

DAM FAILURE

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Hazard Description

Dams are water storage, control or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of, or breach in, the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream. Dam failures can result from any one, or a combination, of the following causes:

- Prolonged periods of rainfall and flooding, which cause most failures;
- Inadequate spillway capacity, resulting in excess overtopping of the embankment;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components;
- Improper design or use of improper construction materials;
- Failure of upstream dams in the same drainage basin;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion;
- Destructive acts of terrorists; and
- Earthquakes, which typically cause longitudinal cracks at the tops of the embankments, leading to structural failure.

Benefits provided by dams include water supplies for drinking, irrigation and industrial uses; flood control; hydroelectric power; recreation; and navigation. At the same time, dams also represent a risk to public safety. Dams require ongoing maintenance, monitoring, safety inspections, and sometimes even rehabilitation to continue safe service.

In the event of a dam failure, the energy of the water stored behind the dam is capable of causing rapid and unexpected flooding downstream, resulting in loss of life and great

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property damage. A devastating effect on water supply and power generation could be expected as well. The terrorist attacks of September 11, 2001 generated increased focus on protecting the country's infrastructure, including ensuring the safety of dams.

One major issue with the safety of dams is their age and the average age of America's 80,000 dams is 51 years. More than 2,000 dams near population centers are in need of repair, according to statistics released in 2009 by the Association of State Dam Safety Officials¹. In addition to the continual aging of dams, there have not been significant increases in the number of safety inspectors resulting in haphazard maintenance and inspection.



The Association of State Dam Safety Officials estimate that \$16 billion will be needed to fix all high-hazard dams, but the total for all state dam-safety budgets is less than \$60 million². The current maintenance budget does not match the scale of America's long-term modifications of its watersheds. Worse still, more people are moving into risky areas. As the American population grows, dams that once could have failed without major repercussions are now upstream of cities and development.

