Appendices

Appendix A Regional summaries of future condition analysis methodologies

As described in Chapter 4, the first step in determining the future extent of both the 1 percent (100-year) and 0.2 percent (500-year) annual chance event flood hazard areas was for the regional flood planning groups to identify areas within each region where future condition hydrologic and hydraulic model results and maps were available. For areas where future condition flood hazard data was not available, the TWDB provided four methods for performing future condition flood hazard analyses. The methods available to the regional flood planning groups for estimating future flood risk included:

- Method 1 - Increasing water surface elevation based on projected percentage population increase (as proxy for development of land areas);
- Method 2 - Utilizing the existing condition 0.2 percent (500-year) annual chance floodplain as a proxy for the future 1 percent (100-year) level;
- Method 3 - A combination of methods 1 and 2 or another method proposed by the planning group; and
- Method 4 - Planning groups could request that the TWDB perform a desktop analysis.

A summary of each region's approach is as follows.

Region 1 Canadian-Upper Red

Region 1 Canadian-Upper Red utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard areas. Region 1 was unique in that it combined the 0.1 percent annual chance cursory floodplain data provided in July 2021 with the 0.2 percent (500-year) annual chance cursory data provided by the TWDB in October 2021. Discrepancies due to varied topography and sampling densities were reconciled by adopting the larger boundary from either the 0.1 percent (100-year) or 0.2 percent (500-year) annual chance flood hazard areas as the new flood hazard boundary, ensuring that the future 0.2 percent (500-year) annual chance flood hazard area will always be equal to or larger than the future 1 percent (100-year) annual chance flood hazard area.

Region 2 Lower Red-Sulphur-Cypress

Region 2 Lower Red-Sulphur-Cypress utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard area. The future 0.2 percent (500-year) annual chance flood hazard area was established based on the difference in widths between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas.

Region 3 Trinity

Region 3 Trinity utilized Method 2 to identify the future 1 percent annual chance flood hazard area. A 40-foot buffer extending from the 1 percent (100-year) annual chance flood hazard area was selected to serve as the potential maximum 0.2 percent (500-year) chance flood hazard area.

Region 4 Sabine

Region 4 Sabine utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard area. Where surface water elevation data is available, a vertical buffer consistent with the difference between the 1 percent (100-year) and 0.2 percent (500-year) annual chance water surface elevations was added to the future 1 percent (100-year) water surface elevation to determine the 0.2 percent (500-year) water surface elevation. In areas without water elevation data, horizontal buffer widths were estimated to determine the difference between the 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas. This difference was applied as a horizontal buffer to the future 1 percent (100-year) annual chance flood hazard area to determine the extents of the future 0.2 percent (500-year) annual chance flood hazard area. The horizontal buffer used varied from 5 to 20 meters depending on the existing topography.

Region 5 Neches
Due to the presence of flood control reservoirs in the region, Region 5 Neches utilized more than one method for determining the future 1 percent (100-year) annual chance flood hazard area. Downstream of the Sam Rayburn Reservoir, the existing flood hazard extent will be maintained for future flood hazard areas. For tributaries feeding into larger rivers within the Neches Basin, the existing 0.2 percent (500-year) annual chance flood hazard area was used as the future 1 percent (100-year) annual chance flood hazard area. This approach was utilized in all streams present in the region, barring the segment of the Neches River downstream of the Sam Rayburn Reservoir. In areas where base level engineering (BLE) data is determined to be the best available, the elevation difference between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance water surface elevations was used as the vertical buffer between the future 1 percent (100-year) and 0.2 percent (500-year) water surface elevations. Where National Flood Hazard Layer (NFHL) Effective data is considered the best available, a horizontal buffer based on the distance between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance floodplains was used to establish the future 0.2 percent (500-year) annual chance flood hazard area.

Region 6 San Jacinto
Region 6 San Jacinto utilized Method 3 to identify the future 1 percent (100-year) annual chance flood hazard area. This meant using the existing 0.2 percent (500-year) annual chance flood hazard area for much of the future 1 percent (100-year) annual chance flood hazard area extent, with the addition of a subsidence buffer and a sea level rise buffer that is applied, as needed, throughout the region. For the future 0.2 percent (500-year) annual flood hazard area, the existing 0.2 percent (500-year) annual chance flood hazard area was buffered by either 500-feet or 850-feet, based on the zone within the region. Additional horizontal buffers accounting for subsidence and sea level rise were applied where applicable.

