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Cover photo:
Guadalupe River Nature Trail at Canyon Lake Dam.

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2024 State Flood Plan: History in the Making

Texas Water Development Board*[1]

Abstract: In August 2024, the Texas Water Development Board adopted the *2024 State Flood Plan,* providing the first-ever comprehensive statewide assessment of flood risk and solutions to reduce the risk and impact to life and property due to flooding. The plan incorporates the findings of 15 watershed-based regional flood plans and includes legislative and floodplain management recommendations to guide state, regional, and local flood control policy to reduce the risk and impact of flooding. During the 86th Texas Legislature in 2019, Senate Bill 8 created the regional and state flood planning process, modeled after the bottom-up regional and state water planning process. Per Senate Bill 8, the Texas Water Development Board will produce a new state flood plan every 5 years based on the flood planning groups' regional plans. This article provides a summary of the *2024 State Flood Plan.*

Keywords: Flood, flood risk, regional flood planning group

[1] Special thanks to all the *2024 State Flood Plan* contributors, as acknowledged in the plan.
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Terms used in paper

Acronym/Initialism	Descriptive Name
FEMA	Federal Emergency Management Agency
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
TWC	Texas Water Code
TWDB	Texas Water Development Board

INTRODUCTION

The *2024 State Flood Plan* presents information from 15 regional flood plans that were developed through the efforts of more than 350 regional flood planning group members, their sponsors, and technical consultants who stepped up to help plan for their communities' futures. In addition to identifying risks to lives and property from flooding, the plan identifies potential actions to help mitigate those flood risks. Per Texas Water Code (TWC) § 16.061(a)(2) and § 16.061(b)(5), the plan also provides Texas Water Development Board (TWDB) legislative and floodplain management recommendations for preventing an increase in flood risks (State Flood Plan, 2019). The plan also includes legislative recommendations from the regional flood planning groups to facilitate floodplain management and flood mitigation, a planning group requirement under TWC § 16.062(h)(1) and 31 Texas Administrative Code 362.3(b)(1) and (32) (Regional Flood Planning, 2019; Guidance Principles, 2023).

In Texas, a state that sees flooding events recurringly intertwined with drought, having a state flood planning process is as critical as its longstanding counterpart, the water supply planning process.

One in every six Texans—5,219,900 of the state's 30 million people—lives or works in known flood hazard areas (TWDB, 2024a). Known flood hazard areas also contain 1,664,200 buildings, of which 1,295,700 are residential; 12,654,000 agricultural acres; 63,900 roadway miles; and 6,258 hospitals, emergency medical services, fire and police stations, and schools (TWDB, 2024a). Existing flood risk in the 1% (100-year) and 0.2% (500-year) annual chance flood hazard areas is one of several pieces of information generated through Texas's first-ever regional and state flood planning process. The process culminated in the TWDB adopting the inaugural state flood plan on August 15, 2024 (TWDB, 2024a).

FLOOD PLANNING HISTORY

Texas has a long history of flooding and flood-related loss across the state, which has taken an enormous toll on people and property. Each of the state's 254 counties has experienced flooding, tropical storms, severe storm events, or all three (Federal Emergency Management Agency [FEMA], 2024). There is no shortage of documented flooding events over the last century. A 1921 rainstorm in Williamson County set a national record with more than 36 inches of rain in 18 hours (TWDB, 2024a). Statewide flooding in 1957 was so extensive that it ended the longest statewide drought of record (TWDB, 2024a). In September 2014, a storm event generated upwards of 10 inches of rain in areas of the South Plains, overfilling playa lakes (National Weather Service [NWS], 2014). Hurricane Harvey caused more than $125 billion in estimated total damages in 2017 (National Oceanic and Atmospheric Administration [NOAA], 2024). In June 2018, widespread flooding across Cameron, Willacy, and Hidalgo counties affected an estimated 20,000 residences and businesses (NWS, 2018). More recently, in August 2022, the Dallas-Fort Worth area received near-record rainfall that led to considerable flooding across the metroplex (Lopez, 2022). Texas is no stranger to flood.

In summer 2016, one year after the Blanco River rose to nearly 41 feet in Wimberley and tragically claimed several lives, stakeholders and members of the Texas Legislature began conversations on the need for a state flood plan that would serve as a long-term strategic document to identify flood mitigation needs and solutions to reduce flood risk statewide (NWS, 2015). What followed was funding provided by the 85th Legislature for TWDB to conduct a survey to better understand flood planning, mitigation needs, and associated costs for communities across the state. The resulting *State Flood Assessment,* delivered to the Legislature in January 2019 at the commencement of the 86th legislative session, was derived from stakehold-

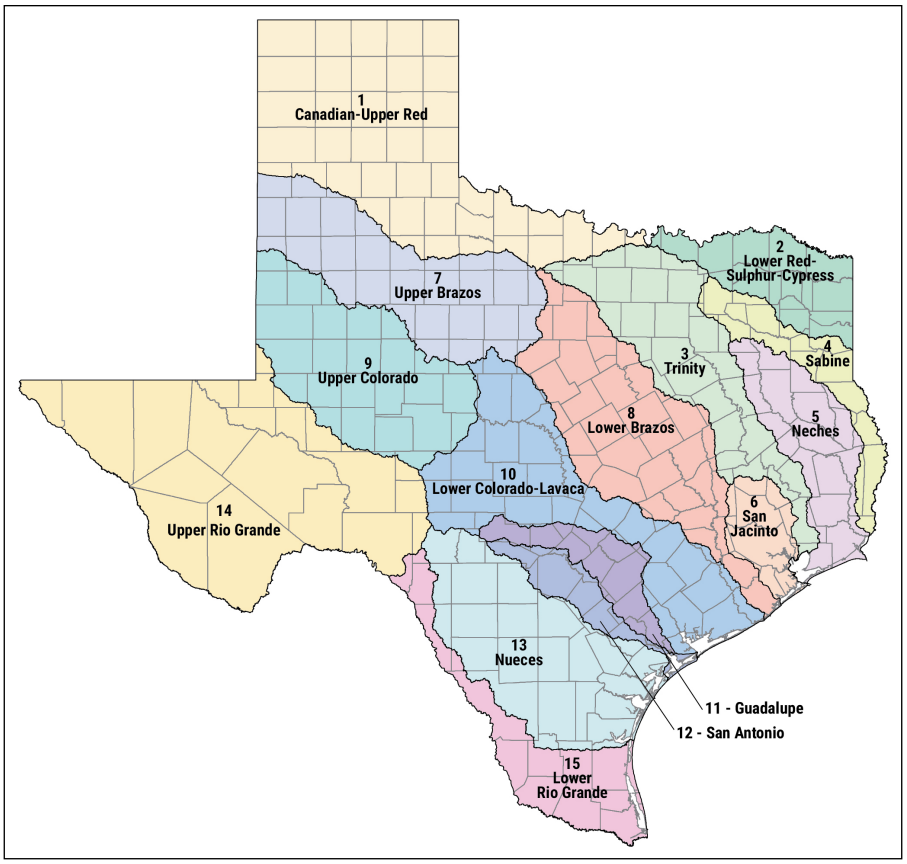

Figure 1. The 15 flood planning regions designated by the Texas Water Development Board (TWDB) on April 9, 2020 (TWDB, 2024a).

er input. The assessment was organized according to the three areas of need described as being most important: 1) increased state resources for implementing mitigation activities, which may include support for policy considerations, increased technical assistance, and data collection; 2) improved and updated flood mapping activities; and 3) coordinated, watershed-based flood planning (TWDB, 2019).

That spring, during the 86th Legislature, Senate Bill 8 created the regional and state flood planning framework and charged TWDB with designating flood planning regions based on river basins; selecting and convening the initial regional planning group memberships; and administering the funding and flood planning through grant contracts (Tex. S.B. 8, 86th Leg., R.S., 2019). Additionally, the Legislature created a new flood financial assistance fund and directed TWDB to help fund flood mitigation projects (Tex. S.B. 7, 86th Leg., R.S., 2019). TWC § 16.061 and § 16.062 outline the overarching goals of Texas's state and regional flood planning process:

- To provide for the orderly preparation for and response to flood conditions;
- To protect against the loss of life and property;
- To be a guide to state and local flood control policy;
- To contribute to water development where possible, all without making flooding conditions worse for neighboring areas (State Flood Plan, 2019; Regional Flood Planning, 2019).

