Dam Safety and Security in the United States

A Progress Report on the National Dam Safety Program in Fiscal Years 2002 and 2003

December 2003

FEMA

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Contents

2 Executive Summary

4 Highlights in 2002 and 2003

7 The Security of Our Nation's Dams

7 The National Strategy for Protecting Dams

9 National Dam Safety Program Activities

10 The Federal and State Role in Dam Safety and Security

10 Introduction

11 The Federal Emergency Management Agency

12 Federal Agencies

16 The States

16 The Private Sector

17 The National Dam Safety Program in 2002 and 2003

17 Introduction

17 The Dam Safety and Security Act of 2002

19 State Accomplishments

24 Research

25 Training

26 Information Technology

32 Federal Agency Programs

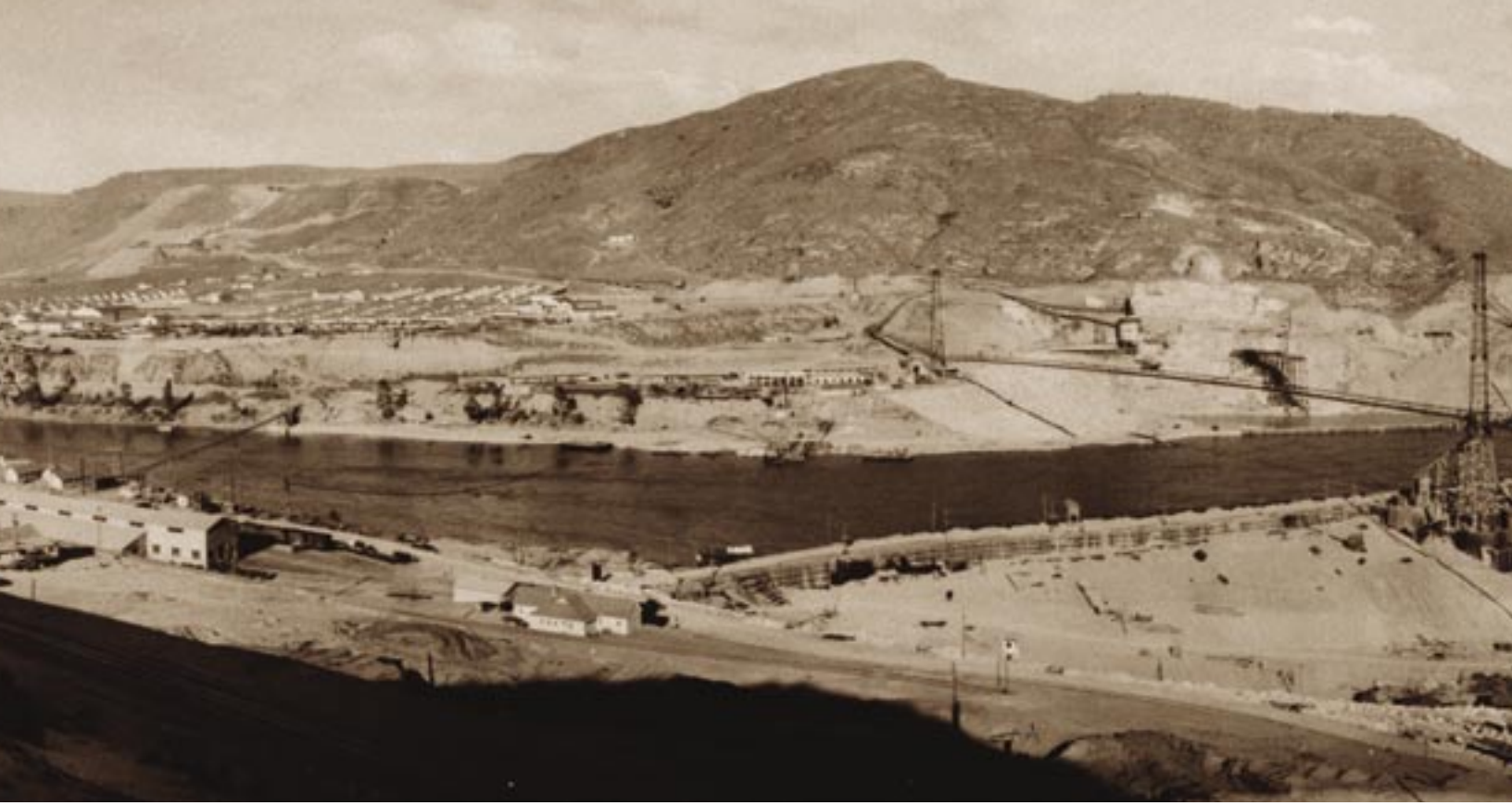
32 Security Activities

33 Federal Agency Accomplishments

42 Focus on the Future

44 List of Acronyms

Cover: Hoover Dam, Arizona-Nevada border



Executive Summary

Next year will mark 25 years of leadership of the National Dam Safety Program by the Federal Emergency Management Agency (FEMA). In July 1979, FEMA was established by Executive Order 12148 in response to the need for unified and coordinated efforts for federal assistance in national disasters. Executive Order 12148 also provided that the Director of FEMA would coordinate all federal efforts in dam safety. In 1986, Title XII of the Water Resources Development Act was enacted to establish and maintain dam safety programs, including training for state dam safety inspectors. Ten years later, in 1996, the Water Resources and Development Act of 1996 (Public Law 104-303) finally codified a program that had been successfully promoting dam safety and mitigating the effects of dam failures for almost 20 years. Section 215 of Public Law 104-303 formally established the National Dam Safety Program and named the Director of FEMA as its coordinator. The passage of the 1996 Act represented the culmination of years of collaborative effort on the part of many in the dam safety community to statutorily create the National Dam Safety Program.

The Dam Safety and Security Act of 2002 (Public Law 107-310), signed into law on December 2, 2002, reauthorizes the National Dam Safety Program for 4 more years and adds enhancements to the 1996 Act that are designed to safeguard dams against terrorist attacks. The Act of 2002 recognizes the importance of protecting our Nation's dams against terrorist attack. There are now over 10,000 dams in the United States that are classified as high-hazard potential, meaning that their failure from any means, including an attack, could result in loss of life, significant property damage, lifeline disruption, and environmental damage. The Act of 2002 addresses this priority through the coordination by FEMA of federal security programs and initiatives for dams and the transfer of federal best practices in dam security to the states. Other significant changes in the Act of 2002 include resources for the development and maintenance of a national dam safety information network and the development by FEMA of a strategic plan that will establish goals, priorities, and target dates to improve the safety and security of dams in the United States.

The Act of 2002 continues all of the programs established by the 1996 Act that have been serving to increase the safety of the Nation's dams. These programs include grant assistance to the states, which provides vital support for the improvement of the state dam safety programs that regulate over 77,000 dams in the United States; training for state dam safety staff and inspectors; a program of technical and archival research, including the development of devices for the continued monitoring of the safety of

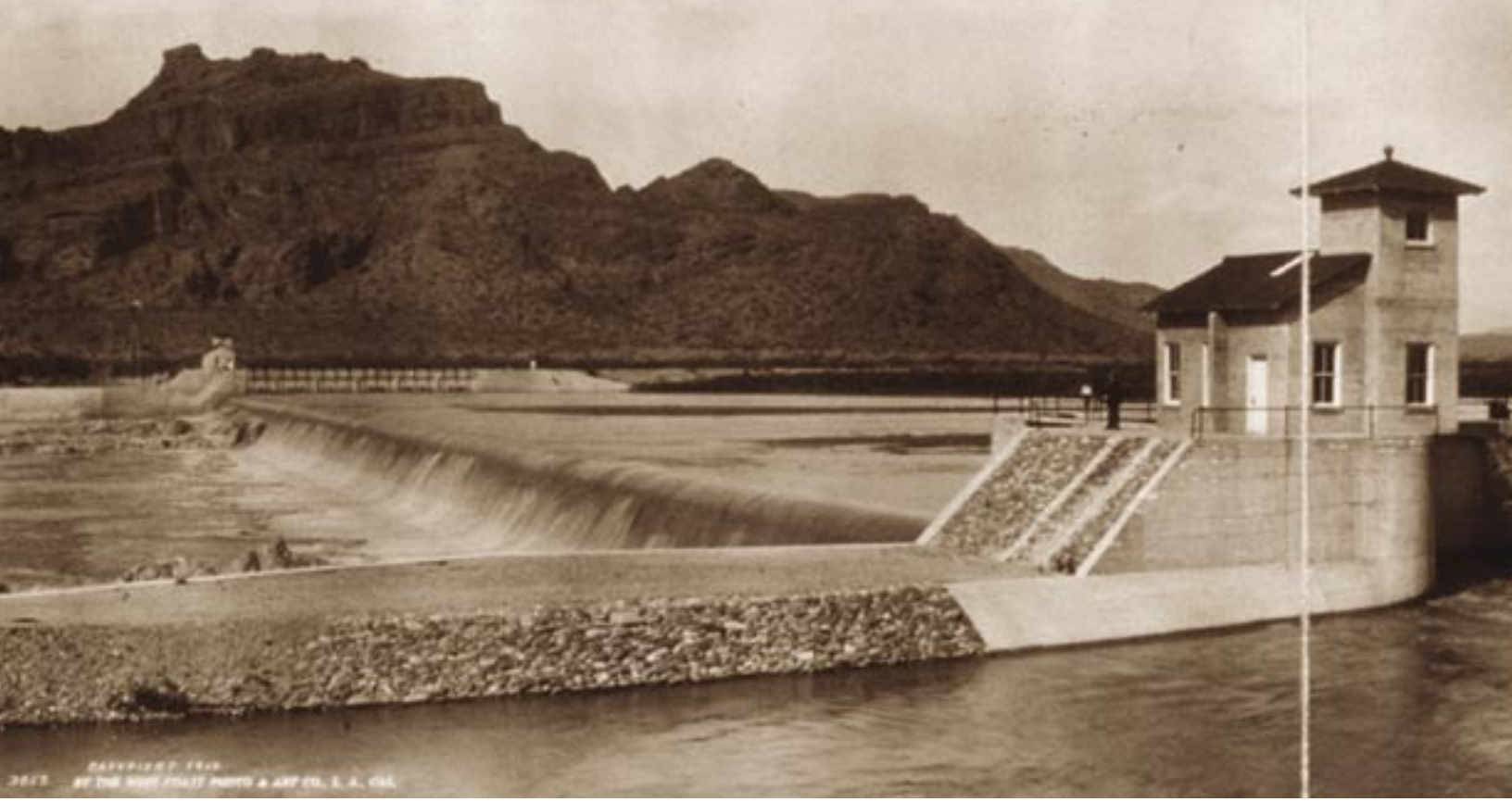
Grand Coulee Dam, Washington. 1936

dams; and the strengthening of the role of the National Dam Safety Review Board, which provides FEMA with advice in setting national dam safety priorities. The Act of 2002 also provides that the Director of FEMA will submit a biennial report to the Congress that describes the status of the National Dam Safety Program, the progress achieved by the federal agencies during the 2 preceding fiscal years in implementing the *Federal Guidelines for Dam Safety*, and the progress achieved by the states participating in the National Dam Safety Program.

The Years 2002 and 2003 have been marked by significant accomplishments in national dam safety and security. Many of the accomplishments are the results of strategies and initiatives envisioned or implemented in Years 1998 and 1999, the first 2 years of National Dam Safety Program funding. Under FEMA leadership, state assistance funds have enabled all participating states to better their programs through increased inspections, emergency action planning, and the purchase of needed equipment. There is now a national research program in dam safety that is focusing on priorities, producing products for both the layperson and the expert, and developing technological tools that drive data collection and analysis toward a better understanding of risk and remediation needs. In the training arena, FEMA has been able to expand existing training programs and begin new training programs to enhance the sharing of expertise between the federal and state sectors.

Under FEMA's leadership, the National Dam Safety Program is dedicated to protecting the lives of American citizens and their property from the risks associated with the development, operation, and maintenance of America's dams. As the last biennial report on the National Dam Safety Program was being prepared in the fall 2001, there were many uncertainties facing the security of our Nation's dams. The most critical question was how the National Dam Safety Program would fit within the rapidly evolving arena for protecting the national infrastructure against both natural and manmade threats. Two years later, the National Dam Safety Program is well positioned to both continue as a strong, self-sustaining program and to successfully become a part of the new national infrastructure protection scheme.

The Dam Safety and Security Act of 2002 codifies FEMA's ongoing relationship with other federal agencies, the states, and private interests to focus attention and energy on improving the safety and security of America's dams. This report to the Congress on the National Dam Safety Program describes national efforts to improve dam safety and security in the United States in Fiscal Year 2002 and 2003.



Highlights in 2002 and 2003

The Dam Safety and Security Act of 2002 Becomes Law

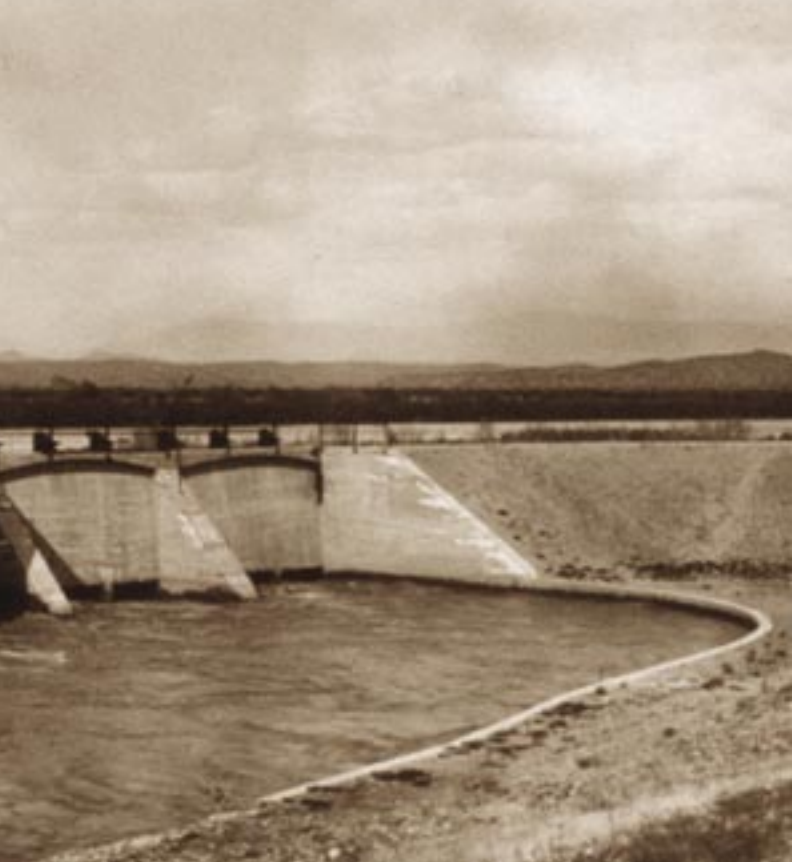
Dams are an integral part of our Nation's infrastructure, equal in importance to bridges, roads, and airports. There are now over 10,000 dams in the United States classified as high-hazard potential, meaning that their failure from any means, including a terrorist attack, could result in loss of life, significant property damage, lifeline disruption, and environmental damage.