Location

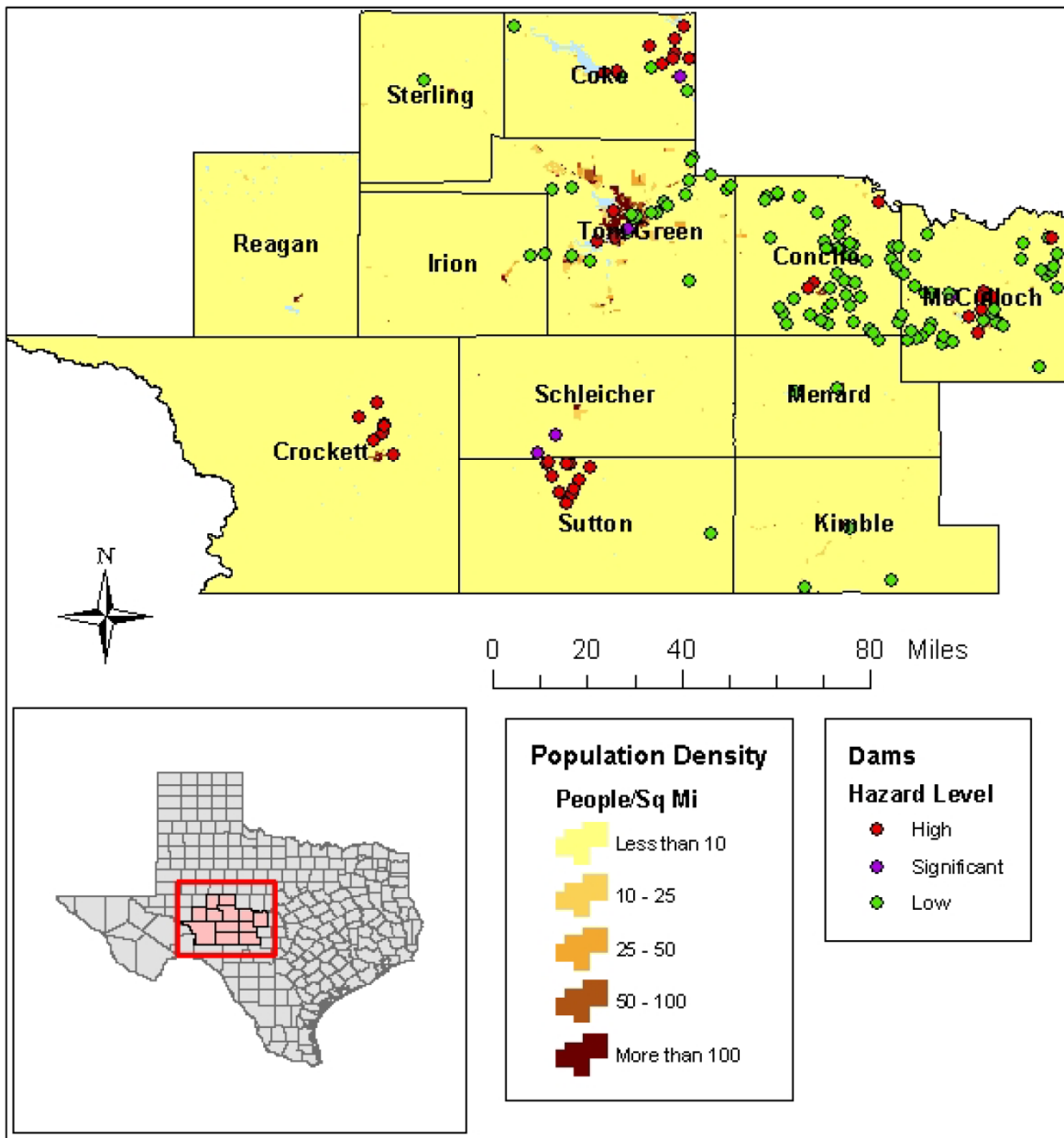
The State of Texas has 7,413 dams, all regulated by the Texas Commission on Environmental Quality (TCEQ). Of these, 854 are considered "high-hazard," 779 are considered "significant-hazard," and 5,780 are considered "low-hazard." According to the American Society of Civil Engineers' "Report Card," the Association of State Dam Safety Officials reports that there are 403 unsafe dams in Texas.³ Although classifications for specific dams in the CVCOG area were not provided by TCEQ, location and volume, elevation, and condition information was factored into the risk ranking. Currently, there are 162 dams within the 12 participating counties in the CVCOG Region.

¹ Association of State Dam Safety Officials, Journal of Dam Safety

² Ibid

³ <http://www.asce.org/reportcard/pdf/tx.pdf>

Figure 10-1. Dam Locations in the CVCOG Region



Extent

The extent or magnitude of a dam failure event is described in terms of the classification of the damages that could result from a dam’s failure; not the probability of failure. The National Interagency Committee on Dam Safety defines high hazard dams as those where failure or mis-operation will cause loss of human life. Prior to 2009, high hazard dams were defined as those at which failure or mis-operation would probably cause loss of human life. Dams classified as “significant” were those at which failure or mis-operation probably would not result in loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, or other significant damage. Low hazard potential dams are those at which failure or mis-operation probably would not result in loss of human life but would cause limited economic and/or environmental losses. Losses would be limited mainly to the owner’s property. Classifications for extent after 2009 are found in Table 10-1 below.

Table 10-1. Extent Classifications

HAZARD POTENTIAL CLASSIFICATION	LOSS OF HUMAN LIFE	DAM STORAGE CAPACITY
Low	None Expected	Less than 10,000 acre-feet
Significant	Probable (1 to 6)	Between 10,000 and 100,000 acre-feet
High	Loss of Life Expected (7 or More)	100,000 acre-feet or more

The extent or average magnitude of a dam failure event that could be expected for each county is shown in Table 10-2 based on location data found in Figure 10-1 and the extent classifications in Table 10-1 above.

Table 10-2. Extent by Jurisdiction

COUNTY	EXTENT CLASSIFICATION	LEVEL OF INTENSITY TO MITIGATE
Coke	Significant	Dam failure presents a significant threat as the County has at least one high hazard dam and one significant hazard dam, which is in fair condition. Loss of life is probable and economic impact appreciable in the event of a failure.

