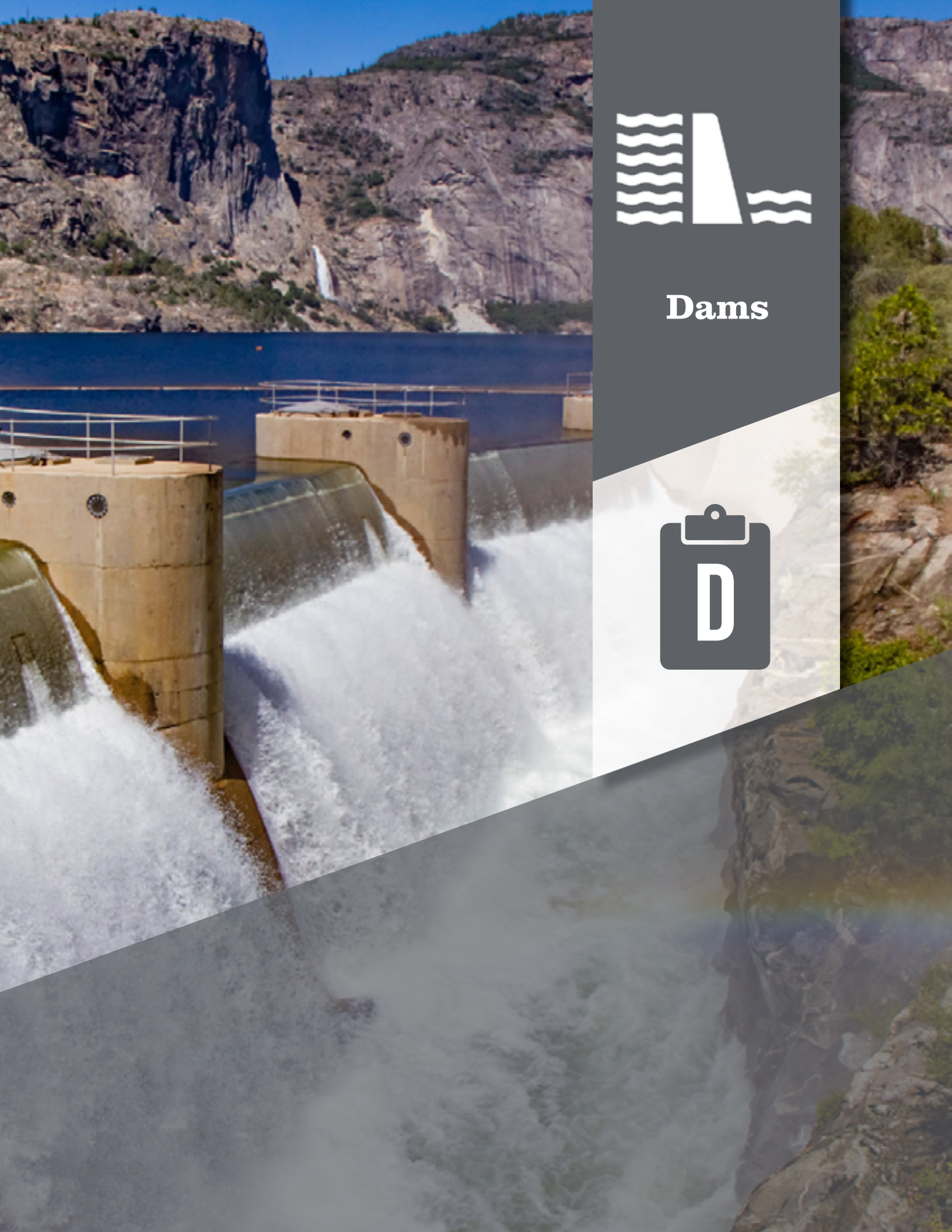

Dams

D

EXECUTIVE SUMMARY

There are over 91,000 dams[1] in the country that serve many purposes. Dams are classified by hazard potential. A high-potential hazard-potential rating does not imply that a dam has an increased risk for failure; it simply means that if failure were to occur, the resulting consequences would likely be a direct loss of human life and extensive property damage. Over the last 20 years, the number of high-hazard-potential dams has more than doubled as development steadily encroaches on once rural dams and reservoirs.[2] Although the number of high-hazard-potential dams has increased, the overall percentage of these dams protected by an Emergency Action Plan has increased as well. As of 2018, 81% of such dams had a plan on file, up 5% from 2015. Unfortunately, due to the lack of investment, the Association of State Dam Safety Officials estimates the number of deficient high-hazard-potential dams now exceeds 2,300.[3] Meanwhile, approximately 3% of dams supply households and businesses with hydroelectric power, and many of these dams are privately owned by utilities and follow a rigorous operations and maintenance schedule.[4]

