2009

INFRASTRUCTURE FACT SHEET

ASCE American Society of Civil Engineers

As dams age and downstream development increases, the number of deficient dams has risen to more than 4,000, including 1,819 high hazard potential dams. Over the past six years, for every deficient, high hazard potential dam repaired, nearly two more were declared deficient. There are more than 85,000 dams in the U.S., and the average age is just over 51 years old.

WATER AND ENVIRONMENT

FACTS ABOUT

DAMS

WATER AND ENVIRONMENT

DAMS

2009 GRADE **D**

RAISING THE GRADES

SOLUTIONS

THAT WILL WORK **NOW**

- **A** = Exceptional
- **B** = Good
- **C** = Mediocre
- **D** = Poor
- **F** = Failing

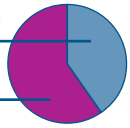
AMERICA'S INFRASTRUCTURE G.P.A. **D**

ESTIMATED 5-YEAR FUNDING REQUIREMENTS FOR **DAMS**

Total investment needs
$12.5 BILLION

Estimated spending
$5.05 BILLION

Projected shortfall
$7.45 BILLION



- ★ **ENCOURAGE** or require effective state dam safety programs that provide adequate funding, staff, and statutory authorities;
- ★ **DEVELOP** emergency action plans for every high hazard dam by 2011;
- ★ **ESTABLISH** a national funding program and parallel state programs to repair nonfederally owned dams;
- ★ **INCLUDE** dam failure inundation mapping as part of the National Flood Insurance Program;
- ★ **EDUCATE** the public about dam safety risks;
- ★ **ENCOURAGE** individuals to educate themselves on the location and condition of dams in their area.

CONDITION

Dams provide essential benefits, including drinking water, power generation, flood protection, irrigation, and recreation. They may be publicly owned and operated by federal agencies, states, cities and municipalities or privately owned and operated by businesses and corporations. Typically earth embankments or concrete structures, dams can reach heights of up to 770 feet and store billions of gallons of water. A dam's "hazard potential" is classified on the basis of the anticipated consequences of failure, not the condition of the dam. The classifications include "high hazard potential" (anticipated loss of life in the case of failure), "significant hazard potential" (anticipated damage to buildings and important infrastructure), and "low hazard potential" (anticipated loss of the dam or damage to the floodplain, but no expected loss of life).

The National Inventory of Dams (NID), which is maintained by the U.S. Army Corps of Engineers (USACE), shows that the number of dams in the U.S. has increased to more than 85,000, but the federal government owns or regulates only 11% of those dams.[3,5] Responsibility for ensuring the safety of the rest of the nation's dams falls to state dam safety programs. Many state dam safety programs do not have sufficient resources, funding, or staff to conduct dam safety inspections, to take appropriate enforcement actions, or to ensure proper construction by reviewing plans and performing construction inspections. For example, Texas has only 7 engineers and an annual budget of $435,000 to regulate more than 7,400 dams.[3] That means each inspector is responsible for more than 1,050 dams. Worse still, Alabama does not have a dam safety program despite the fact that there are more than 2,000 dams in the state. And in some states many dams are specifically exempted from inspection by state law. In Missouri there are 740 high hazard potential dams that are exempted because they are less than 35 feet in height. The task for the states is an enormous challenge. (See Table 1.1)

While the total number of dams is increasing, the number of high hazard potential dams is also increasing at an alarming rate, now totaling 15,237.[3] That represents an increase of more than 3,300 new high hazard potential dams since 2007. This increase is a result of new development below dams, which is dramatically increasing the consequences of failure and resulting in the reclassification of dams. This change in classification requires that significantly greater safety standards be met given the greater consequences of dam failure.

The number of dams determined to be unsafe or deficient has risen from 3,500 in 2005 to 4,095 in 2007.[3] Of that number, high hazard potential dams that are also classified as deficient has risen from 1,367 in 2005 to 1,819 in 2007.[3] The greatest indicator of the condition of the nation's dams can be seen in Table 1.1 that demonstrates the increase in the number of high hazard dams that need to be repaired compared to the number of completed repairs to high hazard dams, which remains flat.[3] The rate of dam repairs is

TABLE 1.1 ★ Number of Deficient Dams in United States by Repair Status

YEAR	# OF DEFICIENT DAMS	# OF HIGH HAZARD DEFICIENT DAMS	# OF HIGH HAZARD REPAIRED DAMS	# OF HIGH HAZARD DAMS NEEDING REPAIR
2001	1,348	488	124	364
2002	1,536	646	163	483
2003	2,004	648	120	528
2004	3,000	979	100	879
2005	3,271	1,367	138	1,229
2006	3,346	1,308	139	1,169
2007	4,095	1,826	83	1,743

SOURCE Association of State Dam Safety Officials

not keeping pace with the increase in the number of high hazard dams that need rehabilitation. The gap between dams needing repair and those actually repaired is growing significantly.

