Section 6. Flooding

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Why Floods Are a Threat

Unique Geographic and Atmospheric Conditions

Texas, because of its size and location, consistently outranks other states in deaths and damage from floods, according to *American Hazardscapes: The Regionalization of Hazards and Disasters* published by the National Academy Press. Texas is second in casualties and damage from hurricanes and tropical storms. Figure 6-1 shows the State's vulnerability to damaging storms.

Characteristics of Flooding in the Basin

Flooding is one of the most frequent disasters, the costliest and the most deadly disaster inflicted on the Guadalupe River Basin. Of the five presidential disaster declarations for Basin Counties since 1992, four were flood-related.

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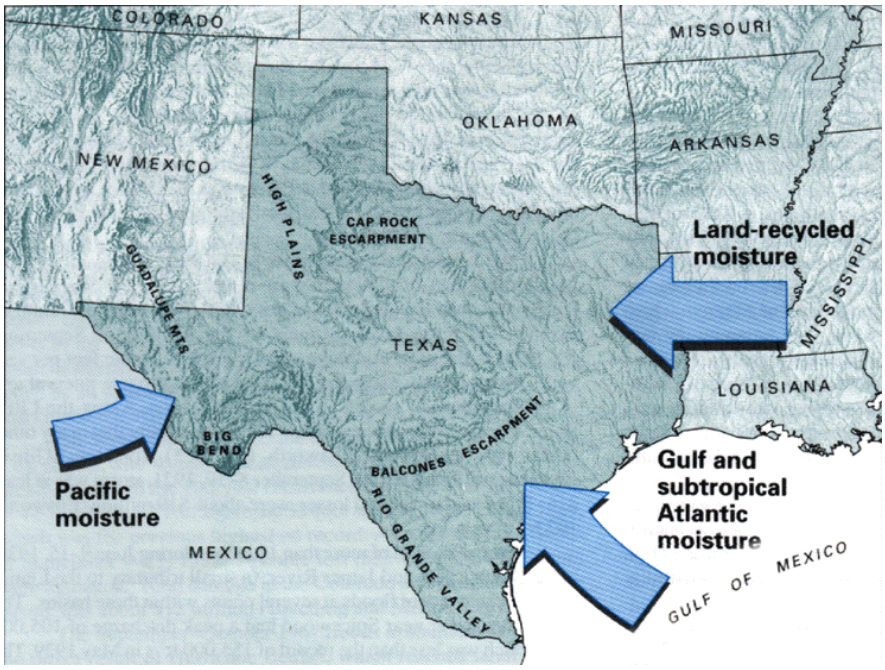
Figure 6-1. Texas Sources of Moisture, U.S. Geological Service



Flash Flooding

Most flood deaths are due to flash floods. The National Weather Service characterizes the Hill County watersheds of Central Texas as "Flash Flood Alley," saying it is one of the regions in the United States at greatest risk for flash floods.

Most flash flooding is caused by slow-moving thunderstorms, by thunderstorms repeatedly moving over the same area ("training"), or by heavy rains from hurricanes and tropical storms. Flash floods can occur within a few minutes of--or after hours of--excessive rainfall. Flash floods can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels. Often there is no warning that flash floods are coming.

Flash flooding poses a danger to residents of the Guadalupe River Basin. A number of roads through low-lying areas are prone to sudden and frequent flooding during heavy rains. Motorists often attempt to drive through barricaded or flooded roadways. It can take less than 18-to-24 inches of water moving across a roadway to carry away most vehicles. Floating cars easily get swept downstream, making rescue difficult and dangerous. The vast majority of flash-flood fatalities are vehicle related.

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Riverine Flooding

Riverine flooding is a natural, necessary and inevitable part of life. Overbank flooding of rivers and streams typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area. Some river floods occur seasonally when winter or spring rainfalls fill river channels with too much water, too quickly. Torrential rains from decaying hurricanes or tropical systems can also produce river flooding.

The Texas Hill County has recorded some of the most intense rainfall in the world. Figure 6-2 shows historic rainfall totals in inches of rain from single events in Central Texas.

Possible rapid and unexpected riverine flooding downstream from a dam failure also can cause loss of life and significant property damage. Dam failure is addressed in Section 15 of this Plan.

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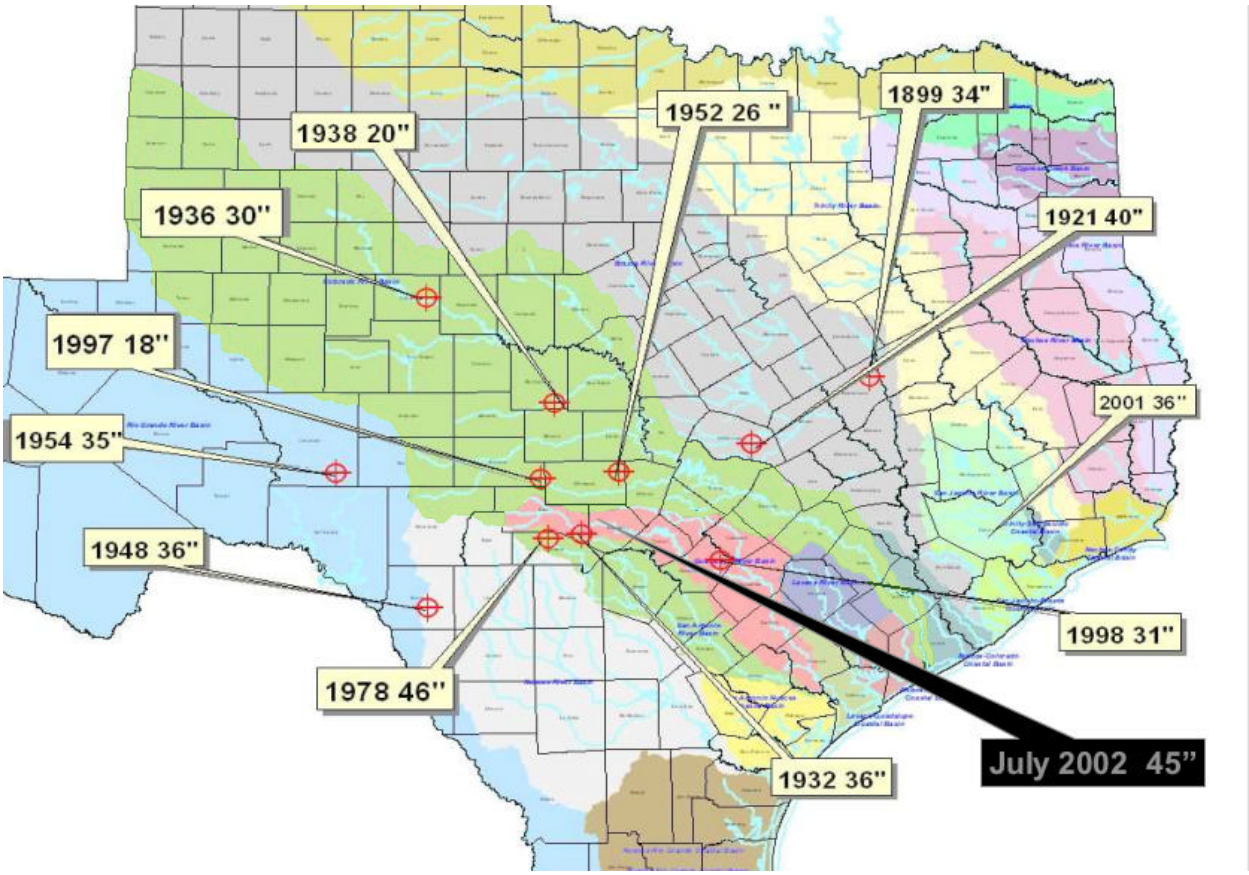
Figure 6-2. Floods Endanger Central Texans
Rainfall totals in inches of rain from single flooding events, U.S. Army Corps of Engineers



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Urban Flooding

Urban flooding increases as more land is converted from fields or woodlands to roads, buildings, and parking lots; and when the natural land is replaced and therefore loses its ability to absorb rainfall. Urbanization changes the natural hydrologic systems of a basin, increasing runoff two to six times over what would occur on natural terrain. During periods of urban flooding, streets can become swift moving rivers, while highway underpasses and underground parking garages can fill with water.

Urban flooding in Houston after Tropical Storm Allison.

El Niño Phenomenon

The term "El Niño" refers to the warming of the coastal waters along the west coast of South America, usually centered around Equador and Peru.[1] This warming causes a shift in the global weather pattern and can produce extended periods of drought or rain. A strong El Niño usually occurs every three to seven years.[2]

Tropical Flooding

Hurricanes and tropical storms also cause floods. Between 1900 and 2000, thirty-seven hurricanes made landfall in Texas. As noted in table 5-1 in Section 5, Hurricanes, six of these were a Category 4, ten were Category 3, nine were Category 2, and thirteen were Category 1.

