils. Precipitation and temperature are the primary weather parameters used for determining ground movement (Sun, Li and Zhou 2017). The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, average annual rainfall is increasing; however, the soil is becoming drier. Rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016).

While there is no established connection that climate change increases land subsidence, secondary impacts of climate change such as drought and flood may have a greater impact on areas experiencing land subsidence. As drought levels increase, the need to pump water from aquifers also increases which exacerbates subsidence (Shirzaei and Bürgmann 2018).

Change of Vulnerability Since 2016 HMP

Earthquake, expansive soils, and subsidence were separate hazards of concern in the 2016 HMP. Based on the connected impacts, these hazards have been grouped together in this HMP update. Overall, the vulnerability to geologic hazards has remained unchanged since the 2016 plan.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.6 Hurricanes/Tropical Storms

The following section provides the hazard profile and vulnerability assessment for the hurricane and tropical storm hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Hurricanes, tropical storms, and depressions (hurricane TS/D) that impact Texas form over warm tropical waters of the Gulf of Mexico or the Atlantic Ocean. The warm, moist air over the ocean rises upward from near the surface, creating an area of lower air pressure. These areas of relative low pressure draw in new air from the surrounding high-pressure areas. Quickly cyclonic (counterclockwise) circulation begins, and rain bands spin out from a wall of wind that surrounds a central area of low barometric pressure (the “eye”). Such storms can grow to a thousand miles in diameter and sustain winds near the eye that approach 200 miles an hour (TDEM 2018).

According to NOAA, tropical cyclones are classified into three main categories (per intensity): tropical depressions, tropical storms, and hurricanes.

Tropical depressions have a maximum sustained winds of 38 mph. Though not as strong as its successors, tropical depressions can bring heavy downpours and sustained winds strong enough to generate rough surf and life-threatening rip currents. When a tropical depression approaches, the National Weather Service may issue a tropical storm watch or warning for the area.

A tropical storm is a tropical cyclone in which the maximum sustained surface wind speeds range from 39 to 73 mph. At this time the tropical cyclone is assigned a name. During this time, the storm itself becomes more organized and begins to become more circular in shape, resembling a hurricane.

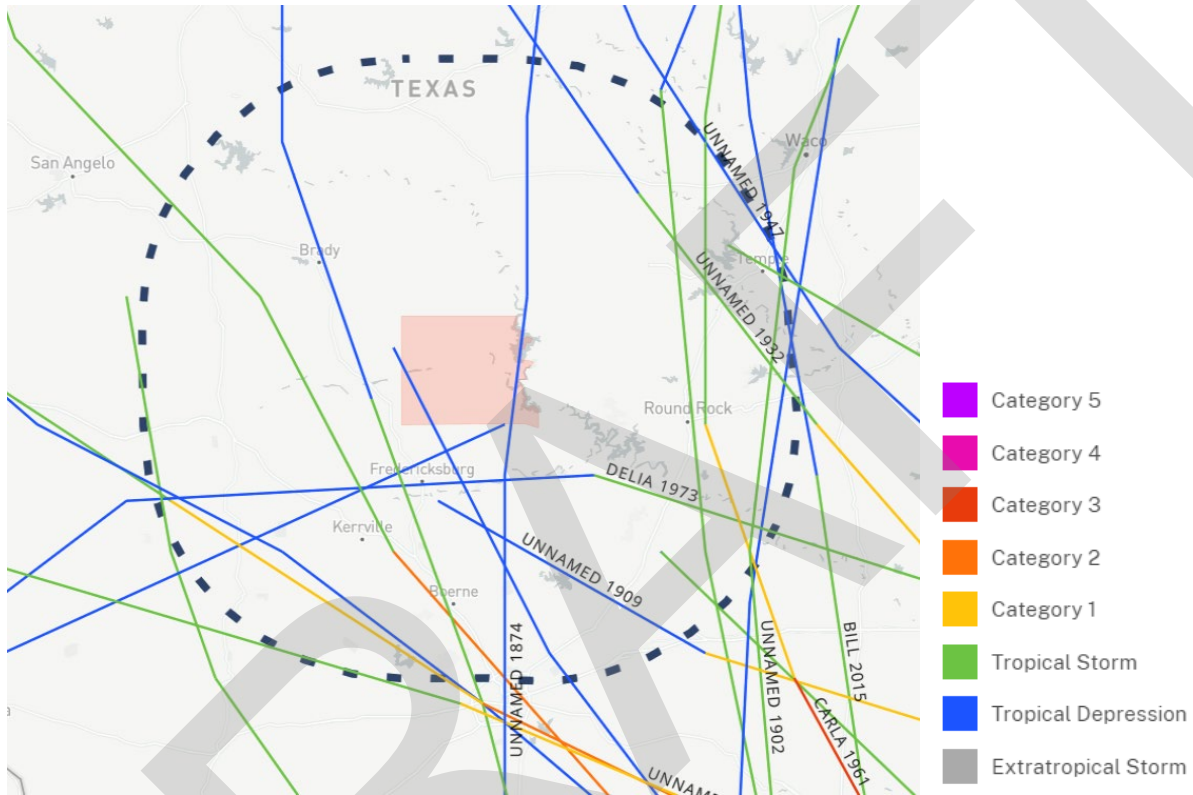
Hurricanes are areas of disturbed weather in the tropics with closed isobars and strong and very pronounced rotary circulation. An area of clear weather called an “eye” is present in the center of the circulation. To qualify as a hurricane, the wind speed is 74 miles per hour (mph) or more. Hurricanes are classified into categories based on wind speed. Thunderstorm rain resulting in urban flooding, battering wave action, intense sea level rise, localized coastal erosion, and significant winds are associated with hurricanes.

Location

Due to Llano County and participating communities’ interior location (approximately 200 miles inland), it is not exposed directly to hurricanes. While the County is considered to have no exposure to hurricanes, the City of Horseshoe Bay has a low-ranking exposure, and the City of Sunrise Beach Village has a medium ranking exposure to hurricanes and tropical storms. San Saba County and the City of San Saba’s interior location (approximately 250 miles inland), it is not exposed directly to hurricanes. San Saba County and the City of San Saba both have a low-ranking exposure to hurricanes and tropical storms.

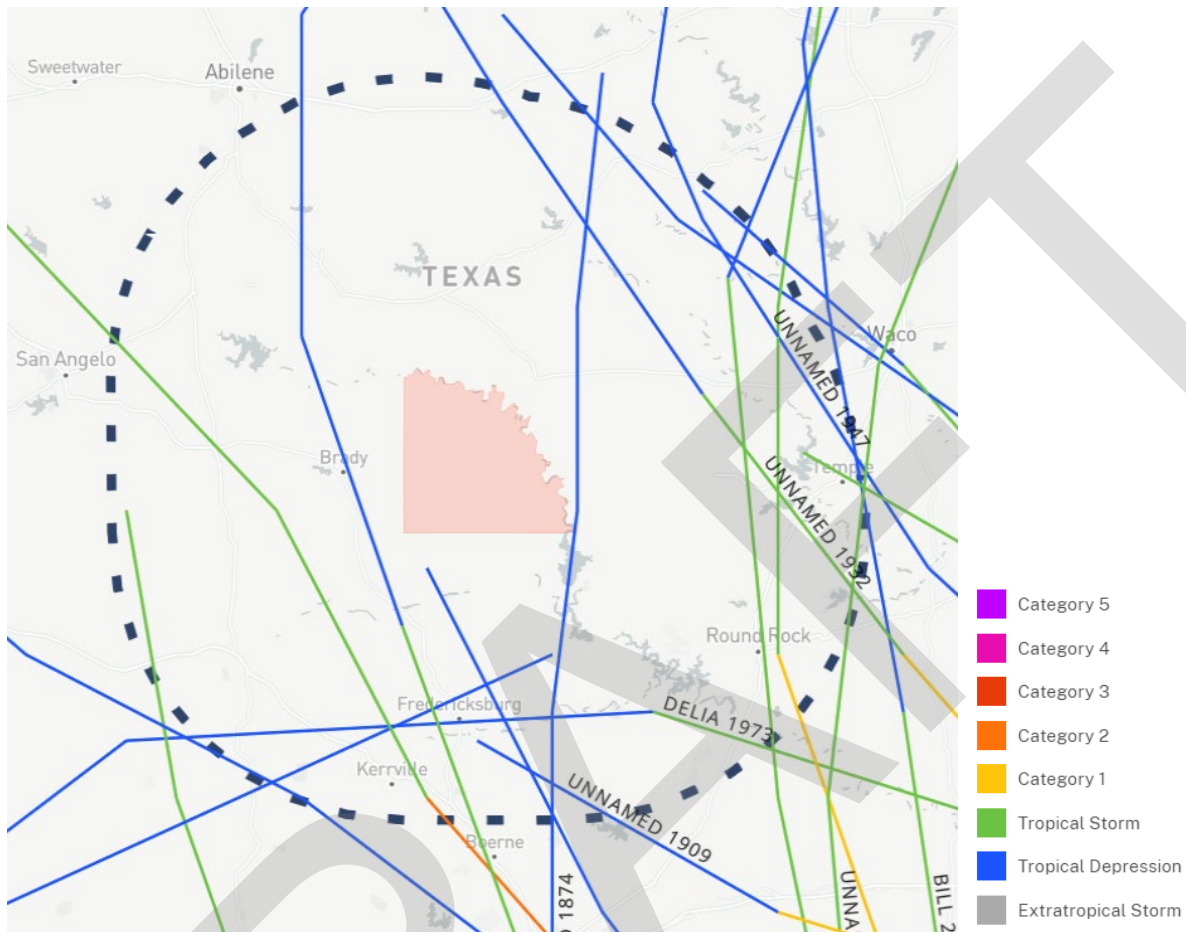
A hurricane or tropical storm event can occur anywhere within the hazard mitigation plan area, moving inland from the Gulf of Mexico. Hurricane events become tropical depressions or tropical storms by the time they reach the planning areas. Within Llano County, the City of Llano and the City of Sunrise Beach Village are within 12 miles of hurricane paths based on historical events. Figure 4.3.6-1 and Figure 4.3.6-2 below show the hurricane path for both Llano and San Saba County's.

Figure 4.3.6-1. Historical Hurricane and Tropical Storms Affecting Llano County



Source: National Hurricane Center 2022

Figure 4.3.6-2. Historical Hurricane and Tropical Storms Affecting San Saba County



Source: National Hurricane Center 2022

Extent

The extent of a hurricane or tropical storm is commonly categorized in accordance with the Saffir-Simpson Hurricane Wind Scale, which assigns a designation of tropical storm for storms with sustained wind speeds below 74 mph and a hurricane category rating of 1–5 based on a hurricane’s increasing sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered *major hurricanes* because of their potential for significant loss of life and damage. Tropical Storms and Category 1 and 2 storms are still dangerous and require preventative measures (NWS NOAA n.d.)

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- **Hurricane/Typhoon Warning** is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain

in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.

- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NHC NOAA 2010).

Hurricanes are classified according to the Saffir-Simpson Hurricane Wind Scale from a Category 1 to Category 5 by sustained wind intensity. Table 4.3.6-1 below shows the categories and the type of damage they produce.

Table 4.3.6-1. Saffir-Simpson Hurricane Wind Scale

Category	Sustained Winds (miles per hour)	Types of Damage Due to Hurricane Winds
1	74-95	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (Major)	111-129	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (Major)	130-156	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (Major)	157 or higher	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Other non-hurricane classifications are tropical storms (39-73 miles per hour) and tropical depressions (0-38 miles per hour)		

Source: NOAA n.d.

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. The MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance.



Peak wind speed projections were generated using Hazus v5.0. Hazus v5.0 estimated the maximum 3-second gust wind speeds for Llano and San Saba County:

- Llano:
 - 100-year MRP – between 39 and 73 mph (Tropical Storm)
 - 500-year MRP – between 39 and 73 mph (Tropical Storm)
- San Saba:
 - 100-year MRP – between 39 and 73 mph (Tropical Storm)
 - 500-year MRP – between 74 and 95 mph (Category 1 Hurricane)

Refer to Figure 4.3.6-3 and Figure 4.3.6-4 below to view the 100- and 500-year MRPs, respectively.

Figure 4.3.6-3. Wind Speeds for the 100-year MRP Event

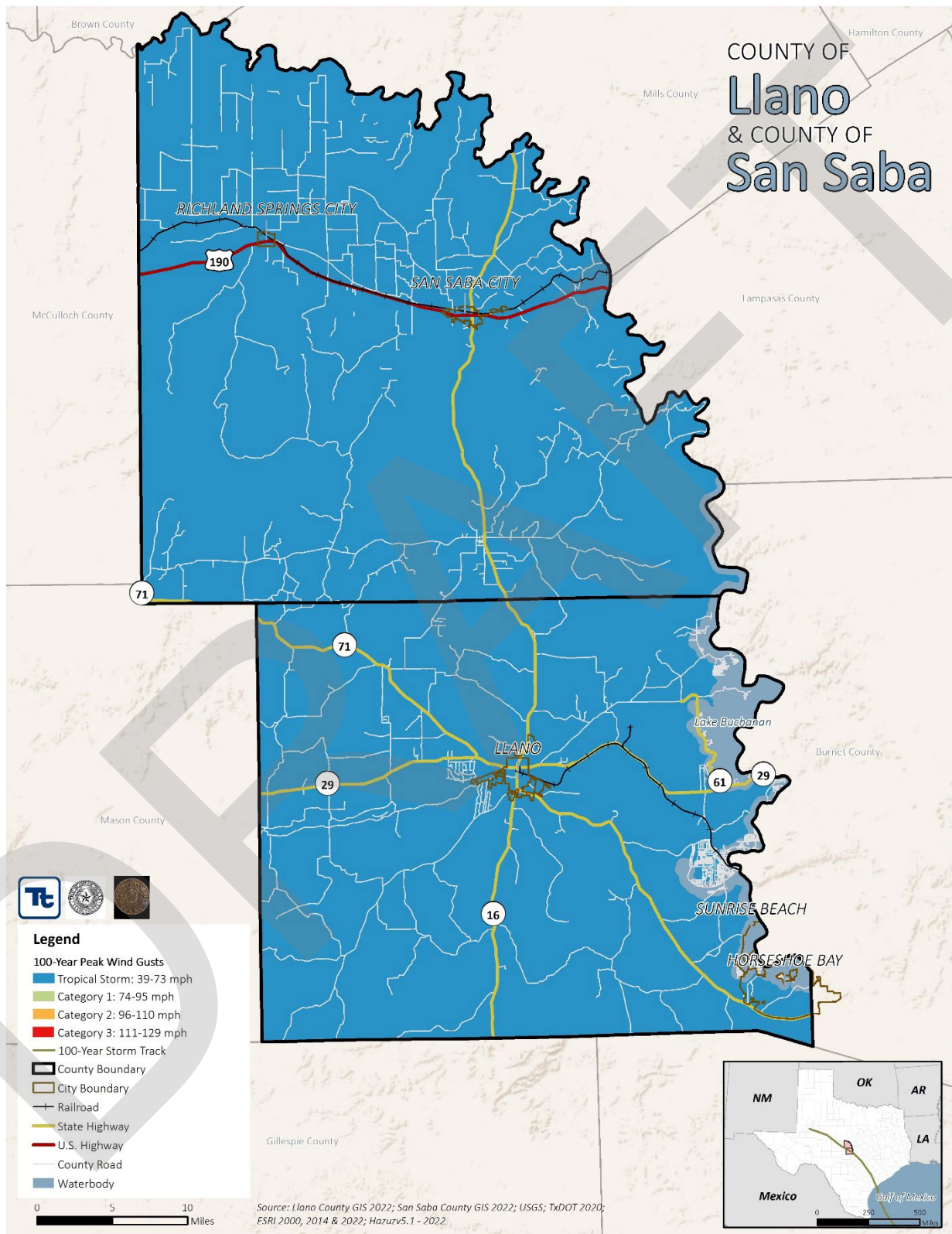
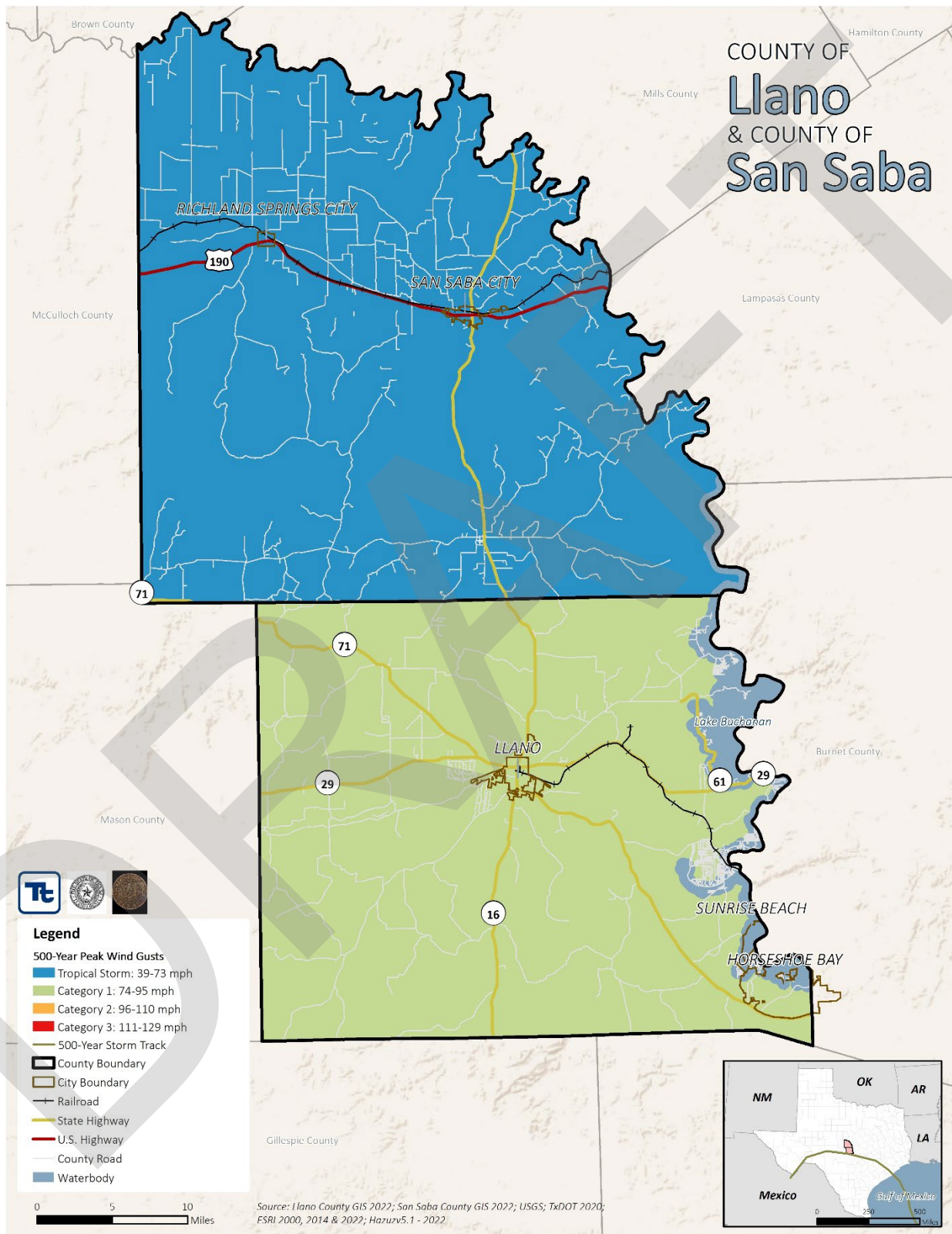


Figure 4.3.6-4. Wind Speeds for the 500-year MRP Event



Worst-Case Scenario

The 500-year MRP event (Category 1 Hurricane for Llano County and Tropical Storm for San Saba County) would be the worst-case scenario for Llano County. A storm of this magnitude could moderate damage to 12 occupied buildings and minor damages to 291. Critical facilities in the planning area would likely sustain moderate damages, particularly to schools and medical care facilities. There would be over \$7.4 million in building damages, causing over 787 tons of debris. The winds associated with a category 1 (speeds between 74 and 95 mph) would cause damages to the roofs, shingles, vinyl sidings, and gutters of buildings. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to powerlines and poles likely will result in power outages that could last a few to several days. Winds associated with tropical depressions, will not bring much, if any, wind damage to an area. Windy conditions will be present, and it can be expected item such as lawn accessories and furniture, garbage bins, and other outside items may be strewn by the sustained winds. However, tropical depressions can still bring heavy downpours and cause intense floods.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were both included in three disaster (DR) or emergency (EM) declarations for hurricane/tropical storm-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.6-2. FEMA Disaster Declaration for the Project Area (1954-2022)

Date(s) of Event	Event Name	FEMA Declaration Number	Llano and/or San Saba County included in Declaration?
September 23, 2005 - October 14, 2005	Hurricane Rita	DR-1606-TX	Llano County, San Saba County
September 20, 2005 - October 14, 2005	Hurricane Rita	EM-3261-TX	Llano County, San Saba County
August 29, 2005 - October 1, 2005	Hurricane Katrina	EM-3216-TX	Llano County, San Saba County

Source: FEMA 2023

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Llano and/or San Saba County were not included any hurricane and tropical storm-related agricultural disaster declarations.

Previous Events

Between 2017 and 2022, the Planning Area was not impacted by any topical depression, tropical storm, or hurricane activity. For events prior to 2017, refer to Appendix I (Supplementary Data).

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of hurricane and tropical storm events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2016 Llano County HMP, the San Saba County HMPs, and FEMA's Disaster

Declarations for States and Counties were used to identify the number of hurricane and tropical storm events that occurred between 1950 and 2022. Table 4.3.6-3 presents the probability of future events for the hurricane and tropical storm hazard.

Table 4.3.6-3. Probability of Future Hurricane and Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hurricane	3	4.16%
Tropical Storm	0	0%
Total	3	4.16%

Sources: NOAA 2023; TDEM 2018; Llano County 2016; San Saba County 2016; FEMA 2022

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all hurricane and tropical storm events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for hurricanes and tropical storms in the Planning Area is considered ‘occasional’.

Climate Change Projections

Temperatures are predicted to increase in the Planning Area and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may expand. Recent hurricane seasons have featured a tropical system occurring before the official start of the season. In 2016, a very rare winter hurricane named Alex developed in the middle of January (BBC 2019). According to NOAA's database, 40 storms formed in the Atlantic Basin before June 1 from 1851 through 2021, a long-term average of one such early storm every four to five years. The 2010s had the most such storms, and there has been a steady increase since the 1990s. However, the 1950s had six such storms, the 1930s had four and there was another four pre-season storm streak from 1887 through 1890. It is possible there were other such storms in the era before satellites – before the mid-1960s – that were missed by ship observations or reports from areas impacted. It remains to be seen if expansion of the traditional hurricane season is a long-term trend or a common occurrence (The Weather Channel 2020). It remains to be seen if other factors such as steering currents, atmospheric shear, and the presence of Saharan dust will be impacted in ways which increase or decrease the risk of hurricanes in the Planning Area.

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is vulnerable to the hurricane and tropical storm hazard. The following text evaluates and estimates the potential impact of the hurricane and tropical storm hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

The impact of hurricanes and tropical storms on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. All residents in the Planning Area (21,243 in Llano County and 5,730 in San Saba County) are exposed to the hurricane storm and tropical storm hazard.

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Economically disadvantaged populations are vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also vulnerable and, physically, they may have more difficulty evacuating. Additionally, the elderly are considered vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. According to the 5-year population estimates from the American Community Survey, Llano County has a total of 1,612 persons living in poverty and 7,975 over the age of 65 years old. San Saba County has a total of 714 persons living in poverty and 1,407 over the age of 65 years old. Please refer to Section 3 (County Profile) for the statistics of these populations.

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus estimates that no households in the Planning Area will be displaced or seek short-term shelter during the 100-year and 500-year MRP hurricane wind events, respectively. Please note that estimates are only based on wind speed and do not account for sheltering needs associated with flooding and storm surge that may accompany hurricane and tropical storm events.

Impact on General Building Stock

Damage to buildings is dependent upon several factors, including wind speed, hail size, storm duration, and storm path. Building construction also plays a major role in the extent of damage resulting from a storm. Due to differences in construction, residential structures are generally more susceptible to storm damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Table 4.3.6-4. Expected Damage for 100-Year Mean Return Period Hurricane Event in the Planning Area

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	16,021	NONE	16,013	99.9%
		MINOR	8	0.1%
		MODERATE	0	0.0%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%
Commercial Buildings	600	NONE	598	99.6%
		MINOR	2	0.3%
		MODERATE	0	0.0%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%
Industrial Buildings	148	NONE	147	99.6%
		MINOR	1	0.3%
		MODERATE	0	0.0%
		SEVERE	0	0.0%

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	Building Count	Percent of Buildings in Occupancy Class
Government, Religion, Agricultural, and Education Buildings	178	DESTRUCTION	0	0.0%
		NONE	177	99.6%
		MINOR	1	0.4%
		MODERATE	0	0.0%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%

Source: Hazus v5.1

*Disclaimer: Results show overall impacts for the entire Planning Area

Table 4.3.6-5. Expected Damage for 500-Year Mean Return Period Hurricane Event in the Planning Area

Occupancy Class	Total Number of Buildings Assessed in Occupancy	Severity of Expected Damage	Building Count	Percent of Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	16,021	NONE	15,734	98.2%
		MINOR	275	1.7%
		MODERATE	11	0.1%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%
Commercial Buildings	600	NONE	588	98.0%
		MINOR	11	1.8%
		MODERATE	1	0.2%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%
Industrial Buildings	148	NONE	145	98.3%
		MINOR	2	1.6%
		MODERATE	0	0.0%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%
Government, Religion, Agricultural, and Education Buildings	178	NONE	175	98.3%
		MINOR	3	1.6%
		MODERATE	0	0.0%
		SEVERE	0	0.0%
		DESTRUCTION	0	0.0%

Source: Hazus v5.1

*Disclaimer: Results show overall impacts for the entire Planning Area

Impact on Critical Facilities

Critical facilities are at risk of being impacted by high winds associated with structural damage, or falling tree limbs/flying debris, which can result in the loss of power. Power loss can greatly impact households, business operations, public utilities, and emergency personnel. For example, vulnerable populations in the Planning Area are at risk if power loss results in interruption of heating and cooling services, stagnated hospital operations, and potable water supplies. Emergency personnel such as police, fire, and EMS will not be able to effectively respond in a power loss event to maintain the safety of its citizens.

Hazus estimates that critical facilities in the Planning Area have a low probability of sustaining minor to moderate damages from the 100-year MRP hurricane wind event.

Table 4.3.6-6. Impact of 100-Year Mean Return Period Hurricane Event on Critical Facilities in the Planning Area

Facility Type	Loss of Days	100-Year Mean Return Period Hurricane			
		Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Care Facilities	0	0.1% - 0.2%	0.0%	0.0%	0.0%
Fire Stations	0	0.2%	0.0% - <0.1%	0.0%	0.0%
Police Stations	0	0.3% - 0.5%	0.0%	0.0%	0.0%
Emergency Response Centers	0	0.3% - 0.4%	0.0%	0.0%	0.0%
Schools	0	0.2%	0.0%	0.0%	0.0%

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2022

Table 4.3.6-7. Impact of 500-Year Mean Return Period Hurricane Event on Critical Facilities in the Planning Area

Facility Type	Loss of Days	500-Year Mean Return Period Hurricane			
		Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
Medical Care Facilities	0	1.2% - 2.0%	<0.1% - 0.2%	0.0%	0.0%
Fire Stations	0	0.2% - 1.4%	0% - 0.1%	0.0%	0.0%
Police Stations	0	0.5% - 2.5%	0% - 0.1%	0.0%	0.0%
Emergency Response Centers	0	0.5% - 2.0%	0% - <0.1%	0.0%	0.0%
Schools	0	0.3% - 2.4%	0% - 0.4%	0.0%	0.0%

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2022

At this time, Hazus does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs. Furthermore, evacuation routes are vulnerable to hurricane wind events.

The Planning Area is often impacted by evacuations from coastal communities along the Gulf Coast and experiences an influx of evacuees.

Impact on Economy

Damage to structures from wind can be the most immediate result of hurricane and tropical storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings.

Table 4.3.6-8. Estimated Losses from the 100-Year and 500-Year Hurricane Events in the Planning Area

Mean Return Period (MRP)	Income Loss	Relocation Loss	Building Losses	Wages Losses	Rental Losses
100-Year	\$0	\$390	\$1,034,790	\$0	\$0
500-Year	\$0	\$304,500	\$7,426,450	\$0	\$103,800

Source: Hazus v5.1

*Disclaimer: Results show overall impacts for the entire Planning Area

Hazus estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the “Impact on General Building Stock” section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

Building losses for the 100-year and 500-year hurricane events are expected to be less than 1-percent of the total replacement cost value for each county.

Table 4.3.6-9. Estimated Building Losses from the 100-Year and 500-Year Hurricane Events in Llano County

Llano Jurisdiction	Total Replacement Cost Value	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane	Percent of Total	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane	Percent of Total
Horseshoe Bay (C)	\$921,317,000	\$0	0.0%	\$0	0.0%
Sunrise Beach (C)	\$345,382,000	\$0	0.0%	\$0	0.0%
Llano (C)	\$564,332,000	\$190,941	0.0%	\$1,084,481	0.2%
Unincorporated Llano County	\$2,408,418,000	\$649,556	0.0%	\$5,941,576	0.2%
Llano County (Total)	\$4,239,449,000	\$840,497	0.0%	\$7,026,056	0.2%

Source: Hazus v5.1; Census 2010/2020

Notes: (C) = City

Table 4.3.6-10. Estimated Building Losses from the 100-Year and 500-Year Hurricane Events in San Saba County

San Saba Jurisdiction	Total Replacement Cost Value	Estimated Building Losses Caused by the 100-Year Mean Return Period Hurricane	Percent of Total	Estimated Building Losses Caused by the 500-Year Mean Return Period Hurricane	Percent of Total
Richland Springs (T)	\$66,306,000	\$0	0.0%	\$0	0.0%
San Saba (C)	\$410,811,000	\$12,641	0.0%	\$15,694	0.0%
Unincorporated San Saba County	\$480,386,000	\$181,648	0.0%	\$384,698	0.0%
San Saba County (Total)	\$957,503,000	\$194,288	0.0%	\$400,392	0.0%

Source: Hazus v5.1; Census 2010/2020

Notes: (C) = City; (T) = Town

Debris management can be costly and may also impact the local economy. Hazus estimates the amount of building and tree debris that may be produced as result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the Hazus Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates.