Region 7 Upper Brazos
Region 7 Upper Brazos applied two different methods for estimating future flood hazard areas, as determined by whether the location is on or off the Caprock, a geological feature in the Texas Panhandle, marking the southern edge of the High Plains. The portion of the river basin that is on the Caprock will maintain the existing flood hazard area for both the future 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas. For the area off the Caprock, the potential future 1 percent annual chance flood hazard area was approximated as a range between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas. The planning group opted to hold the existing 0.2 percent (500-year) annual chance flood hazard area as the future 0.2 percent (500-year) annual chance flood hazard area until further studies are available.

Region 8 Lower Brazos
Region 8 Lower Brazos utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard area. In areas where water surface elevation data is available, a vertical buffer based on the difference between existing 1 percent (100-year) and 0.2 percent (500-year) water surface elevations was applied to the future 1 percent (100-year) water surface elevation to approximate the future 0.2 percent (500-year) annual chance water surface elevation. For other areas, the future 1 percent annual chance flood hazard area was set to match the existing 0.2 percent (500-year) annual chance flood hazard area. Then, typical horizontal buffer widths were estimated in each Hydrologic Unit Code (HUC-8) watershed for rivers, major tributaries, and local streams to determine the thickness of the existing 0.2 percent (500-year) annual chance flood hazard area. This buffer was applied to the future 1 percent (100-year) annual chance flood hazard area to determine the extent of the future 0.2 percent (500-year) annual chance flood hazard area. The planning group determined that the flood hazard areas along the mainstem of the Brazos River should not be modified from existing to proposed conditions due to the large size of the watershed, attenuation of floodwaters by large flood control reservoirs and floodplains,

and results from a 2021 study which concluded that drastic changes in discharge would be necessary to significantly increase the 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas.

Region 9 Upper Colorado

Region 9 Upper Colorado utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard area. In urban areas, the future 0.2 percent (500-year) annual chance flood hazard area was estimated by adding the average difference between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas to the future 1 percent (100-year) annual chance flood hazard area. Population is not projected to increase significantly in the rural portions of the region, so the future 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard area occupy the same extent as existing flood hazard areas.

Region 10 Lower Colorado

Region 10 Lower Colorado utilized Method 2 to identify the future 1 percent annual chance flood hazard area. The future 0.2percent (500-year) annual chance flood hazard area was estimated using a buffer based on the measured difference between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas.

Region 11 Guadalupe

Region 11 Guadalupe utilized Method 2 to identify the future 1 percent (100-year) annual chance flood hazard area. The planning group elected to use base level engineering (BLE) data as a starting point for the analysis due to the full coverage of the dataset throughout the basin. The difference in water surface elevation between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas was added to the existing 0.2 percent (500-year) base level engineering water surface elevation as a vertical buffer, then mapped against the existing terrain to create the future 0.2 percent (500-year) annual chance flood hazard area. In select areas where the extent of the future 0.2 percent (500-year) flood hazard area was smaller than the existing 0.2 percent (500-year) flood hazard area, a horizontal buffer based on the difference between the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard areas was added to the existing 0.2 percent (500-year) annual chance flood hazard area to create the boundary for the future 0.2 percent (500-year) flood hazard area.

Region 12 San Antonio

Region 12 San Antonio utilized Method 2 to identify the future 1 percent annual chance flood hazard area. The future 0.2 percent (500-year) annual chance flood hazard area was estimated based on hydraulic modelling that considered predicted increases in precipitation and subsequent increased peak stormflow during 0.2 percent (500-year) annual chance events. Four horizontal buffers resulted from this analysis based on subregion: Medina, Upper, Mid, and Coastal. The horizontal buffer was applied to each side of the existing 0.2 percent (500-year) annual chance flood hazard area to develop the future 0.2 percent (500-year) annual flood hazard area.

Region 13 Nueces

Region 13 Nueces utilized Method 3 to estimate the future 1 percent (100-year) and 0.2 percent (500-year) Annual Chance Event flood hazard area. In the more densely populated portions of the region, the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard area was buffered based on the estimated percent population increase to determine the future 1 percent (100-year) and 0.2 percent (500-year) flood hazard areas. In the less populated areas, population is not anticipated to significantly increase and thus the existing flood hazard extents were used for the future 1 percent (100-year) and 0.2 percent (500-year) flood hazard areas. The coastal portions of the region were divided into five zones based on their primary river system and further divided based on observed topography.