[1] National Weather Service, National Oceanic and Atmospheric Administration, www.crh.noaa.gov/arx/elnino.html
[2] National Weather Service, National Oceanic and Atmospheric Administration, www.crh.noaa.gov/arx/elnino.html

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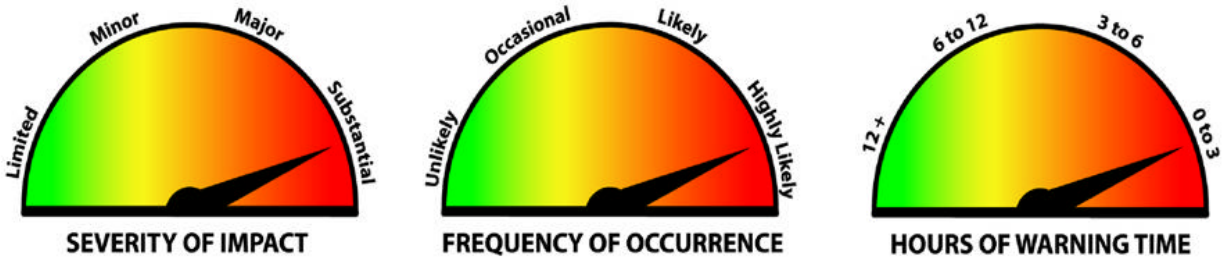
Hazard Profile

Major flooding and flash flooding events can have a severe impact. They can cause deaths, completely shut down facilities for thirty days or more, and cause the destruction of, or major damage to, more than fifty percent of affected properties.

Flooding is a recurring event in the Guadalupe River basin. The annual probability of occurrence of a 100-year flood is one percent. The annual probability of a 500-year flood is 0.2 percent.

Flooding occurs in seasonal patterns. Fronts form when warm, moist air collides with cooler, drier air. Since these masses tend to come together during the transition from summer to winter, most resulting flooding occurs during the spring and fall, although floods can occur in any month. In the Guadalupe River Basin, most floods have occurred, in descending order, in September, July, June, October, and May.

Figure 6-3. Flood Hazard Profile Summary



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Managing Floodwaters

Canyon Dam Flood Control

Canyon Dam is the only flood-control dam located in the Guadalupe River Basin. It was completed in 1963 through a cooperative effort between GBRA and the U.S. Army Corps of Engineers, which owns the Dam.

Canyon Dam is located on the Guadalupe River at river mile 303.0, about 12 miles northwest of New Braunfels, Texas, and about 38 miles north-northeast of San Antonio, Texas. The dam is located in north central Comal County, on the eastern edge of the Edwards Plateau just west of the Balcones Escarpment. The drainage area of Canyon Reservoir is 1,425 square miles and stretches from Comal County across Kendall and Kerr Counties.

Canyon Dam is a multipurpose lake used for flood control, water supply, hydropower, recreation, and fish and wildlife enhancement. It is an earthfill embankment 224 feet high and 6,830 feet long. The embankment consists of compacted earth fill 4,620 feet long, including a 210-foot dike. The outlet works consists of two 6-foot 8-inch by 10-foot slide gates that control the flow through a 10-foot diameter conduit. The slide gates are at the bottom of the intake structure located in the lake upstream from the embankment. The dam has an uncontrolled broad-crested spillway, 1,260 feet long. The lake capacity at different pool elevations is shown in Table 6-1.

Table 6-1. Canyon Reservoir Elevation and Capacity Information, U.S. Army Corps of Engineers

Canyon Reservoir/Capacity Information			
Feature	Elevation (feet NGVD)	Reservoir Capacity	
		Acre-feet	Inches of run-off
Top of dam	974.0		
Maximum design water surface	969.1	1,129,300	14.86
100-year pool elevation	946.0	776,000	10.21
Top of flood control pool and spillway crest	943.0	736,700	9.69
Top of conservation storage	909.0	378,852	5.03
Streambed at dam	750.0	0	0.00

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TABLE 6-2. Dams and Reservoirs in the Guadalupe River Basin

Flood Control Dam		
Canyon Dam	Conservation Pool	
	Capacity	386,210 acre feet
	Surface Area	8,240 acres
	Elevation	909.0 ft. (MSL)
	Flood Control Pool	
	Capacity	346,000 acre feet
	Surface Area	12,890 acres
	Elevation	943.0 ft. (MSL)
Non-Flood Control Dams		
Coleto Creek	Capacity	35,084 acre feet
	Surface Area	3,100 acres
	Elevation	98.0 ft. (MSL)
Dunlap	Capacity	5,900 acre feet
	Surface Area	410 acres
McQueeney	Capacity	5,050 acre feet
	Surface Area	400 acres
TP-4	Capacity	2,624 acre feet
	Surface Area	248 acres
Nolte	Capacity	1,550 acre feet
	Surface Area	153 acres
H-4	Capacity	6,500 acre feet
	Surface Area	696 acres
H-5	Capacity	4,000 acre feet
	Surface Area	488 acres

The reservoir behind Canyon Dam is best understood by thinking of it as a two-part storage chamber. The lower portion, or Conservation Pool, extends from elevation 800 to 909 feet mean sea level (msl) and stores water for GBRA's water supply customers. GBRA is responsible for the Conservation Pool.

The flood component, or "Flood Pool," is the area of the reservoir between 909 msl and 943 msl, which is the level of the spillway, and is dedicated to flood control. Between 943 msl and 974 is the surcharge pool. The flood storage is managed by the COE.

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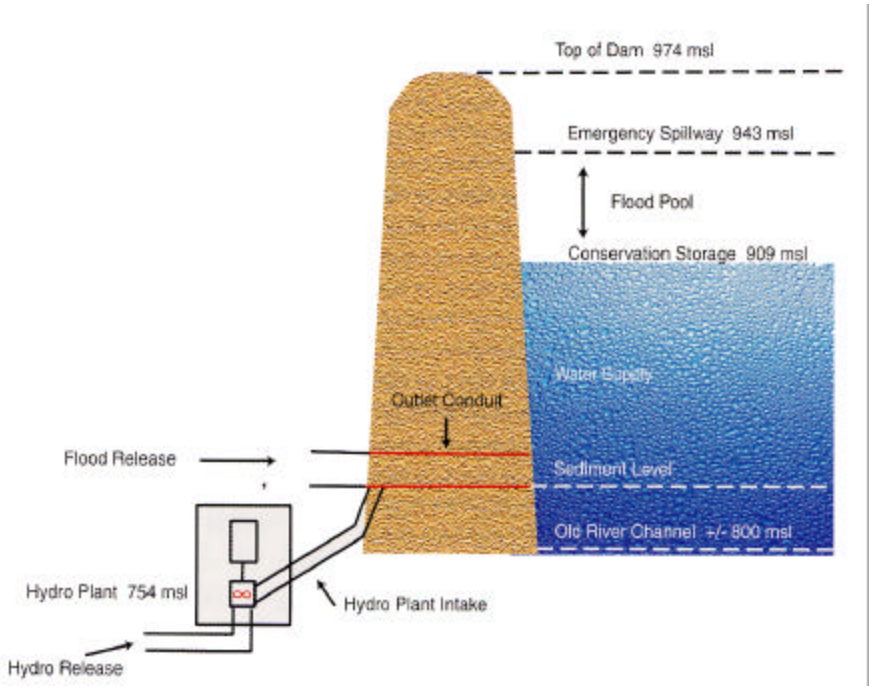
Figure 6-4. Canyon Dam Diagram



The dam's two purposes, to provide flood-control benefits and a dependable source of stored water, are actually competing, in that:

- To maximize the flood control capability of the structure, the reservoir would be kept empty in preparation for the next flood; and
- To maximize water supply capability of the structure, the reservoir would be kept completely full in anticipation of the next drought.

The project is managed to protect the downstream watershed. All floodwater releases from the project are controlled so that the channel capacity of the river downstream is not exceeded as it passes through each community. In other words, release rates must not exceed the river capacity below the Sattler, New Braunfels, and Gonzales areas. The channel capacity, or control point, is 5,000 cfs at Sattler, 10,000 cfs at New Braunfels, and 12,000 at Gonzales.

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Table 6-3. Canyon Reservoir Operations, Excerpted from U.S. Army Corps of Engineers' Regulations

Lake Condition	Operation
Lake level predicted to exceed elevation 909.0 but not 911.0	Make releases to control flows at Sattler gauge to 1,500 cfs, New Braunfels below Comal Creek to 1,500 cfs, or Gonzales to 12,000 cfs, whichever is the smaller.
Lake level predicted to exceed elevation 911.0 but not 943.0	Make releases to control flows at Sattler gauge to 5,000 cfs, New Braunfels below Comal Creek to 10,000 cfs, or Gonzales to 12,000 cfs, whichever is the smaller.
Forecasts indicate that the reservoir will rise above elevation 943.0	Release up to 5,000 cfs to maintain a flow of 12,000 cfs on the Guadalupe River with a combination of gate and spillway releases until the spillway release equals allowable release at which time the gates will be closed. If inflow forecasts indicate that a flood of near spillway design magnitude is in progress, the outlet works gates will be reopened fully.