REGIONAL PLANNING

This process was Texas's first statewide comprehensive effort to identify, address, and plan for flood risk (TWDB, 2024a). Knowing that water does not adhere to jurisdictional boundaries, watershed-based flood risk reduction planning with collaboration and cooperation between neighboring stakeholders—as recommended in the *State Flood Assessment*—is essential. Given the success of the regional water planning process over the last 25 years of 5-year cycles, it was no surprise that regional flood planning should follow a bottom-up process. Relying on local knowledge, involvement, and influence—the literal boots on the ground—to execute such a dynamic planning process is necessary to ensure credible and actionable regional plans.

While the Legislature tasked TWDB with overseeing watershed-based regions, it was TWDB that divided the state into the 15 flood planning regions, each with an associated planning group composed of local stakeholder volunteers (Figure 1). With extensive stakeholder input and

in collaboration with several other state agencies, TWDB also generated rules to govern the regional and state flood planning programs (Regional Flood Planning, 2019). TWC § 16.061 dictates that the regional flood planning groups are responsible for developing regional flood plans every 5 years that are funded primarily through legislative appropriations; administered by TWDB; and guided by statute, rules, contracts, and input from planning group members and the public (State Flood Plan, 2019). To comply with the Texas Open Meetings Act, all planning groups and their committees conduct their business in meetings that are open to the public (Open Meetings Requirement, 1977).

Each planning group must maintain at least one voting member representing each of the following 12 interest categories: the public, counties, municipalities, industry, agriculture, environment, small business, electric-generating utilities, river authorities, flood districts, water districts, and water utilities (Regional Flood Planning, 2019). A TWDB staff member designated as a non-voting member of each regional flood planning group attends each meeting and supports the planning groups as program administrator. Non-voting member representation from the Texas Department of Agriculture, Texas Commission on Environmental Quality, Texas Division of Emergency Management, Texas General Land Office, Texas Parks and Wildlife Department, and Texas State Soil and Water Conservation Board is also required, which fosters collaboration. Additional interests may also be represented as voting and non-voting members at the planning groups' discretion.

To help administer the member-based planning groups, each group must designate a political subdivision of the state, such as a municipality, river authority, or council of governments, to serve as a sponsor (General Regional Flood Planning Group Responsibilities and Procedures, 2023). These sponsors are responsible for arranging meetings, managing grant-funded contracts, and providing public notices. Additionally, the planning groups must select technical consultants to collect information, perform analyses, and prepare the regional flood plan document for submission to TWDB.

While considering a 30-year planning horizon (in this cycle from 2023 to 2053), each regional flood plan must identify current and future flood risks; select achievable flood mitigation goals; and recommend evaluations, projects, and strategies to identify or reduce flood risk (Guidance Principles, 2023; Guidance Principles for State and Regional Flood Planning, 2020). Each plan also includes an assessment of current floodplain management, land use regulations, economic development practices, and policy recommendations (Guidance Principles, 2023; Guidance Principles for State and Regional Flood Planning, 2020). While each successive iteration of regional flood planning will take place over 5-year periods, the first cycle of regional flood planning followed an expedited schedule that spanned a little over 2 years (TWDB, 2024a).

Once TWDB approves the regional flood plans, development of the state flood plan begins. The state flood plan compiles key information from the regional flood plans, delves into planning methodology, presents data for the entire state, and serves as a guide to state flood policy. As it is during the regional planning process, stakeholder and public input is highly sought during state flood plan development. The public is encouraged to submit comments on a published draft during a public comment period prior to TWDB adopting the final state flood plan.

EVALUATING CURRENT INFRASTRUCTURE

As a starting point in the regional flood planning process, and as required by Senate Bill 8, each flood planning group conducted an inventory and assessment of its area's existing natural features and major constructed infrastructure that manage flooding (TWDB, 2024a). This exercise helped build the foundation for understanding each region's potential investment needs to protect against flood risks and impacts. Existing natural features include rivers, tributaries, and functioning floodplains; wetlands and marshes; playa lakes; ponds; sinkholes; coastal features; parks and preserves; and other natural features. Planning groups were given flexibility to determine what constituted "major" infrastructure, but general types included reservoirs, dams, and weirs; levees and revetments; low water crossings, roadway stream crossings, and bridges; detention and retention ponds; stormwater management systems and components; constructed coastal infrastructure; and other.

To aid the planning groups in this task and establish guidelines for consistency, TWDB (2024a) provided the following definitions to categorize the functionality and condition of major flood infrastructure in each region:

Functionality:

- Functional: The infrastructure is serving its intended design level of service.
- Non-functional: The infrastructure is not providing its intended or design level of service.

Condition:

- Deficient: The infrastructure or natural feature is in poor structural or non-structural condition and needs replacement, restoration, or rehabilitation.
- Non-deficient: The infrastructure or natural feature is in good structural or non-structural condition.

In their assessments, planning groups included a general description of the location, condition, and functionality of each natural feature and constructed major infrastructure. The planning groups identified 1,361,643 major flood infrastructure features across all 15 flood planning regions (TWDB, 2024a). About 96% of these have an unknown functionality, less than 1% were identified as non-functional, and about

3.5% were found to be functional. Planning groups reported an unknown condition for 98% of features and categorized less than 1% as deficient and the remaining 1% as non-deficient. The large percentages of unknown functionality stand out, but it is important to remember that this is not a complete inventory and assessment, and reporting and findings are expected to improve as each subsequent cycle occurs. This information is still significant to this planning cycle and in building a baseline from which to plan.

Another important exercise required of planning groups was cataloging proposed or ongoing flood mitigation projects in their regions (TWDB, 2024a). This included providing a general description of the location, funding source, and anticipated benefits of new structural flood mitigation projects currently under construction; non-structural flood mitigation projects currently being implemented; and structural and non-structural flood mitigation projects with dedicated funding for construction and the expected year of completion. The information was intended to help avoid duplicating efforts and potential conflicts between existing and newly proposed flood projects. The 15 planning groups identified 2,798 ongoing or planned projects and studies across the state. Unfortunately, securing completion dates and costs was challenging. Only about 20% (558) of the proposed and ongoing projects had a known cost, which in total exceeded $8 billion. Nevertheless, the available information contributed to the overall process and goals of the regional plans.

UNDERSTANDING FLOOD RISK

Understanding flood risk is essential to planning for floods. Before this first cycle of regional flood planning, many areas of the state did not know their flood risk (TWDB, 2024a). Some had well-documented, updated flood hazard maps, whereas others were working from very outdated maps or none at all. Flood risk is based on three factors: 1) flood hazard (the magnitude and extent of flooding), potential exposure to that hazard (people and property that might flood), and vulnerability (the degree to which a community and/or critical facilities are affected by that flood hazard and how quickly and easily they may recover)(TWDB, 2024a). The greater each component, the greater the overall flood risk.

Using these three components, the regional planning groups performed flood risk analyses for existing conditions, as well as a future conditions scenario that considered potential changes in flood hazards over a 30-year planning horizon (2023–2053). What resulted was the first comprehensive evaluation of flood risk for the entire state of Texas (TWDB, 2024a).

Existing flood risk

To accomplish the task of analyzing existing condition flood risk, planning groups were required to consider riverine flooding (caused by bank overtopping when the river flow capacity is exceeded), pluvial flooding (caused when stormwater inflow in urban areas exceeds the capacity of drainage systems to infiltrate stormwater into the soil or carry it away), coastal flooding (when normally dry, low-lying land is flooded by seawater), and other possible flood-prone areas (areas that have not been previously identified as mapped flood hazard areas but that were captured in the regional flood planning process through other means)(TWDB, 2024a). TWDB provided the planning groups with access to several datasets for this portion of their plans, including FEMA's National Flood Hazard Layer, base level engineering models, flood insurance rate maps, and cursory floodplain data TWDB acquired (TWDB, 2024a). Groups supplemented these datasets with others such as local studies, federal data, land cover data, and Atlas 14 rainfall data.[1]

The flood hazard analyses revealed the locations and extent of flood hazard areas that are subject to flooding during 1% (100-year) and 0.2% (500-year) annual chance flood events, as well as other known flood-prone areas. As defined in the state flood plan, the 1% floodplain is the land predicted to flood during a 100-year storm event, which has a 1% chance of occurring in any given year; the 0.2% floodplain is the land predicted to flood during a 500-year storm event, which has a 0.2% chance of occurring in any given year (TWDB, 2024a). Nearly one-fourth of Texas's land area is in either the 1% or 0.2% annual chance flood hazard areas, with approximately one-fifth of the

[1] National Oceanic and Atmospheric Administration (NOAA) Atlas 14 is a project of the National Weather Service's Hydrometeorological Design Studies Center that provides precipitation frequency information for the U.S. states and territories. A NOAA analysis released in September 2018 finds significantly higher rainfall frequency values in parts of Texas, redefining the amount of rainfall it takes to qualify as a 100-year or 1,000-year event. The study, published as NOAA Atlas 14, Volume 11 Precipitation-Frequency Atlas of the United States, Texas, found increased values in parts of Texas, including larger cities such as Austin and Houston, that will result in changes to the rainfall amounts that define 100-year events, which are those that on average occur every 100 years or have a 1% chance of happening in any given year. In the Austin area, for example, 100-year rainfall amounts for 24 hours increased as much as 3 inches up to 13 inches. Around Houston, 100-year estimates increased from 13 inches to 18 inches, and values previously classified as 100-year events are now much more frequent 25-year events (NOAA, 2018).