Hazus estimates the 100-year and 500-year hurricane events in Llano County would generate 30 tons and 762 tons of debris respectively.

Table 4.3.6-11. Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event in Llano County

Llano Jurisdiction	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Horseshoe Bay (C)	0	0	0	0
Sunrise Beach (C)	0	0	0	0
Llano (C)	8	0	0	0
Unincorporated Llano County	22	0	0	0
Llano County (Total)	30	0	0	0

Source: Hazus v5.1; Census 2010

Notes: (C) = City

Table 4.3.6-12. Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event in Llano County

Llano Jurisdiction	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Horseshoe Bay (C)	0	0	0	0
Sunrise Beach (C)	0	0	0	0
Llano (C)	105	0	0	0
Unincorporated Llano County	657	0	0	0
Llano County (Total)	762	0	0	0

Source: Hazus v5.1; Census 2010

Notes: (C) = City

Hazus estimates the 100-year and 500-year hurricane events in San Saba County would generate 9 tons and 25 tons of debris respectively.

Table 4.3.6-13. Estimated Debris Created During the 100-Year Mean Return Period Hurricane Wind Event in San Saba County

San Saba Jurisdiction	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Richland Springs (T)	0	0	0	0
San Saba (C)	1	0	0	0
Unincorporated San Saba County	8	0	0	0
San Saba County (Total)	9	0	0	0

Source: Hazus v5.1; Census 2010

Notes: (C) = City; (T) = Town

Table 4.3.6-14. Estimated Debris Created During the 500-Year Mean Return Period Hurricane Wind Event in San Saba County

San Saba Jurisdiction	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
Richland Springs (T)	0	0	0	0

San Saba Jurisdiction	Brick and Wood (Tons)	Concrete and Steel (Tons)	Tree (Tons)	Eligible Tree Volume (Cubic Yards)
San Saba (C)	1	0	0	0
Unincorporated San Saba County	24	0	0	0
San Saba County (Total)	25	0	0	0

Source: Hazus v5.1; Census 2010

Notes: (C) = City; (T) = Town

Impact on the Environment

Wind from hurricanes and tropical storms can knock over power lines sparking fires which can destroy forests and habitats. Winds can also carry debris and litter across areas which can negatively impact ecosystems and habitats, including water bodies.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the hurricane and tropical storm hazard because the entire Planning Area is exposed and vulnerable; however, due to increased standards and codes, new development can be less vulnerable to the hazard compared with the aging building stock in the Planning Area.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

An increase in population will expose more people to the hurricane and tropical storm hazard.

Climate Change

As noted previously, the entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Temperatures are predicted to increase in the Planning Area and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. As oceans warm, the length of hurricane season may expand. Overall, the Planning Area will continue to remain vulnerable to the hurricane and tropical storm hazard.

Change of Vulnerability Since 2016 HMP

The Planning Area continues to be vulnerable to hurricanes and tropical storms. Hurricane models on debris created were not run for the 2016 HMP. Building losses were based on annualized losses instead of the 100 and 500-year mean return period events analyzed in this HMP update. Overall, the vulnerability assessment presented in this update uses Hazus v5.1 and a more accurate and updated building inventory. This provides more accurate estimated exposure and potential losses for the Planning Area.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.7 Pandemic/Health and Safety

The following section provides the hazard profile and vulnerability assessment for the Pandemic/Health and Safety hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

An outbreak or an epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, or it may be global, at which point it is called a pandemic. Pandemic is defined as a disease occurring over a wide geographic area and affecting a high proportion of the population. A disease outbreak can cause sudden, pervasive illness in all age groups on a local or global scale. A pandemic is a novel virus to which humans have no natural immunity that spreads from person-to-person. A pandemic will cause both widespread and sustained effects and is likely to stress the resources of both the State and federal government (Madhav, et al. 2017). In addition to health impacts, disease outbreaks reaching pandemic proportions can cause social and economic impacts on a global scale (Shang, Li and Zhang 2021).

Coronavirus

Coronavirus disease (COVID-19) is an infectious disease first identified in 2019. The virus rapidly spread into a global pandemic by spring of 2020. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness (World Health Organization n.d.). With the virus being relatively new, information regarding transmission and symptoms of the virus is still new. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Reported illnesses have ranged from mild symptoms to severe illness. Reported symptoms include fever or chills, cough, shortness of breath or difficulty breathing and fatigue. Symptoms may appear 2-14 days after exposure to the virus (CDC 2021).

In an effort to slow the spread of the virus, the federal government and states have urged the public to avoid touching of the face, properly wash hands often, and use various social distancing measures. At the time of this plan update, there are three approved and authorized vaccines available in the United States to reduce risk of severe illness (CDC 2021).

Influenza

The risk of a global influenza pandemic has increased over the last several years. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability.

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. An influenza pandemic is a global outbreak of a new influenza A virus.

Pandemics happen when new (novel) influenza A viruses emerge which are able to infect people easily and spread from person to person in an efficient and sustained way (CDC n.d.).

At the national level, the CDC's Influenza Division has a long history of supporting the World Health Organization (WHO) and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research including vaccine studies and serologic assays and provided international outbreak investigation assistance (CDC n.d.).

West Nile Virus

West Nile Virus (WNV) encephalitis is a mosquito-borne viral disease, which can cause an inflammation of the brain. WNV is commonly found in Africa, West Asia, the Middle East and Europe. West Nile Virus was first reported in Texas in 2002. In a small number of cases, WNV has been spread by blood transfusion, which has resulted in the screening of blood donations for the virus in the US, or by organ transplantation. WNV can also be spread from mother to baby during pregnancy, delivery, or breast-feeding in a small number of cases. The symptoms of severe infection (West Nile encephalitis or meningitis) can include headache, high fever, neck stiffness, muscle weakness, stupor, disorientation, tremors, seizures, paralysis, and coma. WNV can cause serious illness, and in some cases, death. Usually, symptoms occur from two to 14 days after being bitten by an infected mosquito (Texas Department of State Health Services n.d.).

Location

Disease outbreaks can occur without regard for location. However, factors such as density, visitation, and the length of time in which the public spends in a location all contribute to the spread of infectious diseases. For example, COVID-19 is more likely spread by persons in close contact. Indoor areas in which people are in close contact with each other appear to be significant vectors for the disease, which is spread through respiratory droplets. Infectious diseases spread by insects may be subject to other types of location hazards. For example, the prevalence of standing water can provide breeding grounds for diseases such as West Nile Virus. Diseases that can infect humans are variable in nature and methods of transmission. Ultimately, residents need to be vigilant about diseases altogether in order to better understand and respond to disease outbreak hazards.

Extent

The exact size and extent of an infected population depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The transmission rate of infectious diseases will depend on the mode of transmission of a given illness.

Worst-Case Scenario

A worst-case scenario would be a global pandemic similar to the COVID-19 pandemic that began affecting the Planning Area in early 2020, but with more severe health impacts. This could lead to high rates sickness and deaths; strain on healthcare systems; income stress and financial loss; and negative mental health impacts.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were both included in two disaster (DR) or emergency (EM) declarations for pandemic-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.7-1. Pandemic/Health and Safety FEMA Disaster Declarations in the Planning Area

Date(s) of Event	Event Type	FEMA Declaration Number	Llano and/or San Saba County included in Declaration?
January 2020 - Ongoing	COVID-19	DR-4485-TX; EM-3458-TX	Llano County, San Saba County

Source: FEMA 2022

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Llano and/or San Saba County were not included in any pandemic-related agricultural disaster declarations.

Previous Events

For this 2023 HMP update, known pandemic events that impacted the Planning Area between 2017 and 2022 are discussed below. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.7-2. Pandemic/Health and Safety Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
January 2020 - Ongoing	COVID-19	DR-4485-TX; EM-3458-TX	Llano County, San Saba County	As of December 8, 2022 there have been 4,860 positive COVID-19 cases in Llano County and 1,416 positive COVID-19 cases in San Saba County. 101 residents have died in Llano County. 156 residents have died in San Saba County

Sources: FEMA 2022; New York Times 2022; CDC 2023

Probability of Future Occurrences

Though occurrences of disease outbreaks overall are often difficult to predict at the local level, it is anticipated that the Planning Area will continue to be impacted by disease outbreaks for the foreseeable future. Additionally, seasonality for cold and flu is well established and anticipated in Texas on an annual basis.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for pandemic/health and safety events in the Planning Area is considered ‘occasional’.

Climate Change Projections

Climate change will likely have significant indirect impacts on disease outbreaks. In Texas, higher temperatures, decreased water availability, and more severe storm events are anticipated due to climate change. According to the World Health Organization (WHO), changing climatic conditions are being studied for impacts upon disease transmission. Seasonal infectious diseases that are influenced by meteorological conditions may see significant variability in recurrence and duration. The WHO concludes that variations in infectious disease transmission patterns are likely major consequences of climate change (WHO 2021).

In the publication “What Climate Change Means for Texas,” the US Environmental Protection Agency (EPA) notes that warming temperatures will exacerbate current public health concerns. “Seventy years from now, Texas is likely to have three or four times as many days per year above 100°F as it has today. Certain people are especially vulnerable, including children, the elderly, the sick, and the poor. High air temperatures can cause heat stroke and dehydration and affect people’s cardiovascular and nervous systems” (EPA 2016).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The following discusses the Planning Area’s vulnerability, in a qualitative nature, to the pandemic hazard.

Impact on Life, Health, and Safety

The entire population of the Planning Area is vulnerable to the disease outbreak hazard. Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and the potential impacts associated with this hazard. Healthcare providers and first responders have an increased risk of exposure due to their frequent contact with infected populations. Areas with a higher population density also have an increased risk of exposure or transmission of disease to do the closer proximity of population to potentially infected people.

Most recently with COVID-19, the Centers for Disease Control and Prevention have indicated that persons over 65 years and older, persons living in a nursing home or long-term care facility, and persons with underlying medical conditions such as diabetes, severe obesity, serious heart conditions, etc. are at a higher risk of getting severely ill (CDC 2021). According to the 2020 American Community Survey, 37.5-percent of Llano County residents (or approximately 7,975 people) and 10.3-percent of San Saba County residents (approximately 1,407 people) are over the age of 65.

Impact on General Building Stock

No structures are anticipated to be directly affected by pandemic events.

Impact on Critical Facilities

No critical facilities are anticipated to be affected by disease outbreaks. Hospitals and medical facilities will likely see an increase in patients, but it is unlikely that there will be damages or interruption of services. However, large rates of infection may result in an increase in the rate of hospitalization which may overwhelm hospitals and medical facilities and lead to decreased services for those seeking medical attention. The 2020 coronavirus pandemic has led to overwhelmed hospitals in numerous hotspots throughout the Planning Area.

Impact on Economy

Disease outbreaks impacts on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address disease outbreaks have not been quantified in available documentation. As evidenced in the COVID-19 outbreak, quarantines, shutdowns, and social distancing measures can have outsized economic impacts, particularly on the leisure, tourism, and food/accommodations sectors.

Impact on the Environment

The environment is not anticipated to be directly affected by pandemic events.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the disease outbreak hazard because the entire Planning Area is exposed and vulnerable. Additional development of structures in close proximity to waterbodies or areas with high population density are at an increased risk.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

An increase in population will expose more people to the pandemic hazard as residents move into area and the population exposed increases. Population density changes when households move throughout the Planning Area could influence the number of persons exposed to disease outbreaks. Higher density jurisdictions are not only at risk of greater exposure to disease outbreak, but density may also reduce available basic services provided by critical facilities such as hospitals and emergency facilities for persons that are not affected by a disease.

Climate Change

The relationship between infectious diseases occurrence and climate change is difficult to predict with certainty. However, there may be linkages between the two. Changes in the environment may create a more livable habitat for vectors carrying disease as suggested by the Centers for Disease Control and Prevention (CDC n.d.). Localized

changes in climate and human interaction may also be a factor in the spread of disease. For example, in the wake of Hurricane Harvey prolonged and intense precipitation provided breeding grounds for mosquitos that necessitated mosquito control measures.

The relationship between climate change and infectious diseases is not universally agreed upon. Climate change may affect the spread of disease, while others are not convinced. However, research indicates that the only force at work in increasing the spread of infectious diseases into the future. Other factors, such as expanded rapid travel and evolution of resistance to medical treatments, are already changing the ways pathogens infect people, plants, and animals. As climate change accelerates it is likely to work synergistically with many of these factors, especially in populations increasingly subject to massive migration and malnutrition (Harmon 2010).

Change of Vulnerability Since 2016 HMP

The pandemic hazard was not profiled in the 2016 HMP and is a new hazard of concern for this 2023 update.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.8 Severe Weather

The following section provides the hazard profile and vulnerability assessment for the severe weather hazard in the Planning Area. The severe weather hazard includes hail, lightning, wind, and tornado. When referring to the Planning Area, it includes both Llano County and San Saba County.

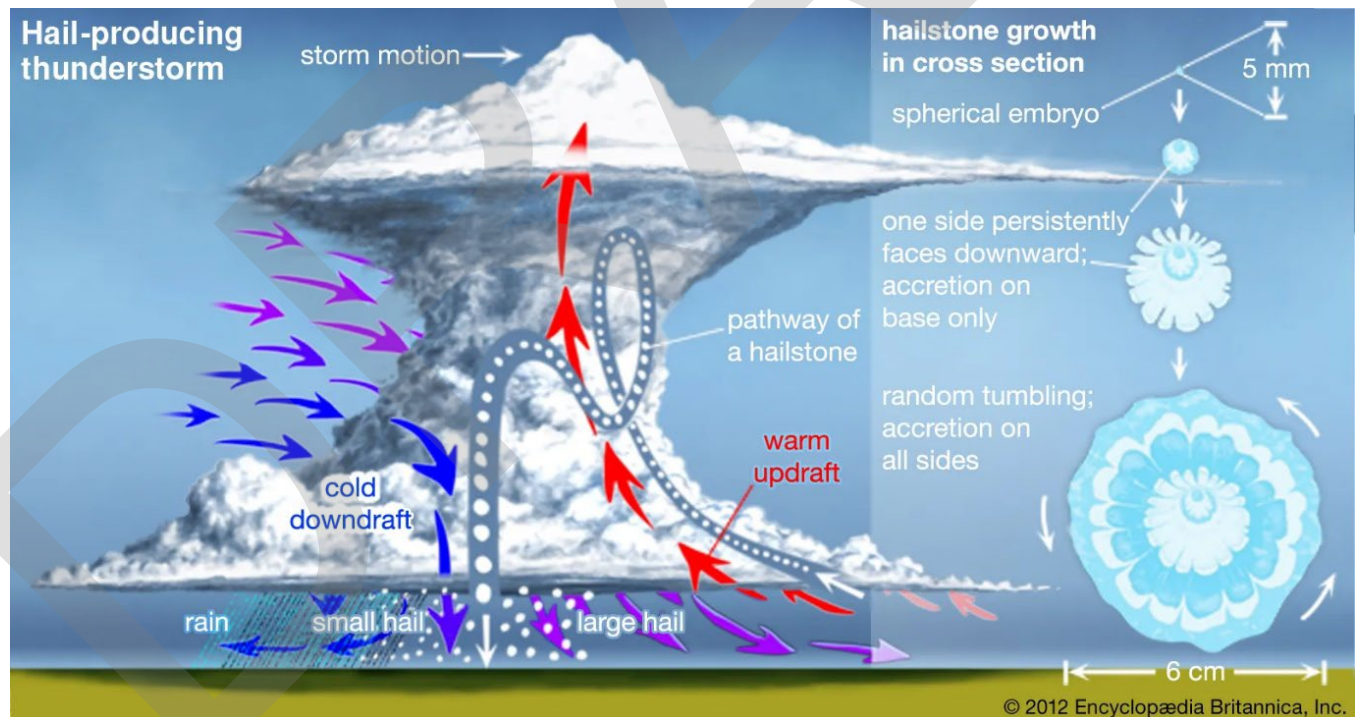
Hazard Profile

Hazard Description

Hail

Hail is a form of solid precipitation. It consists of balls or irregular lumps of ice, each of which is called a hailstone. Hailstones usually measure between 5 millimeters (0.2 in) and 15 centimeters (6 in) in diameter. Hail is possible within most thunderstorms as it is produced by cumulonimbus clouds. Hail formation requires environments of strong, upward motion of air and lowered heights of the freezing level. Any thunderstorm which produces hail that reaches the ground is known as a hailstorm.

Figure 4.3.8-1. Hail Producing Thunderstorm



Source: Encyclopædia Britannica 2019

Hailstones form by colliding with super cooled water drops. Super cooled water will freeze on contact with ice crystals, frozen raindrops, dust, or some other nuclei. The storm's updraft blows the forming hailstones up the cloud. As the hailstone ascends it passes into areas of the cloud where the concentration of humidity and super

cooled water droplets varies. When the hailstone moves into an area with a high concentration of water droplets, it captures the latter and acquires a translucent layer. Should the hailstone move into an area where mostly water vapor is available, it acquires a layer of opaque white ice.

The hailstone will keep rising in the thunderstorm until its mass can no longer be supported by the updraft. It then falls toward the ground while continuing to grow, based on the same processes, until it leaves the cloud. It will later begin to melt as it passes into air that is above freezing temperature.

Lightning

Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges build up enough, this insulating capacity of the air brakes down and there is a rapid discharge of electricity that we know as lightning. The flash of lightning temporarily equalizes the charged regions in the atmosphere until the opposite charges build up again. Lightning can occur between opposite charges within the thunderstorm cloud (intra-cloud lightning) or between opposite charges in the cloud and on the ground (cloud-to-ground lightning). Most lightning starts inside a thunderstorm and travels through the cloud. It can then stay within the cloud or continue to travel through the open air and eventually to ground. There are roughly 5 to 10 times as many flashes that remain in the cloud as there are flashes which travel to the ground, but individual storms may have more or fewer flashes reaching ground. Lightning can be seen in volcanic eruptions, extremely intense forest fires, surface nuclear detonations, heavy snowstorms, in large hurricanes, and obviously, thunderstorms (NOAA n.d.).

Wind

Differences in atmospheric pressure generate winds. At the Equator, the sun warms the water and land more than it does the rest of the globe. Warm equatorial air rises higher into the atmosphere and migrates toward the poles creating a low-pressure system. At the same time, cooler, denser air moves over Earth's surface toward the Equator to replace the heated air creating a high-pressure system. Winds generally blow from high-pressure areas to low-pressure areas. The boundary between these two areas is called a front. The complex relationships between fronts are what causes different types of wind and weather patterns.

Prevailing winds are winds that blow from a single direction over a specific area of the Earth. Areas where prevailing winds meet are called convergence zones. Generally, prevailing winds blow east-west rather than north-south because of Earth's rotation which generates what is known as the Coriolis effect. The Coriolis effect makes wind systems twist counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere (Turgeon and Morse 2022).

Tornado

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. Most tornadoes are on the ground for less than 15 minutes (NOAA n.d.).

Tornadoes are spun from two types of thunderstorms:



- Supercell Tornadoes are the most common and most dangerous. A rotating updraft is key to a supercell and when combined with warm, moist air at ground level is often what can spawn a tornado.
- Non-Supercell Tornadoes are usually developed by a strong linear convection system; however, these storms tend to spawn much weaker tornadoes (NOAA n.d.).

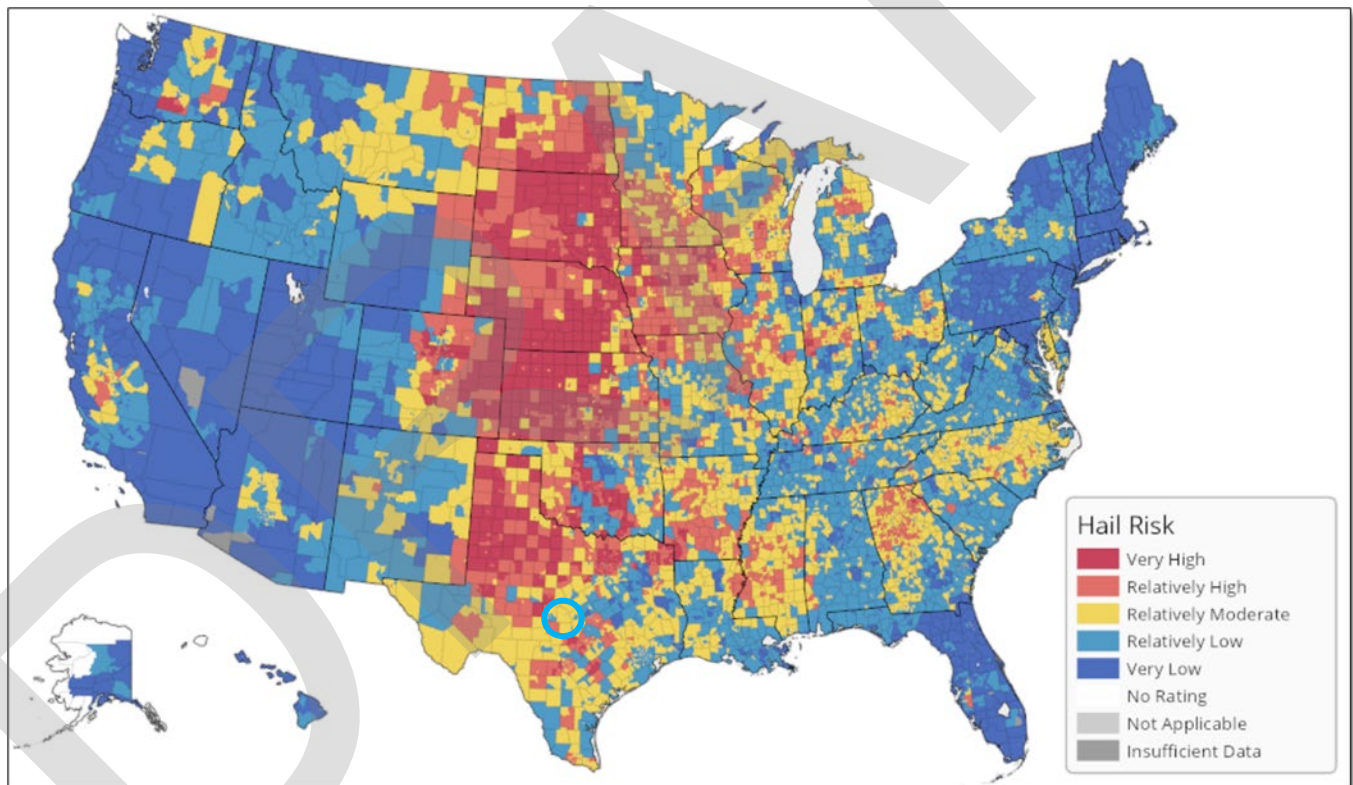
Location

The entire extent of the project area is exposed to the hailstorm hazard.

Hail

In the National Risk Index, a Hail Risk Index score and rating represent a community's relative risk for Hail when compared to the rest of the United States. Presented as a map above, the Hail Risk Index score and rating is shown nationwide. The State of Texas ranges from a very high to relatively high risk of hail in the Northwestern part of the State to a more relatively moderate and relatively low grouping in the western, central, and eastern parts of the State – some counties in these areas are labelled as relatively high risk. The project area, consisting of both Llano and San Saba Counties, are rated as being at a relatively moderate risk for hail.

Figure 4.3.8-2. FEMA's National Hail Risk and Rating Map



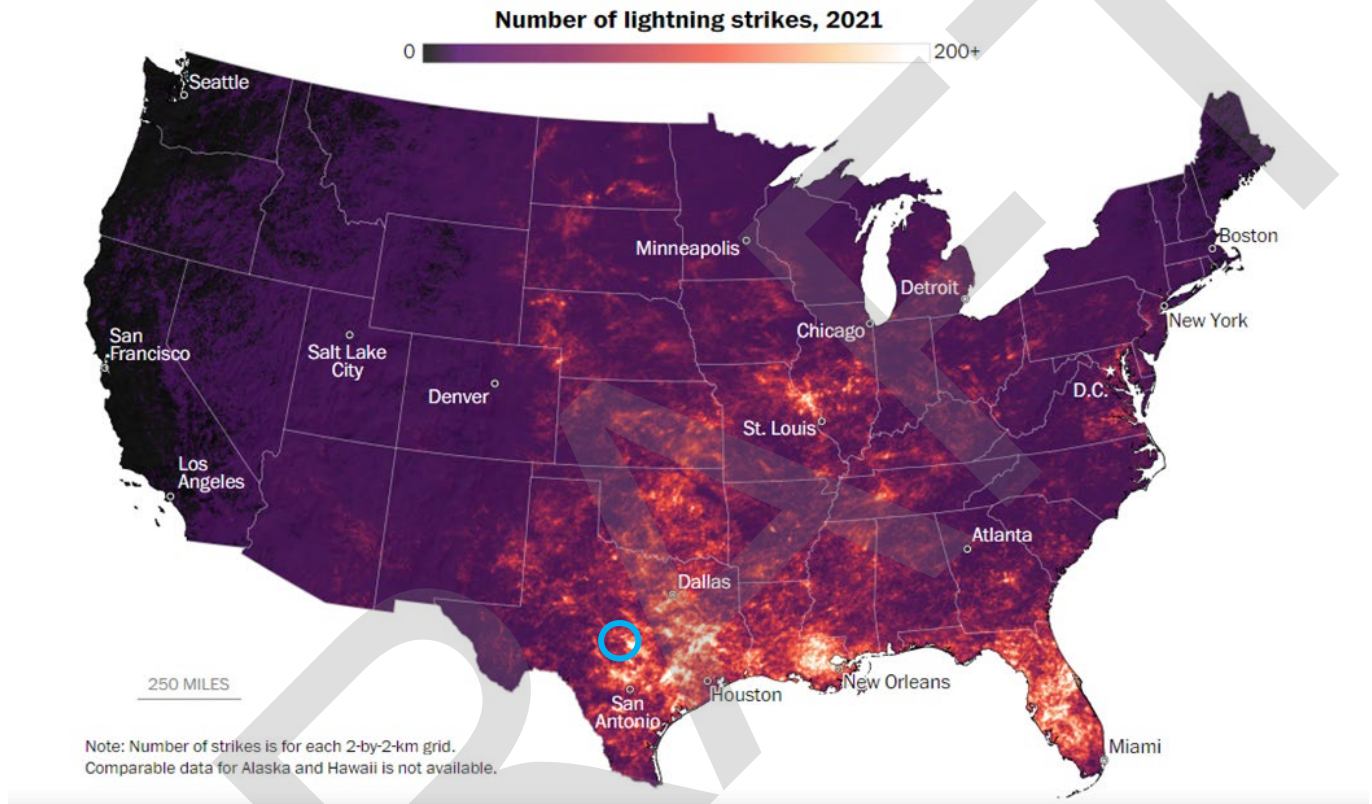
Source: FEMA 2021

Note: The blue circle shows the general location of the Planning Area.

Lightning

In 2021, Texas was one of the top two states to experience lightning. This is thought to be attributed to their relatively tropical and less stable atmospheres (Patel and Dormido 2022). This being said, both counties are vulnerable to lightning, and it can affect all locations in both counties.

Figure 4.3.8-3. Distribution of Lightning Strikes



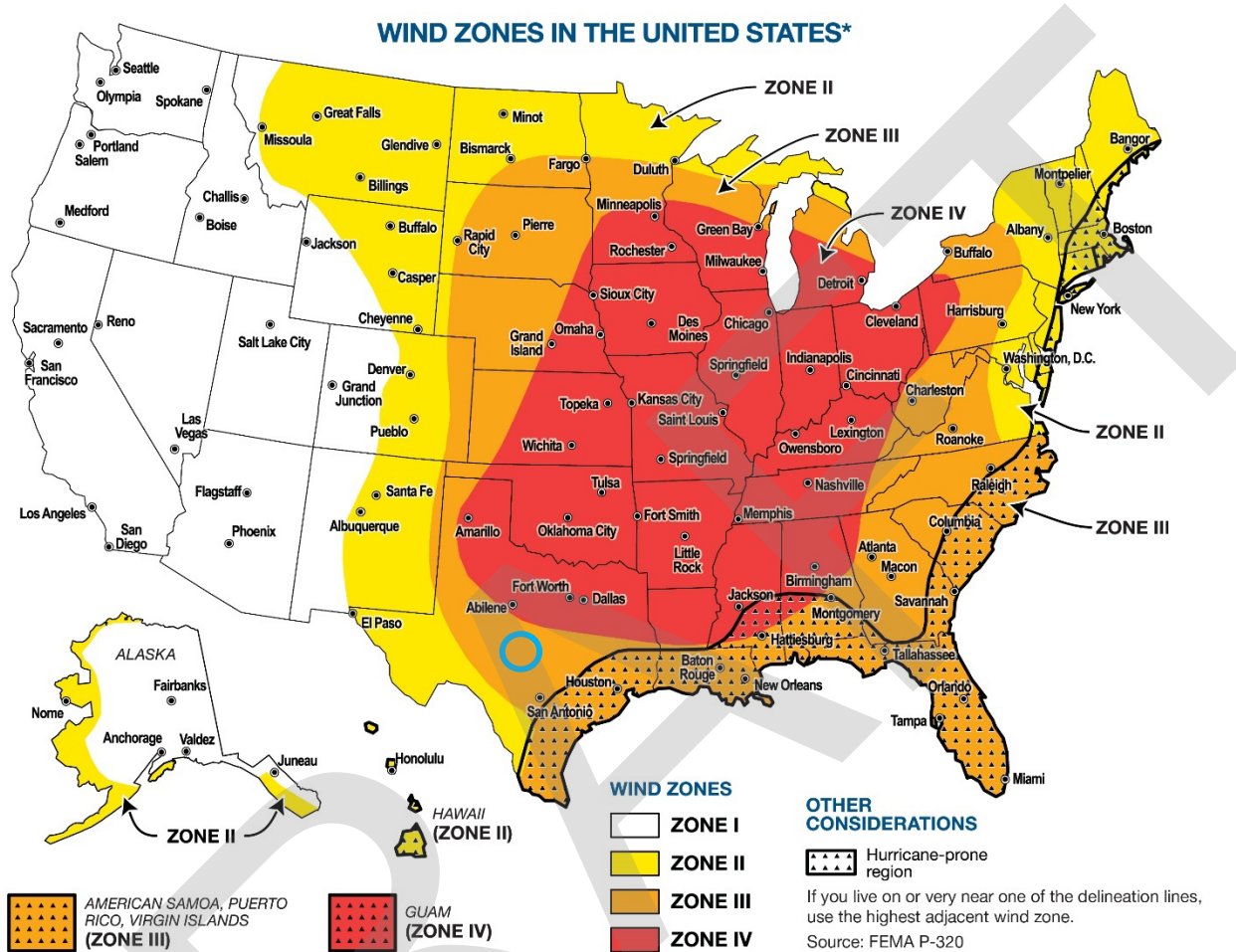
Source: Patel and Dormido 2022

Note: The blue circle shows the general location of the Planning Area.