All other dams along the Guadalupe River are used for generation of hydroelectricity rather than flood control. These dams pass floodwaters through the system. The Coleto Creek Reservoir in Victoria County operates in much the same way. It also does not have flood-control capacity.

Stream Gauges

U.S. Geological Survey (USGS), in cooperation with the Corps of Engineers, National Weather Service, the Upper Guadalupe River Authority, and GBRA maintain a network of rain gauges and stream level sensors in the Guadalupe River Basin. There are seven USGS gauges upstream of Canyon Dam. Of the seven upstream gauges, four are on the main stem of the Guadalupe River and are used to forecast inflows. The location of the gauges and sensors is presented in Figure 6-6.

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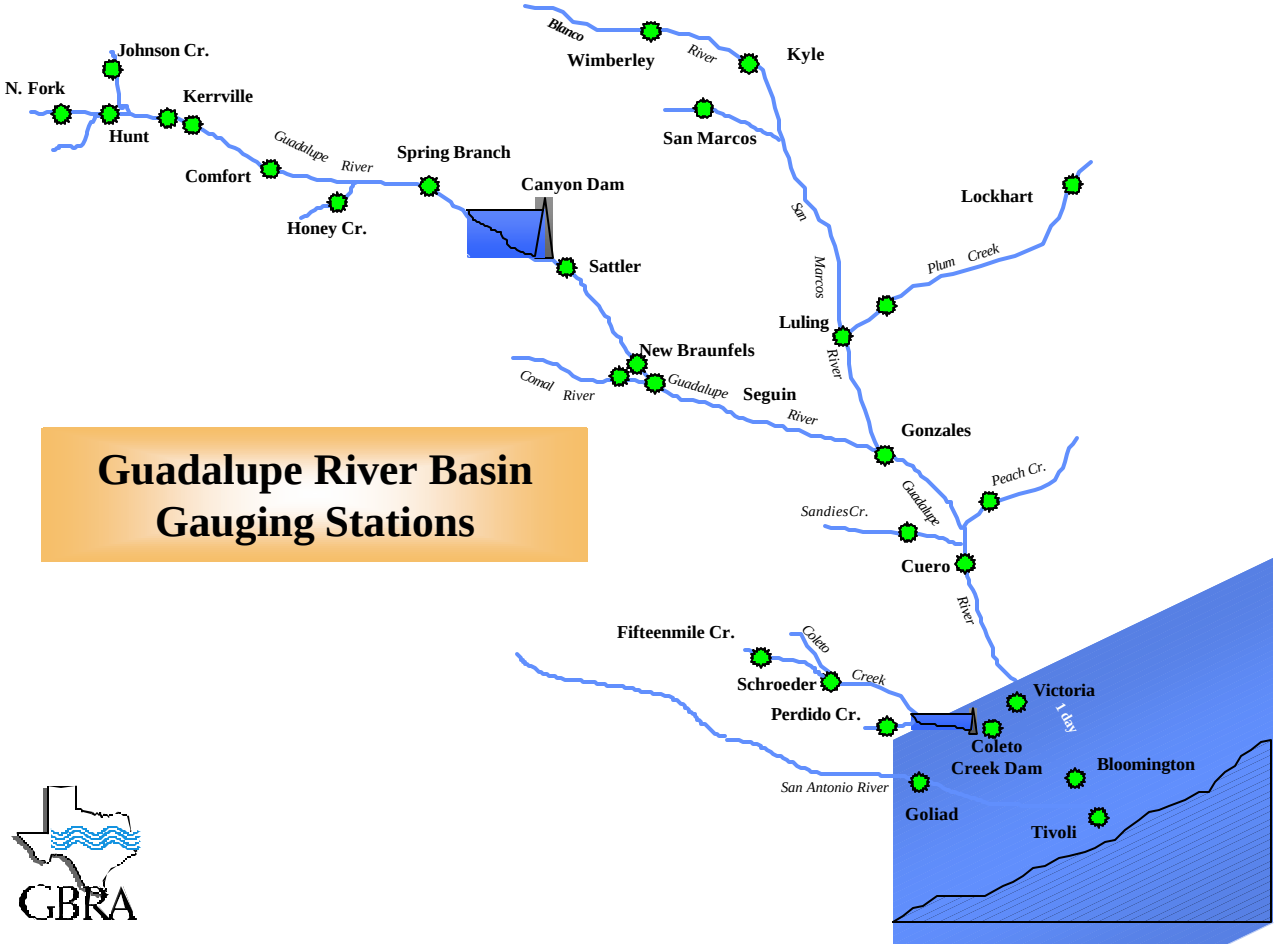
Figure 6-5. Guadalupe River Basin Gauging Stations



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Emergency Procedures

During major floods, GBRA assists county emergency management coordinators by e-mailing the latest river forecasts from the National Weather Service—River Forecast Center. The message consolidates the river forecasts and makes it easier for the emergency management coordinators to read.

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History of Flooding

Major Flood Events

Numerous flood events have been recorded in the Guadalupe River basin since 1930. These events ranged from isolated floods that affected local areas to basin-wide floods spawned by unusually heavy rainfalls.

According to the U.S. Army Corps of Engineers[3], Canyon Dam experienced the worst flood in its 40-year history in July, 2002. A low-pressure system migrated west from Florida to Texas in late June. This system became nearly stationary over South Central Texas pulling tropical moisture inland from the Gulf of Mexico causing heavy rainfall. Storms repeatedly poured rain on an area from southwest of San Antonio in the northern Hill County causing tremendous rainfall accumulations. According to the U.S. Army Corps of Engineers, a few areas near Center Point in Kerr County may have received more than 50 inches of rain during a seven-day period. [4]

Table 6-4. Rainfall Totals, Canyon Reservoir Watershed, June 29- July 6, 2002, US Army Corps of Engineers

Location	Inches of rain
Bankersmith	31.88
Camp Verde	34.17
Canyon Dam	19.83
Comfort 2	31.59
Kendalia	25.66
Sisterdale	30.75
Waring	45.50

The average rainfall over the Canyon Reservoir watershed was 22 inches, resulting in approximately 700,000 acre-feet of runoff into the reservoir. This volume of water was enough to almost fill the flood control pool twice. The water level rose over 40 feet, and peaked almost 7.3 feet above the

3 The Flood Event of 30 June – 18 July, 2002 in the Texas Hill County, John Rael, P.E., Hydraulic Engineer, Fort Worth District, September 2003.

4 The Flood Event of 30 June – 18 July, 2002 in the Texas Hill County, John Rael, P.E., Hydraulic Engineer, Fort Worth District, September 2003.

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spillway crest. The maximum discharge over the spillway was about 66,800 cfs, while the channel capacity of the Guadalupe River at New Braunfels, downstream of Canyon Dam is 12,000 cfs. The flood caused millions of dollars in damages below Canyon Dam even though the dam reduced the peak flow in the Guadalupe River to about half of what it would have been. The U.S. Army Corps of Engineers estimates that Canyon Dam prevented an estimated $46.2 million in damages during this event. Of the seven fatalities attributed to this flood event, none occurred in the Guadalupe River.

Figure 6-7 on the following pages shows a few selected major flood events[5]. This is followed by Table 6-5, which provides a more extensive list of flooding events as reported to the National Oceanic and Atmospheric Administration, from 1950 – 2002.

[5] Selected major flood events were drawn from "Major and Catastrophic Storms and Floods in Texas – Open File Report 03-193," by R. M. Slade, Jr. and John Pastton, U.S. Department of the Interior and U.S. Geological Survey, prepared in cooperation with the Lower Colorado River Authority, the Federal Emergency Management Agency, and the Guadalupe-Blanco River Authority.

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A Brief History of Major Floods in the Guadalupe-Blanco River Basin

June-July 1932

Heavy rain June 30-July 3, 1932 on parts of the Nueces and Guadalupe River Basins produced historically significant peak discharges at several streamflow-gaging stations. Very heavy rain fell on the upper Guadalupe River Basin west of Kerrville, causing catastrophic flooding. This rain amounted to more than 35 inches during about 36 hours at the State Fish Hatchery above Ingram. Heavy rainfall also was recorded in the Frio and Medina River Basins. Resulting flash floods were responsible for seven deaths and property losses exceeded $0.5 million.

July 1936

On July 3, 1936, the Guadalupe River at Victoria reached a gage reading of 31.22 feet, the highest stage ever recorded. The equivalent discharge was 179,000 cfs. This flood was the result of 6 days of rainfall over the Guadalupe Watershed. The upper basin received as much as 21 inches. Gonzales had 9.01 inches in one day. There were 26 deaths in the basin and an estimated $2 million in damages in Victoria County.