CONDITION & CAPACITY

Dams are present in all 50 states, serving a wide range of daily needs, such as water storage, irrigation, hydropower, mining, flood control, and recreation. The public most commonly thinks of engineering marvels like the Hoover Dam in Nevada, which provides water supply and hydroelectric power to Arizona, Nevada, and California. However, only 3% of dams are currently a source of hydroelectric energy.

Dams are classified by regulatory agencies based on their hazard potential or anticipated downstream consequences in the event of failure. The failure of a dam that is classified as **high-hazard-potential** is anticipated to cause a loss of life. As of 2019, there are approximately 15,600 dams[5] in the United States that are classified as high-hazard structures. Over the last 20 years, the number of high-hazard-potential dams has more than doubled as development steadily encroaches on once rural dams and reservoirs.[6] Meanwhile the number of dams classified as **significant hazard-potential**, meaning a failure would likely cause significant economic damage, but not necessarily loss of life, reduced during this period from 11,882 in 2017 to 11,343 dams[7] in 2019.

Another contributing factor to the shift in classification of dams is increases in state funding for dam safety programs. With state dam safety programs better able to assess these structures, the opportunity for owners to become aware of rehabilitation, repair, or removal needs increases, as does the likelihood of dams being classified as high hazard potential. Signs of improved funding began as early as 2015 as state economies began to recover from the 2008 recession.[8] Approximately 69% of dams in the National Inventory of Dams (NID) maintained by the U.S. Army Corps of Engineers are state-regulated dams.[9]

Recent crises following heavy seasonal rains, like the failure of the Oroville Dam spillway in 2017 or the failure of the

Edenville and Sanford dams in Michigan, have made major headlines, highlighting the poor condition of many of the nation's dams. Thankfully, incidents of large-scale flooding such as these are rare. Proper maintenance, routine inspection, necessary upgrades, and implementation of an Emergency Action Plan can ensure optimal conditions, which in turn protect the public health, safety, and welfare.

The average age of our nation's dams is 57 years. By 2030, seven out of 10 dams in the United States will be over 50 years old. While this is not a reflection on hazard potential, the high average age means that the majority of dams will not have been built to current standards, let alone incorporate newer standards that improve their resilience and reduce the risk to downstream areas. Furthermore, at the time of their construction, they may have been considered low hazard potential, so they may not be able to withstand the increasingly frequent and severe weather events or other natural hazards like earthquakes.

A secondary classification applied to any dam refers to its condition rating based on structural safety. In the National Inventory of Dams (NID), dams can range from "not rated," which refers to either the lack of inspection or lack of rating, to "satisfactory," indicating no existing or potential dam safety deficiencies. States and federal agencies may have additional definitions and rating applications that are used to classify dams. Definitions may vary slightly from state to state as well as among federal agencies.

FUNDING & FUTURE NEED

Without specific funding programs, many dam owners cite lack of funding as the reason maintenance and upgrades are deferred. As of 2019, over half (56.4%) of U.S. dams were privately owned.[10] The remaining dams are divided among a variety of owners; among them, 20% are local, 4.7% are federal, while an almost equal figure, 4.8%, are owned by states. It should be noted that 42% of federal dams[11] fall under the purview of the U.S. Army Corps of Engineers (USACE) or the Bureau of Reclamation. The smallest share of dams (2.4%) are held by public utilities. Identifying dam owners is critical as funding rehabilitation and repair falls to them.