Wind

According to the FEMA Winds Zones of the United States map, Llano County and San Saba County are in Wind Zone III, where wind speeds can reach up to 200 mph (Building America Solution Center n.d.).

Figure 4.3.8-4. Wind Zones



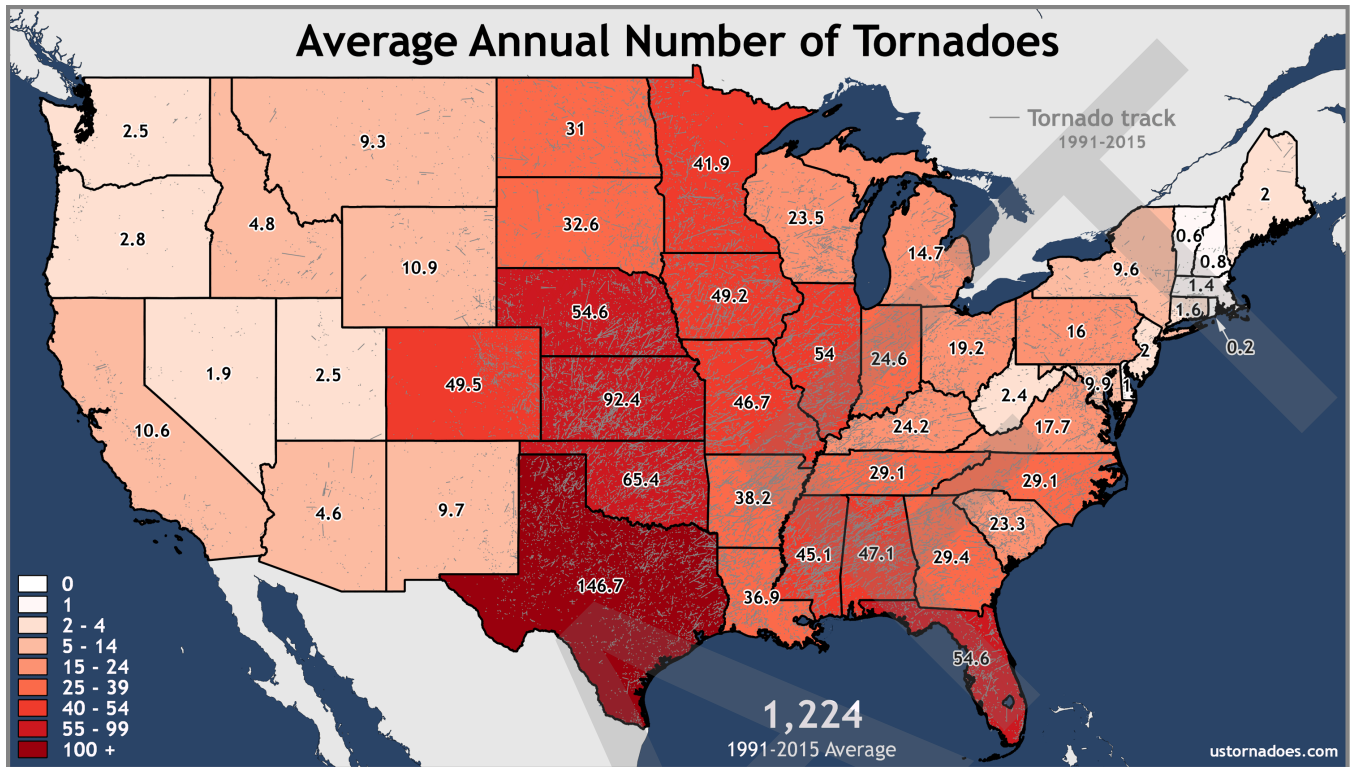
Source: Building America Solution Center n.d.

Note: The blue circle shows the general location of the Planning Area.

Tornado

Tornadoes can occur at any time of the year, with peak season for Texas from May into early June (NOAA n.d.). An average of 1,141 tornadoes occurs in the United States each year, based on tornadoes recorded between 1985 and 2014. The State of Texas averages 140 tornadoes each year.

Figure 4.3.8-5. Average Number of Tornadoes by State



Source: Livingston 2016

Extent

Hail

The severity of damage caused by hailstorms depends on the hailstone sizes (average and maximum), number of hailstones per unit area, and associated winds. Storms that produce high winds in addition to hail are most damaging and can result in numerous broken windows and damaged siding. The NOAA/TORRO Hailstorm Intensity Scale as seen in Table 4.3.8-1 is representative of the damage from hailstorms.

Table 4.3.8-1. Combined NOAA / TORRO Hailstorm Intensity Scales

Size Code	Intensity Category	Typical Hail Diameter (in.)	Approximate Size	Damage Impacts
H0	Hard Hail	Up to 0.33	Pea	No damage
H1	Potentially Damaging	0.33 - 0.60	Marble	Slight damage to plants, crops
H2	Potentially Damaging	0.60 - 0.80	Dime	Significant damage to fruit, crops, vegetation
H3	Severe	0.80 - 1.20	Nickel to Quarter	Severe damage to fruit and crops, damage to glass and plastic structures, plant and wood scored
H4	Severe	1.20 - 1.60	Ping Pong Ball	Widespread glass damage, vehicle bodywork damage

Size Code	Intensity Category	Typical Hail Diameter (in.)	Approximate Size	Damage Impacts
H5	Destructive	1.60 - 2.0	Golf Ball	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	2.0 - 2.4	Egg	Aircraft bodywork dented, brick walls pitted
H7	Very Destructive	2.4 - 3.0	Tennis Ball	Severe roof damage, risk of serious injuries
H8	Very Destructive	3.0 - 3.5	Baseball	Severe damage to aircraft bodywork
H9	Super Hailstorm	3.5 - 4.0	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorm	4.0+	Softball and up	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Sources: State of Texas 2018

Notes: The Hailstorm Intensity Scale allows planners to gauge past damage and mitigate for future expected damage.

Hailstorms can cause extensive property damage affecting both urban and rural landscapes. Fortunately, most hailstorms produce marble-size or smaller hailstones. These can cause damage to crops but they normally do not damage buildings or automobiles. Larger hailstones can destroy crops, livestock, and wildlife and can cause extensive damage to buildings, including roofs, windows, and outside walls. Vehicles can be total losses. When hail breaks windows, water damage from accompanying rains can also be significant. A major hailstorm can easily cause damage running into the millions of dollars (State of Texas 2018).

Lightning

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. The Lightning Activity Level (LAL) is a scale which describes lightning activity. The scale is part of the National Fire Danger Rating System. The scale is a range of numbers, from one to six, which reflects frequency and character of cloud-to-ground lightning (NWCG n.d.) (NOAA n.d.).

Table 4.3.8-2. Lightning Activity Level

Lightning Activity Level (LAL)	Conditions
1	No Thunderstorms
2	Isolated thunderstorms. Light rain will occasionally reach the ground. Lightning is very infrequent, 1 to 5 cloud to ground strikes in a five-minute period.
3	Widely scattered thunderstorms. Light to moderate rain will reach the ground. Lightning is infrequent, 6 to 10 cloud to ground strikes in a five-minute period.
4	Scattered thunderstorms. Moderate rain is commonly produced. Lightning is frequent 11 to 15 cloud to ground strikes in a five-minute period.
5	Numerous thunderstorms. Rainfall is moderate to heavy. Lightning is frequent and intense, greater than 15 cloud strikes in a five-minute period.
6	Dry lightning (same as LAL 3, but without rain). This type of lightning has the potential for extreme fire activity and is normally highlighted in fire weather forecasts with a Red Flag Warning.

Sources: NWCG n.d.

The National Lightning Detection Network, NLDN, consists of over 100 remote, ground-based sensing stations located across the United States that instantaneously detect the electromagnetic signals given off when lightning strikes the earth's surface. These remote sensors send the raw data via a satellite-based communications network to the Network Control Center operated by Vaisala Inc. in Tucson, Arizona. Within seconds of a lightning strike, the NCC's central analyzers process information on the location, time, polarity, and communicated to users across the country (NASA n.d.).

Wind

Wind is often measured in terms of wind shear. Wind shear is a difference in wind speed and direction over a set distance in the atmosphere. Wind shear is measured both horizontally and vertically. Wind shear is measured in meters per second times kilometers of height. Under normal conditions, the winds move much faster higher in the atmosphere, creating high wind shear in high altitudes.

The amount of force that wind is generating is measured according to the Beaufort scale. The scale is named for Sir Francis Beaufort, who established a system for describing wind force in 1805 for the British Royal Navy. The Beaufort scale has 17 levels of wind force. "0" describes conditions that are so calm that smoke rises vertically. "12" describes a hurricane, and "13-17" are reserved only for tropical typhoons, the most powerful and potentially destructive wind systems (Turgeon and Morse 2022).

Figure 4.3.8-6. Beaufort Wind Scale

#	MPH	Knots	Description	Specifications
0	< 1	< 1	Calm	Smoke rises vertically.
1	1-3	1-3	Light Air	Direction of wind shown by smoke drift but not by wind vanes.
2	4-7	4-6	Light Breeze	Wind felt on face; Leaves rustle; Wind vanes moved by wind
3	8-12	7-10	Gentle Breeze	Leaves and small twigs in constant motion; Wind extends light flag.
4	13-18	11-16	Moderate	Raises dust, loose paper; Small branches moved.
5	19-24	17-21	Fresh	Small trees begin to sway; Crested wavelets form on inland waters.
6	25-31	22-27	Strong	Large branches in motion; Whistling heard in telephone wires; Umbrellas used with difficulty.
7	32-38	28-33	Near Gale	Whole trees in motion; Inconvenience felt walking against the wind.
8	39-46	34-40	Gale	Twigs break off trees; Wind generally impedes progress; Mobile homes may shake.
9	47-54	41-47	Strong Gale	Slight structural damage occurs; Mobile homes, sheds, roofs, lanais, and RV's suffer minor damage.
10	55-63	48-55	Storm	Small trees uprooted; Moderate damage occurs to mobile homes and RV's; Brick and wood frame houses receive minor structural and roof damage; Some signs blown down.
11	64-73	56-63	Violent Storm	Moderate sized trees uprooted; Large branches snapped off trees; Chimneys and road signs toppled; Significant mobile home damage; Power lines downed.
12	74-95	64-83	Hurricane Category 1	Mobile homes overturned; Large trees and branches downed; Moderate roof damage to wood and brick homes; Minor pier damage.

Source: NOAA n.d.

The NWS issues advisories and warnings for winds. Issuance is normally site-specific. High wind advisories, watches, and warnings are products issued by the NWS when wind speeds can pose a hazard or are life threatening.

Tornado

Damage from tornadoes can vary from minor damage that break tree limbs to massive damage demolishing homes in its path. The type of damage depends on the intensity, size, and duration of the tornado. The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). This is the scale now used exclusively for determining tornado ratings by comparing wind speed and actual damage. Figure 4.3.8-7 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Tornadoes are not measured as they happen. It takes surveyors to look at the damage to determine what wind speed could have caused the destruction. Also, they need to differentiate whether the wind damage was caused by a tornado or just straight-line winds (Beddoes 2022).

Figure 4.3.8-7. EF Scale

EF Rating	Wind Speeds	Expected Damage	
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	

Source: Beddoes 2022

Worst-Case Scenario

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and erosion occur. A worst-case event would involve prolonged high winds or a tornado, an intense hail event, and a lightning strike at a critical facility (such as an emergency service station) during a thunderstorm. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads and landslides on steep slopes. Flooding could further obstruct roads and bridges, further isolating residents. Important issues associated with a severe weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- Redundancy of power supply must be evaluated.
- The capacity for backup power generation is limited.
- The potential for isolation after a severe storm event is high.
- There is limited information available for local weather forecasts.
- The lack of proper management of trees may exacerbate damage from high winds.

Previous Occurrences and Losses

FEMA Disaster Declarations

Between 1954 and 2022, Llano and San Saba County were included in two disaster (DR) or emergency (EM) declarations for severe weather events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

- DR-1239-TX- (1998) Severe Storm: Llano and San Saba
- DR-1709-TX- (2007) Severe Storm: Llano and San Saba

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2012 and 2022, Llano and/or San Saba County were not included in any severe weather-related agricultural disaster declarations.

Previous Events

For this 2023 HMP update, known severe weather events that impacted the Planning Area between 2017 and 2022 are discussed below. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.8-3. Hail Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
March 28, 2017	Thunderstorm Wind	N/A	N/A	A thunderstorm produced wind gusts estimated at 60 mph that damaged the roof of a business building.
April 3, 2018	Hail	N/A	N/A	Thunderstorms developed as a cold front moved into a warm, moist airmass over South Central Texas. Some of these storms produced severe hail.
April 10, 2017	Hail	N/A	N/A	A cold front interacting with a moist and unstable atmosphere resulted in severe storms that produced large hail across the Northwest Hill Country.
May 25, 2018	Thunderstorm Wind	N/A	N/A	Storms produced large hail and damaging winds that also contributed to flooding.
July 4, 2018	Thunderstorm Wind	N/A	N/A	A thunderstorm produced wind gusts estimated at 70 mph that uprooted trees at the Lighthouse Country Club in Kingsland.
April 17, 2019	Hail	N/A	N/A	A Pacific Cold Front and the West Texas dry line resulted in several severe thunderstorm reports of large hail and damaging winds.
May 8, 2019	Hail	N/A	N/A	Daytime heating, an approaching upper-level low pressure system and a dryline across West Central Texas triggered the development of a few supercell thunderstorms. These severe storms produced baseball size hail and damaging thunderstorm wind gust reports across the area.
May 30, 2019	Hail	N/A	N/A	A cold front moved into South Central Texas and stalled. Thunderstorms formed along this front and some of them produced large, 3-inch hail and damaging wind gusts.
June 9, 2019	Hail	N/A	N/A	Thunderstorms developed along a cold front that moved through the region. These storms formed in an unstable airmass with high CAPE and steep mid-level lapse rates leading to large, golf ball sized hail and widespread damaging wind gusts many of which were estimated to be over 70 mph.
January 10, 2020	Hail	N/A	N/A	A strong Pacific cold front moved into a warm, moist airmass and generated

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
				thunderstorms in the warm sector. Some of these storms produced large hail (half dollar sized) and damaging wind gusts.
April 12, 2020	Thunderstorm Wind	N/A	N/A	Some of these storms produced tornadoes and large hail and caused over 10 million dollars in damages.
May 27, 2020	Hail	N/A	N/A	An upper-level low and surface cold front interacted to generate thunderstorms. The airmass these features moved into was strongly unstable with steep lapse rates aloft and was conducive for storms producing large hail and damaging wind gusts.
March 22, 2021	Hail	N/A	N/A	Isolated severe thunderstorms formed and produced mainly large hail.
March 24, 2021	Hail	N/A	N/A	An upper-level low moved into west Texas and provided lift to generate convection. There was a warm, moist airmass over South Central Texas and a warm front just north of the area. The front acted as a focus for convection and some of the storms produced large hail.
April 12, 2021	Hail	N/A	N/A	Thunderstorms formed along a frontal boundary in Central Texas and moved through the northeastern part of South-Central Texas. Some of these storms produced tennis ball size hail.
April 15, 2021	Hail	N/A	N/A	A stationary cold front draped to the south of the region and potent upper-level disturbances approaching from Northern Mexico caused increasing wind shear and instability across portions of West Central Texas. These features triggered isolated elevated severe thunderstorms near Abilene on April 14. On April 15, more severe thunderstorms resulted in several large to very large hailstorms.
May 9, 2021	Hail	N/A	N/A	Thunderstorms developed along a cold front in Central Texas and moved into South Central Texas. Some of these storms produced quarter to ping pong ball sized hail.
June 2, 2021	Thunderstorm Wind	N/A	N/A	One of these storms produced damaging wind gusts.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
May 28, 2021	Hail/Tornado	N/A	N/A	Thunderstorms developed in the warm sector ahead of a cold front. Some of these storms produced golf ball size hail, damaging winds, and heavy rain that led to flash flooding. There was one weak tornado.
May 14, 2022	Hail	N/A	N/A	Isolated to scattered thunderstorms developed during the late afternoon and early evening. A few storms became severe and produced large hail.
May 24, 2022	Thunderstorm Wind	N/A	N/A	Severe storms moved into the Heartland and produced large hail and wind damage through the early evening. A few more severe thunderstorms moved southeast into the Concho Valley from the Permian Basin and produced marginal severe hail and strong wind gusts around 70 mph.

Sources: NOAA 2022; USDA FSA 2022; FEMA 2022; San Saba County 2016; Llano County 2016

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of hail events for the County Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2016 Llano HMP and the 2016 San Saba County HMP were used to identify the number of hail events that occurred between 1950 and 2022. Table 4.3.8-4 presents the probability of severe weather events for Llano County; Table 4.3.8-5 presents the probability of future severe weather events for San Saba County.

Table 4.3.8-4. Probability of Future Severe Weather Events, Llano County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hail	186	100%
Lightning	0	0
Tornado	9	12.33%
Wind Events	77	100%
Total	272	100%

Sources: NOAA 2022; State of Texas 2018; Llano County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all hail events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Based on past occurrences, Llano County can expect to experience at least one severe weather event annually (NOAA 2022).

Table 4.3.8-5. Probability of Future Severe Weather Events, San Saba County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Hail	140	100%
Lightning	0	0%
Tornado	13	17.81%
Wind Events	68	93.15%
Total	221	100%

Sources: NOAA 2022; State of Texas 2018; San Saba County 2016

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all hail events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

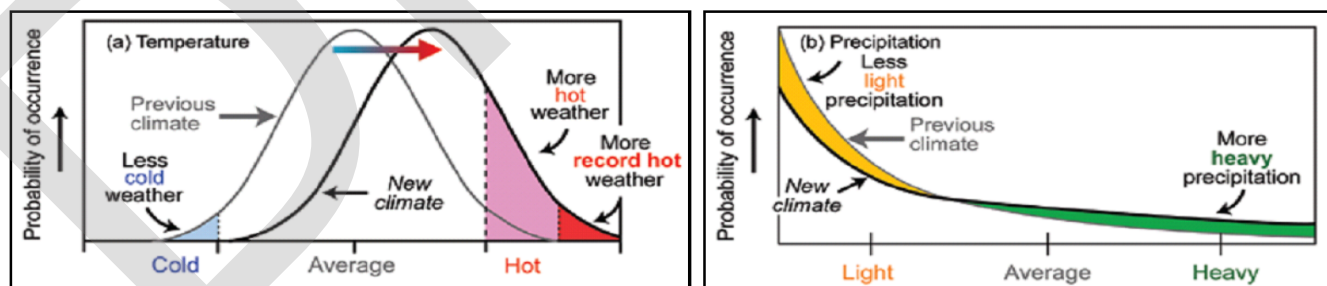
Based on past occurrences, San Saba County can expect to experience at least one severe weather event annually (NOAA 2022).

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. In the eastern two-thirds of the State, rainstorms are more intense, and floods are becoming more severe. In the coming decades, storms are likely to become more severe in Texas (EPA 2016). Periods of extreme precipitation increase the risk of hail and lightning (Centers for Climate and Energy Solutions n.d.). Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (UCAR 2017).

Climate change presents a significant challenge for risk management associated with severe weather. The frequency of severe weather events has increased steadily over the last century. The number of weather-related disasters during the 1990s was four times that of the 1950s, and cost 14 times as much in economic losses. Historical data shows that the probability for severe weather events increases in a warmer climate (see Figure 4.3.8-8). The changing hydrograph caused by climate change could have a significant impact on the intensity, duration, and frequency of storm events. All of these impacts could have significant economic consequences (Llano County 2016) (San Saba County 2016).

Figure 4.3.8-8. Severe Weather Probabilities in Warmer Climates



Source: Llano County 2016; San Saba County 2016

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the severe weather hazard. The following text evaluates and estimates the potential impact of the severe weather hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

The impact of thunderstorms on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. As a result of severe weather events, residents can be displaced or require temporary to long-term sheltering.

The most common problems associated with severe storms are immobility and loss of utilities. Residents impacted by severe weather may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by winds associated with severe weather can lead to injury or loss of life.

Although the entire population of both Counties is exposed to strong wind events, hail and lightning, some populations are more vulnerable. Vulnerable populations include the elderly, low income, linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. In general, populations who lack adequate shelter during a thunderstorm or severe wind event, those who are reliant on sustained sources of power in order to survive, and those who live in isolated areas with limited ingress and egress options are the most vulnerable.

Impact on General Building Stock

The entire Planning Area's building stock is exposed to the severe weather hazard. Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Building construction also plays a major role in the extent of damage resulting from a storm. Due to differences in construction, residential structures are generally more susceptible to storm damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems.

Manufactured housing (i.e., mobiles homes) is particularly vulnerable to high winds and tornadoes. The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, design to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U. S. Census 2020)." They can include multi-wide and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their lightweight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Impact on Critical Facilities

Overall, all critical facilities in Llano and San Saba Counties are vulnerable to being affected by severe storm events. Utility infrastructure could suffer damage from lightning, hail and high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such

the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Impact on Economy

Impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Business interruption losses include losses associated with the inability to operate a business because of the damage sustained during a storm or the temporary living expenses for those displaced from their home because of an event. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the populations.

The wind's power to erode the land can be detrimental to agriculture. Loess, a sediment that can develop into one of the richest soils for farming, is easily swept up by wind. Even when farmers take precautions to protect it, the wind can erode up to 2.5 kilograms of loess per square meter. (1.6 pound per square foot) every year (Turgeon and Morse 2022).

Wind is a renewable resource that does not directly cause pollution. Wind energy is harnessed through powerful turbines. Wind turbines have a tall tubular tower with two or three propeller-like blades rotating at the top. When the wind turns the blades, the blades turn a generator and create electricity. The economic drawback to wind farms, however, is the wind itself. If it's not blowing, there's no electricity generated. (Turgeon and Morse 2022).

According to NOAA's Technical Paper on *Lightning Fatalities, Injuries, and Damage Reports in the United States from 1959 - 1994*, monetary losses for lightning events range from less than \$50 to greater than \$5 million (larger losses associated with forest fires with homes destroyed and crop loss) (NOAA 1997).

Hail-producing severe storms impact the economy; impacts include loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair or replacement of buildings. Additionally, vehicles parked outdoors are vulnerable to hail damage and could increase economic impacts of a storm.

Impact on the Environment

Wind and hail can knock over power lines sparking fires which can destroy forests and habitats. Lightning can strike trees and create fires which can take out entire habitats and displace animals.

Wind is needed to disperse seeds to distant and nearby places which increases the spread of plant genetics (Turgeon and Morse 2022). Winds can also carry debris and litter across areas which can negatively impact ecosystems and habitats, including water bodies.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The

Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Understanding future changes that impact vulnerability in the Counties can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. Areas targeted for potential future growth and development could be potentially impacted by thunderstorms since the entire County is exposed to the lightning hazard. However, due to increased standards and codes, new development can be less vulnerable to the severe weather hazard compared with the aging building stock in the Counties.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.). An increase in population will expose more people to the severe weather hazard.

Climate Change

Scientists must attempt to predict how climate change might affect the individual weather “ingredients” that produce storms which produce strong wind events. These weather ingredients are (Geographic n.d.):

- Warm, moist air
- An unstable atmosphere
- Wind at different levels moving in different directions at different speeds, a phenomenon known as wind shear

As global temperatures rise, the hotter atmosphere can hold more moisture. This increases atmospheric instability, a vital supercell ingredient. On the other hand, as the planet warms, wind shear (another vital ingredient) is likely to decrease. These two forces work against each other, and it is difficult to anticipate which might have a greater impact on tornado formation (Geographic n.d.).

The entire State of Texas is projected to experience an increase in the frequency and severity of extreme storms and rainfall. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017).

Climate change may lead to an increase in the number of lightning strikes and lightning-producing storms. Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later

this century in a changing climate, leading to increased rainfall and posing a greater threat of flooding across wide areas (University Corporation for Atmospheric Research [UCAR] 2017). The changing climate may also increase the frequency of lightning flashes could rise by an estimated 50-percent across the continental United States over the next century. A warmer atmosphere can hold more moisture and moisture is one of the key ingredients for triggering a lightning strike (Sanders 2014).

Change of Vulnerability Since 2016 HMP

The population has increased in the Planning Area, increasing the number of people that could be impacted by severe weather hazard. Climate Change is creating stronger storms, making wind hazards more probable than in the previous plan. As existing development and infrastructure continue to age, they can be at increased risk to failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.9 Winter Weather

The following section provides the hazard profile and vulnerability assessment for the winter weather hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Severe winter weather brings the threat of snow, freezing rain, and ice storms to Llano and San Saba Counties. Winter weather involves weather events in which the main types of precipitation are snow, sleet, or freezing rain. They can be a combination of heavy snow, blowing snow, and dangerous wind chills. According to the National Severe Storms Laboratory, the three basic components needed to make a winter storm include the following:

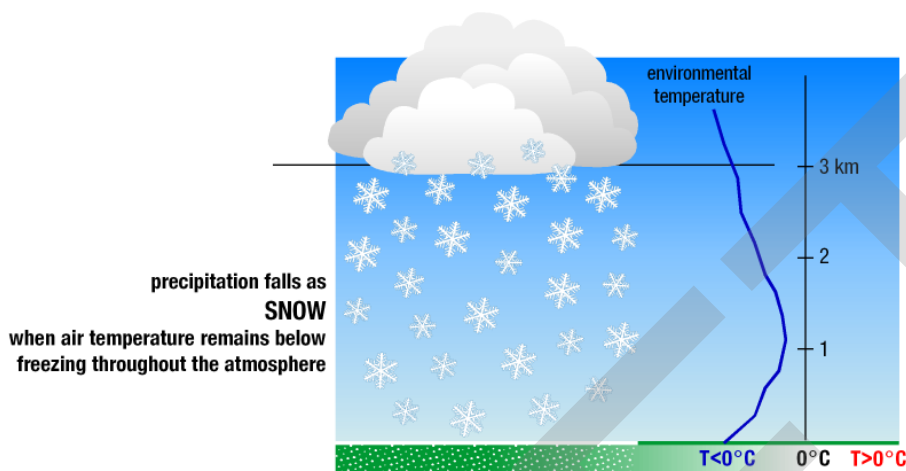
- Below-freezing temperatures (cold air) in the clouds and near the ground to make snow and ice.
- Lift, something to raise the moist air to form clouds and cause precipitation, such as warm air colliding with cold air and being forced to rise over the cold dome or air flowing up a mountainside (orographic lifting).
- Moisture to form clouds and precipitation, such as air blowing across a large lake or the ocean.

Some winter storms are large enough to immobilize an entire region while others might only affect a single community. Winter storms typically are accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and blocked roadways, downed utility lines, and power outages. In the Planning Area, winter weather includes snowstorms, blizzards, and ice storms. Extreme cold temperatures and wind chills are associated with winter weather; however, they are discussed in Section 4.3.3 (Extreme Temperature).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 °F) and water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellet, which then falls to the earth. Snow falls in different forms: snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Figure 4.3.9-1 depicts snow creation.

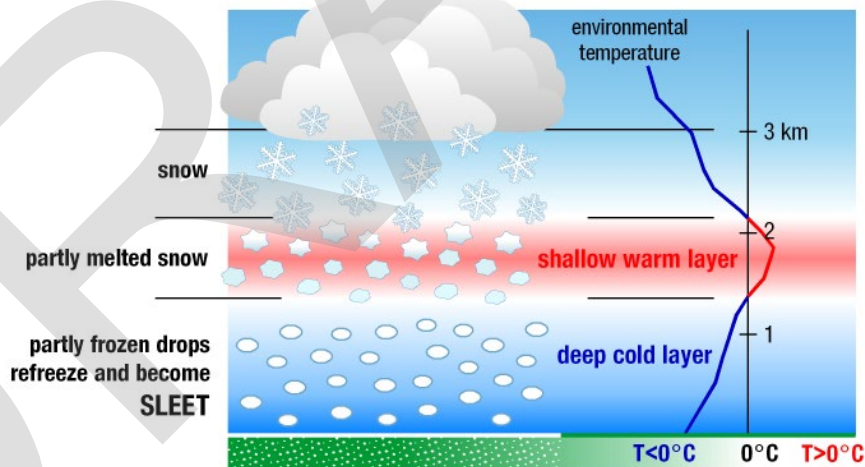
Figure 4.3.9-1. Snow Creation



Source: NOAA NSSL n.d.

Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets, which are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. Sleet is made up of drops of rain that freeze into ice as they fall through colder air layers. They are usually smaller than 0.30 inches in diameter (NSIDC 2020).

Figure 4.3.9-2. Sleet Creation



Source: NOAA NSSL n.d.