Many dams are determined to be deficient as a result of aging, deterioration, and a lack of maintenance. Often dams are deemed unsafe or deficient as a result of increased scientific and engineering knowledge about large flood events and earthquakes, and the ability to predict a dam's structural response to such extreme events, which pose a significant safety threat. Many dams were constructed 30 or 40 years ago using the best science and engineering at the time. But as a result of the additional 40 years of historical records and greater abilities to predict increases in loads on dams and the dams'

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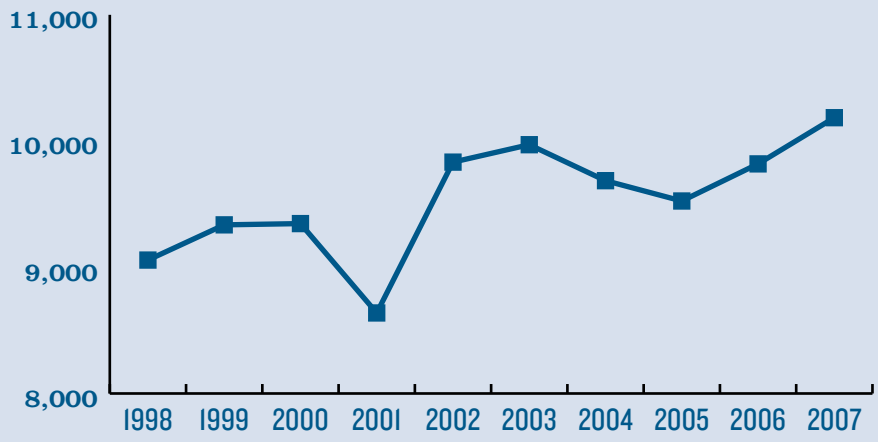
FIGURE 1.1 ★ Number of High Hazard Dams in the United States



SOURCE Association of State Dam Safety Officials

responses to those events, more dams are being identified as unsafe or deficient.

The National Dam Safety Program (NDSP), which was established by the Water Resource Development Act of 1996, created a national dam safety program administered by the Federal Emergency Management Agency that is designed to provide incentive grants to states and training to encourage research.[12] While there have been successes and improvements as a result of the NDSP and stronger state programs, the safety and condition of the nation's dams have not improved overall. Successes have included modest increases in staffing, budgets, and dam safety inspections in some state programs. The number of Emergency Action Plans (EAPs)—essential plans used in the event of a failure to identify and notify people residing below a dam, and to coordinate their evacuation—has also increased.[9] However, the number of high hazard potential dams nationwide that have EAPs remains at a lackluster 50%. Even worse is the fact that many high hazard potential dams are unregulated and uninspected. Approximately 30% of the high hazard potential dams have not been inspected within the last five years (see Figure 1.1).

Federal agencies own or regulate a very small percentage of the 85,000 dams in the U.S. but they face significant challenges in terms of oversight.[8] As the country's dams age, downstream development increases, and better engineering methods are developed, more significant rehabilitation will be needed. Examples include the

RAISING THE GRADES
CASE STUDIES

U.S. NATURAL RESOURCES CONSERVATION SERVICE ★
Watershed Rehabilitation Program

The U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) has provided technical and funding assistance to local watershed sponsors to construct 11,000 project dams (primary purposes being flood control, water supply, and grade stabilization) since 1948—most of these dams were installed under the Watershed Protection and Flood Prevention Act (PL 83-566).[13] While these watershed project dams provide significant annual benefits, thousands of these dams need to be rehabilitated: 1,065 watershed dams have already exceeded their design life and by 2015 an additional 4,300 dams will have exceeded their design life; 1,000 dams need to be rehabilitated due to stricter dam safety standards as a result of downstream development greatly increasing the consequences of a dam failure.

The NRCS has implemented a very successful program to provide assessments, planning, designs, and construction funding to begin the enormous task of repairing watershed dams throughout the U.S. The success of the program has been a result of partnerships between the NRCS, local sponsors, and state dam safety officials—leadership and funding provided by Congress. The design and construction funding is cost-shared—65% is provided by the NRCS and 35% is provided through local participation. To date, 77 dams have been rehabilitated, an additional 55 have been authorized for construction, and another 31 are in the planning phase.

Congress has continued its leadership role by providing $100 million in the 2008 Farm Bill (mandatory funding) and has authorized $85 million to be appropriated for fiscal years 2008 through 2012 (discretionary funding) to support the Watershed Rehabilitation Program. Over the next four years (FY 2009–2012), the NRCS anticipates performing 400 dam assessments, processing 250 local sponsor requests for assistance, developing 200 rehabilitation plans, completing 170 designs, and rehabilitating 120 watershed dams.

$317 million rehabilitation of Wolf Creek Dam, which is owned by the USACE, and the major improvements to Folsom Dam, which were jointly undertaken by the USACE and the U.S. Bureau of Reclamation at an estimated cost of $1.5 billion through 2019.