In fact, the most recent Association of State Dam Safety Officials' (ASDSO) cost estimate indicates the combined total to rehabilitate the nation's non-federal dams exceeds $66 billion.[12] To rehabilitate just those high-hazard-potential dams would cost nearly $20 billion.[13] Additional estimates show the need to rehabilitate federal dams is approximately $27.6 billion.[14]

The High Hazard Potential Dam Rehabilitation (HHPDR) Program authorized in 2016's Water Infrastructure Improvements for the Nation (WIIN) Act is one new program that can help address existing

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funding needs. The goal of this program is to help fund the repair, removal, or rehabilitation of the nation's non-federal, high-hazard-potential dams. In federal fiscal year (FY) 2020 this program was funded at $10 million, less than **0.1%** of the ASDSO need estimate and a **quarter** of its FY20 $40 million authorization.[15]

Dam owners must meet eligibility requirements to receive an HHPDR grant. Eligibility is subject to classification (a high-hazard-potential classification by the State Dam Safety Program) and requires applicants to fail to meet minimum dam safety standards, pose an unacceptable risk to the public, and have an approved Emergency Action Plan (EAP). As of June 2020, there are approximately 60 projects across 25 states that could be construction-ready within the year based on pandemic-related stimulus funds that would require approximately $538 million in total investment.[16] Additionally, there are 1,300 state-regulated high-hazard-potential dams in the NID rated poor or unsatisfactory with an EAP.

When fully appropriated, the HHPDR program has the potential to help repair some of the highest priority dam safety rehabilitation projects in the country. Otherwise, states must navigate a series of smaller state and federal programs. Federal programs include those within the Bureau of Reclamation and National Rural Conservation Services, receiving more than $100 million in FY2019 for grants with funding authority of more than $85 million. For the first time in FY2021, Congress appropriated $12 million to the Corps Water Infrastructure Financing Program (CWIFP), which enables local investment in infrastructure projects like dams that enhance community resilience to flooding, promote economic prosperity, and improve environmental quality. While at the local level, nearly half of states have a grant or low-interest revolving loan program to assist dam owners with repairs. This local commitment of funds can help stretch the potential federal grants even further.

EDENVILLE DAM POWERHOUSE & SPILLWAY

PUBLIC SAFETY

Dam failures not only put the public at risk, they can also cost our economy billions of dollars in damages. Failure includes more than the dam's damage, but can negatively impact many other infrastructure systems, such as roads, bridges, and water systems. When a dam fails, resources must be devoted to the prevention and treatment of public health risks as well as the resulting structural consequences.

EAPs identify potential emergency conditions at a dam, specify preplanned actions to be followed to minimize property damage and loss of life should those conditions occur, and are initiated in the event of an impending dam failure or other uncontrolled releases of water. The number of high-hazard-potential dams with EAPs continues to steadily climb toward a recommended goal of 100%; as of 2018, 81% of dams have EAPs — up from 77% in 2017.[17] Additionally, 34 states reported 90% or more of their high-hazard-potential dams had EAPs on file,[18] while this same number of states saw 100% of their high-hazard-potential dams inspected in 2018.[19]

Every state except Alabama has established a regulatory program for dam safety that bears a large responsibility for public safety, including the certification of EAPs. These programs have regulatory authority for 69% of the NID dams.[20] Further improving public safety is the increase in staffing within state dam safety programs over the past several years. In 2018, state programs spent nearly $60 million[21] on dam safety regulation, a 22% increase over the previous four years. One result from this spending is an increase in dam safety program staff — nearly 450 full-time equivalents[22] — across the 50 states.

Adequate staffing is important to state dam safety program performance. The range of state-regulated high-hazard-potential dams per staff ranges from 5.8 to 120.7, with a national average of 28.6 high-hazard-potential dams per Full-Time Equivalent (FTE) staff. Nineteen states have a staffing ratio more than 10 percent above the national average. State numbers significantly above the high-hazard-potential dams per FTE national average can be an indicator of the need for additional staff resources. Adequate staffing can enable dam safety programs to improve inspection rates and asset monitoring, while also reducing dam owners' challenges in completing needed repairs and upgrades. At the federal level, the National Dam Safety Program (NDSP), which was reauthorized in 2018 through FY 2023, helps facilitate collaboration among stakeholders within federal agencies, states, and owners to streamline dam safety roles and responsibilities.