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COUNTY	EXTENT CLASSIFICATION	LEVEL OF INTENSITY TO MITIGATE
Concho	Low	The County only has two significant hazard dams and multiple low hazard dams located in less densely populated areas. Economic losses would be negligible and loss of life is not anticipated in the event of a dam failure.
Crockett	Low	The County has two significant hazard dams and a couple of low hazard dams, therefore loss of life is not probable.
Irion	Low	All dams located inside the County are considered low hazard dams.
Kimble	Low	The County only has low hazard dams. Loss of life is not expected and any economic loss would be negligible.
McCulloch	Significant	The County has at least one high hazard dam, one significant hazard dam, and multiple low hazard dams. Loss of life is probable and economic impact appreciable in the event of a failure. One of the county's dams is breached; however this dam is only eight feet with no storage capacity.
Menard	Low	The county only has low hazard dams, therefore loss of life is not expected in a breach and any economic loss would be negligible.
Schleicher	Low	The County only has low hazard dams, both located in the unincorporated areas. Loss of life is not expected and economic impact appreciable in the event of a failure.
Sterling	Low	The County only has one dam and it is a low hazard dam, therefore loss of life is not expected in the event of a failure.
Sutton	Low	Although the County has one significant hazard dam, this dam is not located in a populated area and is listed as being in good condition.

COUNTY	EXTENT CLASSIFICATION	LEVEL OF INTENSITY TO MITIGATE
Tom Green	Significant	Dam failure presents a significant threat as the County has two high hazard dams, one significant hazard dam, and multiple low hazard dams that are located throughout the County. In the event of a dam failure, loss of life is probable and economic loss is appreciable.

Historical Occurrences

There are about 80,000 dams in the United States today.⁴ Catastrophic dam failures have occurred frequently throughout the past century. Between 1918 and 1958, 33 major U.S. dam failures caused 1,680 deaths. From 1959 to 1965, nine major dams failed worldwide. Some of the largest disasters in the U.S. have resulted from dam failures. More than 520 dam incidents, including 21 dam failures, were reported in the past two years to the National Performance of Dams Program, which collects and archives information on dam performance from state and federal regulatory agencies and dam owners.

The State of Texas has not experienced loss of life or extensive economic damage due to a dam failure since the first half of the twentieth century. However, due to limited state staff, many incidents are not reported and, therefore, the actual number of incidents is likely to be greater.

There has not been a recorded dam failure event for any of the participating jurisdictions in the planning area.

Probability of Future Events

No historical events of dam failure have been recorded in the CVCOG Region, though the risk of dam failure is monitored closely. Due the lack of historical occurrences, the probability of a future event is unlikely, meaning an event is possible within the next ten years.

Vulnerability and Impact

Significant and high hazard dams are located in both rural and populated areas in the CVCOG planning area. Although low hazard dams are those at which failure or mis-operation probably would not result in loss of human life and would cause limited economic

⁴ Federal Emergency Management Agency, Dam Safety Program, <http://www.fema.gov/hazards/damsafety/>

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and/or environmental losses, damage to agriculture and housing is possible due to the amount of low hazard dams in each county.

Flooding is the most prominent effect of dam failure. If the dam failure is severe, a large amount of water would enter the downstream waterways forcing them out of their banks. There may be significant environmental effects, resulting in flooding that could disperse debris and hazardous materials downstream that can damage local ecosystems. In addition debris carried downstream can block traffic flow, cause power outages, and disrupt local utilities such as water and wastewater. Surge waves resulting from dam breaks have the potential to create major losses.

Annualized loss-estimates for dam failure are not available; neither is a breakdown of potential dollar losses of critical facilities, infrastructure and lifelines, or hazardous-materials facilities. If a major dam should fail, however, the severity of impact could be substantial.

A dam breach could result in multiple deaths with facilities being shut down for 30 days or more, and more than 50 percent of property destroyed or damaged. For these reasons, creating mitigations actions to remove or protect people and structures from the path of destruction is necessary in order to minimize impact from dam failure.