Blizzards

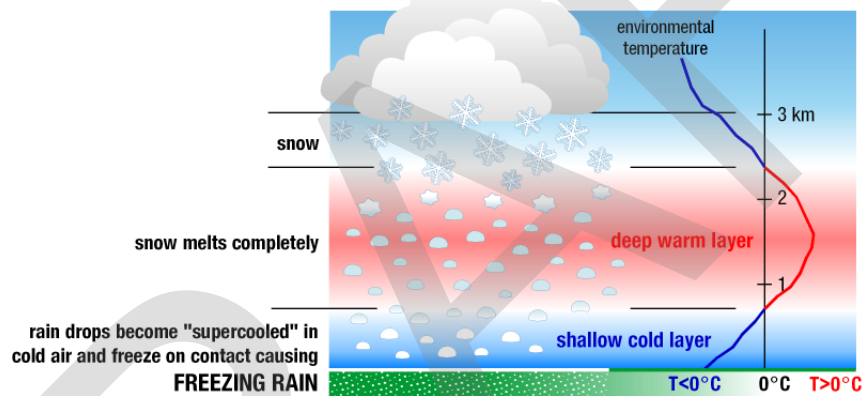
A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile, as the predominant conditions over a 3-hour period. Extremely cold temperatures often are associated with blizzard conditions but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20 °F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough

to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (NWS n.d.).

Ice Storms

An ice storm describes those events when damaging accumulations of ice are expected during freezing rain situations. Significant ice accumulations typically are accumulations of 0.25-inches or greater. Heavy accumulations of ice can bring down trees, power lines, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small accumulations of ice can be extremely dangerous to motorists and pedestrians (NWS 2018).

Figure 4.3.9-3. Freezing Rain Creation



Source: NOAA NSSL n.d.

Location

Winter weather can happen anywhere in the state of Texas. The southern portions of the state are not as likely to incur severe winter weather, but when it does happen, the impacts are much stronger because the communities and governments are not as prepared. Both Llano County and San Saba County average 0 inches of winter-related precipitation per year, making a severe winter weather an unlikely occurrence (Bestplaces 2022).

Extent

The magnitude or severity of a severe winter storm depends on several factors, including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5 and is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population

(based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA NCEI n.d.). Table 4.3.9-1 presents the five RSI ranking categories.

The maximum winter weather extent that can be expected in Llano County and/or San Saba County is an RSI Category 5 snowfall event. Because the Planning Area is located in the National Centers for Environmental Information's south climate region, the amount of snow that can fall for this category event is up to 15 inches; however, the area will most likely see lower amounts of snow based on history of occurrence. The last major winter weather event to affect the Planning Area were two RSI Category 3 winter storms in February 2021.

Table 4.3.9-1. RSI Ranking Categories for the South Climate Region

Category	Description	RSI Value	Snowfall Thresholds
1	Notable	1–3	<2
2	Significant	3–6	>2
3	Major	6–10	>5
4	Crippling	10–18	>10
5	Extreme	18.0+	>15

Source: NOAA NCEI n.d.

Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NOAA 2017).

According to the National Weather Service (part of NOAA), the magnitude of a severe winter storm can be qualified into five main categories by event type:

- Heavy Snowstorm – Snowfall accumulating to 4 inches or more in 12 hours or less or snowfall accumulating to 6 inches or more in 24 hours or less.
- Sleet Storm – Significant accumulations of solid pellets that form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists.
- Ice Storm – Significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations; significant ice accumulations are usually ¼" or greater.
- Blizzard – Sustained winds or frequent gusts of 35 mph or more; considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period.
- Severe Blizzard – Wind velocity of 45 mph, temperatures of 10°F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period.

The NWS uses winter weather watches, warnings, and advisories to ensure that people know what to expect in the coming hours and days.

- Watches
 - Blizzard – Conditions are favorable for blizzard conditions to be met in the next 12 to 48 hours.
 - Winter Storm – Issued when winter storm conditions, defined above, are possible within 24 to 48 hours.
- Warnings

- Blizzard – Issued when sustained winds or frequent gusts ≥ 35 mph combined with blowing and or falling snow, reducing visibility below 1/4 mile for 3 hours or more, when imminent or expected within the next 36 hours. Temperatures are assumed below 32°F, and snow should accumulate at least one inch in 12 hours.
- Winter Storm – Issued when the following conditions, capable of producing high impact and potentially life-threatening conditions, are occurring, or expected to occur within the 36 hours: snow - ≥ 1 inch in 12 hours; sleet - $\geq 1/2$ inch in 12 hours; and or a combination of snow, sleet, ice with snow or sleet meeting warning criteria
- Ice Storm – Issued when $\geq 1/8$ inch of Ice is expected to accrete on trees, power lines, and bridges/overpasses for the entirety of the event. These conditions are capable of producing high impact and potentially life-threatening conditions and are either occurring or expected to occur within the next 36 hours.
- Advisories
 - Winter Weather – Issued when the following conditions, capable of producing significant, but not necessarily life threatening, inconveniences, are occurring or expected to occur within the next 36 hours:
 - Snow: 1/2 to 1 inch in 12 hours
 - Sleet: $< 1/2$ inch in 12 hours
 - Ice: $< 1/8$ inch in 12 hours
 - Combination: Snow, sleet, and ice with snow or sleet meeting advisory criteria.

Worst-Case Scenario

A worst-case severe winter storm scenario would be a storm similar to that of the February 2021 ice storms which brought extreme temperature lows, deaths and injuries, significant buildup of ice on structures and infrastructure including highway overpasses. A storm like this could lead to downed trees and power lines, power outages, closed roadways, and overall impact to the planning area. This would lead to disruption in emergency services and limited access to essentials (e.g., water, heat).

Previous Occurrences and Losses

Many sources have provided historical information regarding previous occurrences and losses associated with severe winter storm events in Llano County and/or San Saba County. According to the NOAA-NCEI storm events database, Llano County and San Saba County have been impacted by 24 winter weather events between 1950 and 2022 (NCEI NOAA 2021).

FEMA Disaster Declarations

Between 1954 and 2022, Llano and San Saba County were each included in two disaster (DR) or emergency (EM) declarations for winter weather-related events. Generally, these disasters cover a wide region of the State; therefore, they can impact many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2022). Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

Table 4.3.9-2. Winter Weather FEMA Disaster Declarations in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA Declaration Number	Llano and/or San Saba County included in the Declaration?
February 11 - 21, 2021	Severe Ice Storm	3554-EM-TX	Llano County, San Saba County
February 11 - 21, 2021	Severe Ice Storm	4586-DR-TX	Llano County, San Saba County

Source: FEMA 2022

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, San Saba County was included in one winter weather-related agricultural disaster declaration.

Date(s) of Event	Event Type	USDA Declaration Number	Llano and/or San Saba County included in the Declaration?
February 10 - 19, 2021	winter storm, blizzard, snow, ice, and high winds	S4975	San Saba County

Source: USDA 2022

Previous Events

For this 2023 HMP update, known winter weather events that impacted the Planning Area between 2017 and 2022 are discussed below in Table 4.3.9-3. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.9-3. Winter Weather Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
January 16, 2018	Winter Storm	N/A	N/A	A cold front brought a shallow layer of subfreezing air to South Central Texas. Isentropic lift of warm moist air over this shallow cold layer led to wintry precipitation. Most of the precipitation was freezing rain and sleet, but there was some snow toward the end of the event. There were reports of 1/8 inch of ice accumulated in Leon Valley, New Braunfels, and San Geronimo. Icy roads were a problem across the region. Ice closed many roads across the region and caused numerous vehicle accidents. No property or crop damages were reported.
January 2, 2019	Winter Weather	N/A	N/A	Light freezing drizzle and light freezing rain started in West Central Texas mainly around midnight on January 2nd and continued off and on through the morning of January 3. A glaze of ice formed on area

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				roadways as temperatures ranged from 26 degrees in the north near Haskell to 32 degrees in the south along Interstate 10. Sleet and light snow mixed with the precipitation at times especially along and north of a line from Sweetwater to Brownwood. This wintry precipitation made area roadways very hazardous and led to many accidents across the area and resulted in the closing of offices on January 2. Another area of freezing rain and sleet moved across West Central during the night of the January 2, and into the early morning hours of January 3. No property or crop damages were reported.
February 5 – 6, 2020	Winter Weather	N/A	N/A	A strong cold front brought freezing temperatures and scattered precipitation. Precipitation was a mix of rain, sleet, and snow. Sleet was reported in Atascosa, Uvalde, Kendall, Llano, and Lavaca Counties with no accumulation. Sleet and snow were reported in Real, Kerr, Bexar, Guadalupe, Hays, Travis, and Williamson. In Williamson County Weir, Taylor, and Georgetown had 1/4 of snow and Round Rock and Serenada had 0.2. In Travis County Pflugerville saw 1/2 of snow, parts of Austin had 1/4 to 0.4, Jollyville, Sunset Valley, Lost Creek, and West Lake Hills had 0.2, and Jollyville and San Leanna had 0.1. There were reports of only snow in Val Verde, Bandera, Gillespie, Comal, Caldwell, and Bastrop Counties. Camp Swift in Bastrop County had 1/4 of snow. In Hays County Wimberley had 0.1 of snow and in Comal County New Braunfels had 0.1. With the minor accumulations there weren't any impacts from this event. A strong cold front brought freezing temperatures and scattered

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				precipitation. Precipitation was a mix of rain, sleet, and snow. Sleet was reported in Llano County. With the minor accumulations there weren't any impacts from this event. No property or crop damages were reported.
December 31, 2020	Winter Weather	N/A	N/A	A winter storm dumped heavy snow from Roscoe south to Sterling City, Barnhart and Ozona. This storm also produced a mixture of freezing rain, sleet, and snow over the remainder of West Central Texas. The freezing rain that fell before the snow was heavy enough to result in scattered tree limb damage and power outages across the area. However, Coleman County was hardest hit by the ice that left many without power. Most of the snow ended south of Interstate 20 before midnight, but some of the snow continued into New Year's Day mainly along and north of Interstate 20. The ice and snow also made travel difficult across the area. National Weather Service Cooperative Observer in San Saba measured 3 inches of snow. No property or crop damages were reported.
December 31, 2020	Winter Storm	N/A	N/A	A cold front brought cold air to South Central Texas on December 30 and then stalled along the coast. On the 31st an area of low pressure developed along the front as an upper-level trough moved from northern Mexico into Texas. This combination led to the development of snow showers across the northern part of the area. Snow accumulation was reported in Burnet, Edwards, Gillespie, Kerr, Llano, and Real Counties ranging from 0.2 inches to 4.5 inches. Here are some reports: Burnet 5.0 NNW 0.5 in. Rocksprings 8.5 WSW 4.5 in. Rocksprings 8.9 SE 4.5 in.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				Fredericksburg 5.3 N 0.2 in. Ingram 14.2 NW 4.0 in. 1.4 NW Ingram 3.4 in. Ingram 1.1 NNW 2.1 in. Hunt 1.4 NNE 2.0 in. Ingram 8.6 WSW 1.2 in. Castell 0.1 E 1.4 in. Camp Wood 7.3 NE 3.0 in. No property or crop damages were reported.
January 10, 2021	Heavy Snow	N/A	N/A	This upper low blanketed a large part of West Central Texas with snow. This storm system resulted in heavy snow amounts of 4 to 8 inches along and north of a line from Mertzon to San Angelo to San Saba. Many schools and universities closed on January 11. Schools had a two-hour delay in the south where the snow was the lightest. Roads became snow packed across the region, making travel difficult. National Weather Service CoCoRaHS Observer located 0.7 miles south of Cherokee reported 5.5 inches of snow. No property or crop damages were reported.
January 10, 2021	Winter Storm	N/A	N/A	An upper-level low pressure center moved across Texas cooling the atmosphere above the boundary layer leading to precipitation changing from rain to sleet and snow. Snowfall totals ranged from two inches to six inches. The highest snow totals were in Jarrell and Leander in Williamson County where 6.0 inches fell. These were the highest totals in each county: Bastrop 3.0 inches at Paige, Blanco 2.5 inches at Spicewood, Burnet 4.5 inches near Tow, Gillespie 2.5 inches at Fredericksburg, Hays 2.0 inch at Dripping Springs, Lee 2.2 inches at Fedor, Llano 2.0 inches at Llano, Travis 4.5 inches at Austin. No property or crop damages were reported.
February 10 – 12, 2021	Winter Weather	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County	A shallow arctic airmass moved into the West Central Texas on February 9 and continued to slowly move south across the region on February

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
			USDA: San Saba County	10. Warm gulf moisture overran the frontal boundary and resulted in periods of widespread freezing drizzle across West Central Texas. Roads became covered with an icy glaze, making travel difficult. This ice also caused some power lines to sag in Nolan County. A traffic fatality was reported in Tom Green County on the morning of February 11. Roads became covered with a glaze of ice. No property or crop damages were reported.
February 11, 2021	Winter Storm	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A series of weather systems brought several rounds of winter weather to South Central Texas from February 11 through February 18. The first episode of winter weather started when a cold front moved through South Central Texas on February 10 and stalled over South Texas. This brought cold air to the region and once it was in place, a combination of isentropic flow over the frontal boundary and an upper-level shortwave trough produced sufficient lift to produce precipitation. With warm air above the boundary layer and sub-freezing air near the surface, the precipitation fell as freezing rain. Pictures from a trained weather spotter showed ice accumulation from freezing rain of 0.10 inches on trees, vehicles, and elevated surfaces near Llano. Pictures showed at least 0.5 inches of ice accumulation south of Llano. Picture from a trained spotter showed 3/4 inch of ice accumulation on a deck near Llano. No property or crop damages were reported.
February 11, 2021	Winter Storm	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A fast-breaking ice storm with freezing rain, sleet and some snow impacted the Northwest Hill Country and the Interstate 10 Corridor near Junction. This led to a traffic fatality and rapid ice accumulations.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				Hundreds of tractor trailers and motorists became stranded overnight and into the morning of the February 12 on Interstate 10 near Junction and Sonora. Several churches provided shelter and food for these stranded motorists. The thick ice brought down power poles, power lines, two communication towers and lots of tree branches and trees across Kimble County. San Saba Sheriff's Department reported a half inch of sleet on roadways across the town of Cherokee. No property or crop damages were reported.
February 14 – 15, 2021	Winter Storm	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A series of weather systems brought several rounds of winter weather to South Central Texas from February 11 through February 18. The second round came on the 13th and 14th with cold air still in place in the low levels, another upper-level shortwave trough moved across Texas providing lift for precipitation. The deeper atmosphere had warm air above the cold leading to a second round of freezing rain. The third round of winter weather was initiated by another upper-level shortwave trough on the 14th and 15th. This system brought cooler air above the boundary layer and turned precipitation to snow. Most of the area had only snow, but there were also short periods of freezing rain in a few places. In addition to the snow, bitterly cold air and breezy winds combined to bring extreme wind chill values on the 15th. With a FOIA (Freedom of Information Act) the state of Texas DSHS has produced some fatality numbers (direct vs indirect) for this event. However, there are no details provided on gender, exact location, or time of death. Direct deaths are from hypothermia. Indirect deaths

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				are listed as deaths from falls, carbon monoxide, heating related fire, motor vehicle accidents, drowning, exacerbation of chronic illness, and frostbite. In some cases where fatality information was obtained by emergency managers, some details have been documented. Dates of deaths were placed on Feb 15 as an estimate and to be consistent of when some of the coldest temperatures occurred. In addition, overall monetary losses for individual counties cannot be computed with the substantial number of insured loss claims due to water pipes bursting in homes and businesses along with monetary loss due to rolling power blackouts. Insured loss numbers are not passed onto individual NWS offices. In the more urbanized counties where population is larger, overall uninsured and insured losses likely will total in the 100s of millions of dollars. The state of Texas will likely accumulate Billions in losses with this winter event. Snowfall overnight on the 14th and 15th blanketed the county with as much as 5.0 in. Some snow totals included 3.0 in. in Kingsland, 4.0 in. in Inks Lake, and 5.0 in. in Llano. No property or crop damages were reported.
February 14 – 15, 2021	Heavy Snow	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A powerful Valentines Snow Storm, with subzero wind chills, low visibilities in blowing and heavy snow swept across a large part of West Central Texas. This heavy snow and blowing snow made travel very difficult over most of the area. This snow stayed on the ground through much of the week, before mostly melting on Saturday, February 20. Anywhere from 2 to 8 inches fell across the region. There was a 25-to-35-mile swath of heavier snow that extended from Abilene to San

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				Angelo where about 10 inches of snow fell. This snow was quite dry in water content. San Saba Sheriff's Department estimated 4 inches of snow in San Saba. National Weather Service Cooperative Observer located 7 miles northwest of San Saba measured 3 inches of snow. No property or crop damages were reported.
February 14 – 15, 2021	Extreme Cold/Wind Chill	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A series of weather systems brought several rounds of winter weather to South Central Texas from February 11 through February 18. The second round came on the 13th and 14th with cold air still in place in the low levels, another upper-level shortwave trough moved across Texas providing lift for precipitation. The deeper atmosphere had warm air above the cold leading to a second round of freezing rain. The third round of winter weather was initiated by another upper-level shortwave trough on the 14th and 15th. This system brought cooler air above the boundary layer and turned precipitation to snow. Most of the area had only snow, but there were also short periods of freezing rain in a few places. In addition to the snow, bitterly cold air and breezy winds combined to bring extreme wind chill values on the 15th. With a FOIA (Freedom of Information Act) the state of Texas DSHS has produced some fatality numbers (direct vs indirect) for this event. However, there are no details provided on gender, exact location, or time of death. Direct deaths are from hypothermia. Indirect deaths are listed as deaths from falls, carbon monoxide, heating related fire, motor vehicle accidents, drowning, exacerbation of chronic illness, and frostbite. In some cases where fatality information was

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				obtained by emergency managers, some details have been documented. Dates of deaths were placed on Feb 15 as an estimate and to be consistent of when some of the coldest temperatures occurred. In addition, overall monetary losses for individual counties cannot be computed with the substantial number of insured loss claims due to water pipes bursting in homes and businesses along with monetary loss due to rolling power blackouts. Insured loss numbers are not passed onto individual NWS offices. In the more urbanized counties where population is larger, overall uninsured and insured losses likely will total in the 100s of millions of dollars. The state of Texas will likely accumulate Billions in losses with this winter event. Extreme cold temperatures and breezy winds combined to produce wind chill values of -5 to -10 degrees F. No property or crop damages were reported.
February 16 – 18, 2021	Heavy Snow	FEMA: 3554-EM-TX, 4586-DR-TX USDA: S4975	FEMA: Llano County, San Saba County USDA: San Saba County	A series of weather systems brought several rounds of winter weather to South Central Texas from February 11 through February 18. The next round of winter weather came February 16 and 17. A surface trough developed along the Texas coast and an upper-level jet streak moved over the top of it. This created warm advection above the boundary layer and another round of freezing rain over the eastern half of the area. The final episode of winter precipitation came February 17 and 18. The main upper trough axis moved across Texas and cooled the deeper atmosphere. The height falls led to upward motion that produced precipitation. A few spots had a mix of wintry precipitation at the start of this episode, but it all

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in the Declaration?	Description
				turned quickly to snow. Estimated 0.40in. of ice accumulation near Long Mountain. No property or crop damages were reported.
January 11, 2022	Winter Weather	N/A	N/A	An upper-level trough moved across Texas producing sufficient lift to generate light precipitation. The vertical temperature profile produced a mixture of rain and sleet over northern parts of South-Central Texas. There was no accumulation or impacts. Light sleet was reported in Llano and the western side of Lake Buchanan. The sleet was melting on contact. No property or crop damages were reported.
January 20, 2022	Winter Weather	N/A	N/A	A strong cold front brought cold air to South Central Texas. This was followed by an upper-level trough that generated light precipitation across the region. Precipitation was a mix of sleet, snow, freezing rain, and rain. There was very little accumulation and no significant impacts. No property or crop damages were reported.
February 2 - 3, 2022	Sleet	N/A	N/A	The combination of an arctic airmass, abundant moisture and an upper-level storm system resulted in a winter storm with widespread snow/sleet/freezing rain across much of west central Texas on February 2nd and 3rd. There was 0.5 inch of sleet reported across San Saba County. No property or crop damages were reported.
February 3, 2022	Winter Storm	N/A	N/A	A strong arctic cold front brought some of the coldest air of the season to South Central Texas. Precipitation in the cold airmass fell as a mixture of sleet and freezing rain. TxDot reported icy bridges in Llano and Kingsland. Sleet accumulated to 0.8 in Llano. No property or crop damages were reported.

Sources: FEMA 2022; NCEI NOAA 2021

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of winter weather events for the County. Information from the NOAA-NCEI storm events database, the 2019 State of Texas HMP, the 2016 Llano County HMP, the San Saba County HMP, and FEMA’s Disaster Declarations for States and Counties were used to identify the number of winter weather events that occurred between 1950 and 2022. Table 4.3.9-4 presents the probability of future events for the winter weather hazard in Llano County. Table 4.3.9-5 presents the probability of future events for the winter weather hazard in San Saba County.

Table 4.3.9-4. Probability of Future Winter Weather Events in Llano County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Blizzard	0	0
Extreme Cold/Wind Chill	1	1.38
Heavy Snow	1	1.38
Ice Storm	0	0
Sleet	0	0
Winter Storm	15	20.83
Winter Weather	8	11.11
Total	25	34.72

Sources: NOAA NCEI 2022; FEMA 2022; State of Texas 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all winter weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

Table 4.3.9-5. Probability of Future Winter Weather Events in San Saba County

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Blizzard	0	0
Extreme Cold/Wind Chill	1	1.38
Heavy Snow	3	4.16
Ice Storm	4	5.55
Sleet	1	1.38
Winter Storm	5	6.97
Winter Weather	9	12.5
Total	23	31.94

Sources: NOAA NCEI 2022; FEMA 2022; State of Texas 2018

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all winter weather events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-4 and Table 4.4-5). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for winter weather in the Planning Area is considered ‘rare’.

Climate Change Projections

Changes in climate can affect how much snow falls and influence the timing of the winter snow season. Changes in the amount of snow covering the ground, and changes in how the snow melts in the spring, will affect the water supplies that people use for things like farming and making electricity (NSIDC 2010). With these projections, the Planning Area might not experience an increase in winter weather events, but the lack of snow could impact the water supply.

According to the National Climate Assessment, rising air and water temperatures and changes in precipitation are intensifying droughts, increasing heavy downpours, reducing snowpack, and causing declines in surface water quality, with varying impacts across regions. Future warming will add to the stress on water supplies and adversely impact the availability of water in parts of the United States (USGCRP 2018).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The entire Planning Area is exposed to the winter weather hazard. The following text evaluates and estimates the potential impact of the winter weather hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

For the purposes of this HMAP, the entire population of the Planning Area (21,243 in Llano County, 5,730 in San Saba County) is exposed to winter weather events. The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

According to the 2020 ACS 5-Year Population Estimate, 37.5-percent of the population in Llano County and 10.3-percent of the population in San Saba County is 65 and over. Winter weather events can reduce the ability of these populations to access emergency services.

Winter weather can immobilize a region and paralyze a city. Additional impacts include stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Accumulations of snow can collapse buildings and knock down trees and power lines. The cost of snow removal, repairing damages, and loss of business can have large economic impacts on cities and towns (NOAA NSSL n.d.).

Impact on General Building Stock

The entire general building stock inventory in the Planning Area is exposed and potentially vulnerable to the winter weather hazard; however, properties in poor condition or in particularly vulnerable locations may be at risk to the most damage. In general, structural impacts include damage to roofs and building frames rather than building content. Current modeling tools are not available to estimate specific losses for this hazard. As an alternate approach, the percent damage to structures that could result from winter weather conditions is considered. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place). Therefore, the table's data should be used as estimates only for planning purposes with the knowledge that the associated losses for winter weather events vary greatly.

Impact on Critical Facilities

Full functionality of critical facilities, such as police, fire, and medical facilities is essential for response during and after a winter weather event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from winter weather events. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles, utility lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice can cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2006). Winter weather events, such as ice storms, can lead to power outages. Therefore, it is recommended that critical facilities install backup power sources.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair might be required.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the Planning Area.

Impact on the Environment

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources (USGS 2020). Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Any areas of growth could be potentially impacted by the winter weather hazard because the entire Planning Area is exposed and vulnerable. The ability of new development to withstand winter weather impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14 and 0.25 percent every five years from 2025 to 2035, followed by a projected growth between 0.68 and 3.3 percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3 percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

With an increase in population, more people will be exposed to winter weather events. Additionally, the age of the population, changes in their geography, and how climate change could alter the winter weather received (rain versus snow) will be important to continue to assess future changes in vulnerability.

Climate Change

Climate is defined not just as average temperature and precipitation, but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can potentially alter prevalence and severity of weather extremes, such as winter storms. While predicting changes in winter weather events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2022). Based on the projections, the Planning Area can expect to experience more rain than snow during the winter months. In the immediate future, the Planning Area can anticipate continuing to experience the impacts of winter weather events.

Change of Vulnerability Since 2016 HMP

The Planning Area's population increased since the last plan; increasing the number of people impacted during a winter weather event. Therefore, the entire Planning Area remains vulnerable to winter weather events. While winter storms are a rare occurrence, they can occur and cause impacts.

Section 4 Risk Assessment

4.3 Hazard Profiles

4.3.10 Wildfire

The following section provides the hazard profile and vulnerability assessment for the wildfire hazard in the Planning Area. When referring to the Planning Area, it includes both Llano County and San Saba County.

Hazard Profile

Hazard Description

Wildfire is defined as a sweeping and destructive burning conflagration and can be further categorized as wildland, wildland urban interface, or intermix fires.

- **Wildland Wildfires** are wildfires encompassing prescribed fire and wildfire. Wildland fires are a natural element of both grassland and forest ecology and historically occurred across the state of Texas (Texas Parks & Wildlife 2022).
- **Wildland Urban Interface (WUI) Wildfires** occur in the transition zone between unoccupied land and human development where structures and other development meets with undeveloped wildland or vegetative fuels (U.S. Fire Administration 2022).
- **Intermix Wildfires** occur in areas where structures are scattered among or mixed with wildland vegetation, without a clearly defined boundary (Law Insider 2022).

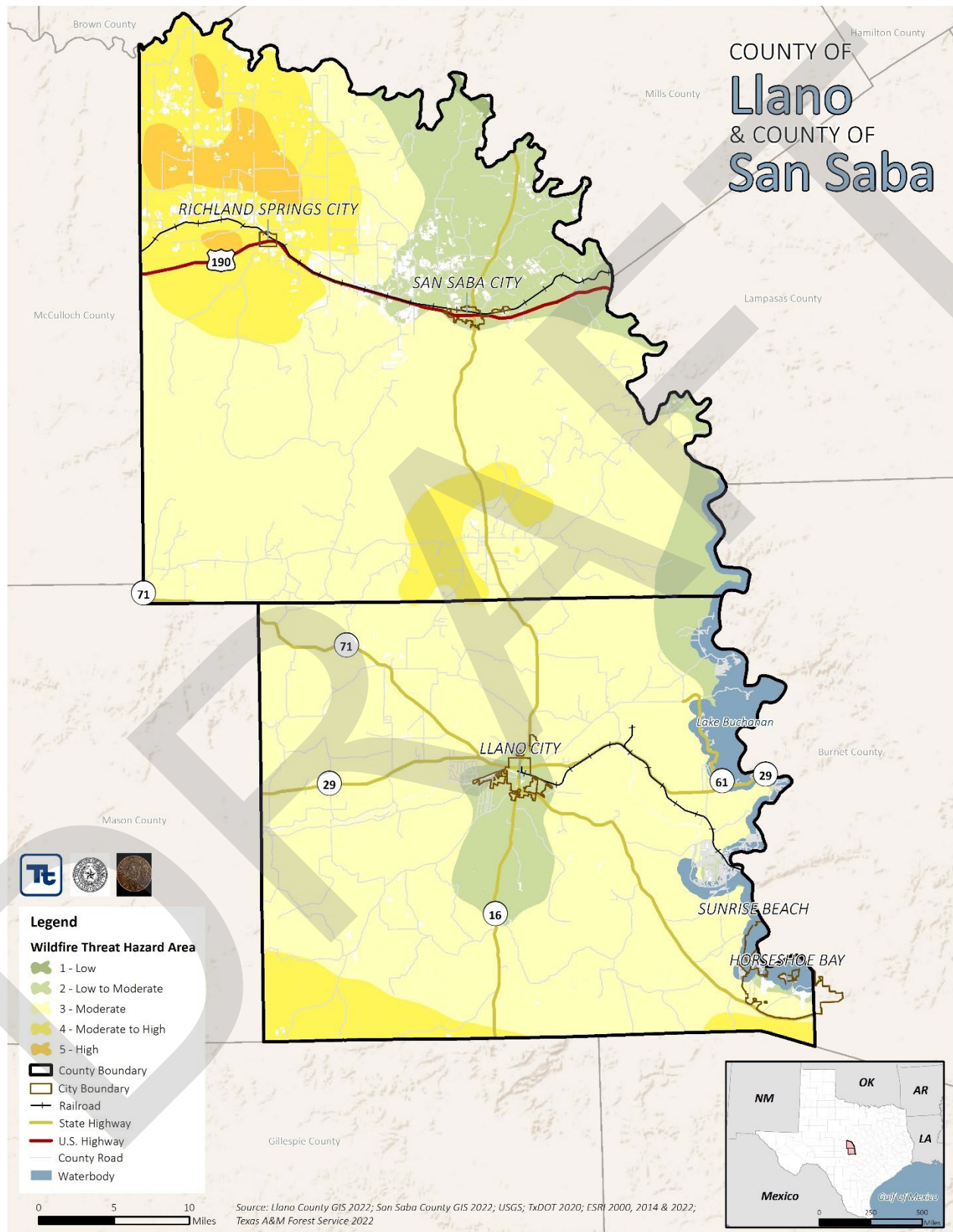
Wildfire probability depends on local weather conditions, topographic factors, and existing “fuels” such as natural vegetation. Outdoor activities such as camping, debris burning, and construction can affect the number and the extent of wildfires. Wildfires can result in widespread damage to property and loss of life. Lightning can cause wildfire events. Drought and extreme heat can also increase the wildfire potential.

Wildland fires are fueled almost exclusively by natural vegetation. Wildland Urban Interface (WUI) fires are fueled by both vegetation and the built environment. When homes are built adjacent to wildland areas, rural wildfires advance through all available fuels, which can include homes and other structures. Another factor that affects wildfire behavior is fuel to wind exposure (State of Texas 2018).