The Dam Safety and Security Act of 2002, which was signed into law on December 2, 2002, addresses security for dams through the coordination by the Federal Emergency Management Agency (FEMA) of federal security programs and initiatives for dams and the transfer of federal best practices in dam security to the states. Other significant changes in the Act of 2002 include resources for the development and maintenance of a national dam safety information network and the development by the National Dam Safety Review Board of a strategic plan that establishes goals, priorities, and target dates to improve the safety and security of dams in the United States.

The Act of 2002 continues all of the programs established by the 1996 Act that have been serving to increase the safety of the Nation's dams, including increased funding authority to support improvement of the state dam safety programs that regulate over 77,000 dams in the United States, the work of the Interagency Committee on Dam Safety (ICODS), and the development of the strategic plan and the biennial report on the National Dam Safety Program; training for state dam safety staff and inspectors; a continued program of technical and archival research, including the development of devices for the continued monitoring of the safety of dams; and increased reliance on the National Dam Safety Review Board, which provides the Director of FEMA with advice on national policy issues affecting dam safety and helps oversee the operation of state dam safety programs.

FEMA Becomes Part of the New U.S. Department of Homeland Security

On March 1, 2003, FEMA officially became part of the new U.S. Department of Homeland Security (DHS). The DHS has three primary missions: to prevent terrorist attacks within the United States; to reduce America's vulnerability to terrorism; and to minimize the danger from potential attacks and natural disasters. To accomplish this mission, the DHS serves as the primary liaison and facilitator for cooperation among federal departments and agencies, state and local governments, and the private sector. FEMA's continuing mission within the new Department is to lead



Granite Reef Diversion Dam of the Salt River Project, Arizona. 1913

the effort to prepare the Nation for all hazards and to effectively manage federal response and recovery efforts following any national incident.

In February 2003, the DHS released the *National Strategy for the Physical Protection of Critical Infrastructures and Key Assets,* the product of months of consultation across a broad range of public and private sector stakeholders. The *National Strategy* defines the road ahead for a core mission area identified in the President's National Strategy for Homeland Security: reducing the Nation's vulnerability to acts of terrorism by protecting our critical infrastructure and key assets from physical attack. The *National Strategy* lists dams as a one of five key asset categories, and states the following relative to the importance of key assets in general and dams in particular: "Key assets and high profile events are individual targets whose attack—in the worst-case scenarios—could result in not only large-scale human casualties and property destruction, but also profound damage to our national prestige, morale, and confidence. Individually, key assets like nuclear power plants and dams may not be vital to the continuity of critical services at the national level. However, a successful strike against such targets may result in a significant loss of life and property in addition to long-term, adverse public health and safety consequences."

The *National Strategy* identifies major initiatives to overcome protective challenges for dam structures. FEMA and its partners in the National Dam Safety Program are now working to address many of the initiatives identified in the *National Strategy.* The integration of security safeguards for dams into the sector-wide initiatives identified by the DHS is a major opportunity for the National Dam Safety Program. The National Dam Safety Program has already begun the transfer of best practices on threat assessment and will continue to enhance and expand these efforts.

State Programs Continue To Show Significant Improvement

The primary purpose of the Dam Safety and Security Act of 2002 is to provide financial assistance to the states for strengthening their dam safety programs. In Fiscal Year (FY) 2002 and 2003, FEMA distributed a total of $7.5 million to all of the participating states and Puerto Rico for dam safety.

There have been many improvements in the Nation's dam safety as a result of the state assistance funding. In 1998, the National Dam Safety Review Board, which was established by the National Dam Safety Program Act and serves as the leading national advisory group on dam safety, developed performance criteria for the states. The performance criteria are designed to capture information on the number of state-regulated high- and significant-hazard potential dams in each state with an Emergency Action Plan (EAP), the number of dam inspections conducted each year by each state, and the number of dams that have been identified by the states as in need of remediation.

A comparison of data from the states for 2001 and 2002 indicates that National Dam Safety Program funding has resulted in very significant increases in the number of EAP's over the past 2 years: a 47 percent increase in the absolute number of EAP's for state-regulated high- and significant-hazard potential dams, resulting in a 7 percent increase in the completion percentage over the last reporting cycle. Today, 36 percent of all state-regulated high- and significant-hazard potential dams have an EAP. Since 1998, the number of EAP's for state-regulated high- and significant-hazard potential dams has increased from 4,000 dams to approximately 7,500 dams in 2002. The number of dam inspections conducted by the states also has increased since data was first collected for 1998-1999, from a total of approximately 13,000 inspections to approximately 14,500 inspections in 2002. Data from these and other critical areas demonstrate that dam safety has improved in the United States over the last 5 years as a result of the National Dam Safety Program.

Strategic Plan for Research Is Developed

To guide decisions on the funding of specific research projects, the National Dam Safety Review Board has developed a 5-year Strategic Plan that prioritizes research

needs in dam safety and security. The goal in developing the 5-year Strategic Plan is to ensure that priority will be given to those projects that demonstrate a high degree of collaboration and expertise, and the likelihood of producing products that will contribute to the safety and security of dams in the United States.

Much of the input to the Strategic Plan originated with the results from research workshops sponsored with National Dam Safety Program funds over the last 5 years. The research workshops have resulted in the identification of highly valuable research that can be accomplished in a relatively short period of time, and the identification of other opportunities to improve dam safety programs and processes. The recommended research from incomplete or future workshops will be integrated into the Strategic Plan as the recommendations are finalized. The initiatives identified by the DHS for national implementation in the *National Strategy* also will be integrated into the 5-year Strategic Plan for dam safety research.

Training Program Focuses on Dam Security

Since the inception of the National Dam Safety Program in 1979, FEMA has supported a strong, collaborative training program for dam safety professionals and dam owners.

With the training funds provided under Public Law 104-303 and Public Law 107-310, FEMA has been able to expand existing training programs, begin new initiatives to keep pace with evolving technology, and enhance the sharing of expertise between the federal and state sectors. Training activities in 2002 and 2003 include a National Dam Safety Program Technical Workshop on dam site security, vulnerability assessments, and security plan effectiveness; the Association of State Dam Safety Officials Regional Technical Seminars; state training assistance funds; the Training Aids for Dam Safety (TADS) Program; the ICODS Expert Videotape Series; and the Multi-Hazard Building Design Summer Institute: Dam Safety course.

Refinement of Information Technology Tools Continues

A primary objective of the National Dam Safety Program has been to identify, develop, and enhance technology-based tools that can help educate the public and assist decision-makers. The development and refinement of three database systems/software programs have been major accomplishments over the past 2 years. These include the National Performance of Dams Program (NPDP), an incident reporting database headquartered at Stanford University; the National Inventory of Dams (NID), a database used to track information on the Nation's water control infrastructure; and the Dam Safety Program Management Tools (DSPMT) program. In 2000, the DSPMT was integrated with the NID to provide quality assurance tools and to allow the external and internal reporting on dam safety program status, degree of implementation, and improvement. The DSPMT software now resides on the PCs of nearly all federal and state dam safety program managers and was used to coordinate the data collection of 2002 state evaluation criteria reports for performance assessment by FEMA.

In 2000, FEMA established the National Dam Safety Information Committee under the National Dam Safety Review Board to develop a Strategic Plan for a national dam safety information resources infrastructure. In March 2003, the Committee issued a final draft of its Strategic Plan for Dam Safety Information Resources. The Strategic Plan calls for the development of a virtual eDams network that will provide all basic data information needs for dam safety professionals and improve the efficiency and effectiveness of data collection.

The NPDP, the NID, and the DSPMT program have received major emphasis and funding under the National Dam Safety Program and are collecting invaluable data on the status of dams, dam incidents, and dam safety programs in the United States. In turn, these data are assisting Program partners in better documenting failure modes and identifying research and training needs. The eDams network, if implemented, will be integrated within a sector-wide critical infrastructure database envisioned by the *National Strategy*.

Federal Agencies Maintain Strong Programs

Although the Federal Government owns or regulates only about 5 percent of the dams in the United States, many of these dams are significant in terms of size, function, benefit to the public, and hazard potential. Since the implementation of the *Federal Guidelines for Dam Safety* in 1979, the federal agencies have done an exemplary job in ensuring the safety of dams within their jurisdiction.

For FY 2002 and 2003, all of the federal agencies responsible for dams implemented the provisions of the *Guidelines*. They accomplished this by sharing resources whenever and wherever possible to achieve results and improvements in dam safety. Many of the federal agencies also continue to maintain very comprehensive research and development programs and training programs, and are now incorporating security considerations and requirements into these programs to protect their dams against threats.

Dam at Mirror Lake, Kilbourn, Wisconsin. Circa 1900

The Security of Our Nation's Dams

The National Strategy for Protecting Dams

The events of September 11, 2001, significantly changed perspectives on dam safety by raising the possibility of terrorists using America's own resources to bring harm to the public. Addressing this most important challenge is a priority of the national dam safety agenda.

In March 2003, the Federal Emergency Management Agency (FEMA) officially became a part of the new U.S. Department of Homeland Security (DHS). The first priority of the DHS is to protect the Nation against future terrorist attacks. To accomplish that priority, the DHS serves as the primary liaison and facilitator for cooperation among federal departments and agencies, state and local governments, and the private sector.

In February 2003, the DHS issued the *National Strategy for the Physical Protection of Critical Infrastructures and Key Assets,* the product of months of consultation across a broad range of public and private sector stakeholders. The National Strategy defines the road ahead for a core mission area identified in the President's National Strategy for Homeland Security: reducing the Nation's vulnerability to acts of terrorism by protecting our critical infrastructure and key assets from physical attack. The *National Strategy* lists dams as a one of five key asset categories, and states the following relative to the importance of key assets in general and dams in particular: "Key assets and high profile events are individual targets whose attack—in the worst-case scenarios—could result in not only large-scale human casualties and property destruction, but also profound damage to our national prestige, morale, and confidence. Individually, key assets like nuclear power plants and dams may not be vital to the continuity of critical services at the national level. However, a successful strike against such targets may result in a significant loss of life and property in addition to long-term, adverse public health and safety consequences."

The *National Strategy* identifies two major challenges for dams: limitations in resources and assessment and management of risk. Of the approximately 77,000 dams in the United States, the Federal Government is responsible for only about 5 percent of the dams whose failure could result in loss of life or significant property damage. The remaining dams belong to state or local governments, utilities, and corporate or private owners. As a result, the resources available to protect dam property vary greatly from one category to the next. The distributed nature of dam ownership also complicates assessment of the

Eaglenest Dam, New Mexico. 1922

potential consequences of dam failure for certain categories of dams. Given these realities, the need to develop more comprehensive mechanisms for assessing and managing risks to dams is clear.

The *National Strategy* identifies the following major initiatives to overcome protective challenges for dam structures.

- **Develop risk assessment methodologies for dams.** DHS, in cooperation with appropriate federal, state, and local government representatives and private-sector dam owners, will design risk assessment methodologies for dams and develop criteria to prioritize dams in the National Inventory to identify structures requiring enhanced security evaluations and protection focus.

- **Develop protective action plans.** DHS, together with other appropriate departments and agencies, will establish an intergovernmental working group to explore appropriate protective actions for the Nation's critical dams.

- **Establish a sector-Information Sharing Analysis Center (ISAC).** DHS will work with other appropriate public and private sector entities to establish an information and warning structure for dams similar to the ISAC model in use within other critical infrastructure sectors.

- **Institute a national dam security program.** DHS and other appropriate departments and agencies, such as the Association of State Dam Safety Officials and the United States Society on Dams, will collaborate to establish a nationwide security program for dams.

- **Develop emergency action plans.** DHS, together with other appropriate departments and agencies, will identify the areas downstream from critical dams that could be affected by dam failure and develop appropriate population and infrastructure protection and emergency action plans.

- **Develop technology to provide protective solutions.** DHS, together with other appropriate departments and agencies, will explore new protective technology solutions for dams. Technology solutions hold significant promise for the identification and mitigation of waterborne threats. For example, technical options might include deploying sensors and barriers and communication systems to reduce the possibility of an unauthorized craft or device entering a critical zone located near a navigational dam.

The initiatives for dams that are listed in the *National Strategy* will all have major consequences for mitigation. FEMA is now working in close cooperation with other federal departments, agencies, and programs, state agencies, and the private sector on cross-sector initiatives to identify, assess, and protect dams and other vulnerable structures.

National Dam Safety Program Activities

Since September 11, 2001, the National Dam Safety Program has been proactive in dealing with security threats to dams.

Since September 11, 2001, the National Dam Safety Program has been proactive in dealing with security threats to dams, and there are now many National Dam Safety Program activities underway to address the initiatives identified for the protection of our Nation's dams.

In February 2002, FEMA established the Task Force on Dam Safety Security under the National Dam Safety Review Board. The purpose of the Task Force, which has now become an official Work Group under the Review Board, is to serve as a national asset to facilitate dialogue on dam security and to offer technical support on policy and guidance related to the security of the Nation's dams. Activities identified by the Work Group correlate to the initiatives identified in the *National Strategy*, including risk analysis, modeling strategies, procedures for the classification of information, recovery planning, surveillance, and physical access and protection.

The primary focus of the Work Group in Fiscal Year (FY) 2002 and 2003 has been on providing state dam safety officials with the best practices and guidelines for the screening and vulnerability assessment of dams. In January 2003, FEMA sent all 50 states and Puerto Rico a guidance package with threat assessment guidelines and screening assessment procedures. The package contained "Threat Assessment, Protection and Response: Guidance for Non-Federal Dam Owners and Regulators" and the "Security Prioritization Screening Tool for Dams." These guidelines are to be used in evaluating security at dams under each state dam safety official's jurisdiction. Based in part on the guidance, the State of New Jersey has developed a model program that can be used as a prototype by all state dam safety programs.