In 2009, the Association of State Dam Safety Officials (ASDSO) estimated that the total cost to repair the nation's dams totaled $50 billion and the needed investment to repair high hazard potential dams totaled $16 billion. These estimates have increased significantly since ASDSO's 2003 report, when the needed investment for all dams was $36 billion and the needed investment for high hazard potential dams was $10.1 billion.[4]

The 2009 report noted an additional investment of $12 billion over 10 years will be needed to eliminate the existing backlog of 4,095 deficient dams. That means the number of high hazard potential dams repaired must be increased by 270 dams per year above the number now being repaired, at an additional annual cost of $850 million a year. To address the additional 2,276 deficient—but not high hazard—dams, an additional $335 million per year is required, totaling $3.4 billion over the next 10 years.[4]

While much progress in identifying the condition of the nation's dams has been made since the implementation of the NID, the 2008 failure of a dam retaining coal ash from a power plant in Tennessee points out significant gaps in the regulation of dams associated with the power and mining industry at both the federal and state levels. Many states do not have the authority to regulate mining dams, other states only regulate mining dams after the mining operation has stopped, and some states regulate mining dams through departments other than those that administer the dam safety program. At the federal level there are significant differences in regulatory standards between the coal mining industry and the metal/nonmetal industries regarding standards for design, inspection, and the requirements to provide EAPs for high hazard dams.

RESILIENCE

Dams are generally not very resilient because few have redundant structures, many have regional impacts, and only 50% of high hazard dams have EAPs.

The U.S. Department of Homeland Security, through the Office of Infrastructure Protection, has started addressing this important issue in collaboration with the dam safety and dam security communities, federal and state agencies, and the entire spectrum of owners and operators. Given the large number of dams and their broad range of resiliency levels, efforts are being made to develop a rational prioritization approach for coordinating protection programs and resiliency enhancements. Important physical and functional characteristics of dams—such as the consequence of failure and loss of critical benefits—are considered the basis for identifying which dams would have the most severe and long lasting impact if service was lost (drinking water, hydropower, flood damage reduction, inland

RAISING THE GRADES
CASE STUDIES

BEXAR COUNTY, TX ★ Martinez Creek Dam No. 5

When it was constructed in 1964, the Martinez Creek Dam was designed to protect agricultural lands. Since that time, development in the area has increased and the lake formed by the dam is an integral part of the city of Live Oak's park system. County officials applied to the NRCS Small Watershed Rehabilitation Program for grants to rehabilitate the dam since its hazard level had increased from low to high. Since the dam was raised and the spillway upgraded, engineers now expect the dam to last another 100 years. *Photo courtesy of the San Antonio River Authority.*

RINGWOOD, NJ ★ Skyline Lake Dam

Following several devastating flood events that resulted in more than 35 dam failures, the state of New Jersey developed funding programs for the rehabilitation of dams. Two state bond acts have provided the New Jersey Department of Environmental Protection, Bureau of Dam Safety and Flood Control, with $110 million to administer low interest loans for dam rehabilitation projects. Twenty-four dams, including 19 high hazard dams, have been completed so far; 29 more, including 10 high hazard dams, are under construction; and 45, including 11 high hazard dams, are in some stage of planning and design. Owners of the Skyline Lake Dam applied to this state program and received $900,000 to reconstruct the concrete spillway and stabilize the earth embankment to allow for overtopping during a storm. Overall, approximately $32.8 million has been disbursed from the program to date. *Photo courtesy of New Jersey Department of Environmental Protection, Office of Engineering and Construction.*

RAISING THE GRADES
CASE STUDIES

SANDOVAL COUNTY, NM ★ NRCS Rehabilitated Dam

Just outside of Albuquerque, New Mexico, the Piedra Liza Dam today protects seven times as many people as when it was built in the early 1950s. Analyses in the early 2000s showed deficiencies within the dam and should it fail, as many as 1,700 residents in the area and 43,000 commuters on Interstate 25 could be adversely affected. Sandoval County applied to the NRCS Small Watershed Rehabilitation Program for assistance in 2005 and by 2007 repairs had been completed. *Photo courtesy of the U.S. Natural Resources Conservation Service.*

navigation, etc.). By considering the impact on all sectors—public safety, local commerce, service suppliers, etc.—in the risk evaluation process, strategies that target increased resilience and improved security can be effectively identified.

CONCLUSION

Despite some successes, the overall condition of the nation's dams has not improved in recent years. This is evidenced by the rising numbers of dams—especially high hazard dams—that are deficient and in need of repair as well as by the limited number of dams that are actually repaired each year. In order to make significant improvements in the nation's dams—a matter of critical importance to public health, safety and welfare—Congress, the administration, state dam safety programs, and dam owners will have to develop an effective inspection, enforcement and funding strategy to reverse the trend of increasingly deteriorating dam infrastructure. ★

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