Location

Wildfires are not confined to any specific geographic area and can vary greatly in size, location, intensity and duration, especially during extended and prolonged drought and high wind conditions. Llano and San Saba Counties have the potential for future wildfires due to a combination of population growth, topography, and densely covered Ashe Juniper trees, which contain a highly flammable resin (State of Texas 2018, Lady Bird Johnson Wildflower Center 2011).

Figure 4.3.10-1. Wildfire Threat Hazard Area in the Planning Area



Extent

There appears to be no dominant extent scale for wildfire; however, the Characteristic Fire Intensity Scale is the reported scale on the Texas A&M Forest Service Texas Wildfire Risk Application portal (Texas A&M Forest Service 2022).

Similar to the Richter scale for earthquakes, the Characteristic Fire Intensity Scale (FIS) provides a standard scale to measure potential wildfire intensity. FIS consist of five classes where the order of magnitude between classes is ten-fold. The minimum class, Class 1, represents very low wildfire intensities and the maximum class, Class 5, represents very high wildfire intensities.

Table 4.3.10-1. Characteristic Fire Intensity Scale

FIS Class	Description
CLASS 1 VERY LOW	Very small, discontinuous flames, usually less than one foot in length; very low rate of spread; no spotting. Fires are typically easy to suppress by firefighters with basic training and non-specialized equipment.
CLASS 2 LOW	Small flames, usually less than two feet long; small amount of very short-range spotting possible. Fires are easy to suppress by trained firefighters with protective equipment and specialized tools.
CLASS 3 MODERATE	Flames up to 8 feet in length; short-range spotting is possible. Trained firefighters will these fires difficult to suppress without support from aircraft or engines, but dozer and plows are generally effective. Increasing potential for harm or damage to life and property.
CLASS 4 HIGH	Large flames, up to 30 feet in length; short-range spotting common; medium range spotting possible. Direct attack by trained firefighters, engines, and dozers is generally ineffective, indirect attack may be effective. Significant potential for harm or damage to life and property.
CLASS 5 VERY HIGH	Very large flames up to 150 feet in length; profuse short-range spotting, frequent long-range spotting; strong fire-induced winds. Indirect attack marginally effective at the head of the fire. Great potential for harm or damage to life and property.

Source: Texas A&M Forest Service 2022

Worst-Case Scenario

A worst-case scenario would involve a wildfire during a high wind event, preceded by prolonged elevated temperatures and drought. This type of event would have both short- and long-term effects on the Planning Area. The fire could burn structures and infrastructure creating power and communication outages. Parts of the Planning Area could experience limited ingress and egress as transportation corridors are blocked by fire. Air quality would be affected and could pose serious risks for the elderly and those with compromised respiratory systems.

Previous Occurrences and Losses

The Planning Area is susceptible to regular wildfire events. Most wildfires have occurred in the spring and summer months; however, with intensified drought and extreme heat, fires may occur year-round.

FEMA Disaster Declarations

Between 1954 and 2022, Llano and/or San Saba County were included in five disaster (DR), emergency (EM), or fire management (FM) declarations for wildfire-related events (FEMA 2022). Detailed information about the declared DR and EM disasters since 1954 is provided in Section 3 (County Profile).



Table 4.3.9-1. Winter Weather FEMA Disaster Declarations in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA Declaration Number	Llano and/or San Saba County included in the Declaration?
November 27, 2005 – May 14, 2006	Wildfire	DR-1624-TX	Llano County, San Saba County
March 14 – September 1, 2008	Wildfire	EM-3284-TX	Llano County, San Saba County
April 6, 2011 – August 29, 2011	Wildfire	DR-1999-TX	San Saba County

Source: FEMA 2022

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2017 and 2022, Llano and/or San Saba County were not included in any wildfire-related agricultural disaster declarations.

Previous Events

For this 2023 HMP update, known wildfire events that impacted the Planning Area between 2017 and 2022 are listed in Table 4.3.10-2. For events prior to 2017, refer to Appendix I (Supplementary Data).

Table 4.3.10-2. Wildfire Events in the Planning Area (2017 to 2022)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
July 18-24, 2018	Wildfire	N/A	N/A	The 308 Wildfire burned 1,200 acres in Llano County.
July 23-24, 2019	Wildfire	N/A	N/A	The Cap Fire started one mile west of CR-413 and three miles north of Hwy-16 in Llano County. The fire burned 351 acres before it was contained.
August 13-16, 2020	Wildfire	N/A	N/A	The Trails Wildfire burned 400 acres in Llano County. Fire officials issued a voluntary evacuation notice for part of Horseshoe Bay. One home was destroyed and another badly damaged by the fire. Damages were estimated at \$300,000.
August 2020	Wildfire	N/A	N/A	The Mays Fire, started by an idling vehicle, burned 10,00 acres in San Saba and McCulloch Counties.
May 2022	Wildfire	N/A	N/A	The Sandstone Mountain Fire burned 351 acres southeast of the Town of Llano.
May 2022	Wildfire	N/A	N/A	The Twin Starts Fire burned about 450 acres just off Highway 71 in Llano County.
May 2022	Wildfire	N/A	N/A	The Slab Road Fire burned nearly 60 acres in Llano County.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Llano and/or San Saba County included in Declaration?	Description
May 2022	Wildfires	N/A	N/A	11 additional grass fires broke out along a 20-mile stretch of Highway 71 between Marble Falls and Llano. One structure was threatened, but not damaged.
May 2022	Wildfire	N/A	N/A	The Mayfield Fire burned more than 1,500 acres in rural San Saba County, northeast of Fredonia.

Sources: NOAA NCEI 2022; Ramkissoon 2022; KVUE 2022; Clifton 2022; Gravois 2022; Kirkpatrick 2020

Notes: Events recorded by FEMA, the National Climatic Data Center (NOAA NCEI), and major media coverage are listed in this table. Other smaller wildfire events may have occurred in the Planning Area between 2017-2022.

Probability of Future Occurrences

For the 2023 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of land subsidence events for the County. Information from NOAA-NCEI storm events database, the 2018 State of Texas HMP, the 2016 Llano and San Saba County HMPs, and major media outlets were used to identify the number of wildfire events that occurred between 1950 and 2022. Table 4.3.10-3 presents the probability of future events for the wildfire hazard in Llano and San Saba Counties.

Table 4.3.10-3. Probability of Future Wildfire Events

Hazard Type	Number of Occurrences Between 1950 and 2022	% Chance of Occurring in Any Given Year
Wildfire	138	100%

Sources: NOAA NCEI 2022; State of Texas 2018; Llano County 2016; San Saba County 2016; Ramkissoon 2022; KVUE 2022; Clifton 2022; Gravois 2022; Kirkpatrick 2020

Note: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected events since 1968. Due to limitations in data, not all land subsidence events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for the Planning Area were ranked (Table 4.4-3). The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Team, the probability of occurrence for wildfire events in the Planning Area is considered 'occasional'.

Climate Change Projections

The climate of Texas is changing. Most of the State has warmed between one half and one degree Fahrenheit in the past century. Higher temperatures and drought are likely to increase the severity, frequency, and extent of wildfires, which could harm property, livelihoods, and human health. On average, more than 1-percent of the land in Texas has burned each decade since 1984. Wildfire smoke pollutes the air and can increase medical visits for respiratory and heart problems (EPA 2016). Periods of extreme drought increase the risk of wildfire (Centers for Climate and Energy Solutions n.d.).

Vulnerability Assessment

To understand risk, a community must evaluate assets exposed to and vulnerable to the identified hazard. The locations in the Planning Area that within the moderate to high wildfire threat hazard area are most vulnerable to

the wildfire hazard. The following text evaluates and estimates the potential impact of the wildfire hazard in the Planning Area as a whole.

Impact on Life, Health, and Safety

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. In addition, wildfire may threaten the health and safety of those fighting the fires. First responders are exposed to dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Persons with access and functional needs, the elderly, and very young may be especially vulnerable to a wildfire if there is not adequate warning time before evacuation is needed.

Table 4.3.10-4. Estimated Population Located Within the Wildfire Threat Hazard Areas in Llano County

Llano Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located Within the Wildfire Threat Hazard Areas			
		Number of People in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Number of People in the High Wildfire Threat Hazard Area	Percent of Total
Horseshoe Bay (C)	4,257	3	0.1%	0	0.0%
Sunrise Beach (C)	739	0	0.0%	0	0.0%
Llano (C)	3,325	0	0.0%	0	0.0%
Unincorporated Llano County	12,922	53	0.4%	0	0.0%
Llano County (Total)	21,243	56	0.3%	0	0.0%

Source: Texas A&M Forest Service 2022; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.10-5. Estimated Population Located Within the Wildfire Threat Hazard Areas in San Saba County

San Saba Jurisdiction	Total Population (2020 Decennial Census)	Estimated Population Located Within the Wildfire Threat Hazard Areas			
		Number of People in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Number of People in the High Wildfire Threat Hazard Area	Percent of Total
Richland Springs (T)	244	242	99.3%	0	0.0%
San Saba (C)	3,117	0	0.0%	0	0.0%
Unincorporated San Saba County	2,369	364	15.4%	85	3.6%
San Saba County (Total)	5,730	606	10.6%	85	1.5%

Source: Texas A&M Forest Service 2022; Census 2020

Notes: (C) = City, (T) = Town

Impact on General Building Stock

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. As of 2008, the International Building code requires minimum standards be met for new buildings in fire hazard severity zones. It is unknown how many buildings in the Planning Area were built to these standards. However, there is only a small percentage of buildings in the moderate to high or high wildfire threat hazard area, thus not many are vulnerable to wildfires (Table 4.3.10-6 and Table 4.3.10-7).

Table 4.3.10-6. Estimated Number and Total Replacement Cost Value of Structures Located in the Wildfire Threat Hazard Areas in Llano County

Llano Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Wildfire Threat Hazard Areas							
			Number of Buildings in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Number of Buildings in the High Wildfire Threat Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the High Wildfire Threat Hazard Area	Percent of Total
Horseshoe Bay (C)	2,174	\$921,317,000	2	0.1%	\$795,288	0.1%	0	0.0%	\$0	0.0%
Sunrise Beach (C)	909	\$345,382,000	0	0.0%	\$0	0.0%	0	0.0%	\$0	0.0%
Llano (C)	1,733	\$564,332,000	0	0.0%	\$0	0.0%	0	0.0%	\$0	0.0%
Unincorporated Llano County	8,788	\$2,408,418,000	58	0.7%	\$20,929,465	0.9%	0	0.0%	\$0	0.0%
Llano County (Total)	13,604	\$4,239,449,000	60	0.4%	\$21,724,754	0.5%	0	0.0%	\$0	0.0%

Source: Texas A&M Forest Service 2022; Census 2020

Notes: (C) = City

*Disclaimer: Horseshoe Bay City statistics are based on both Llano County and Burnet County coverage. Results may be over or underestimated.

Table 4.3.10-7. Estimated Number and Total Replacement Cost Value of Structures Located in the Wildfire Threat Hazard Areas in San Saba County

San Saba Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Number and Total Replacement Cost Value of Structures Located in the Wildfire Threat Hazard Areas							
			Number of Buildings in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the Moderate to High Wildfire Threat Hazard Area	Percent of Total	Number of Buildings in the High Wildfire Threat Hazard Area	Percent of Total	Total Replacement Cost Value of Buildings Located in the High Wildfire Threat Hazard Area	Percent of Total
Richland Springs (T)	213	\$66,306,000	212	99.4%	\$66,013,884	99.6%	0	0.0%	\$0	0.0%
San Saba (C)	1,311	\$410,811,000	0	0.0%	\$0	0.0%	0	0.0%	\$0	0.0%
Unincorporated San Saba County	1,819	\$480,386,000	287	15.8%	\$77,590,227	16.2%	67	3.7%	\$16,334,934	3.4%
San Saba County (Total)	3,343	\$957,503,000	499	14.9%	\$143,604,111	15.0%	67	2.0%	\$16,334,934	1.7%

Source: Texas A&M Forest Service 2022; Census 2020

Notes: (C) = City, (T) = Town



Impact on Critical Facilities

Critical facilities not built to fire protection standards, utility poles and lines, and facilities containing hazardous materials are most vulnerable to the wildfire hazard. Most roads and railroads would not sustain damage except in the worst scenarios, although roads and bridges can be blocked by debris or other wildfire-related conditions and become impassable. Table 4.3.10-8 and Table 4.3.10-9 indicate the number of lifeline facilities located in the wildfire threat hazard areas. If a wildfire reached the following critical facilities, their vulnerability could complicate response and recovery efforts during and following an event:

- **Hazardous Materials and Fuel Storage**—During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.
- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the Planning Area.
- **Fire Stations**—If fire stations were compromised during a wildfire event, it would make fire suppression and support services even more challenging.

Table 4.3.10-8. Estimated Number of Lifeline Facilities Located in Wildfire Threat Hazard Areas in Llano County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Moderate to High Wildfire Threat Hazard Area	Number of Lifelines Located in the High Wildfire Threat Hazard Area
Communications	5	0	0
Energy	28	0	0
Food, Water, Shelter	18	0	0
Hazardous Material	7	0	0
Health and Medical	14	0	0
Safety and Security	38	0	0
Transportation	177	6	0
Llano County (Total)	287	6	0

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021; Texas A&M Forest Service 2022

Table 4.3.10-9. Estimated Number of Lifeline Facilities Located in Wildfire Threat Hazard Areas in San Saba County

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the Moderate to High Wildfire Threat Hazard Area	Number of Lifelines Located in the High Wildfire Threat Hazard Area
Communications	2	0	0
Energy	0	0	0
Food, Water, Shelter	2	1	0
Hazardous Material	0	0	0
Health and Medical	0	0	0
Safety and Security	15	4	0
Transportation	111	22	3
San Saba County (Total)	130	27	3

Source: Llano County GIS 2022; Hazus v5.1; Texas A&M 2022; FEMA 2021; Texas A&M Forest Service 2022

Impact on Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business and decrease in tourism. Wildfires can cost thousands of taxpayer dollars to suppress and control and can involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Impact on the Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, affecting the types, structure, and spatial extent of native vegetation. However, it also can cause severe environmental impacts:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Fire can have negative consequences for endangered species.
- **Soil Sterilization**—Some fires burn so hot that they can sterilize the soil. Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost.
- **Reduced Timber Harvesting**—Timber can be destroyed and lead to smaller available timber harvests.
- **Reduced Agricultural Resources**—Wildfire can have disastrous consequences on agricultural resources, removing them from production and necessitating lengthy restoration programs.
- **Damaged Cultural Resources**—Scenic vistas can be damaged, access to recreational areas can be reduced and destruction of cultural resources may occur.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the Planning Area can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. The Planning Area considered the following factors to examine potential conditions that may affect hazard vulnerability:

- Potential or projected development
- Projected changes in population
- Other identified conditions as relevant and appropriate, including the impacts of climate change

Projected Development

Urbanization tends to alter the natural fire regime and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of development toward wildfire hazard areas can be managed with

strong land use and building codes. The International Building Code includes minimum standards related to the design and construction of buildings in fire hazard zones. The Planning Area is well equipped with these tools and this planning process has assessed capabilities with regards to the tools. As the Planning Area experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

Projected Changes in Population

Llano County has experienced an increase in population between the 2010 Census (19,301) and the 2020 Census population of 21,243. The population of the County is expected to increase over the next few years. San Saba County experienced a decrease in population between the 2010 Census (6,131) and the 2020 Census population of 5,730. The Texas Demographic Center has produced population estimates for the region that were last updated in 2018 based on 2010 Census data. The estimates show a slight projected decline for Llano County between 0.14- and 0.25-percent every five years from 2025 to 2035, followed by a projected growth between 0.68- and 3.3-percent every five years from 2035 to 2050. The estimates show projected decline for San Saba County between 1.51 and 4.3-percent every five years from 2025 to 2050 (Texas Demographic Center n.d.).

An increase in population of the Planning Area will expose more people to the wildfire hazard.

Climate Change

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Change of Vulnerability Since 2016 HMP

For this hazard mitigation plan update, the Wildfire Threat Hazard Area from the Texas A&M Forest Service 2022 was referenced to determine areas within the Planning Area that are vulnerable to wildfires. Population statistics have also been updated using the 2020 Census. Overall, this vulnerability assessment uses a more accurate and updated building inventory which provides more accurate estimated exposure and potential losses for the Planning Area.

4.4 Hazard Ranking

A comprehensive range of hazards that pose a significant risk to Llano and San Saba Counties were selected and considered during the development of this plan; see Section 4.2 (Identification of Hazards of Concern). However, each community has differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the Planning Area can be found in their jurisdictional annexes in Volume II, Section 9 (Annexes) of this plan.

To this end, a hazard risk ranking process was conducted for the Planning Area using the method described below. This method includes four risk assessment categories—probability of occurrence, impact (population, property and economy), adaptive capacity, and changing future conditions (i.e., climate change). Each was assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories is described below.

4.4.1 Hazard Ranking Methodology

Estimates of hazard risk for the Counties were developed using methodologies promoted by FEMA’s hazard mitigation planning guidance, generated by FEMA’s Hazus risk assessment tool, and input from Llano and San Saba Counties and participating jurisdictions.

As described in Section 4.1 (Methodology and Tools), three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the Counties will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event.

The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on their potential risk to the Planning Area as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and subject-matter input; assumptions are included, as appropriate, in the following subsections. The limitations of this analysis are recognized given the scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- Probability of Occurrence - The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the Counties.
- Impact—The following three hazard impact subcategories were considered: impact to people; impact to buildings; and impact to the economy. The results of the updated risk assessment and/or professional

judgement were used to assign the numeric values for these three impact subcategories. A factor was applied to each subcategory, giving impact on population the greatest weight.

- Population—Numeric value x 3
- Buildings—Numeric value x 2
- Economy—Numeric value x 1
- **Adaptive Capacity** - Adaptive capacity describes a jurisdiction’s current ability to protect from or withstand a hazard event. This includes capabilities and capacity in the following areas: administrative, technical, planning/regulatory, and financial. Mitigation measures already in place increases a jurisdiction’s capacity to withstand and rebound from events (e.g., codes/ordinances with higher standards to withstand hazards due to design or location; deployable resources; or plans and procedures in place to respond to an event). In other words, assigning ‘weak’ for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas ‘strong’ adaptive capacity means the jurisdiction does have the capability to effectively respond, which decreases vulnerability. These ratings were assigned using the results of the core capability assessment with subject-matter input from each jurisdiction.
- **Climate Change (Changing Future Conditions)** - Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was included. This was important to the Planning Area to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.3.1 through 4.3.10. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Hazard Ranking Equation

$$[\text{Probability of Occurrence} \times 0.3] + [(\text{Impact on Population} \times 3) + (\text{Impact on Property} \times 2) + (\text{Impact on Economy} \times 1) \times 0.3] + [\text{Adaptive Capacity} \times 0.3] + [\text{Climate Change} \times 0.1]$$

Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. Using the weighting applied, the highest possible risk factor value is 6.9. The higher the number, the greater the relative risk. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = Values less than 3.9; Medium = Values between 3.9 and 4.9; High = Values greater than 4.9.

Table 4.4-1. Summary of Hazard Ranking Approach

Category	Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
Probability of Occurrence	Unlikely	A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.	0	30%
	Rare	Between 1 and 10% annual probability of a hazard event occurring.	1	
	Occasional	Between 10 and 100% annual probability of a hazard event occurring.	2	
	Frequent	100% annual probability; a hazard event may occur multiple times per year.	3	

Category		Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
Impact (Sum of all 3)	Population (Numeric Value x 3)	Low	14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	1	30%
		Medium	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	2	
		High	30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	3	
	Property (Numeric Value x 2)	Low	Property exposure is 14% or less of the total number of structures for your community.	1	
		Medium	Property exposure is 15% to 29% of the total number of structures for your community.	2	
		High	Property exposure is 30% or more of the total number of structures for your community.	3	
	Economy (Numeric Value x 1)	Low	Loss estimate is 9% or less of the total replacement cost for your community.	1	
		Medium	Loss estimate is 10% to 19% of the total replacement cost for your community.	2	
		High	Loss estimate is 20% or more of the total replacement cost for your community.	3	
Adaptive Capacity		Weak	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.	1	30%
		Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/Jurisdiction capabilities.	0	
		Strong	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high.	-1	
Climate Change		Low	No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).	1	10%
		Medium	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).	2	
		High	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).	3	

Note: A numerical value of zero is assigned if there is no impact.

*For the purposes of this exercise, “impacted” means exposed for population and property and estimated loss for economy. For non-natural hazards, although they may occur anywhere in the Planning Area, an event will not likely cause countywide impacts; therefore, impact to population was scored using an event-specific scenario.

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.

- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

4.4.2 Hazard Ranking Results

Using the process described above, the ranking for the identified hazards of concern was determined for Planning Area (refer to Table 4.4-2 and Table 4.4-3). The hazard ranking is detailed in the subsequent tables that present the stepwise process for the ranking. The ranking includes the entire planning area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the Counties and the participating jurisdictions have applied the same methodology to develop the countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: 1) to describe the probability of occurrence for each hazard; 2) to describe the impact each would have on the people, property, and economy; 3) to evaluate the capabilities a community has with regards to the hazards of concern; and 4) to consider changing future conditions (i.e., climate change) in Llano and San Saba Counties.



Table 4.4-2. Ranking for Hazards of Concern for Llano County

Hazard of Concern	Probability		Impact	Population		Impact	Impact		Impact	Economy		Total Impact Value	Adaptive Capacity	Climate Change
	Category	Numeric Value		Numeric Value	Weighted Value (x3)		Property Numeric Value	Weighted Value (x2)		Numeric Value	Weighted Value (x1)			
Dam Failure	Rare	1	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	Moderate	Medium
Drought	Occasional	2	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	High
Extreme Temperature	Frequent	3	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	High
Flood	Frequent	3	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	10	Moderate	High
Geological Hazards	Rare	1	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	Moderate	Medium
Hurricane/Tropical Storm	Occasional	2	Medium	2	2 x 3 = 6	Medium	2	2 x 2 = 4	Low	1	1 x 1 = 1	11	Moderate	High
Pandemic	Occasional	2	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	Medium
Severe Weather	Frequent	3	High	3	3 x 3 = 9	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	15	Moderate	High
Tornado	Occasional	2	High	3	3 x 3 = 9	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	15	Moderate	Medium
Wildfire	Occasional	2	Medium	2	2 x 3 = 6	High	3	3 x 2 = 6	Medium	2	2 x 1 = 2	14	Moderate	High
Winter Storm	Rare	1	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	Moderate	Medium

Table 4.4-3. Ranking for Hazards of Concern for San Saba County

Hazard of Concern	Probability		Impact	Population		Impact	Impact		Impact	Economy		Total Impact Value	Adaptive Capacity	Climate Change
	Category	Numeric Value		Numeric Value	Weighted Value (x3)		Property Numeric Value	Weighted Value (x2)		Numeric Value	Weighted Value (x1)			
Dam Failure	Rare	1	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	Moderate	Medium
Drought	Occasional	2	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	High
Extreme Temperature	Frequent	3	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	High
Flood	Frequent	3	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	Moderate	High
Geological Hazards	Unlikely	1	Low	1	1 x 3 = 3	Medium	2	2 x 2 = 4	High	3	3 x 1 = 3	10	Moderate	Medium
Hurricane/Tropical Storm	Occasional	2	Medium	2	2 x 3 = 6	Medium	2	2 x 2 = 4	Low	1	1 x 1 = 1	11	Moderate	High
Pandemic	Occasional	2	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	Moderate	Medium
Severe Weather	Frequent	3	High	3	3 x 3 = 9	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	15	Moderate	High
Tornado	Occasional	2	High	3	3 x 3 = 9	Medium	2	2 x 2 = 4	Medium	2	2 x 1 = 2	15	Moderate	Medium
Wildfire	Occasional	2	Medium	2	2 x 3 = 6	High	3	3 x 2 = 6	Medium	2	2 x 1 = 2	14	Moderate	High
Winter Storm	Rare	1	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	Moderate	Medium

Table 4.4-4 and Table 4.4-5 presents the total calculations for each hazard ranking value for the hazards of concern in Llano and San Saba Counties, respectively.

Table 4.4-4. Total Hazard Ranking Values for the Hazards of Concern for Llano County

Hazard of Concern	Probability x 30%	Total Impact x 30%	Adaptive Capacity x 30%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Dam Failure	0.3	1.8	0	0.2	2.3
Drought	0.6	3.6	0	0.3	4.5
Extreme Temperature	0.9	3.6	0	0.3	4.8
Flood	0.9	2.7	0	0.3	4.2
Geological Hazards	0.3	3	0	0.2	2.3
Hurricane/Tropical Storm	0.6	3.3	0	0.3	4.2
Pandemic	0.6	3.6	0	0.2	4.4
Severe Weather	0.9	4.5	0	0.3	5.7
Tornado	0.6	4.5	0	0.2	5.3
Wildfire	0.6	4.2	0	0.3	5.1
Winter Storm	0.3	2.7	0	0.2	3.2

Low = Values less than 3.9; **Medium** = Values between 3.9 and 4.9; **High** = Values greater than 4.9

Table 4.4-5. Total Hazard Ranking Values for the Hazards of Concern for San Saba County

Hazard of Concern	Probability x 30%	Total Impact x 30%	Adaptive Capacity x 30%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Dam Failure	0.3	1.8	0	0.2	2.3
Drought	0.6	3.6	0	0.3	4.5
Extreme Temperature	0.9	3.6	0	0.3	4.8
Flood	0.9	2.7	0	0.3	3.9
Geological Hazards	0.3	3	0	0.2	2.3
Hurricane/Tropical Storm	0.6	3.3	0	0.3	4.2
Pandemic	0.6	3.6	0	0.2	4.4
Severe Weather	0.9	4.5	0	0.3	5.7
Tornado	0.6	4.5	0	0.2	5.3
Wildfire	0.6	4.2	0	0.3	5.1
Winter Storm	0.3	2.7	0	0.2	3.2

Low = Values less than 3.9; **Medium** = Values between 3.9 and 4.9; **High** = Values greater than 4.9

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 (Annexes) of this plan. The summary rankings for the Counties reflect the results of the vulnerability analysis for each hazard of concern and vary from the specific results of each jurisdiction. For example, the severe storm hazard may be ranked low in one jurisdiction, but due to the exposure and impact the to the Planning Area, it is ranked as a high hazard and is addressed in the Planning Area's mitigation strategy accordingly. Jurisdictional ranking results are presented in each local annex in Section 9 (Annexes) of this plan.

Section 5 Capability Assessment

According to FEMA’s Mitigation Planning How-To Guide #3, a capability assessment is an inventory of a community’s missions, programs, and policies and an analysis of its capacity to carry them out. Each jurisdiction has a unique set of capabilities available to accomplish mitigation and reduce long-term vulnerable to future hazard events. Capabilities include authorities, policies, programs, staff, and funding. Reviewing existing capabilities helps identify capabilities that currently implement mitigation and leads to loss reductions or that have the potential to be implemented in the future.

This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current federal, state, and local programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the original planning process, Llano County, San Saba County, and all jurisdictions identified and assessed their capabilities in the areas of planning and regulatory, administrative, and technical, and fiscal. By completing this assessment, the Planning Committee and each jurisdiction learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that could exist on undertaking actions.
- The range of local and state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions.
- Actions deemed infeasible, as they are currently outside the scope of capabilities.
- Types of mitigation actions that could be technically, legally (regulatory), administratively, politically, or fiscally challenging or infeasible.
- Opportunities to enhance local capabilities to support long term mitigation and risk reduction.

During the 2022 plan update process, all participating jurisdictions were tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

County and municipal capabilities in the areas of planning and regulatory, administrative, and technical, and fiscal may be found in the Capability Assessment section of their jurisdictional annexes in Section 9 (Jurisdictional Annexes).

5.1 Update Process Summary

The purpose of the capability assessment is to understand the planning, regulatory, administrative, technical, and financial capabilities present in Llano and San Saba Counties. This assessment helps Llano County, San Saba County, and their jurisdictions identify strengths and opportunities that can be used to reduce losses from hazard events and reduce risks throughout Llano County and San Saba County.

To complete the capability assessment, the contracted consultant met with both counties and each jurisdiction virtually to review the capability assessment from the 2016 HMP and update accordingly. In addition to virtual

meetings, the consultant reviewed plans and codes/ordinances to enhance the information provided by the jurisdictions.

A summary of the various federal and state capabilities available to promote and support mitigation and reduce risk in Llano County and San Saba County are presented below. Information provided by the Counties and municipalities are presented in Volume II, Section 9 (Jurisdictional Annexes) of this plan update.

5.2 Planning and Regulatory Capability

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws, and state statutes, and plans and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to the current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. The following provides the planning and regulatory capabilities for Llano and San Saba Counties.

5.2.1 Planning and Regulatory Capabilities – Local

The following tables summarize the planning and regulatory capabilities available to Llano County (Table 5-1) and San Saba (Table 5-2) County, at the local level.