In February 2003, the National Dam Safety Program held National Dam Safety Program Workshop #10: *Dam Site Security-Threat, Consequences and Vulnerability Assessment and Security Plan Effectiveness*. The Workshop at FEMA's Emergency Management Institute, which was designed to transfer best practices in dam security procedures to state dam safety officials, was attended by representatives from 33 state agencies and 12 local agencies. Professionals from the federal and private sector also attended the Workshop, which was entirely developed and funded by the National Dam Safety Program. The National Dam Safety Program has committed funds for four additional dam security workshops for state dam safety officials to be held in FY 2004, and FEMA is working with the states to identify their preferred venues.

Many of the initiatives identified in the *National Strategy* have been a focus of the National Dam Safety Program and its partners for many years. One of the greatest challenges for DHS and FEMA over the next 2 years will be to coordinate the many existing and new activities relating to dam security. For example, the U.S. Army Corps of Engineers and the Bureau of Reclamation have been very proactive for years in developing risk-based profiling systems for dams. The Federal Energy Regulatory Commission has long been a leader in emergency action planning for dams, and its training program is highly acclaimed and both nationally and internationally recognized. Some of the initiatives listed in the *National Strategy* are the focus of work that is just beginning. For example, as research initiatives for dam security are further refined and the structures identified for their study, development, and implementation, the initiatives will be incorporated into the 5-year Strategic Plan for Dam Safety Research. Another new initiative that is on its way to completion is the establishment of a Dam ISAC.

Clearly, there are challenges ahead for all in the dam safety community. The challenges affect every aspect of the way we do business, from our organizational structures and partnerships to the new information that must be acquired to perform our jobs effectively. Most importantly, the National Dam Safety Program is being challenged to adapt its philosophy of how to best protect our national infrastructure. The National Dam Safety Program, through its ongoing and new initiatives, is well positioned to meet these challenges and to respond to the priority of the DHS: to protect the Nation against future terrorist attacks.

The Federal and State Role in Dam Safety and Security

Introduction

In recent years, there has been an ongoing debate over the benefits of dams versus the ecological benefit of their removal. American Rivers reports that 57 dams in 15 states and the District of Columbia will be removed in 2003. Over 100 dams have been removed since 1999, when the removal of the Edwards Dam on the Kennebec River in Maine helped to bring the issue of dam removal to national attention. It should be noted that most of the dams removed have been low-hazard potential dams of less than 15 to 20 feet in height.

While there is agreement among proponents and opponents of dam removal that the benefits of some dams have become obsolete, there also is agreement that many dams in the United States continue to provide great benefit, including flood control, water supply, recreation, irrigation, navigation, power production, and environmental purposes.

The projects on the Lower Colorado Region of the Bureau of Reclamation (Reclamation) are just one example of the benefits that dams can provide. The Lower Colorado Region encompasses parts of five states that contribute to or draw water from the Colorado River. Some of Reclamation's earliest projects, such as the Theodore Roosevelt Dam, Hoover Dam, and Parker Dam, are located in the Lower Colorado Region.

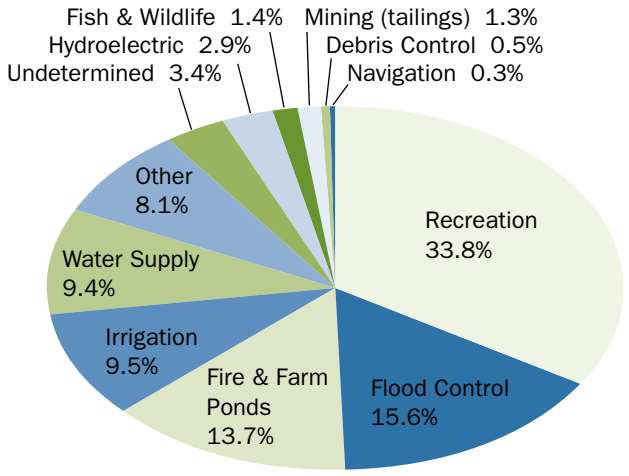
Water: In a typical year, the projects supply irrigation water to more than 2.7 million acres of land in the United States and Mexico, and supply more than 18 million people with municipal or industrial water. Regional dams and reservoirs also help protect water users against drought. Since Hoover Dam was completed in 1935, there has never been a water shortage on the lower Colorado River.

Hydroelectric power: Hydroelectric power plants at Hoover Dam, Davis Dam, Parker Dam, and Senator Wash Dam generate nearly 6 billion kilowatt hours of electricity in an average year, enough energy to meet the average annual needs of more than 3.5 million people.

Recreation: There are 15 major recreation areas located on Reclamation projects in the Lower Colorado Region. These include the Nation's first national recreation site, Lake Mead National Recreation area, which encompasses Lakes Mead and Mohave. Over 12 million people visit the areas each year.

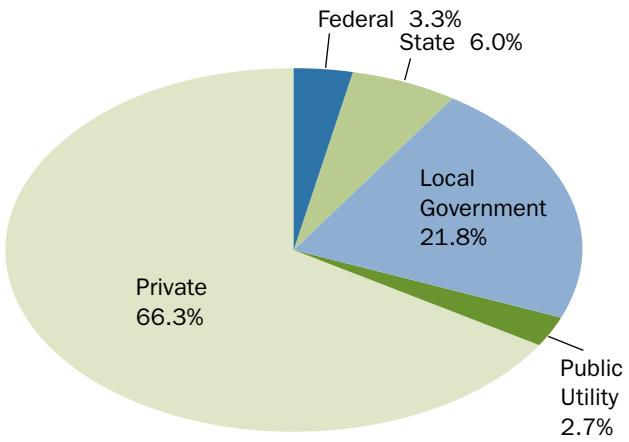
Flood Control: Although Hoover Dam is the only dam on the lower Colorado River with an authorized flood control function, all Reclamation dams help prevent or minimize damaging floods that once characterized the

Figure 1: Primary Purpose of Dams in the U.S.



Source: NID, U.S. Army Corps of Engineers, January 2001

Figure 2: Ownership of U.S. Dams



Source: NID, U.S. Army Corps of Engineers, January 2001

Colorado River and other rivers. Since 1950, benefits realized from flood control operation on the Colorado River are estimated at over $1 billion.

To inform the public about water resource development and the importance that dams and dam safety play in maintaining the Nation's water resources, the United States Society on Dams (USSD), in cooperation with the Federal Emergency Management Agency (FEMA), the Association of State Dam Safety Officials (ASDSO) and others, recently completed a video on the benefits of dams, *Water and Dams in Today's World*. The videotape is available through ASDSO, USSD, and FEMA.

The Federal Emergency Management Agency

Dam owners are responsible for the safety and security of their dams and for their maintenance, upgrade, and repair. Although most of the infrastructure in the United States is owned by public entities, the majority of dams in the United States are privately owned. In terms of regulatory authority, state governments are responsible for approximately 95 percent of the dams listed in the National Inventory of Dams (NID) and federal agencies regulate approximately 5 percent of dams listed in the NID. Given the diffuse nature of dam ownership versus regulation in the United States, it is apparent that dam safety and security are often not solely a federal, state, or local issue. The safety and security of a dam can affect persons and property across local, state, and even national borders. An incident in one area can affect commerce, navigation, and power generation and distribution, or it can cause severe damage in another area. As a result, there is a reasonable federal role to coordinate federal, state, and local efforts to provide dam safety and security to citizens.

Next year will mark 25 years of leadership of the National Dam Safety Program by FEMA. Under FEMA's direction, experts, federal agencies, and others are developing and providing programs that are focused, coordinated, and data driven. The National Dam Safety Program is working with the states, individually and through ASDSO, the USSD, federal agencies, and other stakeholders in dam safety to encourage individual and community responsibility for dam safety.

Two federal organizations that have an important role in guiding the direction of the National Dam Safety Program are the National Dam Safety Review Board and the Interagency Committee on Dam Safety (ICODS), both of which are chaired by FEMA.

National Dam Safety Review Board

Authorized under Public Law 104-303 and Public Law 107-310, the National Dam Safety Review Board provides the Director of FEMA with advice in setting national dam safety priorities and considers the implications of national policy issues affecting dam safety. The National Dam Safety Review Board also helps oversee the development and support of state dam safety programs by reviewing state progress toward meeting all of the criteria listed in the Dam Safety and Security Act of 2002, assisting FEMA in the review of state dam safety programs, and establishing the reasonable costs of implementing a state dam safety program.

The membership of the National Dam Safety Review Board includes the representative from FEMA (the Chair of the Board); representatives from four federal agencies that serve on ICODS; five members selected by the Director of FEMA from among dam safety officials of the states; and one member selected by the Director of FEMA to represent the private sector.

Interagency Committee on Dam Safety

ICODS, which was established in 1980 and meets quarterly, encourages the establishment and maintenance of effective federal programs, policies, and guidelines to enhance dam safety and security, and serves as the permanent forum for the coordination of federal activities in dam safety and security. Until January 2003, ICODS was responsible for overseeing and coordinating the majority of federal and state activities conducted under the National Dam Safety Program through its Subcommittees. This oversight and coordination role has now passed to the National Dam Safety Review Board with the enactment of the Dam Safety and Security Act of 2002.

ICODS, which was formally established by Public Law 104-303 in 1996, is composed of representatives from all the federal agencies that build, own, operate, or regulate dams.

ICODS Agencies

- Department of Agriculture
- Department of Defense
- Department of Energy
- Department of the Interior
- Department of Labor, Mine Safety and Health Administration
- Federal Emergency Management Agency
- Federal Energy Regulatory Commission
- Department of State, International Boundary and Water Commission (U.S. Section)
- Nuclear Regulatory Commission
- Tennessee Valley Authority

Federal Agencies

Since the enactment of Public Law 92-367 in 1972, which authorized the United States Army Corps of Engineers (Corps) to inventory and inspect non-federal dams, the Federal Government's position concerning the importance of correcting safety deficiencies of federal and non-federal dams has been quite clear. Presidential involvement, including President Carter's October 1979 Memorandum and Executive Order 12148, President Reagan's letter to Senator Paul Laxalt regarding water development programs, and President Clinton's designation of mitigation as the cornerstone of the federal multi-hazard emergency management system, further emphasized the need for a

Table 1: Summary Status of Dams for Federal Agencies (FY 2002-2003)

Dept.	Dam Inventory				Periodic Inspections			
Agency	Total	Hazard Classification			Total	Since Last Report		
		High	Sig.	Low		Formal	Inter.	Spec/Const
USDA (Total)	28159	2143	2714	22496	15311	2090	13051	220
ARS	1			1	1		1	
USFS	1814[1]	406[1]	524[1]	884[1]	510[2]	10[2]	350[2]	150[2]
NRCS	26229[3]	1737	2190	21611	14800[4]	2080[4]	12700[4]	70[4]
RHS	60[6]							
RUS	55[6]							
DOD (Total)	888	517	122	249	885	245	638	2
USACE	623[7]	479	88	56	828	233	593	2
Army	210	33	27	150	35	4	31	
Navy	31	5	1	25	8	8		
Air Force	24		6	18	14		14	
DOE	15	2	1	12	21		21	
DOI (Total)	3199	353	109	2737	1077	556	385	136
BIA	286	77	40	169	141	26	62	43/10
BLM	534	8	1	525	258	258	N/A[9]	N/A[9]
BOR	314[10]	239	11	64	575	169	323	83/ongoing[11]
USFWS	189	12	19	158	103	103	N/A[12]	N/A[12]/ongoing[11]
NPS	505[13]	17	38	450	N/A[14]	N/A[14]	N/A[14]	N/A[14]
OSM	1370[16]			1370				
USGS	1			1				
FERC	2557	751	237	1569	3961	463	2942	206/350
IBWC	7	3	1	3	213	5	208	
MSHA (Total)	1371	262	284	825	4628			
Coal	710	232	237	241	3216			
M/NM	661	30	47	584	1412			
NRC	21			21	12[17]			
TVA	49	33	14	2	1586	131	1324	131/0

National Dam Safety Program to enable federal agencies to address dam safety problems expeditiously.

Below is a description of federal agency responsibilities for dam safety. Table 1, Summary Status of Dams for Federal Agencies, provides data on the number of dams owned, operated, or regulated by each agency.

The **U.S. Department of Agriculture (USDA)** is a major planner, designer, financier, constructor, owner, or regulator of more than one-third of all the dams in the NID. USDA dams provide livestock water, municipal water and wastewater, electric power, flood protection, irrigation, fish and wildlife habitat, recreation, sediment detention, and manure storage and treatment. There are six agencies within the USDA involved with dams.

Investigations & Studies		Dam Safety Mods.		Dams with Eap's	
'02-03	Active	'02-03	Active	High	Sig.
105	150	90	40	954	278
		1			
30[2]	50[2]	30[2]	10[2]	354[1]	108[1]
75[5]	100[5]	60[5]	30[5]	600	170
13	31	27	23	484	54
13	28	19	23	459	42
			2	25	12
		3			
	3	2			
		1	1[8]	2	1
131	147	31	49	287	44
94	47	2	5	35	13
2	6	13	1	1	1
26	66	7	4	239	11
9	28	1	11	12	19
N/A[15]	N/A[15]	8	28		
137	123	71	92	751	237
				3	1
14	10	3	1	33	14

1 FS owned and permitted (2001 data).

2 Estimated; performed by FS (2001 data).

3 Totals include dams with currently unknown but probably low hazard classification.

4 Estimated; inspections are performed by NRCS and many other organizations without NRCS involvement.

5 Estimated; investigations, studies, or modifications can be done by dam owners without NRCS involvement.

6 Estimated; primary agency involvement as lender or grantor.

7 Includes 14 dams owned by others in which the Corps of Engineers has a substantial interest in the O&M of the dam.

8 Pond B Dam at Savannah River Operations Office Site; effort is underway.

9 This type of inspection is not performed by BLM.

10 BOR's 477 dams and dikes listed on the National Inventory of Dams are located at 314 individual facilities. Of the 314 facilities, 250 are classified as high- or significant-hazard facilities. The facility count is used for this presentation because inspections, investigations, modifications, and EAP's are counted and reported for individual facilities.

11 BOR and FWS perform quality assurance and construction contract administration activities on an ongoing basis for all dam and dam safety construction activities..

12 Inspections are performed by FWS station personnel on an ongoing basis.

13 No nationwide status report and updating since 1993.

14 Although a number was not provided, NPS reports that numerous formal and informal examinations have been performed.

15 NPS reports that 167 NPS dams have been identified with serious maintenance, operational, structural, or public safety type deficiencies.