Table 1. Identified existing flood hazard areas (square miles) by flood planning region (Texas Water Development Board, 2024a).

Region	1% (100-year) annual chance floodplain	0.2% (500-year) annual chance floodplain	Flood-prone (unknown annual chance)	Total
1	4,305.21	929.65	0.24	**5,235.10**
2	2,820.71	115.16		**2,935.87**
3	4,882.12	451.21	103.91	**5,437.24**
4	2,310.67	176.21		**2,486.88**
5	3,078.52	374.32	261.91	**3,714.75**
6	1,485.56	471.48	1.25	**1,958.29**
7	3,634.37	1,393.99		**5,028.36**
8	4,688.02	485.21	106.18	**5,279.41**
9	4,521.09	1,127.23		**5,648.32**
10	4,514.84	723.23		**5,238.07**
11	985.62	182.84	1.27	**1,169.73**
12	800.20	124.34	0.05	**924.60**
13	4,577.86	1,287.41	8.32	**5,873.59**
14	9,284.72	1,755.47	98.58	**11,138.77**
15	4,163.14	1,180.61	21.38	**5,365.12**
Total	**56,052.64**	**10,778.35**	**603.09**	**67,434.09**

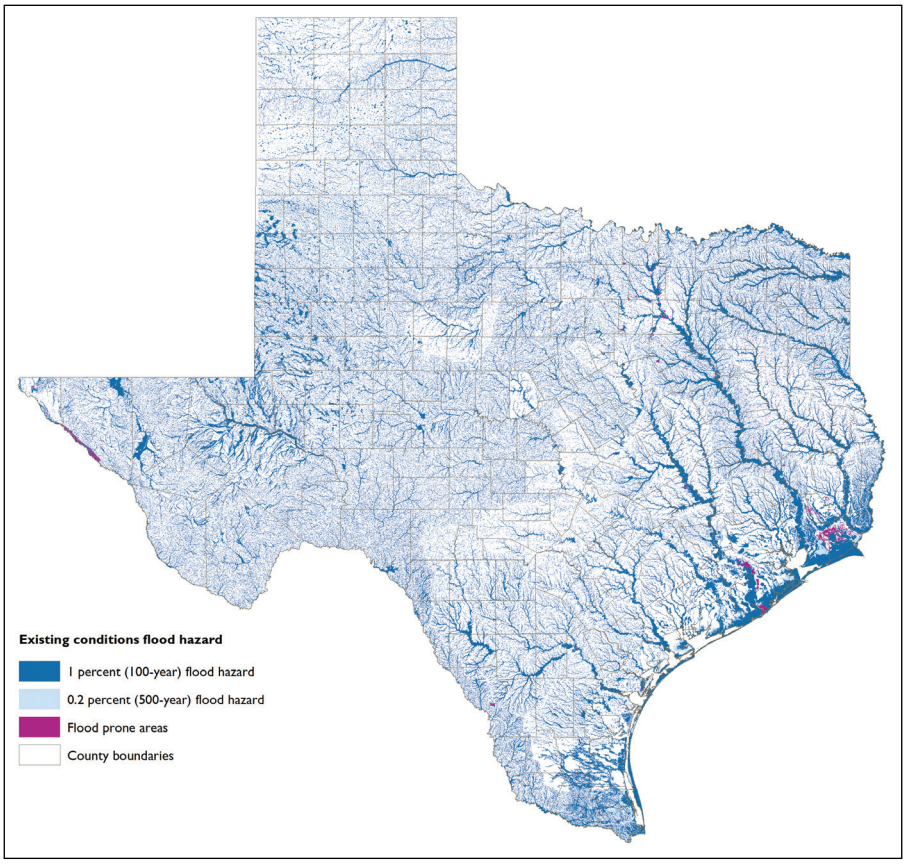

Figure 2. Locations of flood hazards under existing conditions (Texas Water Development Board, 2024a).

Table 2. Summary of statewide existing condition flood exposure (Texas Water Development Board, 2024a).

Flood exposure	1% (100-year) annual chance floodplain	0.2% (500-year) annual chance floodplain	Flood-prone (unknown annual chance)	Total
Population	2,408,561	2,811,347	665,911	**5,885,819**
Buildings[a]	878,098	786,132	125,610	**1,789,840**
Residential buildings	662,107	633,563	106,305	**1,401,975**
Roadway stream crossings (including low water crossings)	69,839	7,669	1,012	**78,520**
Roadway miles	43,444	20,468	1,856	**65,768**
Agricultural areas (acres)	10,200,323	2,453,832	51,695	**12,705,850**
Critical facilities[b]	6,153	8,252	693	**15,098**
Hospitals, emergency medical services, fire stations, police stations, and schools	2,924	3,334	401	**6,659**

Note: All values are counts unless otherwise labeled.

[a] Buildings include all residential, agricultural, commercial, industrial, public, and vacant or unknown.
[b] Critical facilities include hospitals, emergency medical services, fire stations, police stations, schools, shelters, power generation, and water and wastewater treatment plants.

land within the 1% annual chance flood hazard areas (Figure 2, Table 1)(TWDB, 2024a).

The results of the analyses are for purely informational purposes to help communities understand their risks and make more informed decisions. The key findings reflect the use of best available information at the time, creating a solid foundation for all communities but especially those previously lacking this information (TWDB, 2024a). It is important to note that, while this was a significant data-gathering exercise, data gaps still exist—more in some regions than others—for a variety of reasons. Planning groups leveraged the available information to identify needs for potential flood management evaluations (TWDB, 2024a). The hope is that each 5-year cycle of regional flood planning will continue to improve.

After identifying flood hazard locations based on the best available information, the planning groups developed analyses to identify who and what might be in harm's way and to determine if they are located within any flood risk or flood-prone areas (Table 2)(TWDB, 2024a).

Future flood risk

The planning groups were also required to perform future condition flood risk analyses to determine the potential extent of both the 1% (100-year) and 0.2% (500-year) annual chance flood hazard areas looking ahead 30 years into the future (Future Condition Flood Risk Analyses in the Region, 2023).

The planning groups first identified areas in their region for which there were future condition hydrologic and hydraulic model results and maps. In areas where this data was not available, the planning groups could select from TWDB-provided methods for performing the analyses:

1. Increase water surface elevation based on projected percentage population increase;
2. Utilize the existing condition 0.2% annual chance floodplain as a proxy for the future 1% level;
3. Combine methods 1 and 2 or propose another method; or
4. Request that TWDB perform a desktop analysis (TWDB, 2021).

Table 3. Summary of statewide future condition flood exposure (Texas Water Development Board, 2024a).

Flood exposure	1% (100-year) annual chance floodplain	0.2% (500-year) annual chance floodplain	Flood-prone (unknown annual chance)	Total
Population	5,052,378	3,124,151	655,838	**8,832,367**
Buildings[a]	1,618,617	914,219	120,904	**2,653,740**
Residential buildings	1,298,772	750,754	110,260	**2,159,786**
Roadway stream crossings (including low water crossings)	78,320	22,606	923	**101,849**
Roadway miles	59,190	27,564	1,506	**88,260**
Agricultural areas (acres)	12,011,680	3,903,956	24,289	**15,939,925**
Critical facilities[b]	14,581	7,395	545	**22,521**
Hospitals, emergency medical services, fire stations, police stations, and schools	6,182	3,825	286	**10,293**

Note: All values are counts unless otherwise labeled.