August 1945

An intense hurricane struck Matagorda on August 26, 1945. Two-thirds of the Texas coast saw winds of hurricane force. Winds were in excess of 100 mph from Port Aransas to Port O'Connor. The pressure fell to 28.57" at Palacios. Tides were as high as 15 feet at Port Lavaca. Rainfall amounts of 30" were seen along sections of the coast. Heavy damage was seen across Nueces, San Patricio, Aransas, Calhoun, Matagorda, and Wharton counties. Severe crop and livestock losses were suffered along nearly all Middle and Upper Texas coast locations. 3 were killed and damage estimates were near $20.1 million.

October 1960

Heavy rains between October 16 and October 30 caused flash floods on many small streams in south-central Texas. High-intensity rains varied from 6 to 15 inches. Refugio recorded 13.38 in. of rainfall Oct. 16. Flood-waters killed 13 people, and property damage was estimated at more than $6

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September 1961

Hurricane Carla made landfall near Port Lavaca on September 14, 1961. Carla was among the largest hurricanes of historical record. The storm produced many tornadoes, gusts estimated to 175 m.p.h., torrential rains, and a 22 foot storm surge at Port O'Connor. Hurricane force gusts were seen along almost the entire Texas Coast. Her path of devastation inland extended from Victoria to Dallas. The death toll of only 34 in Texas can be attributed in part to what was the largest peace time evacuation of an area in history. A quarter million people fled the middle and upper Texas coasts to move inland to safety.

September 1967

Hurricane Beulah, the third largest hurricane of the twentieth century, swept across South Texas on September 20-21, 1967. It moved inland from the Gulf just south of Port Isabel, striking Brownsville with winds estimates at 140 miles per hour, then turning southwest. Beulah spawned 115 separate tornadoes, including one in New Braunfels. Rain of up to thirty inches accompanied the storm. Three Rivers, Sinton, Victoria and Pleasanton were especially hit hard. Official estimates put the number dead in the State at eighteen and the number injured or sick at 9,000. Property damage was estimated at $100 million and crop damage at $50 million. Some 300,000 people were evacuated during the storm and subsequent flooding.

May 1972

On the evening of May 11, 1972, heavy rain began falling over eastern Comal County, and by midnight, a center of 16.5 inches was measured on the Guadalupe River exactly halfway between New Braunfels and Canyon Lake Dam. By 1:00 AM, the Guadalupe River above the Comal River confluence crested at 31.65 feet and 92,600 cfs.

Residents and business owners wrongly thought that Canyon Dam, 20 miles upstream, would protect them from flooding, but they did not know that the storm fit almost exactly in the Guadalupe River drainage area below Canyon Dam. Homes washed downstream in New Braunfels and Seguin. Many homes were seriously damaged or destroyed in the floodplains along Lakes Dunlap and McQueeney. All the homes on Treasure Island in Lake McQueeney flooded. Fifteen people drowned, eight along the Comal River, and seven on the Guadalupe in New Braunfels. Autos were washed downstream and stacked like cord wood.

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August 1981

A minimal tropical depression made landfall just south of Brownsville on August 29, moved up the Rio Grande Valley, veered north to just south of San Antonio, and was near Seguin near midnight of August 30th. An area of heavy rain 50 –75 miles wide and 200 miles long fell between Seguin and north of Houston, as the center moved across. Rainfall of 10.11 inches was recorded in Geronimo andof 16.31 inches in Gonzales. This caused disastrous flooding on the Lavaca and Guadalupe Rivers.

June 1997

In the early morning hours of June 21st, the third in a series of El Nino-related storms moved into the Texas Hill Country. Thunderstorms began forming near 3:00 AM in the Dilley to Charlotte area and the heavy rain progressed eastward throughout the day to south of Cuero. An area from Schroeder to Yorktown to north of Cuero would receive over 7.00 inches. The area near Bandera and east to Boerne received 8 to 10 inches of rain. This same area received another 8 to 12 inches of rain during the early morning hours of the 22nd. Boerne's three flood-retention dams at the headwaters of Ranger and Cibolo Creeks were overwhelmed in the early morning hours, and a large flood wave slammed through Boerne near 4:30 AM. The Boerne Chief of Police's TV was washed through the plate glass front window of his home just below Boerne City Lake.

The 18 to 22 inches of rain west of Boerne in Kendall County extended into the Big and Little Joshua Creek drainages, sending huge flood waves down them into the Guadalupe River below Waring. The Guadalupe River gage at FM 311 below Spring Branch crested at 45.12

The Guadalupe River lifted this house north of Cuero and it centered on State Highway 72.

October 1998

Between October 17 and 19, 1998, 22 inches of rain fell in the New Braunfels area, bringing devastating floods to the Guadalupe River Basin.

This flood was, in many ways, a repeat of the 1972 flood. Many of the houses rebuilt in 1972 were again destroyed. 31 lives were lost and property damage totaled almost $1 billion.

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GBRA
GUADALUPE-BLANCO RIVER AUTHORITY

Basin-wide, the October 1998 flood was the most destructive in recent history. Between 4,000 and 5,000 homes were damaged. The crest at Cuero was 473,000 cfs, almost 4 times the previous record of 132,000 cfs,Sept 1, 1981.This is the average flow for the Mississippi River. This flow was so massive it flowed over the left bank just northwest of Cuero, flowed over 2 miles across the floodplain, and "ambushed" Cuero, over 2-1/2 miles from the main river channel. Gholke Creek acted exactly as a floodway, collecting the excess flow. The problem with this "floodway" was that it diverted excess flow through the heart of Cuero. Water raged less than a block from the main section of downtown Cuero. Nearly all the western half of Cuero was destroyed. Homes washed downstream, businesses had 10 to 15 feet of water in them, autos washed about like corks, large cement trucks in a cement plant washed downstream until they hit an obstruction. The river was nearly 3 miles wide at Cuero. Cattle were retrieved from the roof of a home in Cuero, obviously washing miles downstream before finding their perch.

July 2002

On June 30, 2002, a low-pressure system migrating westward from Florida combined with a flow of deep tropical moisture from the Gulf of Mexico and stalled over the central and south-central parts of the State. For 8 more days, the storm system continued to draw moisture from the Gulf, triggering several massive storms. As much as 35 inches of rain fell in the area.The large volumes of runoff caused as many as four flood peaks at each of many gages in the Brazos, Colorado, and Guadalupe River Basins. For the first time since it filled in 1968, Canyon Lake poured over its spillway, adding to the flooding in the Guadalupe River.

State-wide, there were 12 deaths. Flooding affected 80 counties in Texas, with total damages of over $1 billion. Twenty-four counties were Federal Declared Disaster areas.

Canyon Dam spillway.

Reported flood events in the Guadalupe River Basin between 1950 and 2002 are listed below.

Table 6-5. Reported Flood Events, by County, 1950 to 2002, Guadalupe River Basin, National Oceanic and Atmospheric Administration

Lower Basin

Event	Year	Date	Deaths	Comments
CALHOUN COUNTY				
Flash flood	1997	17 Mar	0	Port Lavaca
Flash flood	1997	18 Mar	0	Long Mott
Flash flood	1997	18 Mar	0	Port Lavaca
Flash flood	1997	23 May	0	Port Lavaca
Flood	1997	13 Oct	0	Countywide
Flash flood	1998	16 Sep	0	Port O'Connor
Flash flood	1998	16 Sep	0	Seadrift
Flash flood	1998	18 Oct	0	Port Lavaca
Flash flood	2001	5 May	0	Port Lavaca
Flood	2001	31 Aug	0	Countywide
Flood	2001	1 Sep	0	Countywide
Flood	2001	5 Sep	0	Countywide
Flash flood	2002	28 Oct	0	Countywide
Flash flood	2002	4 Nov	0	Central Portion
Flash flood	2002	4 Nov	0	North Portion
Total Number of Events:			**15**	
REFUGIO COUNTY				
Flash flood	1997	18 Mar	0	Refugio
Flash flood	1997	18 Mar	0	Refugio
Flash flood	1997	18 Mar	0	Refugio
Flash flood	1997	23 Sep	0	Tivoli
Flood	1997	9 Oct	0	Countywide
Flood	1997	13 Oct	0	Countywide
Flood	1998	22 Aug	0	
Flash flood	1998	16 Sep	0	Refugio
Flash flood	1998	6 Oct	0	Bayside
Flash flood	1998	18 Oct	0	Woodsboro
Flash flood	1998	18 Oct	0	Woodsboro