Table 5-1. Planning and Regulatory Capabilities – Llano County

Capability	Details	
Building Code	Description:	Town and City Halls in Llano County, Texas provide municipal services for their community, including issuing and enforcing building codes. The Town or City Hall is responsible for ensuring compliance with building codes and investigating possible Llano County building code violations. They keep records on building codes as well as any changes to the building code, and they may also review and approve building and renovation plans. The Town or City Hall typically has records on approved and rejected plans, investigations of Llano County building code violations, and any punishments or abatement plans for code violations. These records can be useful for prospective Llano County property buyers and property owners, and they are typically available through the Town or City Hall websites.
	Responsible Agency:	Texas Department of Insurance
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Llano County Subdivision Regulations - Rules, Regulations and Requirements relating to the approval and acceptance of Improvements in Subdivisions or Re-Subdivisions – 11/23/2020	Description:	An adequate drainage plan shall be designed and prepared by a professional engineer registered in the State of Texas, including the design of drainage facilities, culverts, and/or systems using a minimum ten (10) year storm frequency (unless otherwise directed by the Llano County Commissioner's Court), such that the drainage out of the subdivision does not have a negative drainage impact on neighboring properties. The placement of any structure within the regulatory floodplain shall be in accordance with the Llano County Flood Damage Prevention Order. The following requirements shall apply: (1) Each plat shall include base flood elevation data. (2) All subdivision proposals shall have adequate drainage provided to reduce- exposure to flood hazards. (3) All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical and water systems located and constructed to minimize or eliminate flood damage. (4) All subdivision plats shall have the flood hazard area as indicated on the respective flood insurance rate map(s) clearly delineated on the plat and where appropriate, each lot shall be shaped and sized to provide adequate building space. (5) The developer, builder, seller, or agent shall inform in writing, each prospective buyer of subdivision lots located in flood hazard areas that such property is in an identified flood hazard area and that a Floodplain Development Permit will be required before a structure can be placed on the property. The Llano County Flood Damage Prevention Order can be found in the Development Services Department or at www.co.llano.tx.us for further rules and requirements.
	Responsible Agency:	Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Real Estate Disclosure - Texas Property Code Section § 5.008 - Seller's Disclosure of Property Condition	Description:	Real Estate Disclosure ensures that property owners are aware of historical disaster impacts and gives them information necessary to plan for and mitigate future disasters
	Responsible Agency:	Texas Real Estate Commission
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Llano County Flood Damage Prevention Order – 1/29/2021	Description:	(1) It restricts or prohibits uses that are dangerous to health, safety, or property in times of flood, or cause excessive increases in flood heights or velocities, (2) It requires that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction, and (3) It controls the alteration of natural floodplains, stream channels, water courses, and natural protective barriers, which are involved in the accommodation of flood waters.
	Responsible Agency:	The Llano County Department of Environmental and Emergency Services Administrator is hereby appointed the Floodplain Administrator (FPA) to administer and implement the provisions of this order.



Capability	Details	
Emergency Management - Texas Government Code Chapter 418	Provides Funding for Mitigation:	No
	Hazard:	Flood
	Description:	Emergency Management requirements provide for the planning, mitigation, preparedness, response, and recovery activities necessary for a high impact coastal community.
	Responsible Agency:	Texas Division of Emergency Management
	Provides Funding for Mitigation:	No
The Economic Impact of the Upper Highland Lakes of the Colorado River – Fall 2012	Hazard:	All hazards
	Description:	The economic impact study includes an analysis of demographic, economic, infrastructure and public policy related to the upper Highland Lakes of the Colorado River. It also incorporates public input from a range of stakeholders including residents, landowners, land developers, and elected officials. For Burnet and Llano Counties, lake fluctuations, especially long-term droughts, have tremendous negative consequences for the region. Following the floods of 1900 and 1915 that washed away the first Austin dam and created a floodway one mile wide in Austin, the Texas Legislature created the Lower Colorado River Authority (LCRA) under the Texas Constitution provision Article 16, Section 59. The LCRA was created as a permanent body to effectively manage the Colorado River in Central Texas. It began its operations in 1935, following another flood that washed out the second Austin dam.
	Responsible Agency:	Burnet and Llano Counties formed a partnership to study the economic implications of the Upper Highland Lakes on the two-county region.
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Drought
Llano County Broadband Study - 2022	Description:	In 2020 and 2021, Llano County governments, residents, and businesses experienced significant broadband communications challenges with the closures of businesses, schools, and government offices due to both COVID-19 and adverse weather conditions. Along with others, the Llano County Commissioners, recognize the critical need for reliable communications to better prepare for future emergencies in and around Llano County. A more vibrant network needs to not only be developed to assist local, state, and federal officials communicate under extreme emergency conditions, but to assist with future and increasing economic development and education needs.
	Responsible Agency:	Llano County Commissioners
	Provides Funding for Mitigation:	No
	Hazard:	All
Llano County Transportation and Economic Development Plan – 12/14/2015	Description:	Periodic flooding occurs throughout the County along creeks, reducing roadway connectivity and creating safety hazards. The Federal Emergency Management Agency (FEMA) has identified areas of potential flood hazards. In consultation with the public, TxDOT, and local staff, the Llano County Transportation and Economic Development Plan consider several opportunities to improve existing low-water crossings. Future consideration may be made for low water crossings located on CR 2768 in Castell, CR 103 East of Castell, and CR 102 East of CR 103.
	Responsible Agency:	Llano County, TxDOT, and CAPCOG
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Upper Llano River Watershed Protection Plan – May 2016	Description:	The Coordinating Committee selected a collection of management measures and goals to address sources of concern in a holistic manner to improve both the quality and quantity of flows in the watershed. These measures are directed primarily at improved grazing, wildlife, septic systems and, invasive species management as well as implementation of sound upland and riparian management measures and other water quality protection measures. It is the goal of the Upper Llano WPP to ensure



Capability	Details	
		that the long-term integrity and sustainability of the watershed, springs and rivers are preserved, and that water quality standards and flows are maintained for present and future generations.
	Responsible Agency:	Llano County Watershed Coordination Committee
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Drought, Invasive Species
Llano County Emergency Operations Plan	Description:	Llano County utilizes a basic emergency operations plan that provides guidance to the community in the event of a hazard.
	Responsible Agency:	Llano County Office of Emergency Management.
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Disaster Recovery Plan – 11/16/2020	Description:	It is the policy of the Llano Central Appraisal District to minimize the effects of disasters or emergencies of any kind to property owners and employees while diligently restoring all services in the shortest amount of time.
	Responsible Agency:	The Chief Appraiser is the designated Emergency Coordinator for the District and is responsible to assure the duties outlined in this document are performed for their respective areas. He will stay in constant communication with the Llano County Judge, Llano City Mayor and/or City Manager and the Emergency Disaster Coordinator of Llano County to identify and implement mitigation measures to reduce damage and risk to human lives to protect the health, safety, and welfare of its residents.
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Texas Agri-Life Extension Service	Description:	Agricultural planning reduces the risk to the animals and community during times of disaster.
	Responsible Agency:	Llano and San Saba County Agricultural Extension
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Hurricane, Severe Winter Storm

Table 5-2. Planning and Regulatory Capabilities – San Saba County

Capability	Details	
Building Code	Description:	The County is governed by the Texas Administrative Code § 5.4008, the 2018 International Building Code (IBC), the 2018 International Residential Code (IRC), and NFPA. By using the IRC, IBC, and NFPA the highest standards are assured for County construction to reduce the risk of hazards and protect both lives and property.
	Responsible Agency:	Texas Department of Insurance
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Subdivision Ordinance – San Saba County Subdivision Regulations. Approved 12/13/2021, and as Amended Through 3/12/2022	Description:	San Saba County has established subdivision standards and specifications for construction of roads and drainage, private sewage facilities and development within the floodplain. Where the subdivision is traversed by a water course, drainage way, channel or stream, there shall be provided a stormwater drainage easement or drainage right- of-way conforming substantially with the lines for such water course and of sufficient width to convey all storm and flood water flowing through as may be determined by the Commissioners Court through its authorized representative, to accommodate further width or construction and allow access for maintenance.
	Responsible Agency:	San Saba County Commissioners Court
	Provides Funding for Mitigation:	No
	Hazard:	Flood



Capability	Details	
Real Estate Disclosure - Texas Property Code Section § 5.008 - Seller's Disclosure of Property Condition	Description:	Real Estate Disclosure ensures that property owners are aware of historical disaster impacts and gives them information necessary to plan for and mitigate future disasters
	Responsible Agency:	Texas Real Estate Commission
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Flood Damage Prevention – San Saba Floodplain Regulations – 10/26/2015	Description:	Floodplain regulations reduce risk to lives and property by ensuring mitigation measures are put into place for repetitive loss properties and new construction. A floodplain development permit has been established for all construction and other development to be undertaken in areas of special flood hazard in this community for the purpose of protecting its citizens from increased flood hazards and ensuring that new development is constructed in a manner that minimizes its exposure to flooding.
	Responsible Agency:	Emergency Management Coordinator
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Emergency Management - Texas Government Code Chapter 418	Description:	Emergency Management requirements provide for the planning, mitigation, preparedness, response, and recovery activities necessary for a high impact coastal community.
	Responsible Agency:	Texas Division of Emergency Management
	Provides Funding for Mitigation:	No
	Hazard:	All hazards
Texas Agri-Life Extension Service	Description:	Agricultural planning reduces the risk to the animals and community during times of disaster.
	Responsible Agency:	Llano and San Saba County Agricultural Extension
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Hurricane, Severe Winter Storm
San Saba County Emergency Operations Plan	Description:	San Saba County utilizes a basic emergency operations plan that provides guidance to the community in the event of a hazard.
	Responsible Agency:	San Saba County Office of Emergency Management.
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards

5.2.2 Planning and Regulatory Capabilities – Federal and State

Table 5-3 summarizes the Federal and State level planning and regulatory capabilities available to Llano and San Saba Counties.

Table 5-3. Planning and Regulatory Capabilities – Federal and State

Capability	Details	
Disaster Mitigation Act (DMA)	Description:	The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	HMPs designed to meet the requirements of DMA will remain eligible for future FEMA Hazard Mitigation Assistance funds
	Hazard:	All-natural hazards

Capability	Details	
National Flood Insurance Program (NFIP)	Description:	The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. The Flood Hazard Profile in Section 4.3.6 (Flood) provides information on recent legislation related to reforms to the NFIP. Just 2 jurisdictions in Llano County and 1 jurisdiction in San Saba County actively participate in the NFIP. As of December 2022, there were 557 policies in Llano and San Saba Counties. There have been 486 claims made, totaling over \$13,161,399 for damages to structures and contents.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.
	Hazard:	Flood
NFIP Community Rating System (CRS)	Description:	As an additional component of the NFIP, CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses, (2) facilitate accurate insurance rating, and (3) promote the awareness of flood insurance. Llano and San Saba County could expect significant cost savings on premiums if enrolled in the CRS program. As of April 2022, no communities in Llano and San Saba Counties participate in the CRS program. Communities in both Counties have noted they are exploring the possibility of participating in the program in the future.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities.
	Hazard:	Flood
Local Government Code Title 7. Regulation Of Land Use, Structures, Businesses, and Related Activities Subtitle A. Municipal Regulatory Authority Chapter 211. Municipal Zoning Authority Subchapter A. General Zoning Regulations	Description:	The powers granted under this subchapter are for the purpose of promoting the public health, safety, morals, or general welfare and protecting and preserving places and areas of historical, cultural, or architectural importance and significance. The governing body of a municipality may regulate the size of buildings and other structures, lot coverage, size of open spaces, population density, the location and use of buildings and groundwater use. Zoning regulations must be adopted in accordance with a comprehensive plan and must be designed to: (1) lessen congestion in the streets. (2) secure safety from fire, panic, and other dangers. (3) promote health and the general welfare. (4) provide adequate light and air. (5) prevent the overcrowding of land. (6) avoid undue concentration of population; or (7) facilitate the adequate provision of transportation, water, sewers, schools, parks, and other public requirements. The governing body of a municipality may divide the municipality into districts of a number, shape, and size the governing body considers best for carrying out this subchapter. Within each district, the governing body may regulate the erection, construction, reconstruction, alteration, repair, or use of buildings, other structures, or land. Zoning regulations must be uniform for each class or kind of building in a district, but the regulations may vary from district to district. The regulations shall be adopted with reasonable consideration, among other things, for the character of each district and its peculiar suitability for uses, with a view of conserving the value of buildings and encouraging the most appropriate use of land in the municipality.
	Responsible Agency:	State of Texas

Capability	Details	
Texas Silver Jackets	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
	Description:	Silver Jackets is a program under National Flood Risk Management Program to support agency collaboration and coordination with interagency, state-led flood risk and multiple hazard management teams. Provides resources and develops tools to support information sharing and networking and promotes implementation of flood risk management efforts that improve flood risk awareness and result in actions to reduce risk. For more information: http://silverjackets.nfrmp.us/
	Responsible Agency:	US Army Corp of Engineers
	Provides Funding for Mitigation:	No
Texas General Land Office	Hazard:	Flood
	Description:	The Texas General Land Office (GLO), through the Community Development and Revitalization division, works to rebuild Texas communities by putting Texans back in their homes, restoring critical infrastructure and mitigating future damage through resilient community planning. The GLO is setting a record pace administering both Community Development Block Grant Disaster Recovery (CDBG-DR) and Mitigation (CDBG-MIT) funds from the U.S. Department of Housing and Urban Development (HUD) on behalf of the state of Texas. More than \$14 billion have been allocated for recovery and mitigation following Hurricanes Rita, Dolly, and Ike, the 2011 wildfires, the 2015 and 2016 floods, Hurricane Harvey, the 2018 South Texas floods, and the 2019 disasters. These grants can be used for a wide variety of activities including housing redevelopment, infrastructure repair and long-term planning, depending on HUD guidance.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane, Wildfire
Coastal Erosion Planning and Response Act (CEPRA)	Description:	The average erosion rate for the 367 miles of Texas coast is 4.1 feet per year. Sixty-four percent of the Texas coast is eroding at an average rate of about 6 feet per year, with some locations losing more than 30 feet per year. FEMA estimates that every dollar spent on erosion control and mitigation to preserve wetlands and other natural ecosystems, will provide a return on average of \$4 in future cost-savings. Since 2000, the GLO's Coastal Erosion Planning and Response Program has received \$111.4 million in state-appropriated funding. Project partners (local governments, non-profits, state, and federal entities) have contributed \$52 million in non-federal matching funds and in-kind contributions, along with \$165.2 million in federal funds and in-kind contributions that have resulted in more than 355 coastal erosion response projects.
	Responsible Agency:	General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane, Land Subsidence
	Description:	Texas receives approximately \$2 million annually in grants from National Oceanic and Atmospheric Administration (NOAA) and 90% of the funds are passed through to local governments and entities to address environmental needs and promote sustainable economic development along the coast. Projects must improve the management of the state's coastal resources and ensure long-term ecological and economic productivity. Section 306 administrative funds can be used for non-construction, coastal planning and education, and research. Section 306A improvement funds can be utilized for construction and land acquisition projects and preservation and restoration. CMP funding categories include Coastal Natural Hazards Response, Critical Areas Enhancement, Public Access, Water/Sediment Quantity and Quality Improvements, Waterfront Revitalization and Ecotourism Development, Permit Streamlining/Assistance, Governmental Coordination and Local Government Planning Assistance.
	Responsible Agency:	Texas General Land Office
Coastal Management Program (CMP)	Provides Funding for Mitigation:	Yes



Capability	Details	
Gulf of Mexico Energy Security Act (GOMESA)	Hazard:	Flood, Hurricane
	Description:	GOMESA significantly enhances oil and gas leasing activities and creates revenue sharing provisions for the oil- and gas-producing states of Alabama, Louisiana, Mississippi, and Texas, and their coastal political subdivisions (CPSs). GOMESA funds are used for coastal conservation, restoration, and hurricane protection. The second phase of GOMESA revenue sharing began in Fiscal Year 2017 and expands the definition of qualified Outer Continental Shelf revenues to include receipts from Gulf of Mexico leases subject to withdrawal or moratoria restrictions. A revenue-sharing cap of \$500 million per year for the four Gulf producing states, their CPSs and the Land and Water Conservation Fund applies from fiscal years 2016 through 2055. The \$500 million cap does not apply to qualified revenues generated in those areas associated with Phase I of the GOMESA program. From 2009 through 2016, the state of Texas received \$3,192,269 and its 18 CPSs received \$798,036. The goal of GOMESA funding is to conserve, restore, enhance, and protect the diversity, quality, quantity, functions, and values of the state's coastal natural resources. A primary focus for the GLO will be to protect coastal natural resources while facilitating multiple human uses of coastal resources. The GLO's priority for the expenditures of GOMESA funds include: (1) Restoring and enhancing coastal natural resources, (2) Providing hurricane protection for coastal public resources, (3) Improving water quality, (4) Enhancing the balance between the protection of coastal natural resources and public use of those resources. (5) Improving environmental management, and (6) Mitigating coastal erosion and stabilizing shorelines.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
U.S. Army Corps of Engineers – Dam Safety Program	Hazard:	Flood, Hurricane, Manmade Disasters
	Description:	The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 1997).
	Responsible Agency:	USACE
	Provides Funding for Mitigation:	Yes
Natural Resources Damage Assessment (NRDA)	Hazard:	Flood
	Description:	The natural resource trustees are the designated federal, state, and tribal agencies who are responsible for the natural resources impacted by an oil spill or hazardous substance release. They have common interests in sharing information, ideas, and expertise necessary to compensate the public for harm to natural resources because of oil spills and hazardous substance releases.
	Responsible Agency:	Texas Commission on Environmental Quality
	Provides Funding for Mitigation:	Yes
Coastal and Estuarine Land Conservation Program (CELCP)	Hazard:	Manmade Disasters
	Description:	Lands being targeted for protection through TCELCP include coastal and estuarine areas with significant ecologic, conservation, recreation, historic, and aesthetic values. Many of these lands are threatened by conversion from their natural state to other uses. This section describes the geographic extent of the TCELCP boundary, outlines the types of lands and values to be protected, and gives an assessment of their status and trends (when known), functions and values, and potential threats.



Capability	Details	
		When NOAA provides funding for CELCP, the GLO provides coastal communities an opportunity to apply for up to three projects per year, with federal grants for any single project not to exceed \$3 million.
	Responsible Agency:	NOAA, Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Hurricane
Texas Division of Emergency Management	Description:	TDEM is charged with carrying out a comprehensive, all-hazard emergency management program for the state and assisting cities, counties, and state agencies in implementing their own emergency management programs.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Community Health and Resource Management (CHARM)	Description:	CHARM is directed by the Texas Coastal Watershed Program, a part of Texas A&M AgriLife Extension Service. It is a mapping application that gives local officials, stakeholders, and citizens the power to analyze growth with real-time feedback. Using the weTable tool that transforms an ordinary tabletop into an interactive computer interface, CHARM allows participants to engage the public and gather their input regarding the community's future. The mapping application is supported by a library of data about urbanization, storm surge, conservation, public facilities, and coastal resources. The CHARM application can leverage local knowledge for better long-term planning, and is an ideal tool for communities, watersheds, and environmental projects.
	Responsible Agency:	Texas A&M AgriLife Extension Service.
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Home Program	Description:	The Texas Department of Housing and Community Affairs (TDHCA) administers the HOME Program on behalf of the state. The purpose of the program is to expand the supply of decent, safe, affordable housing and strengthen public-private housing partnerships between units of local governments, public housing authorities, nonprofits, and for-profit entities. TDHCA has set aside funding for Disaster Relief and Persons with Disabilities, among others.
	Responsible Agency:	TDHCA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Texas Water Development Board (TWDB) – Flood Insurance Program	Description:	TWDB is the state agency charged with collecting and disseminating water-related data, assisting with regional planning, preparing the State Water Plan, which addresses the development of the state's water resources. The agency also administers cost-effective financial assistance programs for the construction of water supply, wastewater treatment, flood control and agricultural water conservation projects. The TWDB has made great strides in floodplain management since the last update to the 2013 SHMP. Examples include hiring full time staff to manage the State's Cooperating Technical Partner floodplain mapping program, developing a State Flood Plan (see below for information on both), and creating a website to assist citizens and first responders during a flood event (www.TexasFloods.org). The following is a list of programs available which may assist with flooding and the mitigation of Repetitive and Severe Repetitive Loss properties. TWDB's National Flood Insurance Program group conducts Community Assistance Visits (CAV), Community Assistance Contacts (CAC), and floodplain management training to assist communities with maintaining NFIP compliance and sound floodplain management practices. The CAV is a scheduled visit to an NFIP community for the purpose of conducting a comprehensive assessment of the community's floodplain management program and evaluating its knowledge and understanding of the requirements of the NFIP. The purpose of the CAV is also to assist the community in understanding NFIP requirements when program deficiencies are discovered.

Capability	Details	
		Floodplain Management 101 workshops are offered to local officials and other interested parties which cover the NFIP and various flood loss reduction techniques and strategies, such as the Community Rating System (CRS). The workshops contain training modules on the Texas Water Code, Elevation Certificates, FEMA requirements, community awareness, map reading, permitting, and ordinance comprehension.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Cooperation Technical Partners (CTP)	Description:	TWDB also administers the FEMA Cooperating Technical Partners (CTP) Program, which allows communities, tribal nations, universities, and regional and state agencies to be active partners in FEMA's flood hazard mapping program. The CTP program at the state level aims to produce flood risk information through leveraging state and local funds, updated flood risk products, and coordination between statewide cooperating technical partners.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Fund Development Program	Description:	TWDB also administers the Fund Development Program to provide loans for the planning, design, and construction of water supply, wastewater, and flood control projects. Structural flood protection improvements may include construction of storm water retention basins, the enlargement of stream channels public beach re-nourishment, the control of coastal erosion, and the modification or reconstruction of bridges. Non-structural flood protection improvements may include the acquisition of floodplain properties for use as public open space, the acquisition and removal of buildings and residents located within a floodplain, flood warning systems, and the development of floodplain management plans. The agency conducts an environmental review for all construction projects.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Texas Natural Resources Information System (TNRIS)	Description:	The Texas Natural Resources Information System (TNRIS) is a division of TWDB, and is responsible for producing, archiving, and distributing geographic data to agencies, businesses, and the public. TNRIS supports hazard mitigation planning and implementation in three ways: (1) Provides data to organizations for planning or response activities. (2) Develops, locates, and prepares data for specific needs and/or projects. (3) Updates the State Critical Facility Database.
	Responsible Agency:	TWDB
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Texas Flash Flood Coalition	Description:	The TFFC is an organization dedicated to decreasing the number of deaths caused by flash flooding in Texas. More than 30 representatives of higher education, media, private industry, local, state, and federal governments participate in the coalition. Its strategy is to: (1) Brainstorm and share ideas, data, resources, and best practices (2) Include a diversity of folks from all levels of education, the public, private entities, and academia (3) • Attack the flash flood problem with mitigation, research, technology, education, awareness, warning, and communication
	Responsible Agency:	Works with the Texas Floodplain Management Association
	Provides Funding for Mitigation:	No
	Hazard:	Flood, Flash Flood

Capability	Details	
Community Hazard Analysis and Mitigation Planning Support (CHAMPS)	Description:	The CHAMPS reports are summarized descriptions of historical hazard events and future hazard risks for each county in Texas. These have been developed by the Texas Geographic Society in a project funded by FEMA and administered by TDEM. CHAMPS reports have been developed to provide local mitigation planners with data, maps, and other information they can use to support the hazard assessment portion of the mitigation planning process. Each report includes information on county populations and built environments, historical losses from multiple hazards, and expected future likelihood of more hazard events. Also included with every hazard is a comparative display showing how the number of hazard events in that county compares with the number of events in other counties for that hazard over the same timeframe.
	Responsible Agency:	Texas Geographic Society
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Urban Tree Canopy Project – Resilient Landscapes Program	Description:	TFS has programs and funding opportunities, such as the Urban Tree Canopy Project, that address mitigation by decreasing impact from summer heat, flooding, and erosion. The Fire-Adapted Communities Program provides cost-share funds to assist in informing and preparing citizens to safely co-exist with wildland fire. The Resilient Landscapes Program provides cost-share reimbursement funds to restore healthy, fire-adapted ecosystems. The Firewise USA Program provides cost-share funds in cooperation with the National Fire Protection Administration to encourage homeowners to take individual responsibility for protecting their homes from the risk of wildfire.
	Responsible Agency:	Texas A&M Forest Service
	Provides Funding for Mitigation:	No
	Hazard:	Wildfires
Texas Department of Licensing and Regulation	Description:	Licenses and regulates weather modification programs and hosts the Texas Weather Modification and Advisory Committee meetings. Cloud seeding projects designed to increase rainfall from convective cloud towers are conducted in nearly 31 million acres of Texas. In administering the Texas Weather Modification Act, TDLR's weather modification program issues license and permits for projects using specialized aircraft and sophisticated weather radar systems at sites near Amarillo, San Angelo, and Pleasanton. TDLR also issues permit for hail suppression projects.
	Responsible Agency:	TDLR
	Provides Funding for Mitigation:	No
	Hazard:	Drought
Texas Department of Transportation	Description:	TXDOT incorporates tornado safe rooms into their Safe Rest Stops program through a federally funded Transportation Enhancement program (See Section 6.3). TXDOT also revises its design manual to include improved guidance on NFIP requirements. The agency supports the effort to certify floodplain managers by encouraging all their personnel to become certified. All engineers in TxDOT's central hydraulics branch are certified.
	Responsible Agency:	TxDOT
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Texas Residential Safe Room Rebate Program	Description:	TDEM, through the Hazard Mitigation Assistance (HMA) grants, began offering a rebate incentive for builders and homeowners to build or install residential safe rooms. This program is implemented by local units of government that choose to administer the program through a grant provided through the HMGP or PDM program. TDEM has also published a residential safe room handbook to assist local jurisdictions with the implementation of the program. This program has raised the viability and the visibility of safe rooms in high tornado/windstorm regions of Texas.
	Responsible Agency:	TDEM
	Provides Funding for Mitigation:	Yes
	Hazard:	Tornado, Windstorm

5.3 Administrative and Technical Capabilities

The tables below summarize the administrative and technical capabilities in Llano (Table 5-4) and San Saba (Table 5-5) Counties. Detailed information regarding administrative and technical capabilities in both Counties and the municipalities can be found in each jurisdictional annex found in Volume II, Section 9 (Annexes).

Table 5-4. Administrative and Technical Capability – Llano County

Capability	Details	
Development Services	Description:	Llano County Development Services oversees guidelines, procedures, and permits for all development outside corporate city limits in the County, and they are responsible for floodplain management, construction activity inspections, and regulating subdivisions in unincorporated areas of the County in partnership with other jurisdictions and agencies.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Environmental Compliance & Enforcement	Description:	Environmental Compliance & Enforcement officers investigate crimes such as illegal dumping, illegal burning, and public nuisance as defined by the Texas Health and Safety Code. Complaint forms can be submitted online.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Hazardous Materials
Sheriff's Office	Description:	The Llano County Sheriff's Office, located in Llano, Texas, is a law enforcement agency that promotes public safety in Llano County through public policing and the management of county jails and inmates.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	None
Office of Emergency Management	Description:	Llano County Emergency Services refers to a government agency at the Federal, Texas State, Llano County, or local level that is the lead agency for emergency situations, including preparation, response, and recovery in Llano County, TX. The types of emergencies that fall within the jurisdiction of the Llano County Emergency Management agency include natural disasters, severe weather incidents, civil unrest, and other events that pose a major threat to public safety or a significant disruption to civil society. You may contact Emergency Services for questions about: (1) Llano County emergency preparedness (2) Emergency management services (3) Emergency first response services (4) Natural disasters
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards



Capability	Details	
Llano County Adopt-A-County Road Program	Description:	This program was modeled after the very successful Adopt-A-Highway Program that has been operating in Texas since 1985 and has grown into a national and international litter-prevention effort, saving taxpayers' dollars, and keeping our right of way clean. The Llano County Adopt-A-County Road Program focuses on Llano County roads to support and recognize groups and volunteers who are willing to help pick up litter on our county roads to keep Llano County beautiful. The County will: (1) Work with the participating group to identify the specific section of county road to be adopted. (2) Erect a sign on either end of the adopted section with the participant's name displayed. (3) Provide safety information, trash bags, traffic control signs and safety vests.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Llano County Health Authority	Description:	The Llano County Health Authority is tasked with conducting the COVID-19 Vaccination Rollout. The Authority provides weekly updates online, advertises testing sites and waitlists, and provides information on COVID-19, vaccines, vaccine effectiveness, immunity, and safety.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Pandemic/Health and Safety

Table 5-5. Administrative and Technical Capability – San Saba County

Capability	Details	
County Indigent Health Care Program	Description:	The County Indigent Health Care Program helps low-income Texas residents who don't qualify for other state or federal health care programs have access to health care services. Benefits are limited to participating administrators who provide primary, preventative and some specialty services. These include: (1) Vaccines (2) Medical screening services (3) Annual physical examinations (4) Inpatient and outpatient hospital visits (5) Laboratory and radiology (6) Skilled nursing facility services The program is available to anyone who: (1) Lives in Texas. (2) Has an income level at or below 21 percent of federal poverty guidelines. (3) Has resources less than \$2,000. (4) Isn't eligible for Medicaid.
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Pandemic/Health and Safety
Floodplain Management	Description:	County Floodplain Management is responsible for floodplain management within San Saba County.



Capability	Details	
Guidelines & Permitting	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	Flood
	Description:	County Guidelines & Permitting oversees guidelines, procedures, and permits for all development outside corporate city limits in the County, and they are responsible for construction activity inspections, and regulating subdivisions in unincorporated areas of the County in partnership with other jurisdictions and agencies
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
Office of Emergency Management	Hazard:	None
	Description:	San Saba County Emergency Services refers to a government agency at the Federal, Texas State, San Saba County, or local level that is the lead agency for emergency situations, including preparation, response, and recovery in San Saba County, TX. The types of emergencies that fall within the jurisdiction of the San Saba County Emergency Management agency include natural disasters, severe weather incidents, civil unrest, and other events that pose a major threat to public safety or a significant disruption to civil society. You may contact Emergency Services for questions about: (1) San Saba County emergency preparedness (2) Emergency management services (3) Emergency first response services (4) Natural disasters
	Responsible Agency:	County
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards

5.4 Fiscal Capabilities

Fiscal capabilities are the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions. Table 5-6 provides a list of programs, descriptions, and links for those jurisdictions seeking funding sources. This table is not intended to be a comprehensive list, but rather a tool to help begin identifying potential sources of funding.