[a] Buildings include all residential, agricultural, commercial, industrial, public, and vacant or unknown.
[b] Critical facilities include hospitals, emergency medical services, fire stations, police stations, schools, shelters, power generation, and water and wastewater treatment plants.

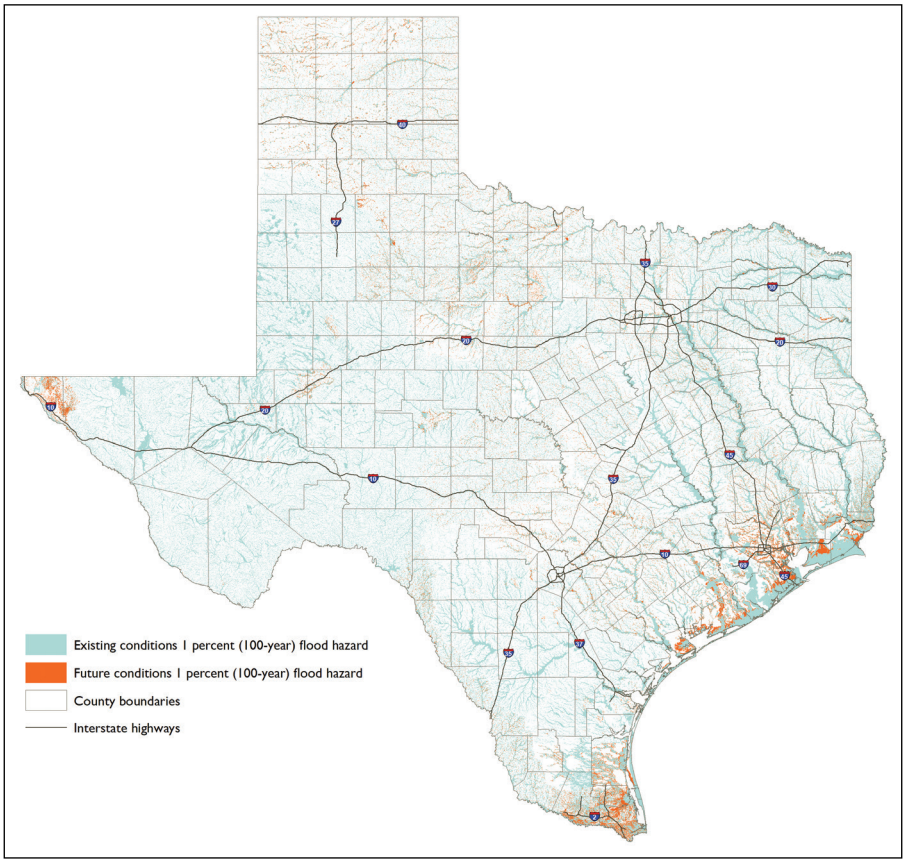

Figure 3. Comparison of existing and future conditions 1% (100-year) annual chance flood hazard area* (Texas Water Development Board, 2024a).

*The extent of the projected future conditions 1% (100-year) annual chance flood hazard area includes the existing conditions 1% (100-year) annual chance flood hazard area.

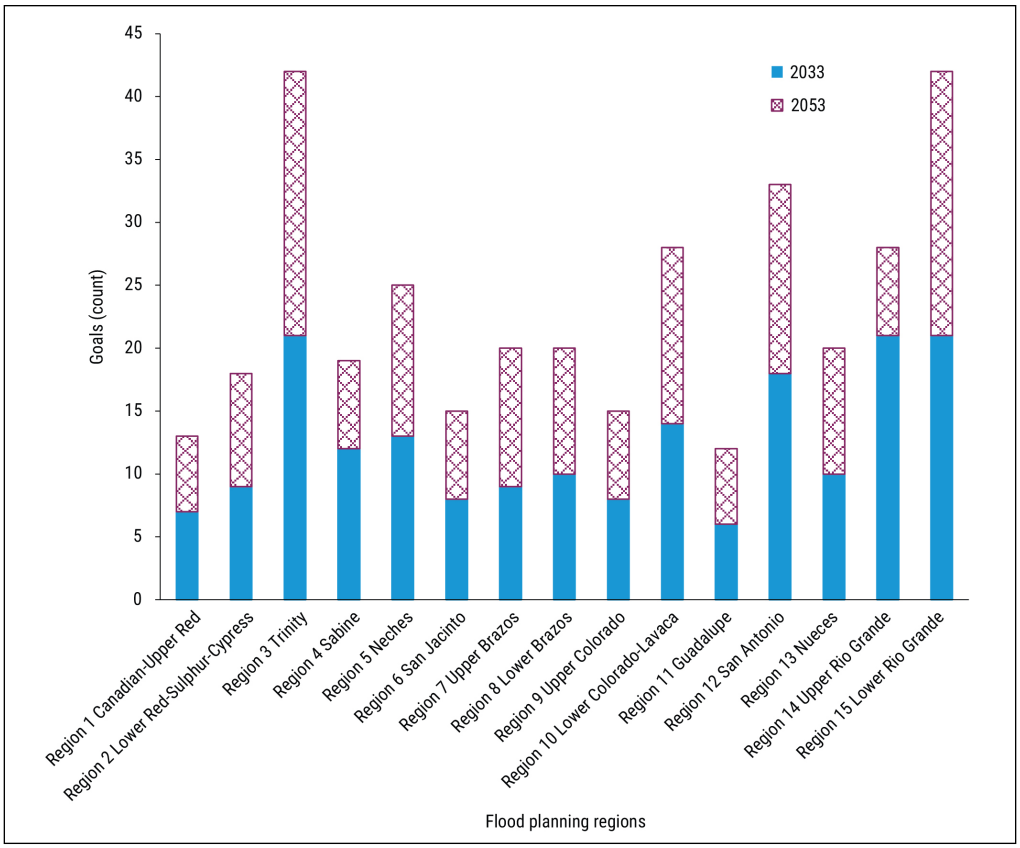

Figure 4. Count of short- and long-term flood planning goals by flood planning region (Texas Water Development Board, 2024a).

Planning groups reported, in summary, that the future condition 1% annual chance flood hazard area is projected to increase by 11% over the existing condition 1% annual chance flood hazard area (Figure 3)(TWDB, 2024a). TWDB is currently working to generate future condition flood hazard coverage for 2060.

As when analyzing existing flood hazards, the planning groups also determined who and what may be harmed in the future 1% and 0.2% annual chance flood hazard areas (Table 3).

GOALS AND SOLUTIONS

To support the overarching flood planning goals identified in the TWC and to help planning groups work toward specific, achievable results, Texas Administrative Code § 361.37 requires the planning groups to identify and adopt short- and long-term goals by 2033 and 2053, respectively (Flood Mitigation and Floodplain Management Goals, 2023).

Goals

The planning groups had considerable latitude when developing their goals. Each was encouraged to consider unique regional characteristics and needs.

Planning groups adopted a total of 350 (187 short-term and 163 long-term) goals (Figure 4)(TWDB, 2024a). Given the diverse geographies, population, and other factors, the number of goals varied among regions, but the average number of goals per region was 17. There were 13 common themes among the adopted goals:

1. conducting flood risk reduction studies (21%);
2. reducing structures and population in the 1% (100-year) and 0.2% (500-year) annual chance event floodplains (16%);
3. implementing flood risk reduction projects (41%);
4. stakeholder and public outreach, education, and training (37%);
5. higher floodplain management standards/policies (23%);
6. roadway safety and early warning systems (17%);
7. infrastructure assessment, maintenance, and rehabilitation (11%);
8. nature-based solutions, green infrastructure, and preservation (9%);
9. funding (9%);
10. reducing flood risk to critical facilities (4%);
11. water supply (1%);
12. nonstructural flood risk reduction (18%); and
13. multiple themes (69%).

