Colorado rethinks dam safety as climate change heightens risk for state's 27 "unsatisfactory" structures

New rules for assessing stability at dams factor in temperature increases and potential for sudden hard rains

Bruce Finley December 1, 2019 at 5:25 pm

RJ Sangosti, The Denver Post

Jeremy Franz, design review engineer for the Colorado Division of Water Resources's Dam Safety division, takes notes before a final inspection of work at Tusker Dam in Arvada on Nov. 20, 2019.

A climate-driven shift toward extreme storms has compelled Colorado officials to rethink the safety of hundreds of dams across the state that hold water and mine waste, including 27 high-hazard structures near people that already are listed as deficient.

They're trying to calculate the potential for sudden hard rain resulting in flooding and accelerated erosion that could trigger fatal collapses. It comes down to physics: Climate scientists project temperature spikes by at least 2 degrees Fahrenheit in Colorado before 2070, and warmer air holds more moisture.

New rules taking effect Jan. 1 require tougher dam designs "to account for expected increases in temperature and associated increases in atmospheric moisture." State officials are contemplating structural work costing $100 million a year to boost resilience.

The likelihood that heavier rain may saturate dams and rupture spillways ranks among the multiplying impacts of climate change that are forcing costly responses.

Wildfires burn more uncontrollably, ravaging forests, threatening people who live in the woods and raising firefighting costs. Shrinking mountain snowpack and an overall trend toward aridity is flummoxing farmers and spurring the ski industry to rely more on artificial snow. Heatwaves render increasingly dense, paved-over cities less habitable.

RELATED: *Map: Colorado has more than 400 "high hazard" dams, and 27 of them are deficient*

The nation's aging dams have been collapsing more than twice as often as they did before 1980, Stanford University researchers have found. And while dam failures that kill people and spread toxic mud remain rare, risks are rising for the growing numbers of Americans who live and work

downstream.

“We recognize that Colorado is already feeling the impacts of climate change,” state natural resources director Dan Gibbs said in a written response to questions from The Denver Post.

“We are incorporating climate impacts into our regulatory and policymaking processes. The more our agency can do today, the more prepared future generations will be to lessen the impacts of global warming and protect our communities, public health and natural resources,” Gibbs wrote.

Old dams, old assumptions

The 90,580 dams around the nation, including 1,737 in Colorado, were built on assumptions of rainfall and flooding derived from weather data collected before 1980. Hundreds of these dams have been deteriorating nationwide, raising risks that communities could be inundated — and now could deteriorate more rapidly.

For example, a 55-year-old earthen dam above Breckenridge that holds the municipal water supply would inundate the town if it collapsed. Rain and runoff from melting snow, seeping under concrete spillways, has created voids.

“The voids are becoming larger,” Breckenridge public works director James Phelps said in a recent interview. Town officials have embarked on a $20 million fix with federal help to be completed by 2023, Phelps said.

“We’ve definitely been seeing more severe events. We didn’t used to get these types of storms,” he said. “The weather patterns are more severe, more staccato than they used to be. They are not as predictable as they once were.”

Hyoung Chang, The Denver Post

Snow covers the Goose Pasture Tarn Dam and Reservoir outside Breckenridge on Nov. 21, 2019.

Dams built more than 100 years ago to store water for irrigating crops in what now is metro Denver loom among those deemed unsatisfactory. These include the Smith Dam in suburban Lakewood and the Polly Deane Dam above

Littleton. Urban housing and commercial development downstream means failures likely would be deadly. Breaches would inundate thousands of people between western mountain foothills and the South Platte River.

A Denver Post examination of state records and interviews with dam safety officials found that, among 432 high-hazard dams statewide where failure likely would kill people, 27 are rated by state inspectors as unsatisfactory. A dozen have been classified that way for more than five years, records show.

Colorado's deficient high-hazard dams are, on average, 95 years old, data shows. They're scattered around the state, mostly near where settlers built communities.

Colorado relies on dam owners to maintain structural stability. Most dams are privately owned. A dozen state dam safety engineers conduct annual inspections at the 432 "high-hazard" and about 300 more "significant hazard" dams to assess stability. Low-hazard dams often aren't inspected unless developers are constructing new housing and shops nearby.

Repair decisions are left to the owners. However, state officials have the power to impose restrictions on how much water can be stored behind ailing dams, which creates an incentive encouraging owners to make repairs. Owners

often resist. Dam repairs can cost hundreds of millions of dollars.

“This is not an emergency situation. If we keep the water level under the 2-feet restriction (a drop in the water level required since 1995), it’s a safe situation,” said Peter Acker, manager of the Agricultural Ditch and Reservoir Company that owns the Smith Dam in Lakewood.

Reinforcing that dam, which enables an emergency “drought” water supply for irrigating metro farms and parks, “is not cost-effective,” said Acker, who added that climate change impacts appear uncertain.

“They don’t know,” he said. “Everybody’s just guessing on this climate change thing.”

Yet the restrictions mean a huge loss of potential revenue by reducing the amount of water that can be stored. Now amid Colorado’s intensifying population growth and development boom, developers, farmers, suburban water providers and state planners are pressing for construction of new dams and expansion of existing dams.