Table 5-6. Fiscal Capabilities

Capability		Details	
Federal			
Hazard Mitigation Grant Program	Description:	The HMGP is a post-disaster mitigation program. It is made available to states by FEMA after each Federal disaster declaration. The HMGP can provide up to 75% funding for hazard mitigation measures. The HMGP can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard prone areas, flood-proofing, or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved Hazard Mitigation Plan (this plan). Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for	



		the HMGP; a local government must apply on their behalf. Applications are submitted to TDEM and placed in rank order for available funding and submitted to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available. For additional information regarding HMGP, please refer to: https://www.fema.gov/hazard-mitigation-grant-program
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Flood Mitigation Assistance Program	Description:	The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is at least 75 percent. For the non-federal share, at most 25 percent of the total eligible costs must be provided by a non-federal source; of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state. TDEM serves as the grantee and program administrator for the FMA program. The FMA program is detailed on the FEMA website: https://www.fema.gov/flood-mitigation-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
Building Resilient Infrastructure and Communities Program	Description:	Building Resilient Infrastructure and Communities (BRIC) will support states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA pre-disaster hazard mitigation program that replaces the existing Pre-Disaster Mitigation (PDM) program. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. For additional information regarding the BRIC program, please refer to: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Extraordinary Circumstances	Description:	For PDM and FMA project subawards, the (FEMA) Region may apply extraordinary circumstances when justification is provided and with concurrence from FEMA Headquarters (Risk Reduction and Risk Analysis Divisions) prior to granting an exception. If this exception is granted, a local mitigation plan must be approved by FEMA within 12 months of the award of the project subaward to that community. For HMGP, PDM, and FMA, extraordinary circumstances exist when a determination is made by the Applicant and FEMA that the proposed project is consistent with the priorities and strategies identified in the State (Standard or Enhanced) Mitigation Plan and that the jurisdiction meets at least one of the criteria below. If the jurisdiction does not meet at least one of these criteria, the Region must coordinate with FEMA Headquarters (Risk Reduction and Risk Analysis Divisions) for HMGP; however, for PDM and FMA the Region must coordinate and seek concurrence prior to granting an exception: (1) The jurisdiction meets the small, impoverished community criteria (see Part VIII, B.2).

		(2) The jurisdiction has been determined to have had insufficient capacity due to lack of available funding, staffing, or other necessary expertise to satisfy the mitigation planning requirement prior to the current disaster or application deadline. (3) The jurisdiction has been determined to have been at low risk from hazards because of low frequency of occurrence or minimal damage from previous occurrences because of sparse development. (4) The jurisdiction experienced significant disruption from a declared disaster or another event that impacts its ability to complete the mitigation planning process prior to award or final approval of a project award. (5) The jurisdiction does not have a mitigation plan for reasons beyond the control of the State, federally recognized tribe, or local community, such as Disaster Relief Fund restrictions that delay FEMA from granting a subaward prior to the expiration of the local or Tribal Mitigation Plan. For HMGP, PDM, and FMA, the Applicant must provide written justification that identifies the specific criteria or circumstance listed above, explains why there is no longer an impediment to satisfying the mitigation planning requirement, and identifies the specific actions or circumstances that eliminated the deficiency. When an HMGP project funding is awarded under extraordinary circumstances, the Recipient shall acknowledge in writing to the Regional Administrator that a plan will be completed within 12 months of the subaward. The Recipient must provide a work plan for completing the local or Tribal Mitigation Plan, including milestones and a timetable, to ensure that the jurisdiction will complete the plan in the required time. This requirement shall be incorporated into the award (both the planning and project subaward agreements, if a planning subaward is also awarded).
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Individual Assistance	Description:	Individual Assistance (IA) provides help for homeowners, renters, businesses, and some non-profit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses could be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals are allowed to borrow up to \$200,000 to repair or replace real estate, \$40,000 to cover losses to personal property, and an additional 20 percent for mitigation. For businesses, loans could be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Non-profit organizations, such as charities, churches, and private universities are eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster but are restricted by law to small businesses only. IA is detailed on the FEMA website: https://www.fema.gov/individual-disaster-assistance .
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Public Assistance	Description:	Public Assistance (PA) provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain non-profit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required. PA is detailed on the FEMA website: https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit .
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards

Department of Homeland Security Grant Program	Description:	The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. In FY 2019, the total amount of funds available under HSGP was \$1.095 billion. HSGP is comprised of three interconnected grant programs including the State Homeland Security Program, Urban Areas Security Initiative (UASI), and the Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Additional information regarding HSGP is available on the website: https://www.fema.gov/homeland-security-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Fire Management Assistance Grant Program	Description:	Assistance for the mitigation, management, and control of fires on publicly or privately-owned forests or grasslands that threaten such destruction as would constitute a major disaster. Provides a 75% federal cost share and the state pays the remaining 25% for actual cost. Information on this program is available on the website: https://www.fema.gov/fire-management-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Assistance to Firefighters Grant Program	Description:	The primary goal of the Assistance to Firefighters Grants is to enhance the safety of the public and firefighters with respect to fire-related hazards by providing direct financial assistance to eligible fire departments, nonaffiliated Emergency Medical Services organizations, and State Fire Training Academies. This funding is for critically needed resources to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Information regarding this grant program is available on the website: https://www.fema.gov/welcome-assistance-firefighters-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
High Hazard Potential Dams Grant Program	Description:	The Rehabilitation of High Hazard Potential Dams Grant Program provides technical, planning, design, and construction assistance in the form of grants to non-Federal governmental organizations or nonprofit organizations for rehabilitation of eligible high hazard potential dams. Information regarding this program is available on the website: https://www.grants.gov/web/grants/view-opportunity.html?oppld=316238.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Small Business Administration Loan	Description:	The Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets. Homeowners could apply for up to \$200,000 to replace or repair their primary residence. Renters and homeowners could borrow up to \$40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances that were damaged or destroyed in a disaster. Physical disaster loans of up to \$2 million are available to qualified businesses or most private nonprofit organizations.

		Additional information regarding SBA loans is available on the SBA website: https://www.sba.gov/managing-business/running-business/emergency-preparedness/disaster-assistance .
	Responsible Agency:	SBA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Community Development Block Grant Program	Description:	CDBG are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, and planning and administration. Public improvements could include flood and drainage improvements. In limited instances and during the times of “urgent need” (e.g., post disaster) as defined by the CDBG National Objectives, CDBG funding could be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event. Additional information regarding CDBG is available on the website: https://www.hudexchange.info/programs/cdbg-entitlement/ .
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Federal Highway Administration - Emergency Relief	Description:	The Federal Highway Administration (FHWA) Emergency Relief is a grant program through the U.S. Department of Transportation (DOT) that can be used for repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of a disaster. New Jersey Department of Transportation serves as the liaison between local municipalities and FHWA. Additional information regarding the FHWA Emergency Relief Program is available on the website: https://www.fhwa.dot.gov/programadmin/erelief.cfm .
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Federal Transit Administration - Emergency Relief	Description:	The Federal Transit Authority (FTA) Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. DOT and directly allocated to Metropolitan Transit Authority (MTA) and Port Authority, this transportation-specific fund was created as an alternative to FEMA PA. Currently, a total of \$5.2 billion has been allocated to New Jersey-related entities. Additional information regarding the FTA Emergency Relief Program is available on the website: https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/emergency-relief-program .
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Disaster Housing Program	Description:	Emergency assistance for housing, including minor repair of home to establish livable conditions, mortgage, and rental assistance available through the U.S. Department of Housing and Urban Development (HUD). Information on this program is available on the website: https://www.hud.gov/program_offices/public_indian_housing/publications/dhap .
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards



HOME Investment Partnerships Program	Description:	Grants to local and state government and consortia for permanent and transitional housing, (including financial support for property acquisition and rehabilitation for low income persons). Information on this program is available on the website: https://www.hud.gov/program_offices/comm_planning/affordablehousing/programs/home/
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
HUD Disaster Recovery Assistance	Description:	Grants to fund gaps in available recovery assistance after disasters (including mitigation). Information on this program is available on the website: https://www.hud.gov/info/disasterresources
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Section 108 Loan Guarantee	Description:	Enables states and local governments participating in the CDBG program to obtain federally guaranteed loans for disaster-distressed areas. Information on this program is available on the website: https://www.hudexchange.info/programs/section-108/
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Smart Growth Implementation Assistance program	Description:	The Smart Growth Implementation Assistance (SGIA) program through the U.S. Environmental Protection Agency (EPA) focuses on complex or cutting-edge issues, such as stormwater management, code revision, transit-oriented development, affordable housing, infill development, corridor planning, green building, and climate change. Applicants can submit proposals under 4 categories: community resilience to disasters, job creation, the role of manufactured homes in sustainable neighborhood design, or medical and social service facilities siting. Information on this program is available on the website: https://www.epa.gov/smartgrowth
	Responsible Agency:	EPA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Partners for Fish and Wildlife	Description:	Financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. Information on this program is available on the website: https://www.fws.gov/partners/
	Responsible Agency:	U.S. Fish and Wildlife Service
	Provides Funding for Mitigation:	Yes
	Hazard:	All Natural Hazards
Transportation Investment Generating Economic Recovery (TIGER)	Description:	Investing in critical road, rail, transit, and port projects across the nation. Information on this program is available on the website: https://www.transportation.gov/tags/tiger-grants
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Community Facilities Direct Loan & Grant Program	Description:	This program provides affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area, and does not include private, commercial, or business undertakings. Information on this program is available on the website: https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program
	Responsible Agency:	USDA

	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Emergency Loan Program	Description:	USDA's Farm Service Agency provides emergency loans to help producers recover from production and physical losses due to drought, flooding, other natural disasters, or quarantine. Information on this program is available on the website: https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/emergency-farm-loans/index_
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Natural Hazards
Emergency Watershed Protection program	Description:	The Emergency Watershed Protection (EWP) program provides assistance to relieve imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences through the Natural Resources Conservation Service. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All Natural Hazards
Financial Assistance	Description:	Financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/
	Responsible Agency:	NRCS
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Emergency Management Performance Grants (EMPG) Program	Description:	Assist local, tribal, territorial, and state governments in enhancing and sustaining all-hazards emergency management capabilities. Information on this program is available on the website: https://www.fema.gov/emergency-management-performance-grant-program
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	All Hazards
Reimbursement for Firefighting on Federal Property	Description:	Provides reimbursement only for direct costs and losses over and above normal operating costs. Information on this program is available on the website: https://www.usfa.fema.gov/grants/firefighting_federal_property.html
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Land & Water Conservation Fund	Description:	Matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities (as well as funding for shared federal land acquisition and conservation strategies). Information on this program is available on the website: https://www.nps.gov/subjects/lwcf/index.htm
	Responsible Agency:	National Park Service
	Provides Funding for Mitigation:	Yes
	Hazard:	All Natural Hazards

Texas Water Development Board Flood Funding	Description:	The TWDB offers a variety of cost-effective loan and grant programs that provide for the planning, acquisition, design, and construction of water related infrastructure and other water quality improvements
	Responsible Agency:	Texas Water Development Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding
Texas A&M Forest Service Prescribed Burn Grants	Description:	Texas A&M Forest Service offers grants to landowners to complete prescribed fires on private land. Each grant targets landowners in different priority areas across the state.
	Responsible Agency:	Texas A&M Forest Service
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Flood Control Dam Infrastructure Projects - Supplemental Funding	Description:	Projects to repair and rehabilitate flood control structures across Texas will now be funded due to a \$150 million appropriations bill legislators passed this session.
	Responsible Agency:	Texas State Soil and Water Conservation Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding, Dam Failure
Flood Infrastructure Fund (FIF)	Description:	FIF program provides financial assistance in the form of loans and grants for flood control, flood mitigation, and drainage projects
	Responsible Agency:	Texas Water Development Board
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding
Texas Coastal Management Program Grant	Description:	Funding for projects that address environmental concerns and promote economic development within the Texas coastal zone.
	Responsible Agency:	Texas General Land Office
	Provides Funding for Mitigation:	Yes
	Hazard:	Erosion and Flooding
Texas Farm and Ranch Lands Conservation Program (TFRCLP)	Description:	Funding conserves natural resources by protecting working lands from fragmentation and development. TFRCLP maintains and enhances the ecological and agricultural productivity of these lands through Agricultural Conservation Easements.
	Responsible Agency:	Texas Parks and Wildlife
	Provides Funding for Mitigation:	Yes
	Hazard:	Flooding

5.5 Plan Integration

Described earlier in this section and within each annex, participating jurisdictions identified integration of hazard risk management into their existing planning, regulatory, and operational/administrative framework (“integration capabilities”) and intended integration promotion (integration actions). Volume II, Section 9 (Jurisdictional Annexes) provides details on how each jurisdiction integrates hazard mitigation into their existing capabilities.

5.5.1 Integration Process

Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Integrating hazard mitigation into a community’s existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Llano and San Saba County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Section 9 (Jurisdictional Annexes) details how this is done for each participating municipality and each County. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes and have added new mitigation actions to support this effort.

The Planning Partnership representatives will continue to incorporate mitigation planning as an integral component of daily government operations. Planning Partnership representatives will continue to work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution presented in Appendix A (Plan Adoption) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

- 1) Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
- 2) The Hazard Mitigation Plan, Master Plans, Emergency Management Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Section 7 (Plan Maintenance) provides for additional information on the implementation of the mitigation plan through existing programs.

Section 6 Mitigation Strategy

6.1 Introduction

This section presents mitigation actions for Llano County and San Saba County (the Planning Area) to reduce potential exposure and losses identified as concerns in the Risk Assessment (Section 5). The Planning Partnership reviewed the risk assessment to identify and develop these mitigation actions, which are presented herein.

This section includes:

- Background and Past Mitigation Accomplishments
- General Mitigation Planning Approach
- Strengths, Weaknesses, Obstacles, and Opportunities
- Review and Update of Mitigation Goals and Objectives
- Mitigation Strategy Development and Update

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

6.2 Background and Past Mitigation Accomplishments

In accordance with DMA 2000 requirements, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this HMP. The Planning Area, through previous and ongoing hazard mitigation activities, has demonstrated that it is proactive in protecting its physical assets and citizens against losses from natural and human-caused hazards. Examples of previous and ongoing actions, projects and capabilities include the following:

- Llano County and San Saba County participated in the development of 2016 Mitigation Plans and facilitated the 2023 Update, which included the participation of all municipal governments in the Planning Area. The current planning process represents the regulatory five-year local plan update process.
- All six municipalities in Llano County and San Saba County participate in the National Flood Insurance Program (NFIP), which requires the adoption of FEMA floodplain mapping and certain minimum construction standards for building within the floodplain.
- Currently, none of Llano County and San Saba municipalities are participating in NFIP Community Rating System (CRS) program.
- Many municipalities in Llano County and San Saba County have adopted regulatory standards regarding land use and zoning that exceed minimum requirements and provide the communities with greater capability to manage development without increasing hazard risk and vulnerability.
- Municipalities have participated on a limited basis in available mitigation grant funding opportunities to implement mitigation projects, including the following:
 - Purchasing NOAA "All Hazards" radios
 - Adopting stricter building codes
 - Implementing water conservation measures
 - Installing sirens for early warning for natural hazard events

- The Counties and municipalities have implemented mitigation actions to protect critical facilities and infrastructure throughout the planning area. These actions and others were identified in each County's Participation in their 2016 Hazard Mitigation Plans.
- TDEM supports Llano County and San Saba County communities reducing their risk and increasing their resilience. They provide a comprehensive program to support local jurisdictions as they assess the risks they face, plan to mitigate them, and fund those plans to implement mitigation projects that reduce risk across the Planning Area.
- In 2020, the Counties and local municipalities responded to and worked to mitigate the impacts of the coronavirus pandemic through education of the public, enforcement of local and state social distancing and masking measures, and establishment of best practices to slow the spread of Covid-19.

These past and ongoing activities have contributed to the Planning Area's understanding of its hazard preparedness and future mitigation activity needs, costs, and benefits. These efforts provide an ongoing foundation for the Planning Partnership to use in developing this HMP update.

6.3 General Mitigation Planning Approach

The overall approach used to update the County and local hazard mitigation strategies are based on FEMA and State of Texas regulations and guidance regarding local mitigation plan development, including:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning).
- FEMA Local Mitigation Planning Handbook, March 2013.
- FEMA Local Mitigation Plan Review Guide, October 1, 2011.
- FEMA Integrating Hazard Mitigation into Local Planning, March 1, 2013.
- FEMA Plan Integration: Linking Local Planning Efforts, July 2015.
- FEMA Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies (FEMA 386-3), February 2013.
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013.

The mitigation strategy update approach includes the following steps that are further detailed in later subsections of this section:

- Section 6.4 – Strengths, Weaknesses, Obstacles, and Opportunities (SWOO) exercise
- Section 6.5 – Review and update mitigation goals and objectives.
- Section 6.6 - Develop and prepare a mitigation strategy, including:
 - Review of the 2016 HMP mitigation actions
 - Identification of progress on the previous county and local mitigation strategies
 - 2023 HMP Mitigation Action Plan
 - Mitigation best practices
 - Mitigation strategy evaluation and prioritization; and
 - Benefit/cost review.

6.4 Strengths, Weaknesses, Obstacles, and Opportunities Exercise

A Strengths, Weaknesses, Obstacles, and Opportunities exercise (SWOO) was completed via online survey by the Planning Partnership. Participants were asked to fill out the SWOO for each of the hazards of concern for the 2023

HMP update. The Planning Partnership was asked to begin the exercise by identifying county, local, and stakeholder strengths to mitigate the risk and potential future impacts of the hazards. Next, the weaknesses, challenges, and obstacles the planning area faces to reduce each hazard's risk were identified. To conclude the discussion of each high-ranked hazard, the meeting attendees were asked to identify potential opportunities for enhanced mitigation. The results were compiled and presented to the Planning Partnership at the risk assessment presentation. The results were also used by the participants to help identify capabilities and potential mitigation actions. Table 6-1 summarizes the strengths, weaknesses, obstacles, and opportunities identified during the exercise:

Table 6-1. Llano and San Saba County SWOO Responses

Hazards	SWOO Responses
Dam/Levee Failure	Strengths - LCRA Dam Modernization Program Inundation Mapping Zones Annual training provided by LCRA; This community has a low probability of dam failure, but we do reside on a lake that is created by a dam. Strengths would be that we are well enough upstream from a major flow incident; Good notification system; The local Conservation Committee within the local NRCS is very proactive in this field
	Weaknesses – Board needs youth representation on committee; Little response capability; Dam age; 70% of dams are privately owned; Dam failure can cause flooding
	Obstacles – Funding; 3 high hazard dams and one significant hazard dam
	Opportunities – Board will follow through on opportunities as they open; Grants; Need to be more in touch with the entity that controls the dam to be notified in case of emergency; Oversight and regular inspections; Independent engineering inspections every 5 years; Evaluate project on dams higher than 32'
Drought	Strengths – Planning area has survived multiple droughts; resilient area, water availability; drought contingency plan; 100,000-gallon water storage; make use of rainfall to offset drought
	Weaknesses – Multiple droughts in history; population growth straining resources; weak enforcement capacity (drought contingency plan); drought conditions are unpredictable; multi-year drought can impact the region
	Obstacles - Low tax-base county makes proactivity hard; funding; need community buy-in for greater enforcement; reduction in electrical power generation
	Opportunities – Continue infrastructure growth and mitigation efforts; resident education could lead to self and neighborhood enforcement; build additional water supply systems that are flexible and adaptive; active water conservation projects
Extreme Temperature (Cold/Heat)	Strengths – County had prior experiences with hazard (notably heat); sent regular communications to the community; generators for water and sewer station
	Weaknesses – Winter storm of 2022 caught County off guard; fewer resources for cold hazards; 65 and older residents are significant part of community demographic; shelter with generator
	Obstacles – Another winter storm could hurt County more given continuing drought; district does not budget for mitigating this hazard
	Opportunities – County can set into place the access necessary to help citizens; improve from lessons learned; implore board members to discuss creating a budget to include mitigation of this hazard; perfect notification systems issues by NWS
Flood (riverine, flash, stormwater)	Strengths – Prior experience; community is self-aware of flood possibilities; barricades for roads; Serve as weather ambassadors to promote watches and warnings; Runoff from storms fills area lakes, ponds and replenishes ground water; LCRA operates flood gates to manage flood waters
	Weaknesses – FEMA; few resources; no emergency evacuation plan for flooding; No warning system in place at low water crossings and flooded roadways

Hazards	SWOO Responses
	Obstacles – Supplies are not as available as they used to be; district does not budget for mitigation of this hazard; Contamination of drinking water; Roads blocked or washed out can cause problems for service to water, gas, sewer and utilities Opportunities – Build storm water runoff map; ask board members to institute funding for hazard mitigation; Installation of high-water warning/detection systems; Identify flood plains
Geologic (earthquake, expensive soils, land subsidence)	Strengths – Not a typical hazard, little exposure Weaknesses – Unprepared for these types of events Obstacles – Funding; don't know what is needed; increase in population will affect this hazard category Opportunities – Ability to plan for this hazard; increased use of ground water should be evaluated and monitored
Hurricane/Tropical Storm	Strengths – Inland distance, little exposure; generators for water and sewer plant Weaknesses – Little experience with hazard; community could have to host people from neighboring communities who need refuge from hazard; Volunteers/Manpower to operate evacuation centers/shelters; Little time to prepare should storm move inward toward Llano County; Residual flooding, tornadoes and wind could cause damage Obstacles – Can prepare if notified by NWS or contiguous counties; funding; Development of a volunteer base for response to tropical incidents Opportunities – Training, development of plan; Llano County could be used as an evacuation center; Have residents prepare homes for high wind which is also necessary preparation for severe storms
Pandemic/Health and Safety	Strengths – Experience with hazard; community responded well to typical federal government guidelines; Past experience in dealing with COVID-19; Use of the Public Health Authority to update county of latest impacts; Clinics and pharmaceuticals available for distribution Weaknesses – Lost people; limited resources, flawed quarantine system/information flow; majority of the community is 65 and older; medical care in the city; rural environment and isolation Obstacles – Not everyone believes that the vaccine is necessary; funding; number of certified caregivers; Lack of public trust; Proper medical advice and treatment to address pandemic Opportunities – More people are looking to County for information; ability to practice with current pandemic; Communication with public; Trust building that information being provided is timely and accurate; Monitoring the impact of the pandemic; Tracking the illnesses impacting county
Severe Weather (lightning, hail, wind)	Strengths – Experience; majority of events do not cause damage; generators for water and sewer plant; Working with the NWS to provide storm watches and warnings to the public; Outdoor warning sirens have been installed in eight locations throughout the county; Everbridge and IPAWS capability provide needed information Weaknesses – Limited resources; shelter with generator to temporarily house people; Power outages; Damage to trees can cause road blockages and downed power lines; Fires can occur as a secondary hazard due to lightning especially during drought conditions; Lightning strikes to communication towers; Generators need to be evaluated for backup power; No safe rooms in county; Damage to manufactured homes Obstacles – Getting communications out ahead of the event; limited resources; Power outages; Damage to trees can cause road blockages and downed power lines; Fires can occur as a secondary hazard due to lightning especially during drought conditions; Lightning strikes to communication towers; Generators need to be evaluated for backup power; No safe rooms in county; Damage to manufactured homes

Hazards	SWOO Responses
	Opportunities – Working our resources; continue to develop plan; inform the community of local weather alert notification systems; More extensive planning using weather forecasts; Take actions during watches and warnings; Use warning sirens to alert recreational users of incoming storms and inclement weather
Tornado	Strengths – Rarely have tornadoes, but do have straight-line winds; experience, strong plan; The able community is willing to lend a hand where extensive damage occurs due to natural disaster; early warning sirens
	Weaknesses – Convincing our citizens to NOT go outside and check out the storm with their cameras for documentation; limited resources; majority of community is 65 and older and would have trouble evacuating; siren warning device; buildings with low code standards that are vulnerable to tornadoes; warning time not adequate
	Obstacles – Getting information out beforehand and documenting damages as soon as possible; limited funding; EMS and fire would be inundated, and County is in an area with longer response times; Funds to pay for siren
	Opportunities – Using our resources; continue to build preparedness plan; update building codes and enforcement of codes
Wildfire	Strengths – Experience, prior mitigation efforts; community is a FireWise community; local and neighboring fire departments well-equipped and ready to respond; staged assets in place by TFS to assist with ground and air support
	Weaknesses – “Still trying to figure out how to get our citizens to be more aware and conscious of their actions throughout each season;” limited resources; Population growth in wildland urban interface; No way to predict wildfires - fireworks, lightning, chains dragging on concrete, grass cutting equipment
	Obstacles – “Still trying to figure out how to get our citizens to be more aware and conscious of their actions throughout each season;” limited funding
	Opportunities – Hazard keeps volunteer fire department rosters active; continue mitigation efforts; Ensure all firefighters receive training; Increase planning efforts for readiness; Creation of defensible space by public/residents; Create evacuation routes and safe zones; Vegetation Management
Winter Weather	Strengths – Learned from 2022 winter storm; generator for water and sewer plant; Member of NWS Storm Ready; Responding to watches and warnings; Notice of storms
	Weaknesses – “We know we didn’t learn enough to be totally proactive for this;” Few resources; majority of community is 65 and older; shelter to temporarily house people and care for their needs; Disruption to emergency services - medical and fire; Heavy accumulation of ice on roads and power lines; Loss of power results in loss of communication services/towers
	Obstacles – “If the state’s systems fail, we rely on our local ‘boots on the ground’ resources;” limited funding; the district does not budget to mitigate this hazard; Rural environment produces isolation and life-threatening conditions for vulnerable populations
	Opportunities – Same resources; continue to build plan, operational capability; Implore board members to budget for mitigation of this hazard; County wide exposure to storms; Monitor power outages by providers; Ensure generators are adequate at critical facilities; Create warming centers

6.5 Review and Update of Mitigation Goals and Objectives

This section documents the efforts to update the guiding principles, and hazard mitigation goals and objectives established to reduce or avoid long-term vulnerabilities to the identified hazards.

6.5.1 Goals and Objectives

FEMA defines **Goals** as general guidelines that explain what should be achieved. Goals are usually broad, long-term, policy statements, and represent a global vision.

FEMA defines **Objectives** as strategies or implementation steps to attain mitigation goals. Unlike goals, objectives are specific and measurable, where feasible.

FEMA defines **Mitigation Actions** as specific actions that help to achieve the mitigation goals and objectives.

According to CFR 201.6(c)(3)(i): “The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.” Further, FEMA mitigation planning guidance recommends establishing objectives to better tie mitigation goals to specific mitigation strategies (e.g., projects, activities, and initiatives).

The goals established in the 2016 Llano County Hazard Mitigation Plan and the 2016 San Saba Hazard Mitigation Plan were presented to the Steering Committee and Planning Partnership for review and amendment throughout the planning process. This review was made with consideration of the hazard events and losses since the 2016 plans, the updated hazard profiles and vulnerability assessment, and the goals and objectives established in the updated 2018 State HMP.

The Steering Committee met on October 13, 2022, to review the 2016 goals and objectives and provided input on updated goals and objectives. These updates were presented to the Planning Partnership during the December 2022 Mitigation Strategy Workshop. As a result of these efforts, Table 6-2 presents the planning area’s updated goals and objectives for the 2023 HMP update. *Italicized* text indicates the updates made to the goals and objectives from the 2016 HMPs.

Table 6-2. Llano and San Saba County 2023 Hazard Mitigation Plan Goals and Objectives

2023 HMP Update Goals	2023 HMP Update Objectives
Protect public health and safety for residents, businesses, and visitors.	Advise the public about health and safety precautions to guard against injury and loss of life from hazards.
	Maximize the utilization of the latest technology to provide adequate warning, communication, and mitigation of hazard events.
	Reduce the damage to, and enhance protection of, dangerous areas during hazard events.
	Protect critical facilities and services.
	Reduce the abandonment of pets and livestock during critical hazard periods.
Protect existing and <i>new properties, critical facilities, community lifelines, and population.</i>	Reduce repetitive losses to the National Flood Insurance Program.
	Use the most cost-effective approaches to protect existing buildings and public infrastructure from hazards.
	Enact and enforce regulatory measures to ensure that development will not put people in harm’s way or increase threats to existing properties.
Increase public understanding, support, and demand for hazard mitigation.	Heighten public awareness of the full range of natural hazards they face.
	Educate the public on actions they can take to prevent or reduce the loss of life or property from all natural hazards.
	Publicize and encourage the adoption of appropriate hazard mitigation measures.
Build and support local capacity and commitment to continuously become less vulnerable to hazard	Build and support local partnerships to continuously become less vulnerable to hazards.
	Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
	Build hazard mitigation concerns into planning and budgeting processes.
	Build emergency services capabilities to adequately safeguard the community before, during, and after a disaster.

2023 HMP Update Goals	2023 HMP Update Objectives
Promote growth in a sustainable manner.	Build and support local partnerships to continuously become less vulnerable to hazards. Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
Maximize the resources for investment in hazard mitigation.	Maximize the use of outside sources of funding. Maximize participation of property owners in protecting their properties. Maximize insurance coverage to provide financial protection against hazard events. Prioritize mitigation projects, based on cost-effectiveness and starting with those sites facing the greatest threat to life, health, and property.

6.6 Mitigation Strategy Development and Update

As required by FEMA, the Counties and participating municipalities completed a comprehensive evaluation of the mitigation strategies and actions from the 2016 HMPs and reported on the status of each. Their update may be found in each jurisdictional annex (Section 9). In addition, the Counties and participating municipalities were provided the opportunity to include new strategies or actions to include in the 2023 HMP Update. New actions were prioritized to ensure they are cost-effective, environmentally sound, and technically feasible using the methodology outlined below.

6.6.1 Review of the 2016 HMP Mitigation Action Plans

To evaluate progress on local mitigation actions, the planning consultant met with each participant to discuss the status of the mitigation actions identified in the 2016 plans. For each action, jurisdictions were asked to provide the status of each action (*No Progress*, *In Progress*, *Ongoing Capability*, *Discontinue*, or *Completed*) and provide review comments on each. Jurisdictions were requested to quantify the extent of progress and provide reasons for the level of progress or why actions were being discontinued. Each jurisdictional annex in Section 9 (Jurisdictional Annexes) provides a table identifying the jurisdiction's prior mitigation strategy, the status of those actions and initiatives, and their disposition within their updated strategy.

Local mitigation actions identified as *Complete*, and those actions identified as *Discontinued*, were removed from the updated strategies. Local mitigation actions identified as an *Ongoing Capability* were incorporated into the capability assessment of each jurisdictional annex. Those actions identified as *No Progress* or *In Progress* that remain a priority for the jurisdiction, have been carried forward into the updated mitigation strategy. Actions identified as *Ongoing Capabilities* which are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

At the August kick-off meeting and during subsequent local-level planning meetings (phone, email), all participating jurisdictions were requested to identify mitigation activities completed, ongoing, and potential/proposed. As new potential mitigation actions, projects, or initiatives became evident during the plan update process, including as part of the risk assessment update and as identified through the public and stakeholder outreach process detailed in Section 2 (Planning Process), jurisdictions were made aware of these either through direct communication (local meetings, email, phone), at

Throughout the planning process, the planning consultant worked directly with each community (phone, email) to assist with the development and update of their annex and include mitigation strategies, focusing on identifying well-defined, implementable projects with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs).