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Event	Year	Date	Deaths	Comments
Flash flood	2000	14 Mar	0	Bayside
Flash flood	2000	14 Mar	0	Refugio
Flash flood	2000	14 Mar	0	Woodsboro
Flood	2001	31 Aug	0	Countywide
Flood	2001	1 Sep	0	Northeast Portion
Flash flood	2002	19 Sep	0	Countywide
Flash flood	2002	28 Oct	0	Countywide
Flash flood	2002	28 Oct	0	Central Portion
Total Number of Events: 19				
VICTORIA COUNTY				
Flash flood	1993	5 May	0	Victoria
Flash flood	1993	18 May	0	Victoria
Flooding	1994	18 Oct	0	Victoria
Flash flood	1997	17 Mar	0	Victoria
Flash flood	1997	18 Mar	0	McFaddin
Flash flood	1997	18 Mar	0	McFaddin
Flash flood	1997	18 Mar	0	Victoria
Flash flood	1997	25 Mar	0	Inez
Flash flood	1997	25 Mar	0	Coleto Creek Park
Flash flood	1997	9 May	0	Victoria
Flash flood	1997	21 Jun	0	Victoria
Flood	1997	13 Oct	0	Countywide
Flash flood	1998	16 Sep	0	Victoria
Flash flood	1998	6 Oct	0	Victoria
Flash flood	1998	18 Oct	0	Victoria
Flood	2001	30 Aug	0	Countywide
Flood	2001	31 Aug	0	Countywide
Flood	2001	31 Aug	0	Countywide
Flood	2001	31 Aug	0	Countywide
Flood	2001	31 Aug	0	Countywide
Flood	2001	1 Sep	0	Countywide
Flood	2001	1 Sep	0	Countywide
Flood	2001	5 Sep	0	South Portion
Flash flood	2002	16 Jul	0	Victoria Rgional Airport
Flash flood	2002	16 Jul	0	Victoria Rgional Airport

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Event	Year	Date	Deaths	Comments
Total Number of Events: 25				

Sources: National Climatic Data Center, National Oceanic and Atmospheric Administration, FloodSafety.com, and The Texas Environmental Center.

Middle Basin

Event	Year	Date	Deaths	Comments
CALDWELL COUNTY				
Flash flood	1997	25 Apr	0	Countywide
Flash flood	1997	7 Jun	0	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flash flood	1997	13 Oct	0	Countywide
Flash flood	1998	21 Feb	0	Countywide
Flash flood	1998	23 Aug	0	Countywide
Flood	1998	17 Oct	0	
Flood	1998	17 Oct	6	Countywide
Flood	1998	17 Oct	0	
Flash flood	2000	2 Nov	0	Countywide
Flash flood	2000	3 Nov	0	Countywide
Flash flood	2000	23 Nov	0	Countywide
Flash flood	2001	31 Aug	0	Countywide
Flash flood	2001	15 Nov	0	Countywide
Flood	2001	16 Nov	0	
Flash flood	2002	8 Apr	0	West Portion
Flash flood	2002	2 Jul	0	West Portion
Flash flood	2002	5 Jul	0	West Portion
Flash flood	2002	8 Oct	0	Countywide
Flood	2002	8 Oct	0	
Flood	2002	24 Oct	0	
Flash flood	2002	24 Oct	0	Countywide
Flash flood	2002	4 Nov	0	Countywide
Flood	2002	4 Nov	0	
Flash flood	2002	4 Dec	0	Countywide
Flood	2002	4 Dec	0	
Total Number of Storms: 26				
DEWITT COUNTY				
Flooding	1994	18 Oct	0	DeWitt
Flash flood	1996	26 Jun	0	Cuero

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Event	Year	Date	Deaths	Comments
Flash flood	1996	8 Sep	0	Central Portion
Flash flood	1997	2 Apr	0	Countywide
Flash flood	1997	4 Apr	0	Countywide
Flash flood	1997	10 Apr	0	Countywide
Flash flood	1997	24 May	0	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flash flood	1997	8 Jul	0	Countywide
Flash flood	1997	7 Oct	0	Countywide
Flash flood	1997	11 Oct	0	Countywide
Flash flood	1997	13 Oct	0	Countywide
Flash flood	1998	6 Jan	0	Countywide
Flash flood	1998	21 Feb	0	Countywide
Flash flood	1998	22 Aug	0	Countywide
Flash flood	1998	23 Aug	0	Countywide
Flash flood	1998	10 Sep	0	Countywide
Flash flood	1998	15 Sep	0	Countywide
Flash flood	1998	16 Sep	0	Countywide
Flood	1998	17 Oct	0	Countywide
Flood	1998	17 Oct	0	
Flood	1998	17 Oct	0	
Flood	1998	18 Oct	0	Countywide
Flash flood	1998	12 Nov	0	North Portion
Flood	1998	13 Nov	0	
Flash flood	1998	13 Nov	0	North Portion
Flood	1998	13 Nov	0	
Flash flood	1999	12 May	0	Countywide
Flash flood	1999	25 Jun	0	North Portion
Flash flood	2000	10 Jun	0	Cuero
Flash flood	2000	3 Nov	0	Countywide
Flash flood	2000	23 Nov	0	Countywide
Flash flood	2001	5 May	0	Northeast Portion
Flash flood	2001	30 Aug	0	Countywide
Flash flood	2001	31 Aug	0	Countywide
Flood	2001	31 Aug	0	
Flood	2001	31 Aug	0	
Flood	2001	1 Sep	0	
Flood	2001	1 Sep	0	
Flash flood	2001	4 Sep	0	Countywide
Flash flood	2001	5 Sep	0	Countywide
Flash flood	2001	15 Nov	0	South Portion

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Event	Year	Date	Deaths	Comments
Flash flood	2002	2 Jul	0	Countywide
Flood	2002	3 Jul	0	
Flash flood	2002	13 Jul	0	Southeast Portion
Flash flood	2002	15 Jul	0	Countywide
Flash flood	2002	16 Jul	0	Southeast Portion
Flash flood	2002	24 Oct	0	Countywide
Flood	2002	26 Oct	0	
Flash flood	2002	4 Nov	0	Countywide
Flood	2002	5 Nov	0	
Total Number of Events: 51				
GONZALES COUNTY				
Flash flood	1996	8 Sep	0	South Portion
Flash flood	1997	10 Apr	0	Countywide
Flash flood	1997	25 Apr	0	Countywide
Flash flood	1997	27 May	0	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flash flood	1997	7 Oct	0	Countywide
Flash flood	1998	21 Feb	0	Countywide
Flash flood	1998	22 Aug	0	Countywide
Flash flood	1998	23 Aug	0	Countywide
Flood	1998	17 Oct	0	Countywide
Flood	1998	17 Oct	0	
Flood	1998	17 Oct	0	
Flood	1998	18 Oct	0	Countywide
Flood	1998	13 Nov	0	
Flash flood	1998	14 Nov	0	East Portion
Flash flood	1999	1 Jan	0	East Portion
Flash flood	1999	25 Jun	0	South Portion
Flash flood	2000	3 Nov	0	Countywide
Flash flood	2000	5 Nov	0	Countywide
Flash flood	2000	23 Nov	0	Countywide
Flash flood	2001	26 Aug	0	West Portion
Flash flood	2001	30 Aug	0	Countywide
Flash flood	2001	31 Aug	0	Countywide
Flash flood	2001	5 Sep	0	West Portion
Flood	2001	17 Nov	0	
Flash flood	2002	2 Jul	0	Southwest Portion
Flood	2002	2 Jul	0	
Flash flood	2002	15 Jul	0	Southeast Portion

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Event	Year	Date	Deaths	Comments
Flash flood	2002	16 Jul	0	East Portion
Flash flood	2002	9 Sep	0	Countywide
Flood	2002	10 Oct	0	
Flash flood	2002	24 Oct	0	Countywide
Flood	2002	24 Oct	0	
Flash flood	2002	4 Nov	0	Countywide
Flood	2002	4 Nov	0	
Flood	2002	5 Nov	0	
Flash flood	2002	4 Dec	0	North Portion
Total Number of Events: 37				

Sources: National Climatic Data Center, National Oceanic and Atmospheric Administration; FloodSafety.com; and The Texas Environmental Center

Upper Basin

Event	Year	Date	Deaths	Comments
GUADALUPE COUNTY				
Flash flooding	1994	15 May	0	Near Seguin
Flash flood	1997	6 Jun	0	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flood	1997	22 Jun	0	Countywide
Flash flood	1998	22 Aug	0	Countywide
Flash flood	1998	23 Aug	0	Countywide
Flood	1998	17 Oct	0	Guadalupe
Flood	1998	17 Oct	0	Guadalupe
Flood	1998	17 Oct	4	Countywide
Flash flood	1999	21 Jun	0	West Portion
Flash flood	2000	10 Jun	0	West Portion
Flash flood	2000	2 Nov	0	Countywide
Flash flood	2000	3 Nov	0	East Portion
Flash flood	2000	5 Nov	0	West Portion
Flash flood	2000	23 Nov	0	Countywide
Flash flood	2001	23 Apr	0	West Portion
Flash flood	2001	27 Aug	0	Countywide
Flash flood	2001	30 Aug	0	Countywide
Flash flood	2001	31 Aug	0	Countywide
Flash flood	2001	5 Sep	0	Countywide