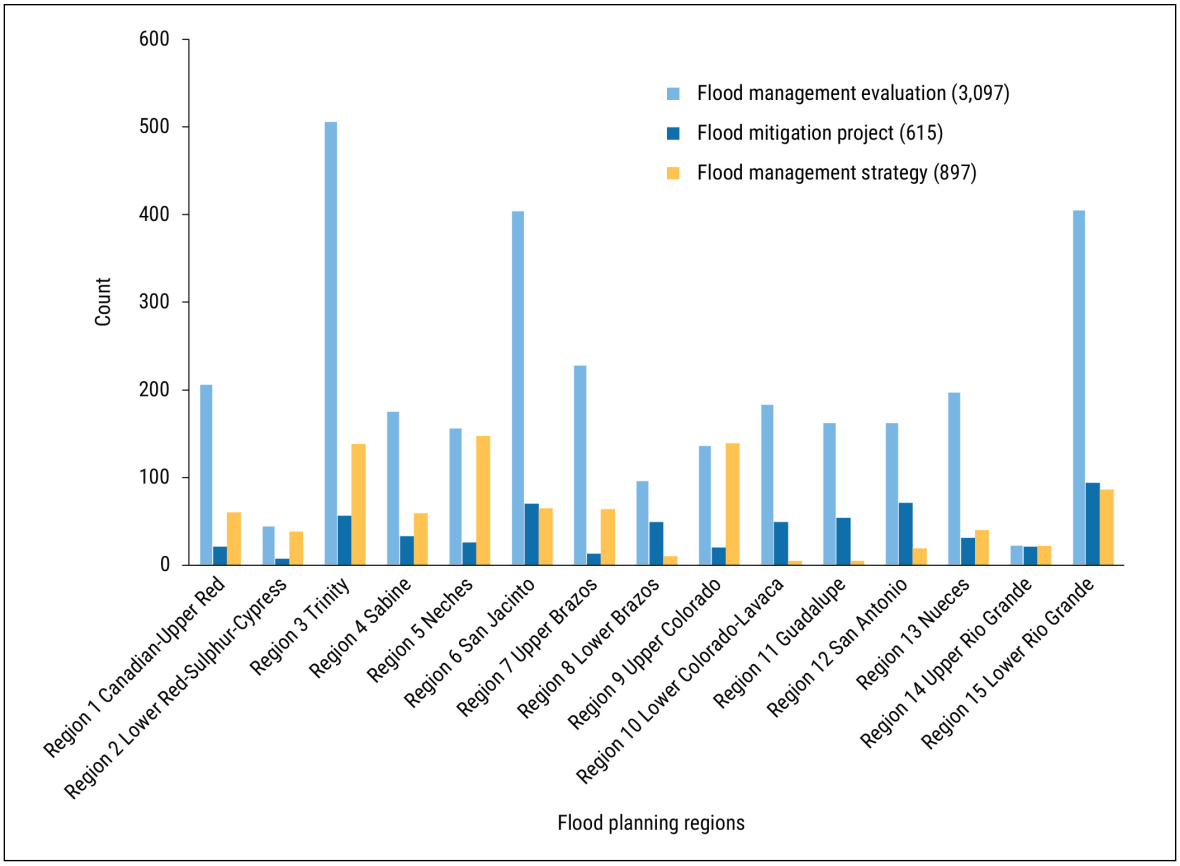

Figure 5. Recommended flood risk reduction solutions by type and region (Texas Water Development Board, 2024a). Note: The flood management strategy count in this table only includes those with non-recurring, non-capital costs.

Approximately 69% (242) of all goals belong to more than one theme (TWDB, 2024a). The most common theme, representing approximately 41% (142) of all goals, is to implement flood risk reduction projects.

During each subsequent 5-year planning cycle, the 15 planning groups will be required to analyze their progress toward each goal from the previous planning cycle. This important step will allow the planning groups to make adjustments to help ensure the goals are still relevant and achievable.

Recommended flood risk reduction solutions

With their goals in mind, the regional planning groups identified, evaluated, and eventually recommended potential flood risk reduction solutions to reduce the risk and impact of flooding across the state (TWDB, 2024a). This multi-step process relied on various data sources, TWDB guidance, and significant stakeholder involvement. It began with identifying areas in greatest need of more data and information that could be gathered through studies and evaluations. Then planning groups identified the areas of greatest known flood risk that would benefit from projects and strategies. Solutions fall within three categories, as defined in the *2024 State Flood Plan*:

1. **Flood management evaluation** — A proposed study to identify, assess, and quantify flood risk or identify, evaluate, and recommend flood risk reduction solutions;
2. **Flood mitigation project** — A proposed structural or nonstructural flood project that has a non-zero capital cost or other non-recurring cost and, when implemented, will reduce flood risk or mitigate flood hazards to life or property;
3. **Flood management strategy** — Ideas and strategies that do not belong in the flood management evaluation or flood mitigation project categories (TWDB, 2024a).

During this first cycle of regional flood planning, TWDB and regional flood planning groups were working on an expedited timeframe, and several groups requested additional time and money from TWDB to amend their initial regional plans with more projects (TWDB, 2024a). TWDB responded by providing the planning groups with additional funding and 6 extra months. This resulted in roughly tripling the number of projects for inclusion in the state flood plan. In total, the planning groups recommended 4,609 flood risk reduction solutions (Figure 5).

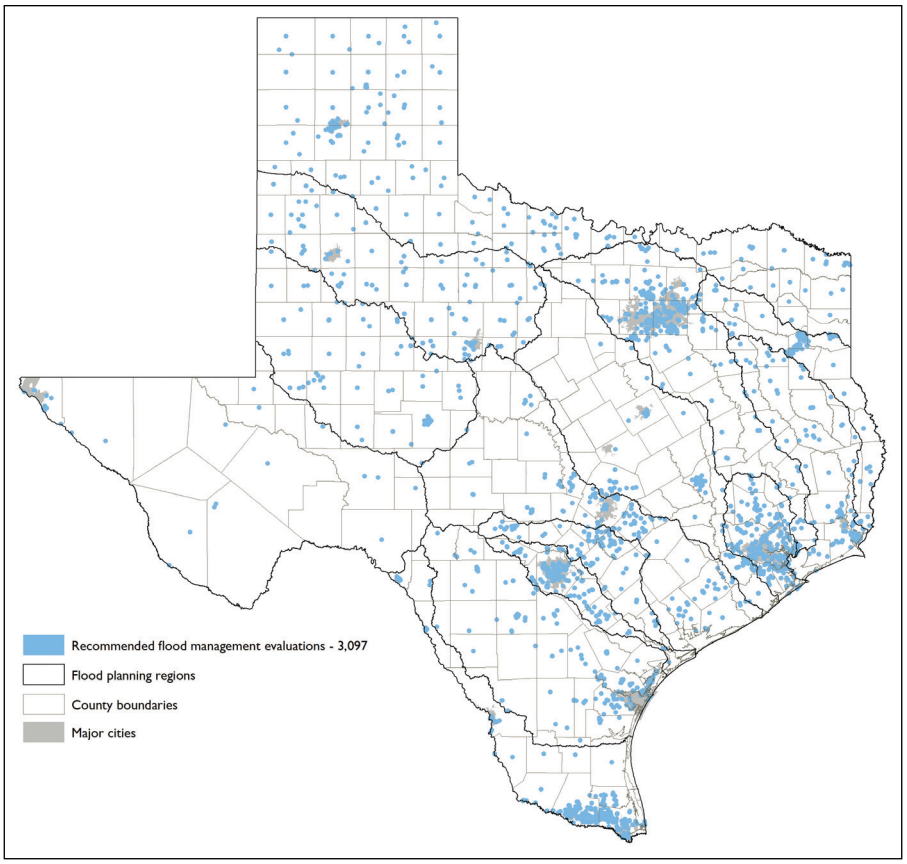

Figure 6. Locations of flood management evaluations recommended by the regional flood planning groups (Texas Water Development Board, 2024a).

Flood management evaluations:

Planning groups recommended 3,097 flood management evaluations within four general categories: engineering project planning (1,983), flood preparedness studies (57), watershed planning (895), and other (162)(Figure 6)(TWDB, 2024a). The recommended flood management evaluation boundaries cover approximately 81% of Texas's total land area. Performing these evaluations would contribute to significant progress in addressing flood data knowledge gaps and high flood risk areas because, as confirmed through the planning process, many parts of Texas have limited and/or outdated floodplain maps.

Flood mitigation projects:

Planning groups recommended 615 flood mitigation projects that would reduce or remove flood risk exposure within the 1% (100-year) and 0.2% (500-year) annual chance floodplains (Figure 7, Table 4)(TWDB, 2024a). To be recommended in regional plans, statute requires that potential projects have "no negative impact" on neighboring areas, meaning reducing one location's flood risk cannot increase the flood risk in neighboring upstream or downstream locations (Regional Flood Planning, 2019). Additionally, potential projects must be permittable, constructable, and implementable (TWDB, 2021). Flood mitigation projects are generally categorized as either structural (projects that involve building or modifying infrastructure) or nonstructural (strategies that do not involve constructing physical barriers or altering the natural flow of water)(TWDB, 2024a).