Colorado has lost storage space for nearly 118,000 acre-feet of water statewide under the restrictions imposed just on the high-hazard dams, records show. By comparison, Denver Water’s long-planned expansion of Gross Reservoir

in Boulder County by raising a dam would add about that amount of water storage capacity at a cost of $340 million.

Helen H. Richardson, The Denver Post

Ranch operations manager Gilbert Marin Jr. looks out over 70 Ranch Reservoir in Kersey on June 25, 2019. The large new reservoir was built and is owned by Bob Lembke, president of United Water and Sanitation District. The dam is not on the list of the state's deficient or at-risk structures.

A changing climate's impact

Colorado officials working with federal climate scientists recently conducted a $1.6 million study aimed at improving methods for assessing dam safety in view of projected climate impacts. They worked with the National Oceanic and Atmospheric Administration and the University of Colorado to create computer modeling tools for engineering analysis that factor in weather science to estimate rainfall.

This study drove the initial efforts to boost resilience in the face of climate warming. Colorado's new dam safety rules incorporate an "atmospheric moisture factor," recognizing that sudden intense rain could blow through existing spillways.

Over the next year, state inspectors will conduct reviews and determine where repairs and reinforcements must be made, Colorado dam safety director Bill McCormick said. McCormick recently was elected to serve as president of the National Association of State Dam Safety Officials.

"In the past, we assumed a stationary climate. The methods that we used to determine rainfall were all backward-looking, at historic storms. Now it doesn't seem that is the smartest way to do it anymore," McCormick said.

"Since we have this changing climate, we have the potential of getting behind. We have to change, find ways to look forward."

Costs in Colorado are expected to top $100 million a year, more than twice what state lawmakers have been allocating for dam maintenance. Nationwide, the state dam safety officials association has estimated that fixing all ailing dams, including more than 12,500 high-hazard dams, would cost $70 billion.

Dam owners may be eligible for Federal Emergency Management Agency funds. Colorado officials received a $260,000 grant for engineering work at the Smith and Polly Deane dams in west metro Denver.

Other states around the country face rising risks and likely will be compelled to act as old dams deteriorate and storms intensify, McCormick said. “There are things we can and should be doing. Let’s get this on our radar.”

AP file

Top: Rescue workers remove a body from the flooding waters near the Toccoa Falls Bible College on Nov. 6, 1977, after a dam burst above the college sending floodwaters through a dorm area. The water also destroyed a wide area of homes. Bottom left: A damaged property is seen under floodwaters in Oroville, Calif., on Feb. 13, 2017. Almost 200,000 people were under evacuation orders in Northern California after a threat of catastrophic failure at the United States' tallest dam. Bottom right: A worker keeps an eye on water coming down the damaged main spillway of the Oroville Dam in Oroville, Calif., on Feb. 14, 2017. A hole in the emergency spillway in the Oroville Dam threatened to flood the surrounding area. (Getty Images file)

Dam failure rates

Catastrophic dam failures in the United States — such as the 2017 Oroville Dam failure that forced evacuations of 190,000 people in California and failures in the 1970s in Idaho and Georgia that claimed 53 lives — have been relatively rare. However, state data shows more than 84 "incidents" requiring quick intervention and dam failures each year. And maps showing "inundation zones" still are kept secret, in line with counterterrorism precautions instituted after the Sept. 11, 2001, attacks — which frustrates residents.

Dam failure rates are increasing. Between 1848 and 2017,

dams in the United States failed at an average rate of 10 a year, according to a 2018 engineering study from Stanford University's National Performance of Dams Program. Colorado had 88 dam failures, more than other states except for Georgia and South Carolina where relatively recent flooding blew out hundreds of small dams. After 1980, dams nationwide failed at an average rate of 24 a year, the study found. And 3.8% of dam failures in the United States led to one or more deaths.

The last major dam failure in Colorado happened suddenly in 1982. Deterioration of the earthen Lawn Lake Dam in Rocky Mountain National Park led to a breach that released 220 million gallons of water, killing three people and causing $31 million in damage around the town of Estes Park.

Some of the worst disasters worldwide resulted from failures at old mines. Colorado and other western states that for more than a century prioritized mineral extraction are left with massive earthen dams that hold mine waste in what are meant to be permanent impoundments.

When floods trigger breaches at mine dams, billions of gallons of mud gush downward, inundating communities, destroying land and vegetation, and clogging waterways.

Colorado officials for years exempted the state's five mine waste dams from dam safety regulations. However, state

mining regulators oversee the mine dams, said Russ Means of the Colorado Division of Reclamation, Mining and Safety.

Four are located at Climax Molybdenum facilities west of Denver. The risk is that coarse, wet sediment could become too saturated, leading to loss of stability, Means said. But mine waste dams in the state appear safe, built to withstand heavy rain over 24 hours from “100-year storms,” he said. “These are high priority sites. These sites are inspected monthly.”

Colorado’s new rules may be extended to mine waste dams as protocols to guide future maintenance, state officials said.

Fixing dams jibes with interest in Colorado for more water storage capacity to enable population growth and development. When assessing the stability of old dams, owners and state overseers have identified options not only to regain use of restricted storage but also to expand dams and reservoirs.

“We need to look at where we can add storage safely and economically,” McCormick said. “For us, public safety is the first priority. But we also understand economics.”