16 OSM and MSHA provide dual regulation of OSM dams. OSM has initiated activities to coordinate the roles of the respective agencies to ensure that the Guidelines are being met.

17 Twelve site inspections covered all 21 structures in NRC's program.

Agricultural Research Service (ARS) owns, operates, and maintains dams as part of its ongoing internationally recognized research programs in hydrologic, hydraulic, and sedimentation processes applicable to dams. ARS owns and operates only one NID dam at one ARS research facility.

Farm Service Agency provides financial assistance for dams through loans, loan guarantees, and grants to farmers and ranchers for land and water resource conservation or natural disaster recovery.

U.S. Forest Service (FS) designs, finances, constructs, owns, operates, and maintains and regulates dams in conjunction with the management of national forests and grasslands. FS owns approximately 1,000 NID dams and administers permits for approximately 2,000 privately owned NID dams.

Natural Resources Conservation Service (NRCS) designs, finances, and constructs dams under its technical and financial assistance programs for individuals, groups, organizations, and governmental units for water storage, sediment detention, and flood protection. The agency does not own, operate, maintain, or regulate any dams. NRCS has provided technical assistance for more than 26,000 NID dams and financial assistance for over 11,000 NID dams.

Rural Housing Service finances dams through loans, loan guarantees, and grants to public entities, local organizations, and non-profit corporations for rural community facilities. The agency does not design, construct, own, or operate dams.

Rural Utilities Service finances dams through loans and loan guarantees under its Electric Program to cooperative associations, public bodies, and other utilities in rural areas for hydroelectric and thermal electric power plants. The agency also finances dams through loans, loan guarantees, and grants to rural communities under its Water and Waste Program for water and wastewater facilities.

The **Department of Defense** is involved extensively with dams as a permitter, owner, manager, planner, designer, constructor, and financier. There are four Department of Defense agencies responsible for, or involved with, dams.

Department of the Air Force has dam safety responsibility for dams located on Air Force bases in the continental United States. The Air Force has jurisdiction over 23 dams.

Department of the Army is responsible for dams that are either on Army installations or controlled by Army installations.

Department of the Navy has dam safety responsibility for dams located on Navy bases. There are 31 candidate dams under Navy jurisdiction for safety inspections.

U.S. Army Corps of Engineers has varying degrees of responsibility or jurisdiction for five categories of dams: (1) dams that the Corps of Engineers planned, designed, constructed, and operates; (2) dams that the Corps of Engineers designed and constructed, but are operated and maintained by others; (3) those non-Corps of Engineers dams and reservoir projects subject to Section 7 of the 1944 Flood Control Act, the 1920 Federal Power Act, as amended, and other laws for which the Corps of Engineers is responsible for proscribing the regulations for the use of storage allocated to flood control and/or navigation; (4) dams for which the Corps of Engineers issues permits under its regulatory authority; and (5) dams that the Corps of Engineers inventoried and inspected under the National Dam Inspection Act of 1972, the Dam Safety Act of 1986, and the National Dam Safety Program Act of 1996.

The Corps of Engineers operates 237 navigation locks, 25,000 miles of commercial navigation channel, and approximately 1,200 Civil Works projects of varying types, including 609 dams, 75 that include Corps hydropower plants and 67 non-federal power plants.

The **Department of Energy** owns and has jurisdiction over 15 dams, as defined in the *Federal Guidelines for Dam Safety,* at 3 sites.

As the Nation's principal conservation agency, the **Department of the Interior (DOI)** is responsible for most of the U.S-owned public lands and natural resources. Through its Bureaus, the Department is responsible for the planning, design, construction, operation, and maintenance of 1,884 dams meeting the definition in the *Guidelines*.

Bureau of Indian Affairs works with the American Indian Tribes to operate and maintain its 117 high- and significant-hazard potential dams on Indian reservations.

Bureau of Land Management (BLM) is responsible for agency-owned dams on public lands in 11 Western States, including Alaska. The BLM dam inventory consists of 534 NID dams.

Bureau of Reclamation is a federal water resource management and development bureau authorized to operate in 17 Western States. In carrying out its mission, Reclamation has developed water resource projects where dams play a major role in the viable development of the resources. Reclamation has reservoirs impounded by 477 dams and dikes.

U.S. Fish and Wildlife (FWS) operates facilities associated with fish and wildlife conservation on National Wildlife Refuges, waterfowl production areas, and national fish hatcheries. The FWS has an inventory of 189 dams.

National Park Service (NPS) manages 505 stream-flow control structures and monitors the status of 265 non-NPS structures which are within or adjacent to park boundaries. An important aspect of the NPS dam safety program is the removal of dams that are deficient and no longer essential for park operations. As land is acquired by the National Park System, dams are sometimes acquired incidental to the main purpose of the acquisition. To date, over 100 dams have been removed, with plans to remove more in the future.

Office of Surface Mining (OSM) regulates surface coal mining operations and the surface effects of underground coal mining operations. The OSM regulates 1,370 structures through the Western Regional Coordinating Center in Denver and the Knoxville Field Office in Tennessee.

U.S. Geological Survey owns and maintains one low-hazard potential earthen embankment that offers no significant downstream hazard.

The Federal Government's position concerning the importance of correcting safety deficiencies of federal and non-federal dams has been quite clear. Presidential involvement … further emphasized the need for a National Dam Safety Program to enable federal agencies to address dam safety problems expeditiously.

The **Department of Labor** responsibility for dam safety is vested in one agency. The ***Mine Safety and Health Administration*** receives its authority and responsibility for regulating safety and health-related aspects of the miners' working environment from the Federal Mine Safety and Health Act of 1977 (30 U.S.C. 801). The Act requires the Secretary of Labor to develop and promulgate improved mandatory health or safety standards to protect the health and safety of the Nation's coal miners or other miners. The Act specifically includes "impoundments, retention dams, and tailing ponds" as part of a "coal or other mine."

The **Department of State** responsibility for dam safety is vested in one agency. The ***International Boundary and Water Commission,*** which is composed of a U.S. Section and a Mexican Section, has jurisdiction over two large international storage dams and four small diversion dams on the Rio Grande and Colorado Rivers. The U.S. Section also is responsible for the maintenance of the American Dam and five NRCS arroyo control dams that are not fully international in nature.

The **Federal Energy Regulatory Commission (FERC)** is authorized by the Federal Power Act to issue licenses to individuals, corporations, states, and municipalities to construct, operate, and maintain dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary for the development of non-federal hydroelectric projects on (1) navigable streams; (2) public lands of the United States; (3) at any Government dam; and (4) on streams over which the Congress has jurisdiction under the Commerce Clause of the U.S. Constitution. As of September 30, 2003, there were 2,557 dams under FERC jurisdiction.

The **Nuclear Regulatory Commission** has regulatory authority over only (1) uranium mill tailings dam; (2) storage water pond dams at in-situ leach mining facilities; and (3) those dams integral to the operation of licensed facilities, or the possession and use of licensed material that pose a radiologically safety-related hazard should they fail.

The **Tennessee Valley Authority** is authorized by the Tennessee Valley Authority Act of 1933 to approve plans for the construction, operation, and maintenance of all structures affecting navigation, flood control, or public lands or reservations in the Tennessee River System. The agency has complete responsibility for the planning, design, construction, operation, and maintenance of its dams.

The States

The states have primary responsibility for protecting their populations from dam failure. Of the approximately 77,000 dams listed in the NID, state governments have regulatory responsibility for 95 percent. Although the programs vary in the scope of their authority, program activities typically provide for the safety evaluation of existing dams, review of plans and specifications for dam construction and major repairs, periodic inspections of construction on new and existing dams, and review and approval of Emergency Action Plans.

At the state level, efforts to regulate dams to ensure public safety surfaced after the failure of the St. Francis Dam in California in 1928, the second worst event after the Johnstown failure. Around midnight on March 12, the 188-foot high St. Francis Dam failed. The dam, located about 60 miles north of Los Angeles, failed suddenly as a result of a foundation defect in an abutment. Warnings were not issued before the failure, and about 420 people died.

The failure of the St. Francis Dam led to the enactment of legislation in California, which became the model for laws in other states. By the mid-1970's, approximately one-half of the states had a system for protecting the public from the potential hazards of dams. Today, all but two states (Alabama and Delaware) have adopted dam safety regulatory laws.

Since its founding in 1984, ASDSO has moved to a leadership role in dam safety and now serves as the official voice for the states. There are four regions active in the support of the Association (Western, Southeast, Northwest, and Midwest), 48 full voting members including Puerto Rico, and over 2,000 members when Associate, Affiliate, and Student members are included. ASDSO was very active in FY 2002 and 2003 with activities undertaken on behalf of the states and with initiatives funded under the National Dam Safety Program. The activities are described in the next section of this report.

The Private Sector

Many organizations are involved in dam safety and security. For example, the USSD, formerly the United States Committee on Large Dams, was established in the early 1930's and is the pre-eminent nationwide professional organization that focuses on dams and water resources development. USSD represents the United States as one of the 82 member countries of the International Commission on Large Dams and has served as the private sector member of the National Dam Safety Review Board since its establishment in 1998.

There are many national and international organizations with interests in dam safety. Some of these organizations include:

National and International Organizations

- American Consulting Engineers Council
- American Planning Association
- American Public Works Association
- American Red Cross
- American Rivers
- American Society of Civil Engineers
- Associated General Contractors of America, Inc.
- Association of State Floodplain Managers
- Earthquake Engineering Research Institute
- Electric Power Research Institute
- Institute for Business and Home Safety
- International Association of Emergency Managers
- National Association of Counties
- National Conference of State Legislatures
- National Emergency Management Association
- National Hazards Research and Applications Information Center
- National Society of Professional Engineers
- National Watershed Coalition
- Portland Cement Association
- Public Risk Management Association
- Water Environment Federation

Cheeseman Dam, Douglas County, Colorado. Circa 1910

The National Dam Safety Program in 2002 and 2003

Introduction

The Years 2002 and 2003 have been marked by significant accomplishments in national dam safety and security. Many of the accomplishments are the results of strategies and initiatives envisioned or implemented in 1998 and 1999, the first 2 years of National Dam Safety Program funding. Under the leadership of the Federal Emergency Management Agency (FEMA), state assistance funds have enabled all participating states to better their programs through increased inspections, emergency action planning, and the purchase of needed equipment. There is now a national research program in dam safety that is focusing on priorities, producing products for both the layperson and the expert, and developing technological tools that drive data collection and analysis toward a better understanding of risk and remediation needs. In the training arena, FEMA has been able to expand existing training programs and begin new training programs to enhance the sharing of expertise between the federal and state sectors. These and other accomplishments in 2002 and 2003 are described below.

The Dam Safety and Security Act of 2002

On December 2, 2002, the Dam Safety and Security Act of 2002 (Public Law 107-310) was signed into law. Section 215 of Public Law 107-310 continues the National Dam Safety Program with the Director of FEMA as its coordinator.

Under the leadership of the Federal Emergency Management Agency, state assistance funds have enabled all participating states to better their programs.

Dam Safety and Security Act of 2002

Purpose

The purpose of the National Dam Safety Program, as expressed in Section 215(a) of Public Law 107-310, is to "reduce the risks to life and property from dam failure in the United States through the establishment and maintenance of an effective national dam safety program to bring together the expertise and resources of the federal and non-federal communities in achieving national dam safety hazard reduction."

Objectives

The objectives of the National Dam Safety Program are to:

- ensure that new and existing dams are safe through the development of technologically and economically feasible programs and procedures for national dam safety hazard reduction;
- encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness;
- encourage the establishment and implementation of effective dam safety programs in each state based on state standards;
- develop and encourage public awareness projects to increase public acceptance and support of state dam safety programs;
- develop technical assistance materials for federal and state dam safety programs;
- develop mechanisms with which to provide federal technical assistance for dam safety to the non-federal sector; and
- develop technical assistance materials, seminars, and guidelines to improve security for dams in the United States.

Initiatives

Public Law 107-310 directs FEMA to carry out a number of initiatives. These initiatives are summarized below:

- Establish a National Dam Safety Review Board to monitor state implementation of Section 215 and advise FEMA on implementation of the National Dam Safety Program;
- Exercise leadership by chairing the Interagency Committee on Dam Safety to coordinate federal efforts in dam safety;
- Transfer knowledge and technical information among the federal and state sectors;
- Provide for the education of the public, including state and local officials, in the hazards of dam failure and related matters;
- Provide funding to the states to establish and maintain dam safety programs through a grant assistance program;
- Provide training for state dam safety staff and inspectors;
- Establish a program of technical and archival research to develop improved techniques, historical experience, and equipment for rapid and effective dam construction, rehabilitation, and inspection; devices for the continued monitoring of the safety of dams; development and maintenance of information resources systems needed to support managing the safety of dams; and initiatives to guide the formulation of effective public policy and advance improvements in dam safety engineering, security, and management. FEMA also will provide for state participation in research and periodically advise all states and Congress on the results of the research; and
- Report to Congress (biennially) on the status of the National Dam Safety Program, the progress achieved by federal agencies during the 2 preceding fiscal years in implementing the *Federal Guidelines for Dam Safety*, and the progress achieved in dam safety by states participating in the Program. The Report to Congress also will include recommendations for legislative or other action that the Director of FEMA considers necessary to achieve National Dam Safety Program goals and objectives.