Planning groups recommended 542 structural projects, of which the most prevalent types are infrastructure projects, followed by low water crossings or bridge improvements, and comprehensive regional projects (TWDB, 2024a). Unsurprisingly, most low water crossings or bridge improvements were recommended by regions within Flash Flood Alley, the region that follows the curve of the Balcones Escarpment from Dallas to Austin and extends just southwest of San Antonio. A total of 73 projects were classified as nonstructural, of which 53 are preparedness studies, 13 are property acquisition, four are property elevation, and three are other types. All but three regions—Region 5 Neches, Region 13 Nueces, and Region 15 Lower Rio Grande—recommended at least one nonstructural project in their plans.

Table 4. Anticipated benefits of flood mitigation project implementation on population and structures currently exposed to 100-year flood risk within project area (Texas Water Development Board, 2024a).

Flood exposure	Existing exposure within project area	Flood risk reduction[a]	Remaining flood risk
Population	1,974,127	640,507	1,333,620
All buildings[b]	637,178	155,905	481,273
Residential buildings	486,767	112,609	374,158
Critical facilities[c]	10,055	2,597	7,458
Low water crossings	1,060	199	861
Roadway miles	12,779	2,329	10,450
Road closures	19,251	5,567	13,684

Note: Quantities are as reported by the flood planning groups and may contain overlap between flood mitigation project boundaries.

[a] As identified by the regional flood planning groups.
[b] Includes all residential, agricultural, commercial, industrial, public, and vacant or unknown.
[c] Includes hospitals, emergency medical services, fire stations, police stations, and schools.

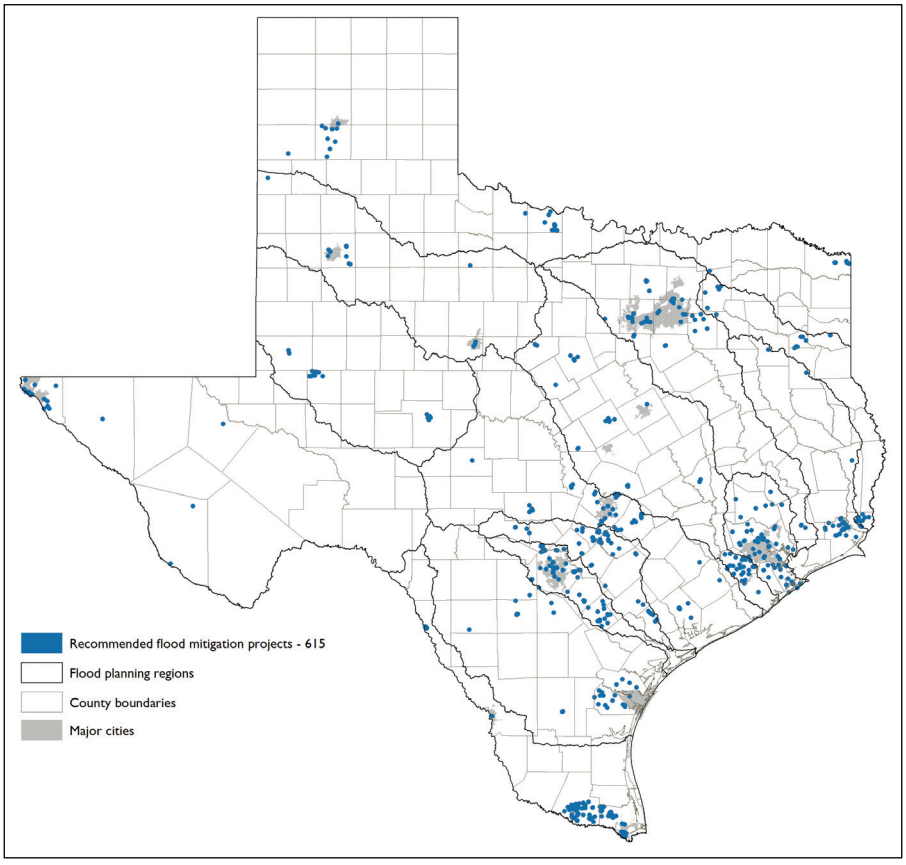

Figure 7. Locations of recommended flood mitigation projects (Texas Water Development Board, 2024a).

Table 5. Anticipated benefits of recommended flood management strategy implementation on existing 100-year flood event exposure (Texas Water Development Board, 2024a).

Flood exposure	Existing risk	Risk reduction[a]	Residual risk
Population	15,283,833	202,832	15,081,001
All buildings[b]	4,608,800	58,387	4,550,413
Residential buildings	3,632,286	40,137	3,592,149
Critical facilities[c]	31,477	84	31,393
Low water crossings	34,391	378	34,013
Roadway miles	180,661	5,874	174,787
Road closures	54,648	199	54,449
Agricultural areas (acres)	36,924,302	974,284	35,950,018

Note: All quantities are counts unless otherwise noted. Quantities are approximate and may contain overlap between some strategy boundaries.

[a] As identified by the regional flood planning groups.
[b] Includes all residential, agricultural, commercial, industrial, public, and vacant or unknown.
[c] Includes hospitals, emergency medical services, fire stations, police stations, and schools.

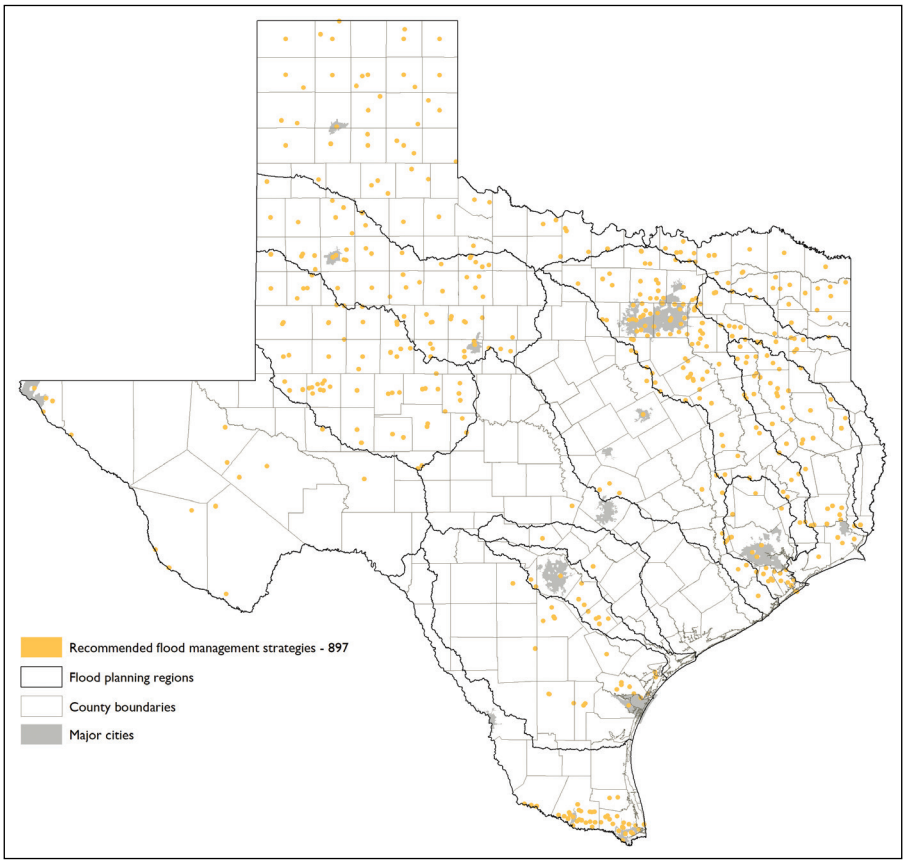

Figure 8. Locations of all recommended flood management strategies (Texas Water Development Board, 2024a).