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Event	Year	Date	Deaths	Comments
Flash flood	2001	5 Sep	0	North Portion
Flash flood	2001	15 Nov	1	Countywide
Flash flood	2002	8 Apr	0	West Portion
Flash flood	2002	30 Jun	0	West Portion
Flash flood	2002	1 Jul	0	West Portion
Flash flood	2002	2 Jul	0	Countywide
Flash flood	2002	5 Jul	0	Countywide
Flood	2002	5 Jul	0	
Flash flood	2002	15 Jul	0	South Portion
Flash flood	2002	9 Sep	0	Countywide
Flash flood	2002	19 Sep	0	Countywide
Flash flood	2002	8 Oct	0	Countywide
Flash flood	2002	23 Oct	0	West Portion
Flash flood	2002	24 Oct	0	Countywide
Flash flood	2002	4 Nov	0	Countywide
Flash flood	2002	4 Dec	0	North Portion
Total Number of Events: 36				
HAYS COUNTY				
Flash flood	1994	7 Oct	0	Hays
Flash flood	1997	23 May	0	Countywide
Flash flood	1997	6 Jun	0	Countywide
Flash flood	1997	7 Jun	0	Countywide
Flood	1997	8 Jun	2	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flood	1997	22 Jun	0	Countywide
Flash flood	1998	21 Feb	0	Countywide
Flash flood	1998	3 Jul	0	Countywide
Flash flood	1998	22 Aug	0	Countywide
Flash flood	1998	23 Aug	0	Countywide
Flood	1998	17 Oct	0	Countywide
Flood	1998	17 Oct	0	Hays
Flood	1998	17 Oct	0	Hays
Flash flood	1999	21 Jun	0	Countywide
Flash flood	2000	9 Jun	0	Countywide
Flash flood	2000	2 Nov	0	Countywide
Flood	2000	4 Nov	0	Hays
Flash flood	2001	26 Aug	0	North Portion
Flash flood	2001	31 Aug	0	Countywide
Flash flood	2001	31 Aug	0	Countywide

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Event	Year	Date	Deaths	Comments
Flood	2001	15 Nov	0	Hays
Flash flood	2001	15 Nov	0	Countywide
Flash flood	2002	30 Jun	0	West Portion
Flash flood	2002	1 Jul	0	South Portion
Flood	2002	1 Jul	0	Hays
Flash flood	2002	2 Jul	0	Countywide
Flash flood	2002	3 Jul	0	West Portion
Flash flood	2002	5 Jul	0	West Portion
Flash flood	2002	19 Sep	0	South Portion
Flash flood	2002	24 Oct	0	South Portion
Flash flood	2002	4 Nov	0	Countywide
Total Number of Events: 32				
KENDALL COUNTY				
Flash flooding	1994	13 May	0	Countywide
Flash flood	1995	29 Jun	0	North Portion
Flash flood	1995	21 Sep	0	Countywide
Flash flood	1996	27 Oct	0	Northwest Part
Flash flood	1997	20 Feb	0	Countywide
Flash flood	1997	4 Apr	0	Countywide
Flash flood	1997	19 May	0	Countywide
Flash flood	1997	27 May	0	Countywide
Flash flood	1997	6 Jun	0	Countywide
Flash flood	1997	21 Jun	0	Countywide
Flood	1997	22 Jun	0	Countywide
Flash flood	1997	8 Aug	0	Countywide
Flash flood	1998	21 Feb	0	Countywide
Flash flood	1998	16 Mar	0	Countywide
Flash flood	1998	22 Aug	0	Countywide
Flash flood	1998	17 Oct	0	Countywide
Flash flood	2000	23 Oct	0	South Portion
Flash flood	2000	2 Nov	0	Countywide
Flash flood	2001	27 Aug	0	Countywide
Flash flood	2001	31 Aug	0	Countywide
Flash flood	2001	5 Sep	0	Countywide
Flash flood	2001	15 Nov	0	Countywide
Flash flood	2002	30 Jun	0	Countywide
Flash flood	2002	1 Jul	0	Countywide
Flash flood	2002	1 Jul	0	Countywide
Flood	2002	2 Jul	0	Kendall

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Event	Year	Date	Deaths	Comments
Flash flood	2002	3 Jul	0	Countywide
Flash flood	2002	3 Jul	0	Countywide
Flash flood	2002	3 Jul	1	Countywide
Flash flood	2002	5 Jul	0	Countywide
Flash flood	2002	14 Jul	0	South Portion
Flash flood	2002	16 Jul	0	Countywide
Flash flood	2002	7 Oct	0	Countywide
Flash flood	2002	24 Oct	0	Countywide
Total Number of Events: 34				

Source: National Climatic Data Center, National Oceanic and Atmospheric Administration.

Historic flood elevations at the Conservation Pool at Canyon Reservoir are shown below.

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Table 6-6. Historic Elevations at Canyon Reservoir, GBRA

Normal Operating Range	100-Yr. Flood Level	Top of Dam	Emergency Spillway	Historic Highs	Date of Historic Highs
Top of conservation pool is 909 while the bottom is about 770.	946	974	943	July 18, 1973	917.35
				August 4, 1978	930.61
				June 18, 1981	919.2
				June 19, 1987	942.68
				March 9, 1992	937.31
				June 27, 1997	937.57
				November 3, 1998	923.7
				July 6, 2002	950.28 or 7.28 feet through the emergency spillway

July 2002 floodwaters pass through the emergency spillway at Canyon Dam.

Location of Hazardous Areas

Flood-hazard areas are determined using statistical analyses of records of riverflow, storm tides, and rainfall; information obtained through consultation with communities; floodplain topographic surveys; and hydrological and hydraulic analyses. FEMA's Flood Insurance Rate Maps (FIRMs) identify areas subject to flood hazard. These include Special Flood Hazard Areas, which are defined as areas that will be inundated by a flood event having a one-percent chance of being equaled or exceeded in any given year. The one-percent-annual-chance flood is also referred to as the base flood or 100-year flood. Moderate flood-hazard areas are also shown on the FIRM, and are the areas between the limits of the base flood and the two-percent-annual-chance (or 500-year) flood. Figure 6-8 is a map showing the approximate 100- and 500-year floodplains in the Guadalupe River

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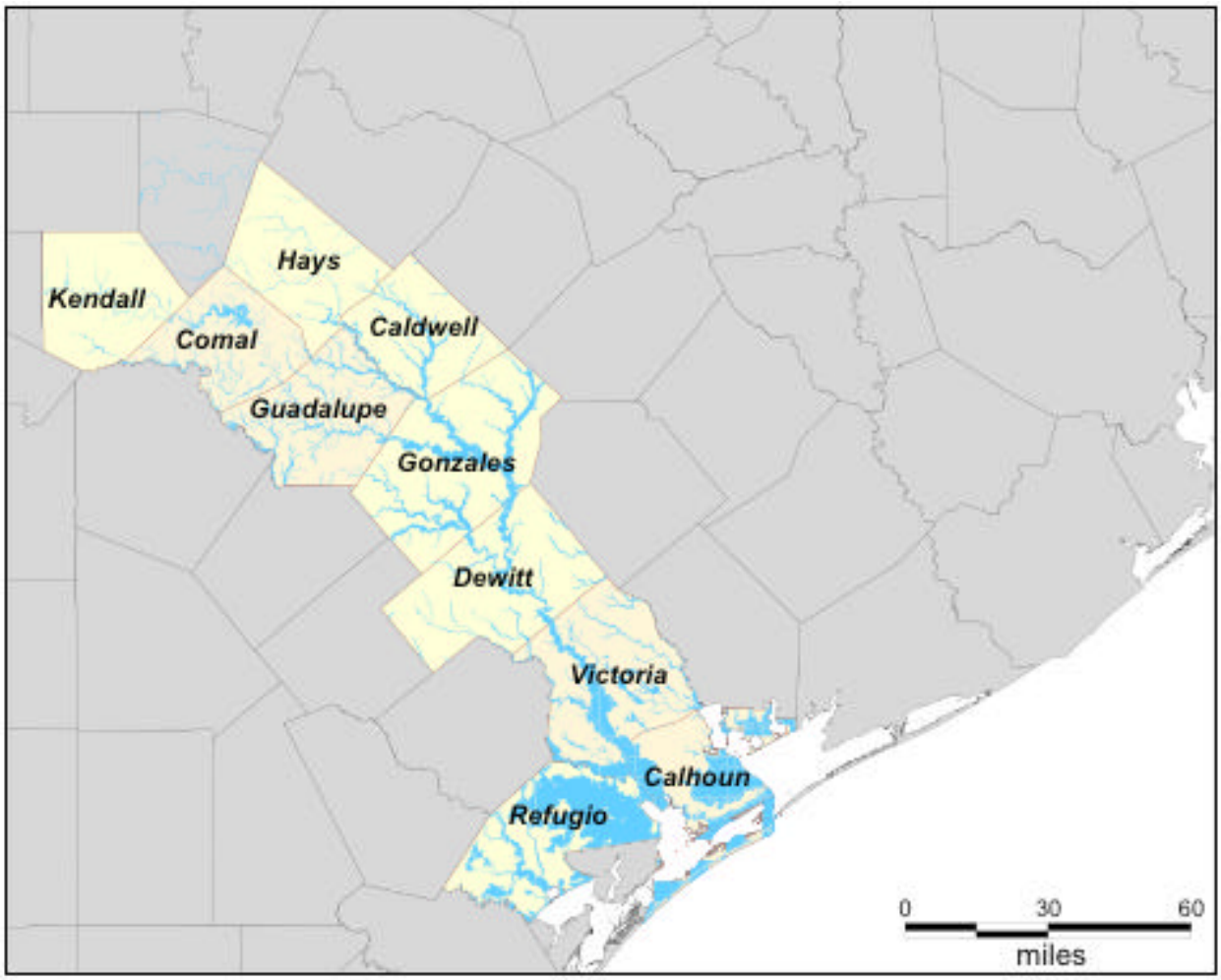
Basin, according to the available data on FEMA Q3 maps and modeling by PBS&J Engineering Company.