State Accomplishments

Overview

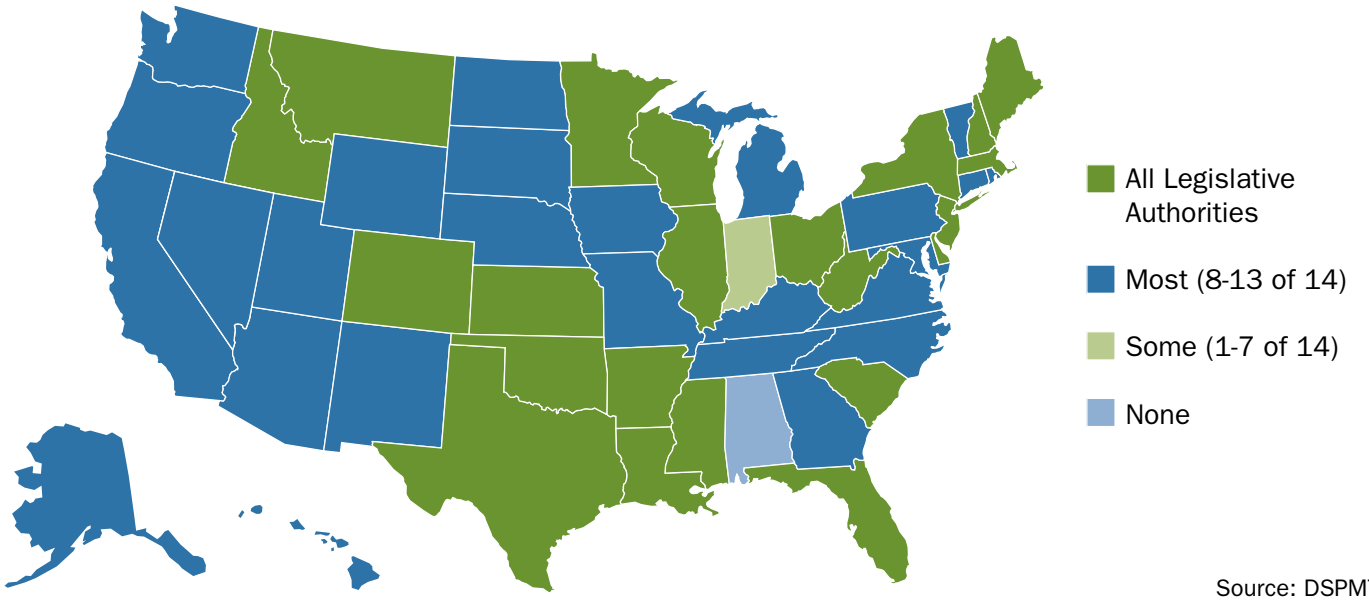
The National Dam Safety Program empowers the states, through grants, technical resources, and training, to enhance their own state programs. The nature of this program allows the states to identify their own priorities where dams are concerned and to take appropriate action according to available resources. Funds provided annually through grants to state dam safety programs can be utilized by the states to develop dam security vulnerability screening tools and threat response plans for high-hazard potential dams.

The state assistance program is intended to help states bring the necessary resources to bear on inspection, classification, and emergency planning for dam safety. For a state to be eligible for assistance under the National Dam Safety Program, the state dam safety program must be working toward meeting the following criteria, as listed in Public Law 107-310:

- The authority to review and approve plans and specifications to construct, enlarge, modify, remove, and abandon dams;
- The authority to perform periodic inspections during dam construction to ensure compliance with approved plans and specifications;
- A requirement that state approval be given on completion of dam construction and before operation of the dam;
- The authority to require or perform the inspection at least once every 5 years of all dams and reservoirs that would pose a significant threat to human life and property in case of failure to determine the continued safety of the dams and reservoirs, and a procedure for more detailed and frequent safety inspections;
- A requirement that all inspections be performed under the supervision of a state-registered professional engineer with experience in dam design and construction;
- The authority to issue notices, when appropriate, to require owners of dams to perform necessary maintenance or remedial work, revise operating procedures, or take other actions, including breaching dams when necessary;
- Regulations for carrying out the legislation of the state;
- The provision for funds to ensure timely repairs or other changes to or removal of a dam to protect human life and property, and if the owner of the dam does not take the action described above, to take appropriate action as expeditiously as possible;
- A system of emergency procedures to be used if a dam fails or if the failure of a dam is imminent; and
- An identification of each dam whose failure could be reasonably expected to endanger human life, the maximum area that could be flooded if the dam failed, and public facilities that would be affected by the flooding.

For a state to qualify for assistance, state appropriations must be budgeted to carry out the legislation of the state. Figure 3 below shows the status of state compliance with all of the legislative authorities listed in the Act.

Figure 3



Source: DSPMT

Table 2: State Grant Amounts for FY 2002 and 2003

State	FY 2002/2003 Awards (in combined $)
Alabama*	48,963
Alaska	55,107
Arizona	63,935
Arkansas	76,924
California	137,457
Colorado	160,128
Connecticut	98,825
Delaware*	48,963
Florida	89,431
Georgia	310,349
Hawaii	58,074
Idaho	79,049
Illinois	137,810
Indiana	130,889
Iowa	264,654
Kansas	492,352
Kentucky	121,000
Louisiana	70,857
Maine	93,812
Maryland	75,802
Massachusetts	159,633
Michigan	96,423
Minnesota	198,712
Mississippi	290,362
Missouri	92,752
Montana	251,236
Nebraska	193,323
Nevada	77,285
New Hampshire	106,381
New Jersey	162,882
New Mexico	81,105
New York	186,612
North Carolina	353,007
North Dakota	88,655
Ohio	171,145
Oklahoma	365,791
Oregon	132,089
Pennsylvania	136,469
Puerto Rico	51,498
South Carolina	207,376
South Dakota	209,214
Tennessee	90,068
Texas	526,464
Utah	86,395
Vermont	72,834
Virginia	83,429
Washington	86,184
West Virginia	70,857
Wisconsin	117,197
Wyoming	144,944

*Alabama and Delaware do not participate in the program but were provided with funding to establish a legislatively mandated state dam safety program.

Scope of State Assistance

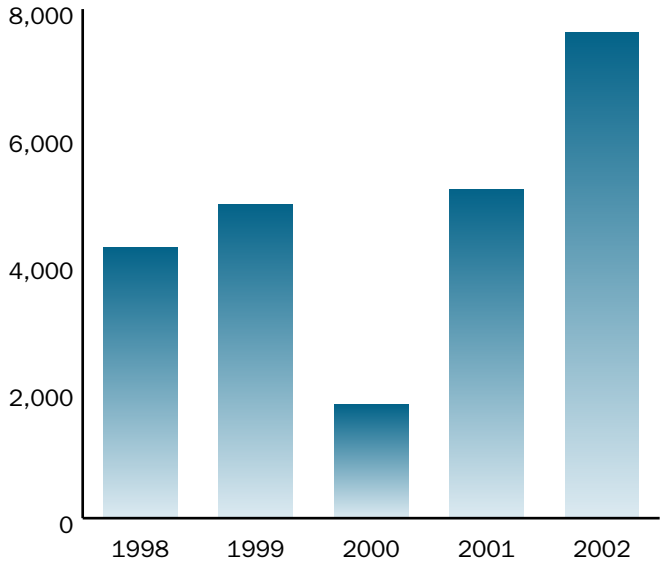
Table 2 lists the state assistance grant amounts (combined) allocated by FEMA for FY 2002 and 2003.

Highlights in FY 2002 and 2003

FY 1998 and 1999 was the first period for which the states provided FEMA with data on the number of dams in their states by hazard classification; the number of dam inspections conducted each year; remediation needs; and the status of dams with Emergency Action Plans (EAP's) by hazard potential classification. Table 3 compares by state the percent of EAP's by state-regulated high- and significant-hazard potential dams for FY 2002 against the data provided for FY 2001.

A comparison of data from the states for 2001 and 2002 indicates that National Dam Safety Program funding has resulted in very significant increases in the number of EAP's over the past 2 years: a 47 percent increase in the absolute number of EAP's for state-regulated high- and significant-hazard potential dams, resulting in a 7 percent increase in the completion percentage over the last reporting cycle. Today, 36 percent of all state-regulated high- and significant-hazard potential dams have an EAP. Of the states reporting in 2002, 32 states increased the number of EAP's for high- and significant-hazard potential dams, 7 states had no change, and only 7 states had a decrease. Of particular note are the increases in EAP's by the States of California and Pennsylvania.

Figure 4: Number of State Regulated Dams with EAP's, All Hazard Potential



Source: DSMPT

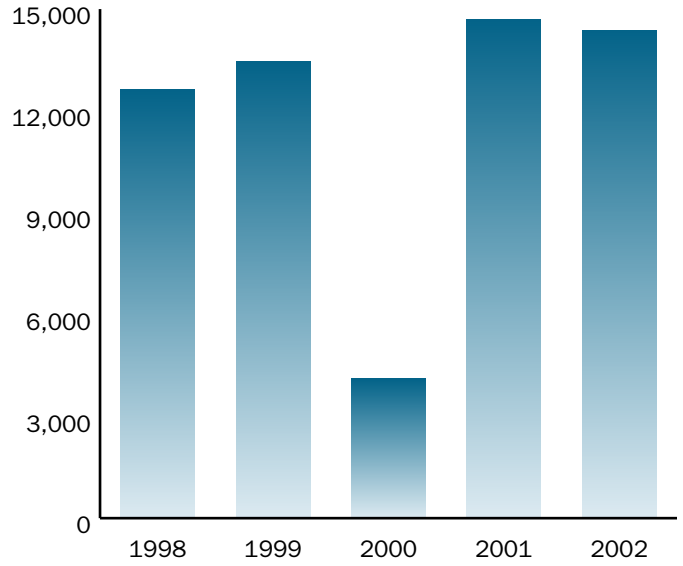
Figure 4 shows the increase in EAP's for state-regulated dams for all hazard potentials from 1998, the first year of National Dam Safety Program funding, through 2002 (data for 2000 was incomplete). The data indicates that approximately 4,000 dams had EAP's in 1998, compared to approximately 7,500 dams in 2002. This is a very strong indication that National Dam Safety Program funding is making excellent strides in realizing one of the most important goals for our Nation's dams: an EAP for 100 percent of all high- and significant-hazard potential dams.

The number of dam inspections conducted by the states remained fairly constant with the last reporting period, but has increased dramatically since data was first collected for 1998-1999, from a total of approximately 12,000 inspections for 1998-1999 to over 14,000 inspections for 2002. Figure 5 shows dam inspections for all hazard potential dams for 1998 through 2002.

Table 4 shows the summary status of state dam safety programs for the year ending in FY 2002.

Each step on the road to dam safety is a success, and all of the states that have received National Dam Safety Program grant funds in FY 2002 and 2003 have achieved successes, whether it be through increases in emergency action planning and inspections, public and dam owner awareness programs, or the implementation of security safeguards for dams.

Figure 5: Timeline of Number of Inspections, All Hazard Potential



Source: DSMPT

Table 3: Percent of EAP's by State-Regulated High- and Significant-Hazard Potential Dams

State	FY 01 Percent	FY 02 Percent	% Change
Alabama*			
Alaska	19	30	+21
Arizona	75	68	-7
Arkansas	33	39	+6
California	28	100	+72
Colorado	99	100	+1
Connecticut	42	42	0
Delaware*			
Florida	89	99	+10
Georgia	4	4	0
Hawaii	4	17	+13
Idaho	70	53	-17
Illinois	48	55	+7
Indiana	3	3	0
Iowa	0	0	0
Kansas	7	21	+14
Kentucky	1	0	-1
Louisiana	5	16	+11
Maine	22	45	+23
Maryland	63	70	+7
Massachusetts	14	8	-6
Michigan	62	80	+18
Minnesota	17	16	-1
Mississippi	4	4	0
Missouri	7	9	+2
Montana	43	42	-1
Nebraska	30	31	+1
Nevada	13	10	-3
New Hampshire	70	84	+14
New Jersey	46	59	+13
New Mexico	1	5	+4
New York	18	20	+2
North Carolina	7	8	+1
North Dakota	1	2	+1
Ohio	15	22	+7
Oklahoma	58	58	0
Oregon	23	29	+6
Pennsylvania	18	79	+61
Puerto Rico	32	31	-1
Rhode Island	0	0	0
South Carolina	90	100	+10
South Dakota	17	18	+1
Tennessee	37	42	+5
Texas	6	6	0
Utah	47	26	-21
Vermont	0	10	+10
Virginia	96	97	+1
Washington	30	37	+7
West Virginia	49	61	+12
Wisconsin	21	26	+5
Wyoming	19	20	+1

*Did not submit data.

Table 4: Summary Status of Dams by State

State	# National Inventory				# State Regulated			
	Total	High	Sig.	Low	Total	High	Sig.	Low
Alabama	2104	171	427	1506	0	0	0	0
Alaska	114	23	32	59	81	16	28	37
Arizona	258	87	46	125	258	87	46	125
Arkansas	1226	164	214	848	402	101	93	208
California	1223	332	687	204	1223	332	687	204
Colorado	1861	318	310	1233	1737	276	296	1165
Connecticut	706	226	452	28	706	226	452	28
Florida	773	101	259	413	773	101	259	413
Georgia	4409	500	0	3909	3824	400	0	3424
Hawaii	131	55	13	63	131	55	13	63
Idaho	361	94	128	139	439	97	144	198
Illinois	1286	172	279	835	1309	172	279	858
Indiana	1055	257	296	502	1129	239	250	640
Iowa	3309	79	188	3042	3286	73	187	3026
Kansas	5859	188	344	5327	5820	192	265	5363
Kentucky	943	213	208	522	905	212	208	485
Louisiana	361	13	52	296	360	12	52	296
Maryland	299	60	76	163	352	63	80	209
Massachusetts	1619	324	743	552	1556	296	726	534
Michigan	902	143	173	586	811	90	162	559
Minnesota	798	40	145	613	712	24	126	562
Mississippi	3433	275	74	3084	3433	275	74	3084
Missouri	4216	630	1010	2576	646	236	204	206
Montana	3134	123	156	2855	2872	98	126	2648
Nebraska	2157	108	245	1804	2157	108	245	1804
Nevada	418	120	106	192	602	128	121	353
New Hampshire	616	87	188	341	826	85	190	551
New Jersey	777	194	372	211	1651	194	372	1085
New Mexico	522	179	97	246	386	152	87	147
New York	1891	379	776	736	1891	379	776	736
North Carolina	3170	1320	922	928	5055	1320	922	2813
North Dakota	772	27	93	652	722	18	87	617
Ohio	1728	470	550	708	1728	470	550	708
Oklahoma	4511	183	88	4240	4388	143	78	4167
Oregon	833	122	181	530	1204	122	181	901
Pennsylvania	1414	811	209	394	1310	757	228	325
Puerto Rico	35	34		1	35	34		1
Rhode Island	509	17	40	452	528	17	41	470
South Carolina	2309	138	479	1692	2301	136	477	1688
South Dakota	2468	84	155	2229	2323	47	144	2132
Tennessee	1061	266	330	465	606	147	198	261
Texas	8060	852	788	6420	8060	852	788	6420
Utah	639	222	210	207	633	197	208	228
Vermont	344	54	130	160	538	54	130	354
Virginia	1570	155	285	1130	519	113	132	274
Washington	806	209	242	355	674	137	219	318
West Virginia	414	342	61	11	355	269	73	13
Wisconsin	1210	226	188	796	991	176	157	658
Wyoming	1299	77	110	1112	1373	77	110	1186