The planning group used the National Oceanic Atmospheric Administration 2022[68] intermediate sea level rise estimate of 1.1 foot and applied an appropriate offset to the existing 1 percent (100-year) and 0.2 percent (500-year) annual chance coastal flood inundation boundaries to determine the future 1 percent (100-year) and 0.2 percent (500-year) flood hazard areas in coastal zones.

Region 14 Upper Rio Grande

Region 14 Upper Rio Grande utilized Method 3 to estimate the future 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard area. Different future conditions analysis methods were utilized for El Paso County and for the remainder of the Upper Rio Grande region outside of El Paso County. In El Paso County, future condition flood risk was estimated by developing new future condition 2D models with considerations for future land use and precipitation. Outside El Paso County, future condition flood risk was identified by estimating areas of future development and by using the existing condition floodplains as a proxy for future condition floodplains within those areas. Subsequently, future flood hazard areas in El Paso County were increased by a significantly greater degree than those outside of El Paso County. Where the future condition adjustments within El Paso County resulted in a total future condition flood hazard area between 1.5 – 2 times the size of the total existing condition flood hazard area, adjustments outside of El Paso County resulted in only a 1 percent increase in the flood hazard area change.

Region 15 Lower Rio Grande

Region 15 Lower Rio Grande utilized Method 2 to identify the future 1 percent (100-year) and 0.2 percent (500-year) annual chance flood hazard area. Typical horizontal buffer widths were estimated in each hydrologic unit-8 for "hilly" terrain and flat coastal areas to determine the existing thickness of the 0.2 percent (500-year) annual chance flood hazard area. The buffer was then applied to the future 1 percent (100-year) annual chance flood hazard areas to determine the extent of the future 0.2 percent (500-year) annual chance flood hazard area.

[68] https://oceanservice.noaa.gov/hazards/sealevelrise/sealevelrise-tech-report.html

Appendix B Ranked lists of recommended flood risk reduction solutions

Texas Water Code § 16.061 requires the state flood plan to include a ranked list of all recommended flood risk reduction solutions. Ranking methodologies primarily focused on criteria related to flood risk and flood risk reduction to life and property.

The overarching goal of the regional and state flood plans is to protect against the loss of life and property by (1) identifying and reducing the risk and impact to life and property that already exists, and (2) avoiding increasing or creating new flood risks by addressing future development within areas known to have existing or future flood risks. The ranking criteria and methodology are generally intended to

- identify areas with the worst existing risk of flooding in the 1 percent (100-year) annual chance floodplain;
- identify flood risk mitigation solutions that may result in greater overall reduction in flood risk;
- and primarily focus on projects with the greater potential to mitigate the risk to life and property.

The TWDB's state flood plan flood risk reduction solutions ranking methodology is intended to provide a consistent approach for use across Texas to systematically address flood hazard with the population, properties, and critical facilities most at risk during a 1 percent (100-year) annual chance event. The ranking process aims to focus on severity of flood risk and reducing flood risk and impact to life and property as described by the legislature. The basic approach is described in Chapter 7 of this text.

The results of TWDB flood risk reduction solutions rankings as described in Chapter 7 include three ranked lists of flood risk reduction solutions

- B.1 Recommended flood management evaluations;
- B.2 Recommended flood mitigation projects; and
- B.3 Recommended flood management strategies with non-recurring, non-capital costs.

These ranked lists are available for review and download on the 2024 State Flood Plan website: https://www.twdb.texas.gov/flood/planning/sfp/index.asp.

Appendix C Summary of available key federal and state funding sources

Historically, federal grant programs related to floodplain management, planning, mitigation, and mapping activities typically offer greater financial assistance than what is available at the local or state level. Some federal programs are not tied to a specific disaster and are open annually as the U.S. Congress authorizes funding. Texas competes with other states for funds from programs such as Cooperating Technical Partners, Flood Mitigation Assistance, and Building Resilient Infrastructure and Communities. In some cases, flood-related projects also compete with other types of non-flood-related projects, such as wildfire management, earthquake preparedness, and backup power generation. Other funding programs are tied to specific declared disasters (e.g., Hurricane Harvey), such as the Hazard Mitigation Grant Program and the Community Development Block Grant – Disaster Recovery program.

The financial assistance programs summarized in Chapter 9 are categorized as state or federal based on the original source of funds. Some federal programs are administered at the state level and may include a state contribution. The following table includes examples of other state and federal flood funding programs, but it is not an exhaustive list of potential state and federal funding sources for flood mitigation. There are many other programs that focus on different areas of need in communities, such as transportation, research, or public education, but the funding may also support activities associated with flood mitigation. Additional references to seek more information on potential funding sources include the Texas Flood Information Clearinghouse,[69] American Flood Coalition,[70] and the Texas General Land Office's MATCH Tool[71] that is currently under development.