Figure 6-7. Riverine Flooding Potential, Guadalupe River Basin (Modeled)



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Starting in 1999, the U.S. Army Corps of Engineers conducted a Flood Feasibility Study (a Section 905 (b) Analysis) to determine if there is a Federal interest in participating in a cost-shared feasibility study for the purposes of providing flood damage reduction, ecosystem restoration, watershed management, and more effective water management within the Guadalupe and San Antonio River Basins. The study identified the following problems in the Guadalupe River Basin.

Cuero

The city of Cuero is located on the Guadalupe River in DeWitt County and has a population of about 6,900. A flood in 1998 inundated approximately 93 percent of the entire city causing extensive damage to homes and closing roads for approximately 8 days. Significant emergency relief, roads, livestock, and infrastructure damages occurred for this flood which was estimated between a 250-year to 500-year event. Based on flooding patterns from the 1998 storm, there may be a need to revise the floodplain mapping for the Cuero area.

Gonzales

The city of Gonzales has an estimated population of 6,500 and is located on the Guadalupe River in the Gonzales County. A severe flood in 1998 caused damages to several residences.

Victoria

The city of Victoria is located on the Guadalupe River and has a population of approximately 64,000 people. In 1998, a flood event resulted in extensive damage to floodplain properties in Victoria. A voluntary buyout of approximately 200 structures was performed by FEMA. Many flood plain residents, however, did not participate in the FEMA buyout, leaving about 130 previously flooded structures still at risk by as frequent as a 10-year event. A previous study performed in 1992 by the Corps of Engineers showed 331 structures within the 0 – 10-year flood zone.

New Braunfels

The city of New Braunfels is located on the Guadalupe River and has a city population of approximately 39,000 people and county population of 75,000 people. Initial examination of survey maps indicate 727 structures were identified within the 100-year flood plain of the Comal River and 956 structures identified within the 500-year flood plain of the Guadalupe River. The estimated average annual damages within the 100-year and 500-year flood plains totaled approximately $369,000 and $1.35 million respectively.

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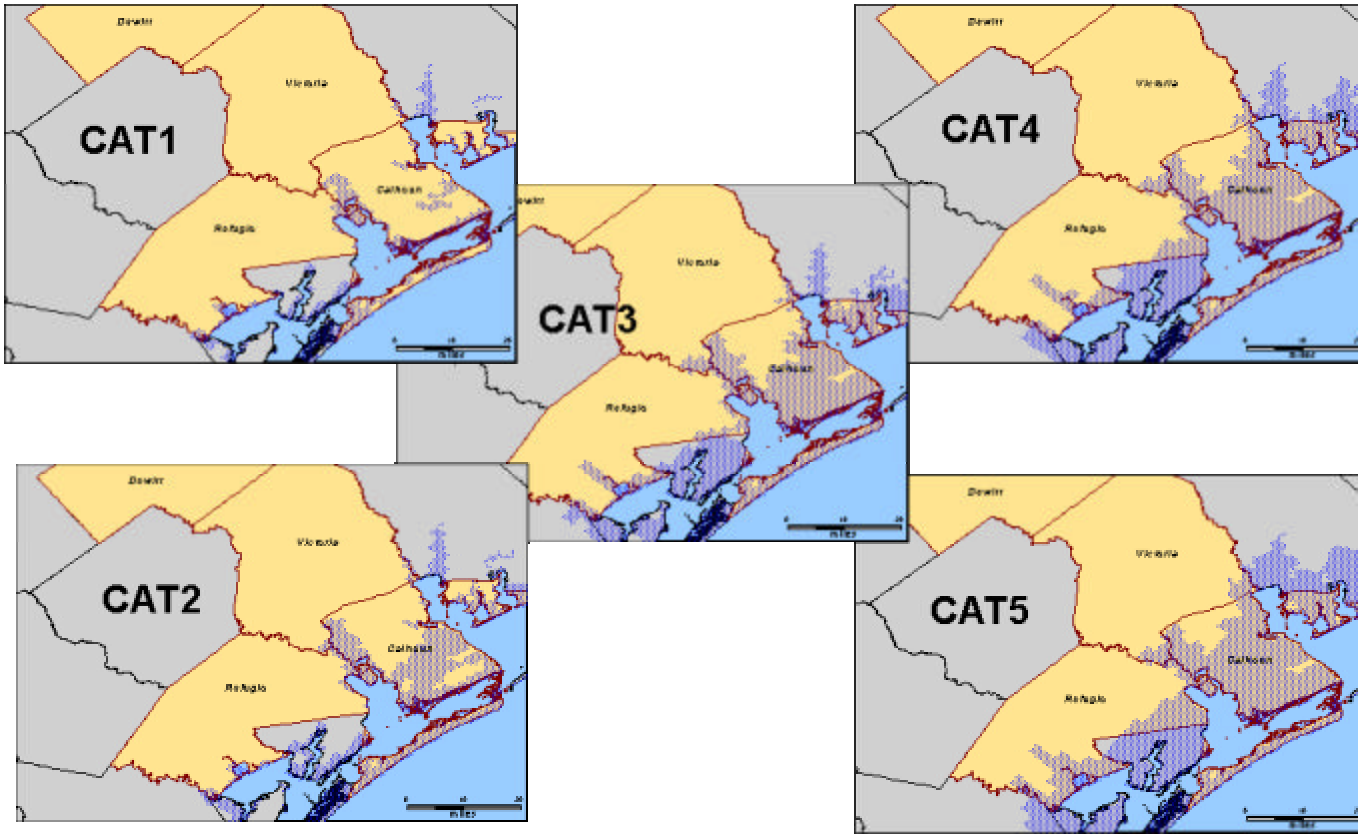
Coastal Flooding

As shown in Figure 6-9, only Calhoun County is at risk from coastal flooding during a Category 1 or 2 hurricane. A hurricane reaching Category 3 or higher in strength, however, may cause additional flooding in Refugio and Victoria Counties.

Figure 6-8. Coastal Flooding Potential in the Guadalupe River Basin, by Category of Hurricane



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NFIP Program Participation

Policies and Losses

The National Flood Insurance Program makes federally-backed flood insurance available in communities that participate in the Program and agree to adopt and enforce ordinances to regulate development in the floodplain. Flood insurance offered through the NFIP is the best way for home and business owners to protect themselves financially against the ravages of flooding. As of September 30, 2002, there were 7,683 flood insurance policies in force in the Guadalupe River Basin covering more than $1 billion in property value. There were 3,474 losses to date and over $105 million in claims payments made as of September 30, 2002.