# Dam Inspections				# EAP's	
Total	High	Sig.	Low	High	Sig.
0	0	0	0	0	0
14	5	7	2	11	2
94	68	6	20	66	24
362	101	97	164	76	0
789	196	461	132	332	687
625	213	189	223	276	296
49	32	6	11	160	126
1050	150	700	200	101	256
1305	400	0	905	14	0
66	50	6	10	3	1
383	84	126	173	90	37
130	72	25	33	135	115
182	35	26	121	16	0
107	38	59	10	0	0
75	26	33	16	86	10
259	65	86	108	0	0
142	10	44	88	3	1
132	55	33	44	54	46
131	37	42	52	65	16
178	15	24	139	81	121
65	25	19	21	24	0
208	150	10	48	13	1
204	167	25	12	25	15
10	10	0	0	93	2
352	36	53	263	103	7
278	132	41	105	23	2
181	29	46	106	85	147
217	65	58	94	178	157
202	91	49	62	12	0
493	196	230	67	182	53
1893	556	275	1062	175	17
161	14	52	95	1	1
126	68	38	20	127	94
1111	136	75	900	124	4
137	21	35	81	72	15
608	470	86	52	671	111
11	11	0	0	11	0
63	0	0	63	0	0
200	120	80	0	152	477
68	15	12	41	30	5
346	148	101	97	143	2
94	46	22	26	97	9
340	190	104	46	105	0
55	25	22	8	15	3
90	36	34	20	111	127
66	24	32	10	90	41
319	220	93	6	161	46
28	10	5	13	71	16
315	17	42	256	33	4

Accomplishments with State Assistance Funds in Fy 2002 and 2003

- Dam safety-related training for state personnel
- Improvements in security and safeguards for dams
- Training of dam owners to conduct annual maintenance reviews
- Purchase of equipment, including state-of-the-art computer systems and software; new equipment to aid in engineering analysis; video inspection cameras to inspect conduits through dams; laptop computers for use in the field to complete inspection reports; surveying equipment; and vehicles for use in inspections
- Revision of state operations and maintenance guidelines
- Increase in the number of dam inspections
- Increase in the submittal of EAP's
- More timely review and issuance of permits
- The testing of EAP procedures through actual simulations of dam failures
- Improved coordination with state emergency preparedness officials
- Improvements to dam inventory databases
- Improved telecommunications
- Identification of dams to be repaired or removed
- Conduct of dam safety awareness workshops
- Development of proposals to strengthen dam safety rules
- Creation of dam safety videos and other outreach materials
- Development of public relations plans and dam safety newsletters

Research

Research is critical to the Nation's agenda for dam safety and security. Research funding under the National Dam Safety Program has addressed a cross-section of issues and needs, all in support of ultimately making dams in the United States safer. In April 1999, the first full year of program funding, the Interagency Committee on Dam Safety (ICODS) Research Subcommittee developed a list of research needs and priorities for dam safety. Over the past 5 years, research funds have been allocated to workshops in the priority areas. As information has become available from the workshops, laymen's guides, expert level guides, and research workshop summaries have been produced. As envisioned in 1999, one of the primary purposes of the research workshops was the development of a Strategic Plan for National Dam Safety Research. The draft Strategic Plan, completed in September 2003, identifies the long-term priorities for dam safety and security research and prototype implementation activities.

Below are summaries of some of the projects sponsored with research funds under the National Dam Safety Program in FY 2002 and 2003. A description of the National Inventory of Dams (NID), Dam Safety Program Management Tools (DSPMT) program, and the National Performance of Dams Program (NPDP), all of which received funding in FY 2002 and 2003, can be found in this section under *Information Technology*.

Dam Seepage Monitoring System

Completed with research funding, the Dam Seepage Monitoring System is an interactive tool designed to help dam owners and operators store instrument measuring data on their personal computers and to transfer that information to state dam safety offices for evaluation, thereby improving the safety of their dams. The Dam Seepage Monitoring System will be upgraded in FY 2004 to make the software Internet accessible. The Dam Seepage Monitoring System is available at no cost from FEMA.

Research Workshops

Research workshops sponsored with National Dam Safety Program funds in FY 2002 and 2003 included:

- Issues, Remedies, and Research Needs Related to Hydrologic Issues (November 2001, Davis, California, Organized and Conducted by the U.S. Army Corps of Engineers (Corps), Hydrologic Engineering Center)

- Issues, Remedies, and Research Needs Related to Spillways (August 2003, Denver, Colorado, Organized and Conducted by the Bureau of Reclamation (Reclamation))

- Issues, Remedies, and Research Needs Related to Seismic Issues, Part II, Ground Motions (September 2003, Organized and Conducted by the U.S. Army Corps of Engineers, Engineering Research & Development Center)

The first research workshop for FY 2004, Issues, Remedies, and Research Needs Related to Outlet Works, will be held in January 2004 in Denver, Colorado.

Research Products

Reports from the research workshops assist the Research Work Group and other groups in reviewing recommendations and developing a strategy for extending the state-of-the-practice.

As the first part of a two-phased project, ASDSO recently completed the final technical guidebook, *A Technical Manual on the Effects of Tree and Woody Vegetation Root Penetrations on the Safety of Earthen Dams*. The second phase of the project will include a guidebook that focuses on animals and a layman's brochure on both plant and animal effects on earthen dams. The brochure will be added to a series of layman's brochures available to dams owners through ASDSO.

Other products scheduled for completion next year include a manual for seepage and internal erosion associated with conduits. Reclamation is leading the project, with contributions from the Federal Energy Regulatory Commission (FERC) and the Corps.

Bibliography of Dam Safety Practices

To launch an effective and efficient research program, the Research Subcommittee recommended that all relevant research data be collected and compiled on the history of dam safety engineering in the major technical areas. To address this need, ASDSO developed a comprehensive *Bibliography of Dam Safety Practices* using its national networking capabilities. The effort, which began in 1999, continues today. The *Bibliography* is updated on a weekly basis and is fully searchable online at ASDSO's web site at www.damsafety.org.

The Cost of Rehabilitating our Nation's Dams

In the spring 2003, ASDSO completed *The Cost of Rehabilitating our Nation's Dams: A Methodology, Estimate & Proposed Funding Mechanisms*. Funded in part through the National Dam Safety Program, the report provides a formula for estimating the cost of rehabilitating all non-federally owned dams in the United States that require rehabilitation. The report also includes recommendations for funding sources, such as a federally supported revolving loan fund for dam repair, dam rehabilitation and, where appropriate, dam removal. The report is available through ASDSO.

Feasibility Report on National Risk Indexing Procedures

One recommendation from the Research Workshop on Risk Assessment was the development of national risk indexing procedures. ASDSO recently completed a feasibility report that focuses on the evaluation of current risk indexing procedures. The report discusses the feasibility of developing a national procedure that could be used by any dam safety agency or owner to prioritize risk across a number of dams.

Training

Since the inception of the National Dam Safety Program in 1979, FEMA has supported a very strong, collaborative training program for both dam safety professionals and dam owners. With the training funds provided under the 1996 Act and the Act of 2002, FEMA has been able to expand existing training programs, begin new initiatives to keep pace with evolving technology, and enhance the sharing of expertise between the federal and state sectors. Training activities conducted in FY 2002 and 2003 are described below.

Regional Technical Seminars and State Training Assistance

For many years, ASDSO has been FEMA's most important partner in the National Dam Safety Program. Each year, in addition to its annual conference, ASDSO conducts four regional technical seminars. In 2002, ASDSO held one seminar in each of its regions on construction inspections and plans and specifications review and on earthquake engineering for dams. In 2003, ASDSO conducted technical seminars on soil mechanics, construction inspections and plans and specifications review.

Training funds for state dam safety officials have been a mainstay of the National Dam Safety Program. Each year, an amount is provided to each of the officials so that they can attend the training of their choice. This flexibility allows the states to focus their training on their specific needs.

National Dam Safety Program Technical Workshop Series

A major training initiative is the National Dam Safety Program Technical Workshop Series. The idea for a series of technical workshops originated with ICODS in 1992. The goal then, as it is now, was to invite recognized authorities in the engineering field to discuss analysis techniques, construction methods, and other issues that can increase the expertise and information available to all of the engineers in the dam safety community. For the first few years of the Technical Workshop Series, the majority of attendees were representatives from federal agencies. With the passage of the 1996 Act, FEMA was able to make the Workshop Series more national in scope, and more inclusive of state and local dam safety personnel and the private sector.

For the last 5 years, training funds have been set aside for state dam safety officials to attend the Workshops. To date, 10 Technical Workshops have been held. On February 20-23, 2002, Technical Seminar No. 9, Inspection, Interpretation, and Follow-Up, was held at FEMA's Emergency Management Institute (EMI). Over 300 people attended the course, including 87 state participants. In February 2003, close to 300 people attended National Dam Safety Program Technical Workshop No. 10, Dam Site Security-Threat, Consequence, and Vulnerability Assessments and Security Plan Effectiveness. Technical Seminar No. 11, Addressing Hydrologic Inadequacy, will be held at EMI on February 18-19, 2004.

Over the years, the Technical Workshops have hosted a pre-eminent roster of speakers on topics such as liquefaction susceptibility, mitigation strategies for dam safety, dam breach analysis and maximum precipitation, and spillway gates. The National Dam Safety Program will not abandon these traditional training topics, but rather will seek opportunities to enhance them with security components so that they compliment the security mission of the Department of Homeland Security.

HEC-RAS and HEC-HMS Training

HEC-RAS is the Corps Hydrologic Engineering Center (HEC) River Analysis System (RAS). The HEC-RAS software analyzes networks of natural and man-made channels and computes water surface profiles based on steady one-dimensional flow hydraulics. The HEC-HMS is the HEC Hydrologic Modeling System (HMS) designed to simulate the precipitation runoff processes of dendrite watershed systems. Training in both HEC-RAS and HEC-HMS has been a priority for state and federal training efforts. Each year, the National Dam Safety Program supports a HEC-RAS course and a HEC-HMS course at EMI.

Training Aids for Dam Safety

One of the most successful training initiatives is the Training Aids for Dam Safety (TADS) program, which consists of 21 modules covering topics from inspection to evaluation to emergency planning. The TADS program consists of three parts: (1) the inspection component, in which state regulators are taught how to conduct a dam safety inspection; (2) the awareness component, which emphasizes dam safety mitigation; and (3) the analysis component, in which state regulators are taught how to analyze dam safety data. EMI is currently working on web-based updates to three of the TADS modules: the inspection of embankment dams module and the modules on evaluation of seepage conditions and how to develop and implement an EAP. The TADS modules are used extensively by state dam safety personnel and the federal agencies.

State Peer Review Program

Each year, FEMA provides funds to ASDSO to assist in its peer reviews of selected state and federal dam safety programs. In FY 2002 and 2003, ASDSO conducted peer reviews of five states and the City of Seattle. Through the program, experienced dam safety professionals from state, federal, and the private sector review program procedures and interview staff using the ASDSO Peer Review Procedures Manual, thereby identifying areas that need improvement.

Multi-Hazard Building Design Summer Institute Course

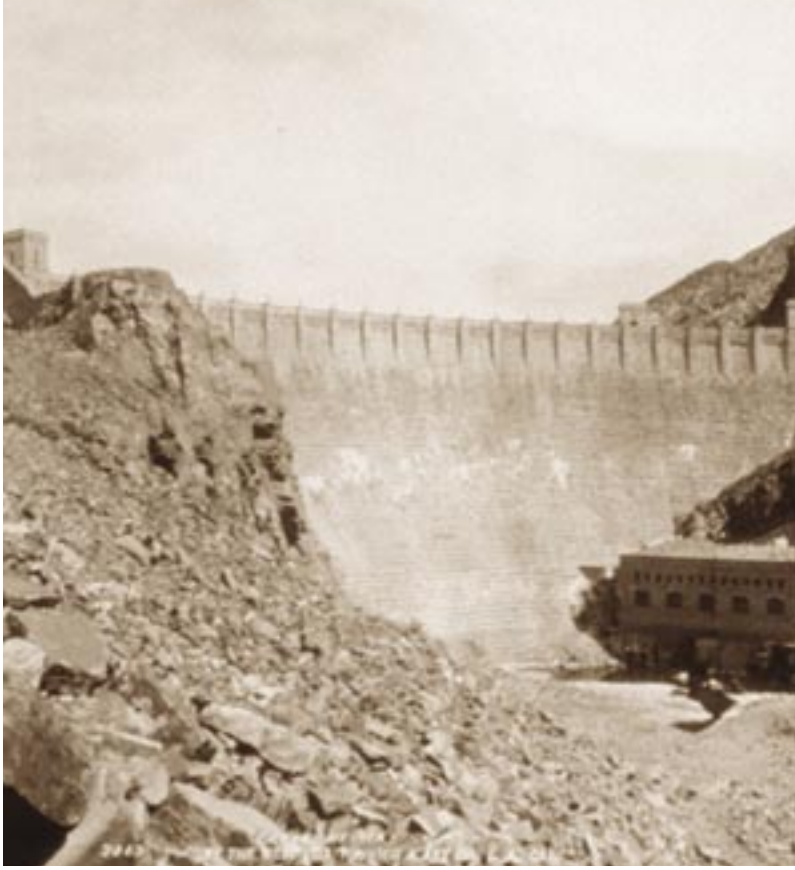
Every other year, FEMA provides National Dam Safety Program training funds to EMI to support the Multi-Hazard Building Design Summer Institute (MBDSI) course in dam safety. The MBDSI courses are updated on a yearly basis to support engineering and architectural faculty. In June 2003, the MBDSI dam safety course was held at EMI. The next dam safety course will be held at EMI in June 2005.

Emergency Action Planning

An EAP is essential to address the potential for loss of life and damage to property and the environment should a high-hazard or significant-hazard potential dam fail. EAP's are the principle tool used by emergency management personnel and first responders to warn and evacuate the vulnerable population below the dams. The states are being strongly urged to develop and exercise EAP's for all high- and significant-hazard potential dams owned by the state.

Emergency action planning is a major initiative of the National Dam Safety Program, with a goal of 100 percent participation for all high- and significant-hazard potential dams. The National Dam Safety Program has supported numerous activities in emergency action planning for both federal and state agencies, including a videotape training production; training courses for state dam safety officials on the development and exercise of an EAP; workshops to assist in the development of EAPs; the development by ICODS of the Federal Guidelines for Dam Safety: Emergency Action Planning for Dams; and laymen's guides on the importance of emergency action planning.

As discussed in the next section of this report, the National Dam Safety Program has identified FERC as the national expert on emergency action planning and the agency has taken the lead in guiding a national program on emergency action planning and implementation. The latest EAP initiative undertaken by FERC was the pre-conference United States Society on Dams (USSD) workshop on emergency preparedness and security at dams held in Charleston, South Carolina in April 2003. This workshop was a follow-on event from the International EAP Worskshop co-sponsored by FERC and ASDSO in Niagara Falls, New York.