Flood management strategies:

Planning groups recommended 897 flood management strategies, including those categorized as regulatory and guidance, flood measurement and warning, education and outreach, infrastructure projects, property acquisition and structural elevation, and other (Figure 8, Table 5)(TWDB, 2024a). The planning groups were required to demonstrate that each recommended flood management strategy meets the following four criteria, as applicable:

- reduces the potential impacts of flooding;
- mitigates for flood events associated with a 1% annual

chance storm event; if not feasible, strategies that mitigate more frequent events were allowed but an explanation was required;
- includes measurable reductions in flood impacts in support of the region's specific flood mitigation and/or floodplain management goals; and
- must not result in an overallocation of a water source based on the water availability allocations in the most recently adopted state water plan (TWDB, 2021).

Statute also requires TWDB to determine that each regional flood plan adequately provides for water supply source development, where applicable (Regional Flood Planning, 2019). Regional flood plans must include summaries and a list of their strategies and projects that would positively or negatively impact water supply (TWDB, 2021). Of the 15 planning regions, four groups recommended solutions that may provide water supply benefits (TWDB, 2024a). Region 11 Guadalupe, Region 12 San Antonio, and Region 15 Lower Rio Grande recommended a total of 37 projects that would provide some water supply benefit if implemented. These projects include detention ponds, aquifer recharge, and natural area conservation easements. Region 14 Upper Rio Grande recommended one flood management strategy with potential water supply benefit. Together, these projects and strategy would generate an estimated volume of 2,071 acre-feet per year.

The final evaluations, projects, and strategies underwent a rigorous process from ideation to inclusion in each regional flood plan and beyond to the state flood plan. TWDB took the recommendations a step further per TWC § 16.061, which requires the state flood plan to include a ranked list of all recommended flood risk reduction solutions (State Flood Plan, 2019). Appendix B of the *2024 State Flood Plan* includes three separate lists of ranked evaluations, projects, and strategies with non-recurring, non-capital costs (TWDB, 2024a).

To accomplish a ranked list of all recommended flood risk reduction solutions, TWDB developed a proposed ranking methodology and solicited stakeholder feedback in spring 2023 (TWDB, 2024a). Overall, the methodology intended to provide a consistent approach to systematically address flood hazard with the population, properties, and critical facilities most at risk during a 1% (100-year) annual chance storm event. The ranking only utilized data provided by planning groups' regional flood plans, with one exception: Using data reported by the planning groups, TWDB calculated the percent of structures removed from the 1% annual chance floodplain. Prior to publishing the initial draft of the *2024 State Flood Plan,* TWDB sought feedback from the TWDB Flood Technical Advisory Group and held two rounds of flood planning stakeholder input.

Table 6. Count and cost of recommended flood risk reduction solutions (Texas Water Development Board, 2024a).

Solutions	Count	Cost
Flood management evaluations	3,097	$2.6B
Flood mitigation projects	615	$49.1B
Flood management strategies[a]	771	$2.8B
Total	**4,483**	**$54.5B**

[a] Includes both implementation costs and non-recurring, non-capital costs. The 771 strategies with non-recurring, non-capital costs are included in the state flood plan ranking and are eligible for the Flood Infrastructure Fund.

FINANCING THE RECOMMENDED SOLUTIONS

Identifying existing flood risk, future flood risk, and feasible solutions to mitigate that risk is a tremendous accomplishment—especially because this was the first time that work has been done for the entire state. Armed with that information, the planning groups were required to indicate how sponsors (local governments, regional authorities, and other political subdivisions) propose to fund their region's recommendations.

Aside from one-time costs for activities like studies, the estimated capital costs of all flood risk reduction solutions recommended by the 15 regional flood planning groups in the inaugural state flood plan total approximately $54.5 billion dollars (Table 6)(TWDB, 2024a). Capital costs are defined as costs for which project sponsors typically would borrow funds and establish repayment through annual debt service. Of the $54.5 billion, 49% ($24 billion) is associated with the Galveston Bay Surge Protection Coastal Storm Risk Management project recommended by Region 6 San Jacinto.

The planning groups administered a funding survey toward the end of the planning cycle. While the overall survey response rate was generally low, the planning groups indicated that many local sponsors may require 80%–90% of the costs in financial assistance to implement solutions (Table 7)(TWDB, 2024a). Local sources, state and federal financial assistance, or other revenue funding sources may be options for communities.

Created in 2019, TWDB's Flood Infrastructure Fund is one such program available to entities (Tex. S.B. 7, 86th Leg., R.S., 2019). With the initial $793 million allocated to the program for financial assistance, TWDB has committed nearly $644 million through loans and grants to local governments to finance drainage and flood mitigation projects in the 2020 Flood Intended Use Plan (TWDB, 2024b). Now that the *2024 State Flood Plan* has been adopted, only recommended flood management evaluations, flood mitigation projects,

Table 7. Estimated cost, reported available funding, and unmet need for all recommended flood risk reduction solutions as identified by the regional flood planning groups* (Texas Water Development Board, 2024a).

	Flood management evaluations[a]			Flood mitigation projects			Flood management strategies		
Region	Estimated cost	Available funding	Unmet need	Estimated cost	Available funding	Unmet need	Estimated cost	Available funding	Unmet need
1	$89.0M	$24.5M	$64.5M	$121.0M	$34.4M	$86.6M	$13.4M	$175.0K	$13.2M
2	$37.9M	$0.0	$37.9M	$52.2M	$0.0	$52.2M	$4.5M	$0.0	$4.5M
3	$220.6M	$24.9M	$195.6M	$703.5M	$70.3M	$633.1M	$745.4M	$81.2M	$664.2M
4	$81.3M	$0.0	$81.3M	$3.3B	$836.5M	$2.4B	$112.4M	$0.0	$112.4M
5	$88.9M	$12.5M	$76.4M	$4.3B	$1.0B	$3.3B	$175.0M	$0.0	$175.0M
6[b]	$905.4M	$2.3M	$903.0M	$31.7B	$8.5B	$23.2B	$1.2B	$2.4M	$1.2B
7	$84.3M	$1.0M	$83.3M	$48.8M	$15.5M	$33.3M	$13.2M	$0.0	$13.2M
8	$29.6M	$0.0	$29.6M	$4.3B	$0.0	$4.3B	$366.4M	$0.0	$366.4M
9	$73.0M	$440.0K	$72.5M	$184.7M	$1.5M	$183.2M	$7.6M	$0.0	$7.6M
10[c]	$62.2M	$0.0	$62.2M	$379.2M	$0.0	$379.2M	$0.0	$0.0	$0.0
11	$85.7M	$0.0	$85.7M	$394.2M	$0.0	$394.2M	$33.5M	$0.0	$33.5M
12	$349.4M	$0.0	$349.4M	$739.0M	$0.0	$739.0M	$999.0K	$0.0	$999.0K
13	$284.5M	$4.8M	$279.7M	$1.2B	$0.0	$1.2B	$20.3M	$0.0	$20.3M
14	$7.6M	$636.2K	$7.0M	$507.8M	$4.8M	$502.9M	$3.6M	$263.1K	$3.3M
15	$227.2M	$0.0	$227.2M	$1.1B	$0.0	$1.1B	$145.0M	$0.0	$145.0M
Total	**$2.6B**	**$71.2M**	**$2.6B**	**$49.1B**	**$10.5B**	**$38.6B**	**$2.8B**	**$84.1M**	**$2.8B**

* Zero or low available reported funding may be partially due to lack of survey responses.

[a] For flood management evaluations, estimated cost includes only the non-construction costs. However, for some flood management evaluations in regions 1, 5, 7 and 9, available funding includes the local sponsor share for the total of non-construction and construction costs.

[b] Value includes the Region 6 San Jacinto-recommended Galveston Bay Surge Protection Coastal Storm Risk Management project with an estimated cost of $24 billion.

[c] Region 10 did not include cost information for its recommended flood management strategies.

and flood management strategies included in the plan and future amendments are eligible for funding from the Flood Infrastructure Fund (Use of Infrastructure Fund, 2023). In 2023, the 88th Texas Legislature appropriated an additional $624 million in funding that will go toward new Flood Infrastructure Fund projects under the 2024–2025 Flood Infrastructure Fund Intended Use Plan (Tex. S.B. 30, 88th Leg., R.S., 2023).

CONCLUSION

The *2024 State Flood Plan* represents a historic accomplishment that will have far-reaching impacts throughout Texas, from coastal communities to the Panhandle plains, and from arid West Texas to the Pineywoods. Communities everywhere, whether they have experienced the devastation of flooding personally or supported others impacted, should know their flood risk and have the tools and information to plan ahead.