Table 6-7. NFIP Policies in Effect

County	Community	Policies in Effect	Total Coverage (Thousands)	Total Losses since 1971	Dollars Paid, Historical
Caldwell	Caldwell County	100	$13,444	25	$775,773
	Lockhart	6	$695	4	$61,398
	Luling	28	$3,870	8	$210,968
	Martindale	32	$3,136	17	$299,700
Calhoun	Calhoun County	1,670	$186,014	258	$1,131,639
	Arcola	19	$3,880	1	$5,012
	Point Comfort	15	$1,399	3	$82,629
	Port Lavaca	631	$87,298	125	$345,882
	Seadrift	115	$10,850	10	$33,363
Comal	Comal County	681	$119,016	324	$15,424,684
	Bulverde, East	4	$980	1	$2,770
	Bulverde, North	2	$560	0	$0
	Bulverde, South	1	$155	0	$0
	Garden Ridge	16	$3,246	3	$6,828
	New Braunfels	830	$128,221	331	$24,282,731
DeWitt	DeWitt County	110	$12,388	110	$2,267,881
	Cuero	208	$26,856	44	$1,518,674
	Yoakum	7	670	0	0

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County	Community	Policies in Effect	Total Coverage (Thousands)	Total Losses since 1971	Dollars Paid, Historical
	Yorktown	15	$747		
Gonzales	Gonzales County	85	$12,473	70	$2,440,365
	Gonzales	143	$9,434	64	$1,752,883
	Nixon	1	$279		
	Waelder	1	$151	1	$1,669
Guadalupe	Guadalupe County	1,400	$248,983	1,344	$66,533,538
	Cibolo	49	$7,080	29	$868,023
	Marion	7	$1,324	10	$812,142
	Seguin	217	$37,588	238	$11,582,967
Hays	Hays County	433	$66,793	213	$3,125,863
	Bear Creek	1	$250		
	Buda	1	$188		
	Kyle	6	$789	1	$3,213
	San Marcos	409	$41,996	335	$3,362,538
	Wimberly	4	$781		
	Woodcreek	17	$2,547	4	$60,457
Kendall	Kendall County	260	$40,480	87	$1,504,217
	Boerne	139	$17,304	28	$213,985
Refugio	Refugio County	46	$6,267	9	$51,722
	Austwell	1	$241	1	
	Bayside	12	$1,309	1	$16,963
	Refugio	23	$1,912	23	$253,956
	Woodsboro	20	$2,389	2	$36,859
Victoria	Victoria County	292	$40,921	123	$2,201,468
	Victoria	1,167	$151,218	286	$3,297,499
	TOTAL	9,217	$1,295,452	4,133	$144,570,259

Market Penetration

Despite the benefits of flood insurance, the National Flood Insurance Program estimates that less than 30 percent of the 12,595 structures in the Basin located in Special Flood-Hazard Areas (the 100-year floodplain) have insurance contracts in force. Unfortunately, it is often after a flood that

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many people discover that their homeowner or business-property insurance policies do not cover flood damage. Approximately 25 percent of all flood damages occur in low-risk zones, commonly described as "outside the mapped flood zone." The present market penetration is shown in Table 6-8 below. In determining market penetration, the estimated number of structures in the Special Flood-Hazard Areas is as reported by local community officials. "Contracts in force" are used by the NFIP in determining sales penetration, rather than "policies in force." One "contract" is placed on an entire condominium building with 50 units, each of which may have separate policies in force.

Table 6-8. NFIP Sales Penetration, September 2002

County	Community	Estimated SFHA* Total	Contracts in Force	Penetration (percent)
Caldwell	Caldwell County	51	43	84.31
	Lockhart	27	1	3.70
	Luling	21	5	23.81
	Martindale	80	19	23.75
Calhoun	Calhoun County	2,262	1,181	52.21
	Arcola	0	3	na
	Point Comfort	31	4	12.90
	Port Lavaca	105	35	33.33
	Seadrift	90	36	40.00
Comal	Data not available			
DeWitt	DeWitt County	115	60	52.17
	Cuero	1,400	11	0.79
	Yorktown	95	8	8.42
Gonzales	Gonzales County	0	44	na
	Gonzales	530	99	18.68
	Nixon	37	0	0.00
	Waelder	90	1	1.11
Guadalupe	Guadalupe County	1,500	787	52.47
	Cibolo	26	19	73.08
	Marion	363	3	0.83
	Seguin	713	93	13.04
Hays	Hays County	1,769	188	10.63
	Kyle	60	2	3.33
	San Marcos	400	318	79.50
	Woodcreek	2	7	350.00
Kendall	Kendall County	101	102	100.99
	Boerne	102	58	56.86

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County	Community	Estimated SFHA* Total	Contracts in Force	Penetration (percent)
Refugio	Refugio County	15	10	66.67
	Austwell	10	0	0.00
	Bayside	4	1	25.00
	Refugio	34	7	20.59
	Woodsboro	0	0	na
Victoria	Victoria County	720	84	11.67
	Victoria	1,842	486	26.38
	TOTAL	12,595	3,715	29.50

* Special Flood Hazard Area

Repetitive Losses

According to the National Flood Insurance Program, there are 76 properties as of August 2003 in the Basin on the Federal Emergency Management Agency's list of Target Repetitive Loss Properties. A repetitive loss property is defined as a property currently insured through the NFIP that has incurred two or more losses of $1,000 or more in any rolling 10-year period since 1978. Properties on the Target Repetitive Loss list are those that have experienced 2 losses within a ten-year period that exceed the value of the structure; 3 losses within the life of the structure that exceed the value of the structure; or 4 or more losses. Together, these properties have collectively incurred a total of 180 losses for cumulative losses of almost $16.7 million. They are expected to incur damages in the future of almost $14 million.

Table 6-9 shows the target repetitive loss properties in the Basin, the number of losses, the cumulative loss value, average annual insured losses, and projected future damages in dollars for the target repetitive loss properties in each jurisdiction.

Table 6-9. Target Repetitive Losses in Guadalupe River Basin Ten-County Region, National Flood Insurance Program, September 2003

County	Number of Target Properties	Number of Losses	Cumulative Losses	Average Annual Insured Losses	Projected Future Damages
Comal	25	52	$6,618,672	$434,497	$5,391,692

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DeWitt	4	17	$367,142	$24,149	$299,680
Guadalupe	40	85	$9,039,680	$635,381	$7,884,476
Kendall	1	4	$46,692	$4,273	$53,030
Victoria	6	22	$586,760	$36,981	$458,905
TOTAL	76	180	$16,658,946	$1,135,281	$14,087,783

The Department of Homeland Security classifies repetitive losses into categories. For the Guadalupe River Basin, Category A (zero repetitive loss properties) applies to Lockhart, Luling, Nordheim, Yoakum, Yorktown, Nixon, Waelder, Point Comfort and Seadrift. Category B (1-9 repetitive losses) includes Caldwell County and Martindale. Category C (10 or more losses) includes DeWitt County, Calhoun County, Victoria County and City of Victoria. No communities participate in the Community Rating System.

People and Property at Risk

HAZUS-MH used FEMA Q3 Flood Zones to delineate the 100-year and 500-year flood boundaries. The HAZUS-MH model shows the estimated number of people at risk (in both the 100- and 500-year floodplains) from riverine and coastal flooding. Almost 30,000 people live where there is a potential for damage to property and loss of life from flooding in the Guadalupe River Basin.

Table 6-10. Social Loss Estimates: People at Risk from Riverine and Coastal Flooding in the Guadalupe River Basin, Using the HAZUS-MH Model

Jurisdiction	At Risk to Flooding[6]
Caldwell	1253
Calhoun	8648
Comal	2140
DeWitt	1307
Gonzales	2215
Guadalupe	4006
Hays	4271
Kendall	832
Refugio	1108

[6] Number of people in the 100- and 500-year floodplains.

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Victoria	3888
TOTAL	**29,667***

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Table 6-11. Number of People at Risk to Coastal Flooding, by Category of Hurricane.

Strength of Hurricane	Number of People at Risk	
	Calhoun County	RefugioCounty
Category 1	4,195	341
Category 2	5,697	353
Category 3	15,015	486
Category 4	18,439	527
Category 5	19,312	856

Potential Damages and Losses

HAZUS-MH Model results estimate that the Guadalupe River Basin faces over $21.6 million in annualized losses from flooding. Table 6-12 shows the estimated potential annualized property losses and annualized percent loss ratios that would occur as a result of a 100-year flood, by County. The annualized loss ratio is calculated as annualized losses divided by the total exposure at risk and is more appropriate to compare the relative risk among counties.

Table 6-12. Annualized Losses and Annualized Loss Ratios from Flooding in the Guadalupe River Basin, using HAZUS-MH

Jurisdiction	Total Exposure	Potential Annualized Losses for Residential Buildings at Risk ($)	Potential Annualized Losses for Commercial Buildings at Risk($)	Annualized Expected Property Losses ($)	Annualized Percent Loss Ratio
Caldwell	30,410,450	1,159,626	62,374	1,222,000	4.02%
Calhoun	235,510,900	947,203	154,197	1,101,400	0.47%
Comal	119,555,000	4,615,160	332,840	4,948,000	4.14%
DeWitt	28,294,570	770,364	65,636	836,000	2.95%

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Jurisdiction	Total Exposure	Potential Annualized Losses for Residential Buildings at Risk ($)	Potential Annualized Losses for Commercial Buildings at Risk($)	Annualized Expected Property Losses ($)	Annualized Percent Loss Ratio
Gonzales	57,461,070	1,889,473	867,527	2,757,000	4.80%
Guadalupe	162,924,000	3,294,157	191,243	3,485,400	2.14%
Hays	149,539,100	3,625,658	318,342	3,944,000	2.64%
Kendall	38,054,150	1,118,020	259,980	1,378,000	3.62%
Refugio	25,483,380	565,091	47,909	613,000	2.41%
Victoria	71,666,440	970,205	349,795	1,320,000	1.84%

GBRA facilities (described on pages 4-18 and 4-19) are also at risk from this hazard. However, no estimate is currently available of potential damages and losses to those facilities.

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