Information Technology

The spectrum of information needs extends from those in Congress who set national priorities and allocate fiscal resources to those of the dam owner and engineer involved in inspections, operations and maintenance, dam safety modifications, and other day-to-day activities of maintaining safe, economically viable facilities and environmentally responsible structures. Given the rapid pace of technology, those in a leadership role must recognize and make the best use of tools to accomplish their objectives. A primary objective of FEMA in its leadership of the National Dam Safety Program is to identify, develop, and enhance technology-based tools that can help educate the public and assist decision-makers.

National Inventory of Dams

The NID is a computerized database of dams in the United States used to track information on our water control infrastructure. The primary source for disseminating the data is the Internet. The NID also includes Internet-based tools to query the data, and features a Geographic Interface System (GIS) interface that allows for the display and analysis of data. Access to the NID is available at http://www.tec.army.mil/nid/. The current NID contains over 77,000 dams. It is a dynamic on-line database with scheduled periodic updates and interim updates (as improved data is received from participants).

Roosevelt Dam and Power House, Arizona. 1913

Information from the NID is used in the development of water resource management, land use management, flood plain management, risk management, and emergency action planning. The NID update process involves a partnership of 68 states, territories, and federal agencies, in coordination with the Corps, FEMA, and ASDSO.

Congress authorized the Corps to inventory dams in the United States with the National Dam Inspection Act (P.L. 92-367) of 1972. The NID was first published in 1975, and has been periodically updated thereafter. The Water Resources Development Act of 1986 (P.L. 99-662) authorized the Corps to maintain and periodically publish an updated NID, and Section 215 of the Water Resources Development Act of 1996 (P.L. 104-303) re-authorized periodic update and provided a continued funding mechanism.

These updates capture more accurate and more comprehensive data on existing dams, changes in existing dams, and new dams. For example, each dam in the NID is assigned a downstream hazard potential classification (by the appropriate regulating authority), based on the potential loss of life and damage to property should the dam fail. With the changes in demographics and post-construction land development in downstream areas, hazard potential classifications need to be updated continually to reflect the dam's current status.

Software to help data owners (states and federal agencies) compile, manage, and report inventory data has been developed and deployed. These software tools enabled data owners to review inventory changes, correct mistakes, and easily send inventory updates to the Corps in 2002. The software also resulted in the receipt of more consistent data, with correct inventory codes, and enabled resolution of discrepancies between data owners. This software is also being used by states and some federal agencies for other reporting purposes, which helps accomplish the goal of one-time data entry for reporting to various organizations for inventory or safety program information.

As the update process continues, the quality of information at all levels in the Nation's dam safety community continues to improve. State inspections and data sharing among state and federal agencies will verify or amend existing data, and identify or complete missing information. The key advantages of this methodology are that it leverages the economic advantages of a partnership effort, fosters cooperation among state and federal agencies, and strengthens risk management and decision-making at the state and national level.

Data from the NID can be analyzed to provide decision-makers with statistical information such as the following:

- National development of water control infrastructure is shifting from a construction phase to a maintenance and rehabilitation phase.

- About 21 percent of the dams in the NID have a high- or significant-hazard potential classification. Downstream hazard potential classifications of high, significant, or low are assigned to each dam in the NID to identify the risk dams can pose due to failure or negligent operation.

- About 29 percent of all dams nationwide have an EAP, as described by the *Guidelines*. These guidelines state that an EAP, commensurate with dam size and location, should be formulated for each dam. EAP's have been prepared for 60 percent of the dams with high-hazard potential and 80 percent of dams with significant-hazard potential. With an increased risk of terrorism against our infrastructure, EAP's are even more critical than before, and can provide an additional measure of protection for downstream residents and dam owners.

In response to the terrorist attacks of September 11, 2001, there has been an increased focus on infrastructure protection nationwide. Following the attacks, the Corps removed the NID from public access while the open availability of the NID with 44 fields of information was analyzed. The ICODS NID Subcommittee concluded that most of the NID data did not pose significant security risks to the Nation's dams, and was information that could reasonably be obtained by the general public through other means, such as almanacs. As a result, the Subcommittee recommended to the Corps that the NID be restored to public access. The Corps Headquarters Dam Safety Officer concurred, and the NID was restored to public Internet access in August 2002, but with removal of the data fields, "Nearest City/Town" and "Distance to Nearest City/Town." The Corps is participating in a Federal Geographic Data Committee focus group to develop security guidelines for publication of geospatial data, which includes analysis of the NID.

Dam Safety Program Management Tools

Since authorization and implementation of the National Dam Safety Program, it has become increasingly clear that there are broad information needs required to support dam safety. These data needs include documenting the condition of the Nation's dams; tracking the existence and progress of dam safety programs; and supporting dam safety professionals who are responsible for evaluating and maintaining the safety of dams in the United States

Satisfying many of these data needs is the DSPMT. The DSPMT is an information collection and management system that is controlled locally by federal and state dam safety program managers and which interacts with national external cooperative information resources for providing as-requested and periodic information on local dam safety information, program needs, and accomplishments within each organization's jurisdiction.

The purpose of the DSPMT is to provide dam safety program managers with a tool to collect unbiased data about dams and dam safety programs, check selected data for accuracy, and then utilize the data to achieve an accurate local and national inventory of dams. The DSPMT helps address programmatic questions such as:

- How well are our dam safety programs being implemented?
- Are we doing too much in some areas and not enough in others?
- Are we spending our scarce resources in the right places?
- Are we improving?

Figure 6

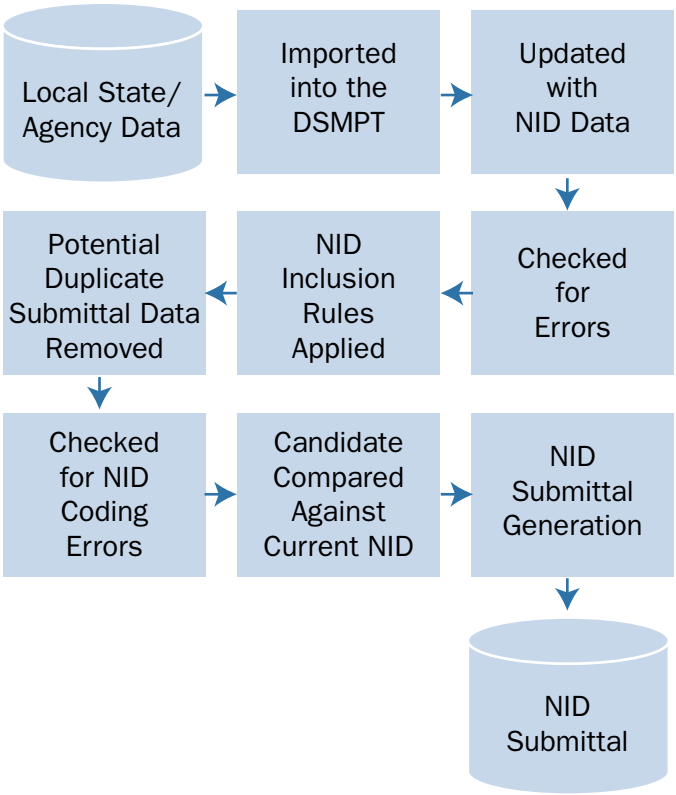


Figure 7: NID Electronic Submittal Status (4/5/2003)

The DSPMT consists of a set of interactive software programs that provide a resource to dam safety data owners, managers, and data providers. The DSPMT includes three distinct, complementary, and interoperable software programs:

- The Dam Safety Program Performance Measures (DSPPM)
- The NID Electronic Submittal Workflow
- Handheld Computer-based Inspection Checklists

The performance measures, or indicators, use unbiased data to assess effectiveness of dam safety programs and organizations in seven key areas. Data entered into the database at each organizational level can be used individually and/or collectively as input at the next higher level to evaluate program performance on broader and broader scales (e.g., district, division, agency, state). The performance measures can be used by organizations such as FEMA, the National Dam Safety Review Board, ICODS, ASDSO, and the USSD to evaluate the health and progress of dam safety programs on a national scale.

The NID Electronic Submittal Workflow software is a natural extension of the NID and part of the DSPMT to help users provide a consistent, error-checked electronic submittal of inventory information. The NID Electronic Submittal workflow is graphically represented in the User Interface form shown in Figure 6.

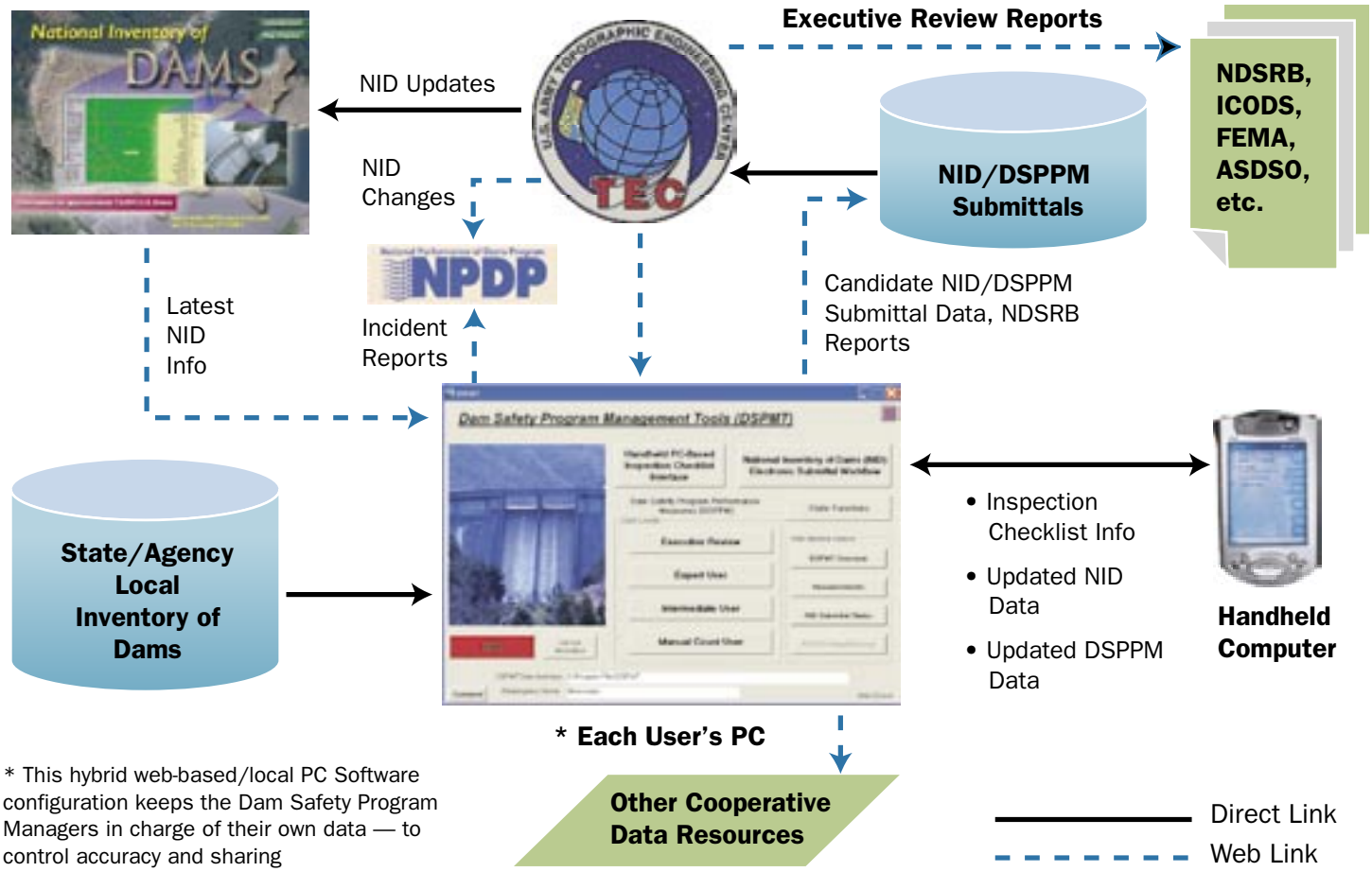
By performing data submittal workflows at the state and agency level, those most familiar with the data and most qualified to make any changes, specifically the data owners, managers, and data providers, are kept in the loop by the program as it highlights areas in the data that potentially need attention, modification, or double-checking. By performing these workflows at the state and agency level, and by using the original data from the day-to-day dam inventory management tools, the data quality and accuracy of the submittal is significantly enhanced.

In 2002, the DSPMT was utilized for collecting inventory information to update the NID. As shown in Figure 7, 13 federal agencies and 43 states provided inventory information in electronic format.

Of those 43 states, 26 directly utilized the DSPMT to generate an electronic submittal. The remainder provided data in other types of electronic submittals that were then easily converted into DSPMT format for integration with the other submittals.

The DSPMT Handheld PC-based Inspection Checklist software consists of a single standardized application for the collection and updating of performance measure information, NID information, and a number of flexible and configurable "plug-in" applications for dam safety inspection checklists. These plug-in applications are available for a variety of organizations, including the FERC,

Figure 8: DSPMT Information Flow



* This hybrid web-based/local PC Software configuration keeps the Dam Safety Program Managers in charge of their own data — to control accuracy and sharing

Reclamation, Arizona, and New Mexico. Based on feedback from these organizations, the inspection checklist software continues to evolve and improve.

The use of the DSPMT by federal agencies and the states is illustrated in the information flow overview shown in Figure 8. An organization's local inventory of dams, in a variety of data formats, can be imported into the DSPMT and used as the local inventory of dams for numerous functions, including performance measure data submittals, NID data submittals, generation of the FEMA State Evaluation Criteria Report, and providing incident information to the NPDP.

With continued reductions in budgets and staffing, both federal and non-federal dam safety programs are in need of continuous efficiency and effectiveness improvements. In addition, there is an ever-increasing need for performance-based reporting internally and to FEMA, Congress, and State Legislatures. The DSPMT provides the tools necessary for evaluating dam safety programs, for reporting accomplishments, and for expressing program needs to others.

National Performance of Dams Program

The NPDP is a national effort to retrieve, archive, and disseminate information on dams and their performance in the United States. The NPDP was founded (and is headquartered) at Stanford University, with financial support provided by FEMA. Working with professional associations and federal and state agencies, the NPDP receives reports on dam incidents, i.e., events that relate to the structural and operational integrity of dams. The mission of the NPDP is to provide information resources that support public and private efforts to improve dam safety, dam design and rehabilitation, and the implementation of effective public policy. As part of its mission, the NPDP operates a database and library on the performance of dams to meet the needs of dam safety professionals. The NPDP home page address is http://npdp.stanford.edu/.