The Interactive State Flood Plan Viewer (www.texasstatefloodplan.org), a component of the *2024 State Flood Plan,* enables users to take an in-depth look at the *2024 State Flood Plan* data. The viewer displays, summarizes, and disseminates at varying geographic scales all data generated by the TWDB state flood planning process, including existing infrastructure, flood hazard areas and exposure, critical and other infrastructure at risk, recommended flood risk evaluations, flood mitigation project recommendations, and more (Figures 9 and 10).

This effort to understand and plan to mitigate Texas's statewide flood hazards and risks is an example of what can be accomplished when experts, stakeholders, and others with an interest in Texas's future come together with common goals. The 15 regional plans and state flood plan would not have been possible without the dedication and commitment by the hundreds of people who spent countless hours on them. Between the program's inception in October 2020 and completion of the first state flood plan, the 15 planning groups conducted more than 550 public flood planning meetings across the state and navigated this process with all the challenges brought by the COVID-19 pandemic and a shorter-than-normal planning cycle (TWDB, 2024a).

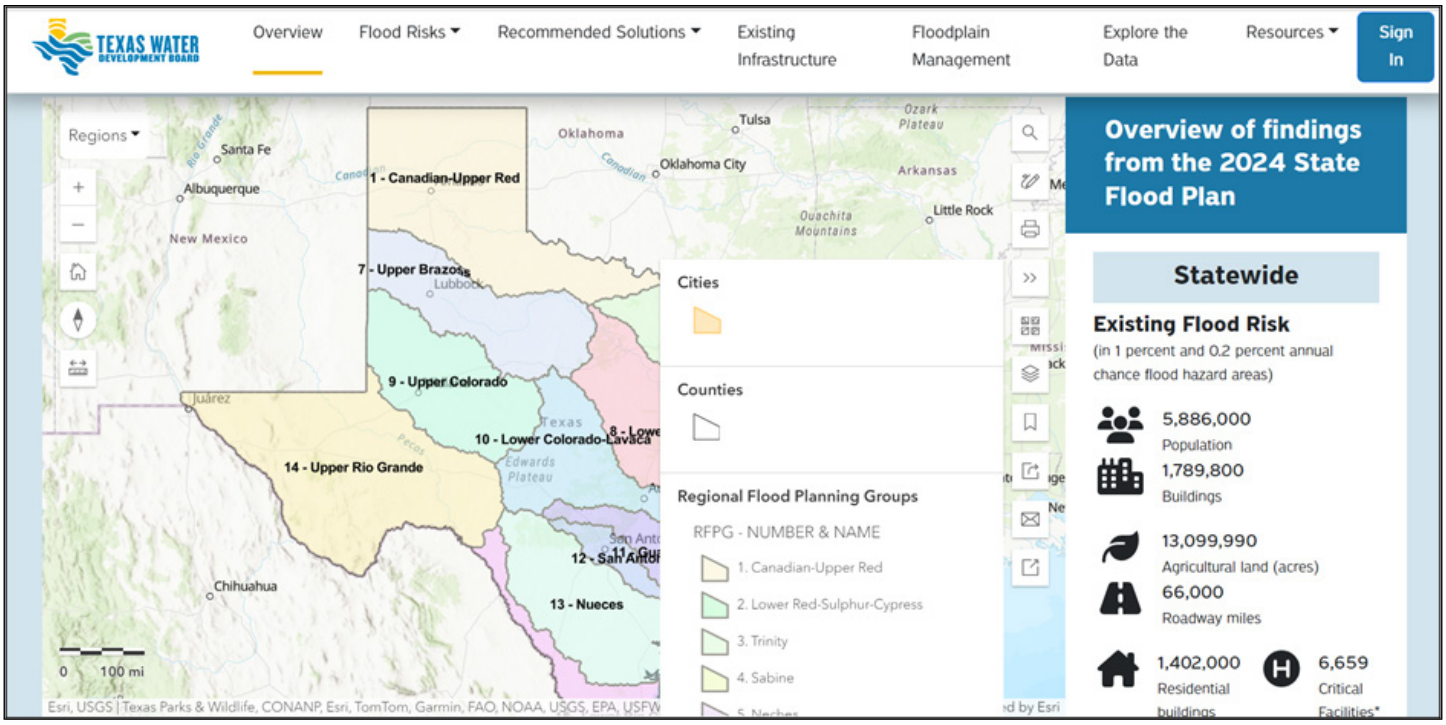

Figure 9. The Interactive State Flood Plan Viewer.

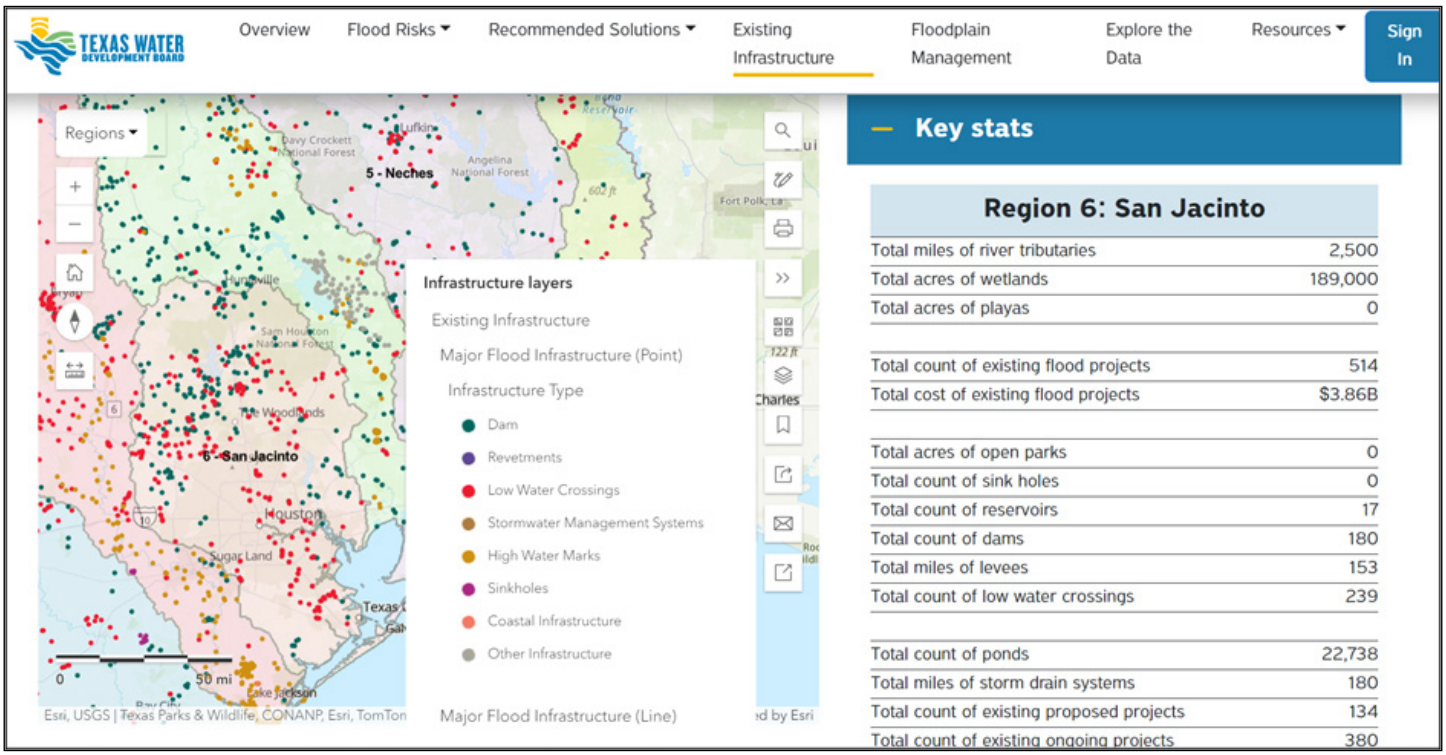

Figure 10. Example of regional data available in the Interactive State Flood Plan Viewer.

With the first cycle of regional and state flood planning in the history books, it is now time to look ahead to future planning cycles that will build off the valuable data and information in this plan, and, more importantly, to all the evaluations, projects, and strategies that will be implemented as a result.

Time and time again it has been proven that anywhere it can rain, it can flood. But with the regional and state flood plans in place, communities already have better data than before and vetted, proposed solutions to make informed, preventative decisions for the future to protect life and property.

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