Steering and Planning Committee meetings, or via their draft jurisdictional annexes.

6.6.2 Identification and Analysis of Mitigation Techniques

Concerted efforts were made to assure that municipalities develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA “Local Mitigation Planning Handbook” March 2013), specifically:

- **Local Plans and Regulations** - These actions include government authorities, policies or codes that influence the way land and buildings are being developed and built.
- **Structure and Infrastructure Projects** - These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- **Natural Systems Protection** - These are actions that minimize damage and losses and preserve or restore the functions of natural systems.
- **Education and Awareness Programs** - These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as the National Flood Insurance Program and Community Rating System, StormReady (NOAA), and Firewise (NFPA) Communities.

6.6.3 2023 HMP Mitigation Action Plan

To help support the selection of an appropriate, risk-based mitigation strategy, each annex provides a summary of hazard vulnerabilities identified during the plan update process, either directly by municipal representatives, through a review of the available county and local plans and reports, and through the hazard profiling and vulnerability assessment process.

In December 2022, the Planning Partnership participated in a mitigation strategy development workshop, supplemented by emails and phone calls between jurisdictions and the contract consultant, for all participating jurisdictions to support the development of focused problem statements based on the impacts of natural hazards in the county and their communities. These problem statements were intended to provide a detailed description of the problem area, including its impacts to the municipality/jurisdiction; past damages; loss of service; etc. An effort was made to include the street address of the property/project location, adjacent streets, water bodies, and well-known structures as well as a brief description of existing conditions (topography, terrain, hydrology) of the site. These problem statements formed a bridge between the hazard risk assessment which quantifies impacts to each community with the development of actionable mitigation strategies.

As discussed within the hazard profiles in Section 4.3 (Risk Assessment), the long-term effects of climate change are anticipated to exacerbate the impacts of weather-related hazards including flood, hurricanes and tropical storm, nor'easter, severe weather, severe winter weather and wildfire. By way of addressing these climate change-sensitive hazards within their local mitigation strategies and integration actions, communities are working to evaluate and recognize these long-term implications and potential impacts, and to incorporate in planning and capital improvement updates.

To assist with the development of mitigation actions, municipalities were provided with the following:

- 2023 HMP goals and objectives
- 2016 HMP mitigation strategies
- Risk assessment results
- Outcome of the SWOO
- Mitigation catalog
- Stakeholder and public input (e.g. citizen and stakeholder survey results)
- FEMA resources

A strong effort has been made to better focus local mitigation strategies to clearly defined, readily implementable projects and initiatives that meet the definition or characteristics of mitigation. Broadly defined mitigation actions were eliminated from the updated strategy unless accompanied by discrete actions, projects, or initiatives. Certain continuous or ongoing strategies that represent programs that are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

Overall, a comprehensive range of specific mitigation initiatives were considered by each plan participant to pursue in the future to reduce the effects of hazards. Some of these initiatives may be previous actions carried forward for this plan update. These initiatives are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in municipal priorities.

Throughout the course of the plan update process, additional regional and county-level mitigation actions were identified by the following processes:

- Review of the results and findings of the updated risk assessment.
- Review of available regional and county plans reports and studies;
- Direct input from county departments and other county and regional agencies
- Input received through the public and stakeholder outreach process.

6.6.4 Mitigation Best Practices

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in the Planning Area, in compliance with 44 CFR Section 201.6(c)(3)(ii). One catalog was developed for each natural hazard of concern evaluated in this plan; referred to as Appendix F (Mitigation Strategy Supplementary Data). The catalogs present alternatives that are categorized in two ways:

- By whom would have responsibility for implementation:
 - Individuals – personal scale
 - Businesses – corporate scale
 - Government – government scale
- By what each of the alternatives would do:
 - Manipulate the hazard
 - Reduce exposure to the hazard
 - Reduce vulnerability to the hazard
 - Build local capacity to respond to or be prepared for the hazard

The alternatives presented include actions that will mitigate current risk from hazards and actions that will help reduce risk from changes in the impacts of these hazards resulting from climate change. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalog, as well as other resources made available to all jurisdictions (i.e., FEMA’s Mitigation Ideas). The catalog provides a baseline of

mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the Planning Partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk from natural hazards within the planning area. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible
- The action is already being implemented
- There is an apparently more cost-effective alternative
- The action does not have public or political support.

6.6.5 Mitigation Strategy Evaluation and Prioritization

Section 201.c.3.iii of 44 CFR requires an action plan describing how the actions identified will be prioritized. Recent FEMA planning guidance (March 2013) identifies a modified STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) mitigation action evaluation methodology that uses a set of 10 evaluation criteria suited to the purposes of hazard mitigation strategy evaluation. This method provides a systematic approach that considers the opportunities and constraints of implementing a particular mitigation action.

Based on this guidance, the Steering Committee has adopted and applied an action evaluation and prioritization methodology which includes an expanded set of 14 criteria to include the consideration of cost-effectiveness, availability of funding, anticipated timeline, and if the action addresses multiple hazards.

The 14 evaluation/prioritization criteria used in the 2023 update process are:

- 1) **Life Safety** – How effective will the action be at protecting lives and preventing injuries?
- 2) **Property Protection** – How significant will the action be at eliminating or reducing damage to structures and infrastructure?
- 3) **Cost-Effectiveness** – Are the costs to implement the project or initiative commensurate with the benefits achieved?
- 4) **Technical** – Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
- 5) **Political** – Is there overall public support for the mitigation action? Is there the political will to support it?
- 6) **Legal** – Does the municipality have the authority to implement the action?
- 7) **Fiscal** – Can the project be funded under existing program budgets (i.e., is this initiative currently budgeted for)? Or would it require a new budget authorization or funding from another source such as grants?
- 8) **Environmental** – What are the potential environmental impacts of the action? Will it comply with environmental regulations?
- 9) **Social** – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
- 10) **Administrative** – Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?
- 11) **Multi-hazard** – Does the action reduce the risk to multiple hazards?
- 12) **Timeline** – Can the action be completed in less than 5 years (within our planning horizon)?

- 13) **Local Champion** – Is there a strong advocate for the action or project among the jurisdiction’s staff, governing body, or committees that will support the action’s implementation?
- 14) **Other Local Objectives** – Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

Specifically, for each mitigation action, the jurisdictions were asked to assign a numeric rank (-1, 0, or 1) for each of the 14 evaluation criteria, defined as follows:

- 1 = Highly effective or feasible
- 0 = Neutral
- -1 = Ineffective or not feasible

Further, jurisdictions were asked to provide a summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results were totaled to assist each jurisdiction in selecting mitigation actions for the updated plan.

As step one in the prioritization process, actions that had a numerical value between 0 and 4 were initially prioritized as low; actions with numerical values between 5 and 9 were initially categorized as medium; and actions with numerical values between 10 and 14 were initially categorized as high. As step two, jurisdictions were then asked to consider the benefits and costs, as well as the desired timeline for implementation and project completion timeline when finalizing each action’s priority as high/medium/low. These attributes are included in the mitigation strategy table and for FEMA-eligible projects in the mitigation worksheets (Section 9 – Annexes).

For the plan update there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. In addition, each jurisdiction was asked to develop problem statements. With this process, participating jurisdictions were able to develop action-oriented and achievable mitigation strategies.

6.6.6 Benefit/Cost Review

Section 201.6.c.3iii of 44CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs. Stated otherwise, cost-effectiveness is one of the criteria that must be applied during the evaluation and prioritization of all actions comprising the overall mitigation strategy.

The benefit/cost review applied in for the evaluation and prioritization of projects and initiatives in this HMP update process was qualitative; that is, it does not include the level of detail required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), and Pre-Disaster Mitigation (PDM) grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with project, action, or initiative.

Costs are the total cost for the action or project, and may include administrative costs, construction costs (including engineering, design and permitting), and maintenance costs.

Benefits are the savings from losses avoided attributed to the implementation of the project, and may include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When possible, jurisdictions were asked to identify the actual or estimated dollar value for project costs and associated benefits. Having defined costs and benefits allows a direct comparison of benefits versus costs, and a quantitative evaluation of project cost-effectiveness. Often, however, numerical costs and/or benefits have not been identified or may be impossible to quantitatively assess.

For the purposes of this planning process, jurisdictions were tasked with evaluating project cost-effectiveness with both costs and benefits assigned to “High”, “Medium” and “Low” ratings. Where quantitative estimates of costs and benefits were available, ratings/ranges were defined as:

- Low = < \$10,000
- Medium = \$10,000 to \$100,000
- High = > \$100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings using the following definitions were used:

Table 6-3. Qualitative Cost and Benefit Ratings

Costs	
High	Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
Benefits	
High	Project will have an immediate impact on the reduction of risk exposure to life and property.
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
Low	Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly. For some of the County initiatives identified, the Planning Partnership may seek financial assistance under FEMA’s HMGP or Hazard Mitigation Assistance (HMA) programs. These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA BCA model process. The Planning Partnership is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the Planning Partnership reserves the right to define “benefits” according to parameters that meet its needs and the goals and objectives of this HMP.

Section 7 Plan Maintenance

This section details the formal process that will ensure that the HMP remains an active and relevant document and that the Planning Partnership maintains their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this section describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategies outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data becomes available, resulting in a plan that will remain current and relevant.

The plan maintenance matrix shown in Table 7-1 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 7-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	Meet annually or upon major update to comprehensive plan or major disaster declaration	Jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Annexes)	Jurisdictional implementation lead identified in Section 8 (Planning Partnership) and Section 9 (Annexes)
Integration	For integration of mitigation principles action to become an organic part of the ongoing county and municipal activities, the Counties will incorporate the distribution of the safe growth worksheet for annual review and update by all participating jurisdictions.	September each year with interim email reminders to address integration in county and municipal activities.	HMP Coordinator and jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Annexes)	HMP Coordinator
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan; compile and finalize the Annual Progress Report	Finalized progress report completed by October 14 of each year	Planning Partnership; Plan Maintenance element	Jurisdictional points of contacts identified in Section 9 (Annexes)
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon major update to Master Plan or major disaster	Llano and San Saba County HMP Coordinator	Jurisdictional points of contacts identified in Section 9 (Annexes)

7.1 Monitoring, Evaluating, and Updating the Plan

The procedures for monitoring, evaluating, and updating the plan are provided below.

The Llano and San Saba County HMP Coordinator is assigned to manage the maintenance and update of the plan during its performance period. The Llano and San Saba County HMP Coordinator will chair the Planning Partnership and be the prime point of contact for questions regarding the plan and its implementation as well as to coordinate incorporation of additional information into the plan.

The Planning Partnership shall fulfill the monitoring, evaluation and updating responsibilities identified in this section which is comprised of a representative from each participating jurisdiction. Each jurisdiction is expected to maintain a representative on the Planning Partnership throughout the plan performance period (five years from the date of plan adoption). As of the date of this plan, primary and secondary mitigation planning representatives (points-of-contact) are identified in each jurisdictional annex in Section 9 (Annexes).

Regarding the composition of the committee, it is recognized that individual commitments change over time, and it shall be the responsibility of each jurisdiction and its representatives to inform the Llano and San Saba County HMP Coordinator of any changes in representation. The Llano and San Saba County HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area.

Currently, the Llano and San Saba County HMP Coordinator is designated as:

Contact Name	Mailing Address	Email Address	Phone Number
Cheryl Kepp, Grant Administrator	801 Ford Street, Llano, Texas 78643	ckepp@co.llano.tx.us	325-247-7756
Gilbert Bennett, Emergency Management Coordinator	100 W Sandstone St, Ste 200A, Llano, Texas 78643	gbennett@co.llano.tx.us	325-247-2039

7.1.1 Monitoring

The Planning Partnership will be responsible for monitoring progress on, and evaluating the effectiveness of, the plan, and documenting annual progress. Each year, beginning one year after plan development, the Llano and San Saba County and local Planning Partnership representatives will collect and process information from the departments, agencies and organizations involved in implementing mitigation projects or activities identified in their jurisdictional annexes (Section 9) of this plan, by contacting persons responsible for initiating and/or overseeing the mitigation projects.

In the first year of the performance period, this will be accomplished by utilizing an online performance progress reporting system, the BAToolSM which will enable municipal and county representatives to directly access mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation. It is anticipated that all participating partners will be prompted by the tool to update progress annually, providing an incentive for participants to refresh their mitigation strategies and to continue implementation of projects. It is expected that this reporting system will support the submittal of an increased number of project grant fund applications due to the functionality of the system which facilitates the sorting and prioritization of projects.

In addition to progress on the implementation of mitigation actions, including efforts to obtain outside funding; and obstacles or impediments to implementation of actions, the information that Planning Partnership representatives shall be expected to document, as needed and appropriate include:

- Any grant applications filed on behalf of the participating jurisdictions,
- Hazard events and losses occurring in their jurisdiction,
- Additional mitigation actions believed to be appropriate and feasible,
- Public and stakeholder input, and
- Plan monitoring for two years (years 2 through 4) of the plan performance period will be similarly addressed via the BAToolSM or manually.

7.1.2 Integration Process of the HMP into Municipal Planning Mechanisms

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Llano and San Saba County HMP Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to Section 9 (Annexes) for how this is done for each participating municipality. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes.

The Planning Partnership representatives will incorporate mitigation planning as an integral component of daily government operations. They will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts
2. The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management/Operations Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

During the HMP annual review process, each participating municipality will be asked to document how they are utilizing and incorporating the Llano and San Saba County HMP 2023 update into their day-to-day operations and planning and regulatory processes. Additionally, the Counties will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report. The following checklist presented in Table 7-2 was adapted from FEMA's Local Mitigation Handbook (2013), Appendix A, Worksheet 4.2. This checklist will help a community analyze how hazard mitigation is integrated into local plans, ordinances, regulations, ordinances, and policies. By completing the checklist, it will help the Counties identify areas that integrate hazard mitigation currently and where to make improvements and reduce vulnerability to future development. In this manner, the integration of mitigation into jurisdictional activities will evolve into an ongoing culture within the Counties.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
Operating, Municipal and Capital Improvement Program Budgets			
When constructing upcoming budgets, hazard mitigation actions will be funded as budget allows. Construction projects will be evaluated to see if they meet the hazard mitigation goals.			
Annually, during adoption process, the municipality will review mitigation actions when allocating funding.			
Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
Do budgets provide funding for hazard mitigation projects identified in the HMP?			
Human Resource Manual			
Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
Prior to, zoning changes, or development permitting, the municipality will review the hazard mitigation plan and other hazard analyses to ensure consistent and compatible land use.			
Does the zoning ordinance discourage development or redevelopment within natural areas including wetlands, floodways, and floodplains?			
Does it contain natural overlay zones that set conditions			
Does the ordinance require developers to take additional actions to mitigate natural hazard risk?			
Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
Do the ordinances prohibit development within, of filling of, wetlands, floodways, and floodplains?			
Subdivision Regulations			
Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			
Do the regulations allow density transfers where hazard areas exist?			
Comprehensive Plan			
Are the goals and policies of the plan related to those of the HMP?			
Does the future land use map clearly identify natural hazard areas?			
Do the land use policies discourage development or redevelopment with natural hazard areas?			
Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
Does the future land use map clearly identify natural hazard areas?			
Do the land use policies discourage development or redevelopment with natural hazard areas?			
Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Transportation Plan			
Does the transportation plan limit access to hazard areas?			
Is transportation policy used to guide growth to safe locations?			
Are transportation systems designed to function under disaster conditions (e.g., evacuation)?			
Environmental Management			
Are environmental systems that protect development from hazards identified and mapped?			

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
• Do environmental policies maintain and restore protective ecosystems?			
• Do environmental policies provide incentives to development that is located outside protective ecosystems?			
Grant Applications			
• Data and maps will be used as supporting documentation in grant applications.			
Municipal Ordinances			
• When updating municipal ordinances, hazard mitigation will be a priority			
Economic Development			
• Local economic development group will take into account information regarding identified hazard areas when assisting new businesses in finding a location.			
Public Education and Outreach			
• Does the municipality have any public outreach mechanisms / programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.1.3 Evaluating

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the HMP goals are being achieved, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Planning Partnership, to be held either in person or via teleconference approximately one year from the date of local adoption of this update, and successively thereafter. At least two weeks before the annual plan review meeting, the Llano and San Saba County HMP Coordinator will advise Planning Partnership members of the meeting date, agenda, and expectations of the members.

The Llano and San Saba County HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting and Soliciting input regarding progress toward meeting plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions.
- The nature or magnitude of the risks has changed.
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available.
- Actions were cost effective.
- Schedules and budgets are feasible.

- Implementation problems, such as technical, political, legal or coordination issues with other agencies are presents.
- Outcomes have occurred as expected.
- Changes in Planning Area resources impacted plan implementation (e.g., funding, personnel, and equipment)
- New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6.

Specifically, the Planning Partnership will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Under/over spending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Partnership will evaluate how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions (“Implementation of Mitigation Plan through Existing Programs” subsection later in this section discusses this process). Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Planning Partnership should refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document, to assist in the evaluation process (see Appendix F –Maintenance). Further, the Planning Partnership should refer to any process and plan review deliverables developed by the Counties as a part of the plan review processes established for prior or existing local HMPs within the Counties.

The Llano and San Saba County HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year of the performance period, based on the information provided by the local Planning

Partnership members, information presented at the annual Planning Partnership meeting, and other information as appropriate and relevant. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Planning Partnership will be able to assess which projects are completed, which are no longer feasible, and what projects should require additional funding.

The Annual HMP Progress Report shall be posted on the Llano County's website to keep the public apprised of the plan's implementation (located at <https://www.llanocountytxhmp.com/>). Additionally, the website provides details on the HMP update planning process.

The HMP will also be evaluated and revised following any major disasters, to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 (Hazard Profiles) of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's disaster resistance and build a better and stronger community.

7.1.4 Updating

To facilitate the update process, the Llano and San Saba County HMP Coordinator, with support of the Planning Partnership, shall use the second annual meeting to develop and commence the implementation of a detailed plan update program. The Llano and San Saba County HMP Coordinator shall invite representatives from TDEM to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the plan update effort, what needs to be included in the updated plan, and a detailed timeline with milestones to assure that the update is completed according to regulatory requirements.

At this meeting, the Planning Partnership shall determine what resources will be needed to complete the update. The Llano and San Saba County HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the State of Texas State Hazard Mitigation Officer.

7.1.5 Grant Monitoring and Coordination

Llano and San Saba County recognizes the importance of having an annual coordination period that helps each planning partner become aware of upcoming mitigation grant opportunities and identifies multi-jurisdiction projects to pursue. Grant monitoring will be the responsibility of each municipal partner as part of their annual progress reporting. The Llano and San Saba County HMP Coordinator will keep the planning partners apprised of FEMA Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Llano and San Saba County intend to be resources to the Planning Partnership in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the Partnership during open windows for grant applications. As part of grant monitoring and coordination, Llano and San Saba County intend to provide the following:

- Notification to planning partners about impending grant opportunities.
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration.
- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects.

Grant monitoring and coordination will be integrated into the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities

7.2 Implementation of Mitigation Plan Through EXISTING Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within Llano and San Saba County there are many existing plans and programs that support hazard risk management. Thus, it is critical that this hazard mitigation plan integrate, coordinate, and complement those existing plans and programs.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the Counties. Within each jurisdictional annex in Section 9 (Annexes), the Counties and each participating jurisdiction identified how each capability reduces risk and how they are integrating hazard risk management into their existing planning, regulatory, and operational/administrative framework. If they are currently not showing this, they indicate how they intend to promote this integration.

It is the intention of Planning Partnership representatives to continue to incorporate mitigation planning as an integral component of daily government operations. The Planning Partnership representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A [Adoption Resolutions]) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Steering Committee anticipates that:

- Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts and
- The Hazard Mitigation Plan, Master Plans, Emergency Operations Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency operations and response plans,
- Training and exercise of emergency response plans,
- Debris management plans,
- Recovery plans,
- Capital improvement programs,
- Municipal codes,
- Community design guidelines,

- Water-efficient landscape design guidelines,
- Stormwater management programs,
- Water system vulnerability assessments,
- Community Wildfire Protection Plans,
- Comprehensive Flood Hazard Management Plans,
- Resiliency plans,
- Community Development Block Grant-Disaster Recovery action plans, and
- Public information/education plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

During the annual plan evaluation process, the Planning Partnership representatives will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report.

7.3 Continued Public Involvement

Llano County, San Saba County, and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted on-line: <https://www.llanocountytxhmp.com/>.

In addition, public outreach and dissemination of the HMP will include:

- Links to the plan on municipal websites of each jurisdiction with capability.
- Continued utilization of existing social media outlets (Facebook, Twitter) to inform the public of natural hazard events, such as floods and severe storms. Educate the public via the jurisdictional websites on how these applications can be used in an emergency.
- Development of annual articles or workshops on flood hazards to educate the public and keep them aware of the dangers of flooding

The Steering Committee representatives and the Llano and San Saba County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments.

The public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The Llano and San Saba County HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting, and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings might also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Steering Committee representatives shall be responsible to assure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan (or draft in the case that the five-year update effort is underway) are available for review, along with instructions to facilitate public input and comment on the HMP.
- Appropriate links to the Llano and San Saba County Hazard Mitigation Action Plan webpage are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during HMP update cycles.

The Llano and San Saba County HMP Coordinator shall be responsible to assure that:

- Public and stakeholder comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan are available for review at appropriate County facilities along with instructions to facilitate public input and comment on the plan.
- Public notices, including media releases, are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.

References

Section 1 – Introduction

Section 2 – Planning Process

Section 3 – Community Profile

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Section 5 – Capability Assessment

Section 6 – Mitigation Strategy

Section 7 – Plan Maintenance

Section 8 – Planning Partnership

Section 9.1 – Llano County Jurisdictional Annex

Section 9.2 – San Saba County Jurisdictional Annex

Section 9.3 – City of Horseshoe Bay Jurisdictional Annex

Section 9.4 – City of Llano Jurisdictional Annex

Section 9.5 – City of San Saba Jurisdictional Annex

Section 9.6 – City of Sunrise Beach Village Jurisdictional Annex

Section 9.7 – Llano County MUD #1 - Blue Lake Community Jurisdictional Annex

Section 9.8 – San Saba Independent School District Jurisdictional Annex

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Section 9.11 – City of Richland Springs Jurisdictional Annex

Section 9.12 – Richland Springs Independent School District Jurisdictional Annex

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Section 9.13 – Richland Springs SUD Jurisdictional Annex

Section 9.14 – Richland Springs Water Jurisdictional Annex

Acronyms and Abbreviations

A

AFG: Assistance to Firefighters Grants

ACS: American Community Survey

ACT: American College Test

ADA: Americans with Disabilities Act

B

BCA: Benefit Cost Analysis

BCEGS: Building Code Effectiveness Grading Schedule

BRIC: Building Resilient Infrastructure and Communities

C

CAC: Community Assistance Contacts

CAPCOG: Capital Area Council of Governments

CAPE: Convective Available Potential Energy

CAV: Community Assistance Visits

CDBG: Community Development Block Grant

CDBG-DR: Community Development Block Grant – Disaster Recovery

CDBG-MIT: Community Development Block Grant Mitigation

CDC: Center for Disease Control

CDMS: Comprehensive Data Management System

CELCP: Coastal and Estuarine Land Conservation Program

CEMP: Comprehensive Emergency Management Plan

CEO: Chief Executive Officer

CEPRA: Coastal Erosion Planning and Response Act

CFR: Code of Federal Regulations

CRS: Community Rating System

CHAMPS: Community Hazard Analysis and Mitigation Planning Support



CHARM: Community Health and Resource Management

CISD: Critical Incident Stress Debriefing

CMP: Coastal Management Program

COVID: Coronavirus Disease

CR: County Road

CSV: Comma Separated Values

CTP: Cooperation Technical Partners

D

DEM: Digital Elevation Model

DFIRM: Digital Flood Insurance Rate Map

DHS: Department of Homeland Security

DMA: Disaster Mitigation Act

DOT: Department of Transportation

DPW: Department of Public Works

DR: Major Disaster Declaration

E

EAP: Education and Awareness Programs

EAP: Event Action Plan

EDC: Economic Development Commission/Committee

EF Scale: Enhanced Fujita Tornado Intensity Scale

EHP: Environmental Planning and Historical Preservation

EM: Emergency Declaration

EM: Emergency Management

EMC: Emergency Management Coordinator

EMPG: Emergency Management Performance Grant

EMS: Emergency Medical Service

ENS: Emergency Notification System

EOC: Emergency Operations Center



EPA: Environmental Protection Agency

ERC: Emergency Response Committee

ES: Emergency Services

ESD: Emergency Services District

EWP: Emergency Watershed Protection

F

FEMA: Federal Emergency Management Agency

FHWA: Federal Highway Administration

FIF: Flood Infrastructure Fund

FIRM: Flood Insurance Rate Map

FIS: Fire Intensity Scale

FM: Farm to Market Road

FMA: Flood Mitigation Assistance

FPA: Floodplain Administrator

FTA: Federal Transit Authority

FY: Fiscal Year

G

GIS: Geographic Information System

GLO: General Land Office

GOMESA: Gulf of Mexico Energy Security Act

H

HAZMAT: Hazardous Materials

HAZUS: Hazards United States

HMA: Hazard Mitigation Assistance

HMAP: Hazard Mitigation Action Plan

HMGP: Hazard Mitigation Grant Program

HMP: Hazard Mitigation Plan

HR: Human Resources



HSGP: Homeland Security Grant Program

HUC: Hydrologic Unit Code

HUD: U.S. Department of Housing and Urban Development

HVAC: Heating, Ventilation, and Air Conditioning

I

IBC: International Residential Code

ICC: Increased Cost of Compliance

IPAWS: Integrated Public Alert and Warning System

IPCC: Intergovernmental Panel on Climate Change

IRC: Internal Revenue Code

ISAA: Information Sharing Access Agreement

ISD: Independent School District

ISO: International Organization for Standardization

IT: Information Technology

J

K

L

LAL: Lightning Activity Level

LCRA: Lower Colorado River Authority

LPR: Local Plans and Regulations

LUE: Land Use Elements

M

MH: Multi-Hazard

MMI: Modified Mercalli Intensity

MRP: Mean Return Period

MTA: Metropolitan Transit Authority

MUD: Municipal Utility District

Mw: Moment Magnitude

N

N/A: Not Applicable

NASA: National Aeronautics and Space Administration

NCC: Network Control Center

NCDC: National Climatic Data Center

NCEI: National Centers for Environmental Information

NEHRP: National Earthquake Hazard Reductions Program

NFIP: National Flood Insurance Program

NFPA: National Fire Prevention Association

NHC: National Hurricane Center

NIC: National Influenza Centers

NLDN: National Lightning Detection Network

NOAA: National Oceanic and Atmospheric Administration

NP: Not Participating

NPL: National Priorities List

NR: Natural Resource Protection

NRCS: Natural Resources Conservation Service

NRDA: Natural Resources Damage Assessment

NSIDC: National Snow and Ice Data Center

NSP: Natural Systems Protection

NSSL: National Severe Storms Laboratory

NWCG: National Wildfire Coordinating Group

NWS: National Weather Service

O

OEM: Office of Emergency Management

P

PA: Public Assistance

PA System: Public Address System

PD: Police Department

PDM: Pre-Disaster Mitigation

PGA: Peak Ground Acceleration

PI: Public Information

POA: Property Owners' Association

PP: Property Protection

PPE: Personal Protective Equipment

PR: Preventative Measures

PUD: Planned Unit Development

Q

R

RL: Repetitive Loss

RM: Ranch to Market Road

ROW: Right-of-Way

RSI: Regional Snowfall Index

RSSUD: Richland Springs Special Utility District

RSV: Replacement Cost Value

S

SAT: Scholastic Assessment Test

SBA: Small Business Administration

STAPLEE: Social, Technical, Administrative, Political, Legal, Economic, and Environmental

SFHA: Special Flood Hazard Area

SGIA: Smart Growth Implementation Assistance

SHMP: State Hazard Mitigation Plan

SIP: Structure and Infrastructure Project

SP: Structural Flood Control Projects

SPC: Storm Prediction Center

SRL: Severe Repetitive Loss

SSC: San Saba County

SSSP: Safe and Supportive School Program

SUD: Special Utility District

SWCD: Soil and Water Conservation District

SWOO: Strengths, Weaknesses, Obstacles, and Opportunities

T

TBD: To Be Determined

TCELCP: Texas Coastal and Estuarine Land Conservation Program

TCEQ: Texas Commission on Environmental Quality

TDEM: Texas Department of Emergency Management

TDHCA: Texas Department of Housing and Community Affairs

TDLR: Texas Department of Licensing and Regulation

TEA: Texas Education Agency

TFFC: Texas Flash Flood Coalition

TFRLCP: Texas Farm and Ranch Lands Conservation Program

TFS: Texas A&M Forest Service

THIRA: Threat & Hazard Identification and Risk Assessment

TIGER: Transportation Investment Generating Economic Recovery

TML: Texas Municipal League

TMUTCD: Texas Manual on Uniform Traffic Control Devices

TNRIS: Texas Natural Resources Information System

TORRO: Tornado and Storm Research Organization

TWDB: Texas Water Development Board

TX: Texas

TXDOT: Texas Department of Transportation

TXWARN: Texas Water/Wastewater Agency Response Network

U

UASI: Urban Areas Security Initiative

UCAR: University Corporation for Atmospheric Research

US: United States

USACE: United States Army Corp of Engineers

USDA: U.S. Department of Agriculture

USDM: United States Drought Monitor

USEPA: U.S. Environmental Protection Agency

USGCRP: U.S. Global Change Research Program

USGS: U.S. Geological Survey

V

VFD: Volunteer Fire Department

W

WCID: Water Control and Improvement District

WFSI: Wildland Fire Susceptibility Index

WHO: World Health Organization

WNV: West Nile Virus

WRN: Weather Ready Nation

WUI: Wildland Urban Interface

X

Y

Z

DRAFT