Finally, low head dams can pose a hazard to unassuming public. A low-head dam is a relatively small, man-made structure spanning a river or stream where water flows over the entire length of the dam. Moderate-to-high flows over these dams create turbulent and recirculating currents that can pull and trap individuals underwater. Because low head dams are inconspicuous, people are often unaware of the dangers these structures pose.

RESILIENCE & INNOVATION

In some areas, engineers, dam owners, regulators, and emergency management professionals are making efforts to engage communities near dams to raise awareness of the potential damage from failure. By expanding community collaboration, stakeholders can support land use decisions, emergency action planning, and maintenance and rehabilitation funding, that all help reduce community risk and improve resilience in the long term.

Further increasing resilience of dams throughout the country is the shift toward a risk-based decision-making process for the design, rehabilitation, and operation of dams. This risk-based approach is innovatively coupled with web-based tools developed by federal agencies, like RiskMAP, DamWatch, and ShakeCast, that aid dam owners in identifying, mitigating, and reacting to potential structural and downstream risks.[23]

RiskMAP, or Risk Mapping, Assessment, and Planning, is a FEMA program that provides communities with flood information and tools they can use to enhance their mitigation plans to protect public safety.[24] The program looks at the lifetime of the asset and identifies other risks within the watershed, which could include dam failures. Dam Watch, a web-based application, provides real-time monitoring of rainfall, snowmelt, stream flow, and seismic events that could pose potential threats to dam safety. With its ability to alert essential staff of critical events, Dam Watch can help ensure Emergency Action Plans and related procedures are executed in a timely fashion. Finally, the ShakeCast system was developed by the U.S. Geological Survey (USGS) as a means of assisting in post-earthquake disaster management, which among other things can include notifying dam owners of potential seismic risks.[25] An extension of the USGS tool, ShakeCast can provide real-time information that enables decisionmakers to take quick action to secure the asset and protect public health and safety.

Dams

RECOMMENDATIONS TO RAISE THE GRADE

- Fully fund the national dam rehabilitation and repair funding program at its full appropriation of $40 million to cost-share repairs for publicly owned, non-federal, high-hazard-potential dams.
- Develop emergency action plans for every high-hazard-potential dam by 2025.
- Implement a national public awareness campaign to educate individuals about high-hazard-potential dams, specifically ensuring the public has a better understanding of the dam rating system and how we determine condition as well as the location and condition of dams in their area.
- Increase state funding for their respective dam safety programs, including adequate staffing of state dam safety offices. Ensure all 50 states have dam safety programs.
- Encourage state and federal agencies to meet reporting deadlines to ensure that adequate data on dams are available for policymakers to facilitate decision-making on funding and to the general public to promote public awareness.
- Require federal agencies that own, operate, or regulate dams to meet the standards of Federal Guidelines for Dam Safety.
- Encourage improved land use planning at the local level so that communication about how dams affect local areas is more accurately known and considered in future planning.

Dams

DEFINITIONS

EMERGENCY ACTION PLAN — A formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life should those conditions occur. The EAP contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities. It also should include inundation maps to show the emergency management authorities the critical areas for action in case of an emergency.

DAM OWNER — Party or parties responsible for the safety and liability of the dam and for financing its upkeep, upgrade, and repair.

DAM REGULATOR — Party or parties responsible for dam safety enforcement including the safety evaluations of existing dams, review of plans and specifications for dam construction and major repair work, periodic inspections of construction work on new and existing dams, and review and approval of emergency action plans.

HIGH-HAZARD POTENTIAL DAM — A dam in which failure or mis-operation is expected to result in loss of life and may also cause significant economic losses, including damages to downstream property or critical infrastructure, environmental damage, or disruption of lifeline facilities.

SIGNIFICANT-HAZARD POTENTIAL DAM — A dam in which the failure or mis-operation is not expected to cause loss of life, but results in significant economic losses, including damages to downstream property, critical infrastructure, environmental damage, or disruption of lifeline facilities.

LOW-HAZARD POTENTIAL DAM — A dam located in a rural or agricultural area where failure would not only cause the loss of the dam itself but may cause minor damage to nonresidential and normally unoccupied buildings, or rural or agricultural land.

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