69 http://www.texasfloodclearinghouse.org/

70 http://www.floodcoalition.org/fundingfinder/#home

71 http://www.match-tool-hub-dewberry.hub.arcgis.com/

Table C-1. Summary of available key federal and state funding sources

Source	Federal agency	State agency	Program name	Grant/loan /both	Post-disaster	Cost share (federal or state/local)	Benefit-cost analysis required
Federal	FEMA	TWDB	Flood Mitigation Assistance Grant program	X	-	Yes	Yes
	FEMA	TDEM	Building Resilient Infrastructure and Communities	X	-	Yes	Yes
	FEMA	TDEM	Safeguarding Tomorrow through Ongoing Risk Mitigation	X	-	Yes	No
	FEMA	TCEQ	Rehabilitation of High Hazard Potential Dam Grant Program	X	-	Yes	No
	FEMA	TDEM	Hazard Mitigation Grant Program	X	X	Yes	Yes
	FEMA	TDEM	Public Assistance	X	X	Yes	Yes
	FEMA	-	Cooperating Technical Partners	X	-	Yes	No
	HUD	GLO	Community Development Block Grant - Mitigation	X	X	Yes	Maybe[a]
	HUD	GLO	Community Development Block Grant Disaster Recovery Funds	X	X	Yes	No
	HUD	TDA	Community Development Block Grant Program for Rural Texas	X	-	Yes	No
	USACE	-	Continuing Authorities Program	X	-	Yes	Indirect[b]
	USACE	Varies	Partnerships with USACE, funded through Water Resources Development Acts or other legislative vehicles[c]	Varies	Varies	Varies	Varies
	EPA	TWDB	Clean Water State Revolving Fund	X[d]	-	No	No
	NRCS	-	Watershed and Flood Prevention Operations	X	-	Yes	Indirect[b]
	NRCS	-	Emergency Watershed Protection Program	X	X	Yes	No
	NRCS	TSSWCB	Watershed Rehabilitation	X		Yes	Indirect[b]
	NRCS	-	Wetland Reserve Easement Program	X		Yes	No
	US EDA	Varies	Various	X	Varies[e]	Yes	No
	US Congress	Varies	Community Project Funding	X	-	Yes	Maybe[f]
	US Congress	Varies	Water Resources Development Act	X	-	Yes	Indirect[b]
State	-	TSSWCB	Structural Dam Repair Grant Program	X	-	Yes	No
	-	TWDB	Flood Infrastructure Fund	X	-	Yes	Yes[g]
	-	TWDB	Texas Water Development Fund	X	-	No	No
	-	TSSWCB	O&M Grant Program	X	-	Yes	No
	-	TSSWCB	Flood Control Dam Infrastructure Projects - Supplemental Funding	X	-	Maybe	Maybe
Local	Not applicable		General Fund	n/a			Varies
			Stormwater or Drainage Utility Fee				
			Special-Purpose District Taxes and Fees				
			Tax Applications				
			Bonds				

[a] Community Development Block Grant - Mitigation only requires a benefit-cost analysis for covered projects (cost over $100 million, Community Development Block Grant funds over $50 million)
[b] These programs don't require a benefit-cost at application but may require coordination between applicant and funding agency to populate benefit-cost analyses in development of the project
[c] Opportunities to partner with USACE are not considered grant or loan opportunities but shared participation projects where USACE performs planning work and shares in the cost of construction.
[d] The Clean Water State Revolving Fund program offers principal forgiveness, which is like grant funding.
[e] US EDA provides assistance through various initiatives, some tied to disaster supplementals, some through other means
[f] Benefit-cost analysis may not be required depending on what phase of project is appropriate for using Environmental Infrastructure through Community Project Funding.
[g] Benefit-cost ratios are not required to be provided for eligible studies that are aimed at identifying potential projects. Nor are benefit-cost ratios required for Flood Early Warning Systems or Flood Response Plans.

FEMA - Federal Emergency Management Administration
HUD - United States Department of Housing and Urban Development
NRCS - Natural Resources Conservation Service
USACE - United States Army Corps of Engineers
US EDA - United States Economic Development Administration
GLO - Texas General Land Office
TDA - Texas Department of Agriculture
TDEM - Texas Division of Emergency Management
TSSWCB - Texas State Soil and Water Conservation Board