Condition Rating of Dam Conduits

As part of research work supported by the National Dam Safety Program, the NPDP has developed an approach to predict the condition of metal conduits in embankment

dams. Utilizing the results of dam safety inspections from the states of New Jersey, Washington, Virginia, Ohio, Kansas, and Oklahoma, a condition rating system was used to characterize the condition of metal conduits. Using this data, along with the age of the dam, a statistical model was developed to predict the condition of metal conduits as a function of age. The results of this assessment, combined with the recommendations of the dam inspectors, allow us to predict as a function of age the likelihood that a conduit will require repair or replacement. This result is illustrated in Figure 9.

Prototype Dam Inspection Reporting

A major challenge facing dam safety today is the need to develop and maintain information resource tools that support day-to-day dam safety activities, as well as long-term program needs, e.g., planning, policy, scheduling. As part of a recent project, the NPDP and dam safety professionals from Ohio have developed a prototype web-based system to compile dam safety inspection results, such as photographs and observations, and generate a draft inspection report that utilizes data available in the NPDP database to populate the report. The report also includes governing regulations, dam safety findings and recommendations, and fact sheets for dam owners. The development of this prototype highlights the tremendous opportunities that exist to develop applications that can support the day-to-day activities of dam safety professionals, eliminate redundant data entry, improve data accuracy, enforce information standards, increase program efficiency, and retain information for easy retrieval. This work was partially supported by the National Dam Safety Program.

Digital Library and Database

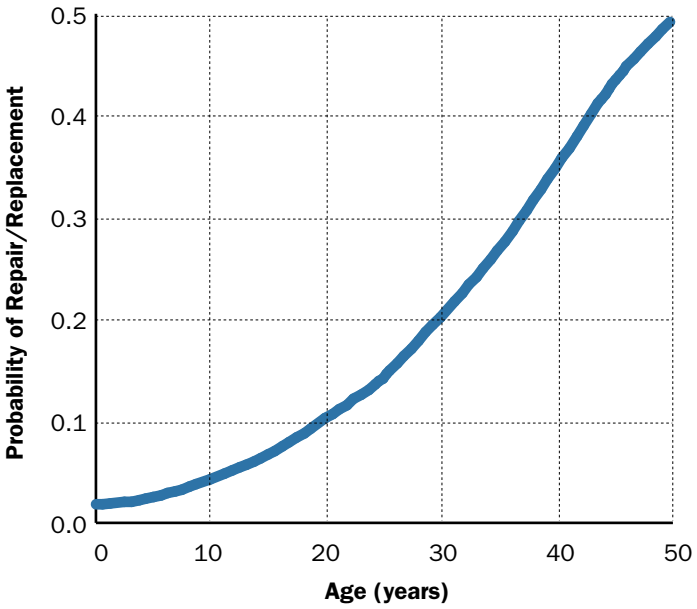
As part of the support provided by the National Dam Safety Program, the NPDP has established a bibliographic database and interface with the Stanford University Library digital archive project. Utilizing the extensive investment the university has made in software and hardware systems to construct a digital archive, the NPDP is able to build an archive that takes advantage of the university's secure digital infrastructure while at the same time remaining autonomous with respect to user access and other factors. With this system in place, NPDP must begin to populate the digital archive.

The NPDP web site provides users with access to information and a variety of tools that includes:

- NPDP Dams Directory
- Availability of an online dam failure consequence database
- Photographs from dam inspections, dam incidents and failures (the NPDP currently has over 10,000 digital photographs in its archive)
- Online dam incident reporting capability, including the uploading of digital documents, i.e., inspection reports and photographs
- Real-time e-mail notification to FEMA dam safety officials and other federal officials of dam failures that have occurred
- Online capability for users to generate reports (graphs, spreadsheets and tables) on recent dam incident notifications.

With the support of NDSP funding, the NPDP serves a wide range of users, including dam safety professionals, dam owners, insurance companies, policy makers, researchers, and students.

Figure 9: Prediction of the likelihood of metal conduits requiring repair or replacement as a function of age.



Federal Agency Programs

The October 4, 1979 Presidential memorandum that directed federal agencies responsible for dams to adopt and implement the *Federal Guidelines for Dam Safety* also directed the heads of these agencies to submit progress reports to the Director of Federal Emergency Management Agency (FEMA). Since that initial report in 1980, the Director of FEMA has solicited follow-up progress reports from the agencies at 2-year intervals.

In June 2004, the *Federal Guidelines for Dam Safety* will be 25 years old. All of the federal agencies responsible for dams are implementing the provisions of the *Guidelines*, sharing resources whenever and wherever possible to achieve results in dam safety, and developing strategies to address diminishing resources and decreases in staffing levels. Many of the federal agencies also initiated security activities in Fiscal Year (FY) 2002 and 2003. These activities are described below along with the activities covered by the *Guidelines*.

Security Activities

Although security is not specifically addressed by the *Guidelines*, many of the federal agencies reported on security activities undertaken since September 11, 2001, to protect their dams against threats.

The Tennessee Valley Authority (TVA), in conjunction with the United States Army Corps of Engineers (Corps), performed security assessments using RAM-D of its 29 dams with a high-hazard potential classification. As a result of the assessment, security upgrades have begun or have been completed on 17 dams. During its response to the major security threat caused by the September 11 attack, TVA also identified the need to improve interagency emergency procedures, communication, and coordination. Since the attack, TVA has developed and implemented an agency emergency response plan that provides for coordinated interagency response to agency-level threats of all types.

The Federal Energy Regulatory Commission (FERC) Security Program for Hydropower Projects was created in FY 2002 in response to September 11. The Security Program provides guidance to FERC staff and licensees to coordinate and complete security activities at hydropower dams under FERC jurisdiction. In FY 2003, the Security Program underwent its first revision; a simplified vulnerability and security assessment tool was developed by FERC; jurisdictional dams were inspected for the adequacy of on-site security; FERC staff participated in several national working groups and committees to coordinate the national response to security at dams; and substantial progress was made in the creation of a national Dam Sector Information

Diversion Dam via Mesa, Arizona. 1908

Sharing and Analysis Center (ISAC) for the purpose of collecting and disseminating threats and security incidents at dams.

Over the past 2 years, the Corps has embarked on a program of protecting its infrastructure. A great deal of time was invested in training staff to conduct security risk assessments at its dams. A total of 353 of the most critical structures were analyzed using the RAM-D program. Security plans using cameras, barriers, fencing, and changes in operational procedures have been implemented at these projects. At other projects, assessments were performed to determine how security could be improved without affecting the dam operation or the ability of the public to enjoy the resources.

Both the U.S. and Mexican Sections of the International Boundary and Water Commission (IBWC) have tightened access to their respective projects. The U.S. Section has talks underway with the Corps regarding risk assessments of IBWC's two large dams.

The administrative framework of the Bureau of Reclamation (Reclamation) changed in response to the events of September 11. The Dam Safety Office moved from the Director of Operations to the newly created Security, Safety, and Law Enforcement (SSLE) Office, which focuses on risk management activities. The Director, SSLE, reports directly to the Commissioner of Reclamation and is responsible for security and safety issues at Reclamation structures. Reclamation also implemented processes for assessing, evaluating, and addressing security risks. During this reporting period, Reclamation assessed and evaluated security at 55 of its most significant hazard facilities.

Federal Agency Accomplishments

Below is a description of federal agency activities during FY 2002 and 2003 in some of the areas covered by the *Guidelines*.

Organization, Administration, and Staffing

As in previous reporting periods, reductions in staffing levels for dam safety remain a concern at some agencies. According to the Corps report, there are serious challenges facing its dam safety organization and the dam safety community in the United States. In FY 2002 and 2003, several Districts and Divisions lost experienced dam safety engineers and engineering technicians due to attrition. Additional attrition and retirements in the next 3-5 years will seriously affect the Corps' ability to adequately staff dam safety offices in several locations. To combat the loss of expertise, the Corps has implemented a number

of initiatives to maintain a viable and well qualified workforce, including a proactive dam safety program that provides a variety of analysis and rehabilitation design and construction opportunities for its professionals and extensive training and research and development programs.

The Corps also reports that the Corps Dam Safety Officer (DSO) established the Corps of Engineers Dam Safety Program Management Team (CEDSPMT) in 2002. The CEDSPMT is empowered to develop and implement a strategic plan and a long-range plan for the Corps Dam Safety Program, including a mission statement, goals, objectives, and performance measures. The team, which meets at least twice each year, establishes the Corps Dam Safety Standards and monitors district compliance.

TVA continues to maintain an adequate staff of experienced dam safety engineers in all disciplines. However, due to anticipated retirements, a structured engineering graduate progression program was implemented in 2003 to develop the expertise in entry-level engineers. An enhanced document management program also has been initiated to provide timely and accurate information that is easily accessible and retrievable from the engineer's desktop computer. Both programs are intended to maintain an efficient and expert workforce.

The staffing trends at Natural Resources Conservation Service (NRCS) are more positive this year than in previous reporting cycles. NRCS dam engineering expertise and staffing levels also have declined over the past decades as overall federal dam design and construction activity has decreased. NRCS installed more than 1,200 new Inventory-size dams in 1965 but less than 100 in 1990, and probably less than 50 in 2000. The number of engineers and engineering technicians in NRCS has declined over most of the past decade, but has increased over the past 2 years to address new agency programs and authorities, including watershed dam rehabilitation. NRCS established a National Design and Construction Center in 2000, and this staff has become a significant internal source of dam expertise. NRCS also has a Memorandum of Understanding (MOU) with Reclamation to collaborate and share technology and resources on water resource activities. NRCS and the Corps have established liaison positions to share program and technical resources for water resource projects. All of these evolving contracts and partnerships will significantly supplement NRCS technical capacity to work on dams in coming years.

The FERC reports that its Dam Safety Program staff, which includes 98 technical personnel, is adequate and competent in hydrology, hydraulics, civil engineering, geology, engineering geology, field investigations and inspections, and geotechnical and structural design. When the need for additional expertise arises, FERC employs qualified outside consultants to provide an independent assessment or to supplement staff expertise.

Reclamation reports that it has excellent management and technical staff resources to accomplish its dam safety activities in accordance with the *Guidelines*. The maintenance of technical expertise continues to receive the attention of Reclamation's leadership. Reclamation has implemented a workforce capability planning process that uses a strategic planning approach to match staff resources with future program needs. Reclamation staff increased from 5,700 employees in June 2001 to 6,000 employees in June 2003.

The Bureau of Land Management (BLM) was required to provide responses to each of the 35 items requested for this progress report and to compare the results to identical items in the FY 2000 and 2001 progress report. For the adequacy of state dam safety organization and staff category, 67 percent of respondents noted adequacy in this area. Alternately, 33 percent of the respondents expressed concern about their staffing levels, stating that additional full-time equivalent (FTE) are needed. BLM noted an increase of 9.2 percent in FTE's performing dam safety activities from the last reporting period, from 76 FTE to 83 FTE. The BLM also reported a 26.1 percent increase in dam safety program activities in the FY 2002 and 2003 period, compared to FY 2000 and 2001.

Dam Inventories

The Navy reports almost a 100 percent increase in the number of its dams from the last reporting period, from 16 to 31. Six of the dams are classified as high- or significant-hazard potential.

An ongoing NRCS effort was begun in 2000 to update the hazard potential classification of all NRCS-assisted project dams over 5 years. As part of this effort, Oklahoma NRCS has inspected, digitally photographed, and located by global positioning system (GPS) more than 2,000 of their project dams over the past year. Similar ongoing efforts in other NRCS States will significantly improve dam inventory data, particularly for project dams over the next 5 years.

The National Park Service (NPS) reports that some of its dams (both NPS and non-NPS) are having their downstream and public safety hazard potential classifications increased because of greater visitor and employee activity downstream and around dams and impoundments. At Cumberland Gap National Historical Park in Kentucky, an intermediate size, downstream high-hazard potential classified dam is being considered for acquisition for watershed protection and has been updated accordingly in the NPS Inventory of Dams.

Inspection Programs

The Nuclear Regulatory Commission (NRC) continues to use the technical assistance of the FERC to assist with dam safety inspections at NRC licensee facilities. During this reporting period, FERC personnel, accompanied by NRC staff, completed inspections at 12 licensee facilities, 7 of which are nuclear safety-related dams at nuclear-powered electric generating facilities and 5 of which are or were formerly associated with the extraction of uranium. No unsafe dams or improper classifications have been identified. Inspections of Department of Energy (DOE) dams also are conducted by FERC under a DOE-FERC Memorandum of Agreement.

During this reporting period, 5-year inspections were performed on the IBWC Amistad, Falcon, Anzalduas, and Retamal Dams using Technical Advisors from the Corps. International Dam is scheduled to be inspected by U.S. Section and Mexican Section staff in late 2003.

As in the last reporting period, the Corps reports that updated hydrologic and meteorological criteria, along with a more detailed hazard classification procedure and new development around downstream of the reservoir, have prompted a change in classification from low- to significant-hazard or high-hazard potential at several dams. The Corps again reports that it is increasingly difficult to properly staff inspections with experienced dam safety personnel, especially at smaller districts. In these cases, resource sharing among districts is available to help minimize the challenges. In addition, a number of young engineers are included on the inspection teams for training purposes.

The Army reports that 35 dams were inspected out of an inventory of 210 dams during the reporting period. The Army notes that the biggest problem with inspections is obtaining the funding to conduct the inspections, and that most inspection results indicate that the dams do not meet current criteria and will need additional work to meet current criteria.

Dam Safety Rehabilitation Programs

For project dams, the NRCS was authorized under the Small Watershed Amendments of 2000 to provide technical and financial assistance for rehabilitation, which is defined in the statute as "all the work necessary to extend the service life of the structural measure (dam) and meet applicable safety and performance standards." NRCS was appropriated $10 million in 2002 and $30 million in 2003 to begin this work. Most of the initial implementation effort has been to communicate this new authority to eligible dam owners, receive and process applications for assistance, rank applications with a risk-based profiling system, assess individual dam rehabilitation needs, develop watershed work plans, and begin the design process. Almost 100 applications for rehabilitation have been received and are at various stages of completion. Construction will be completed on several dams during the reporting period. Sandstone Creek #17A in Oklahoma was the first rehabilitation completed with these appropriations on June 17, 2003.

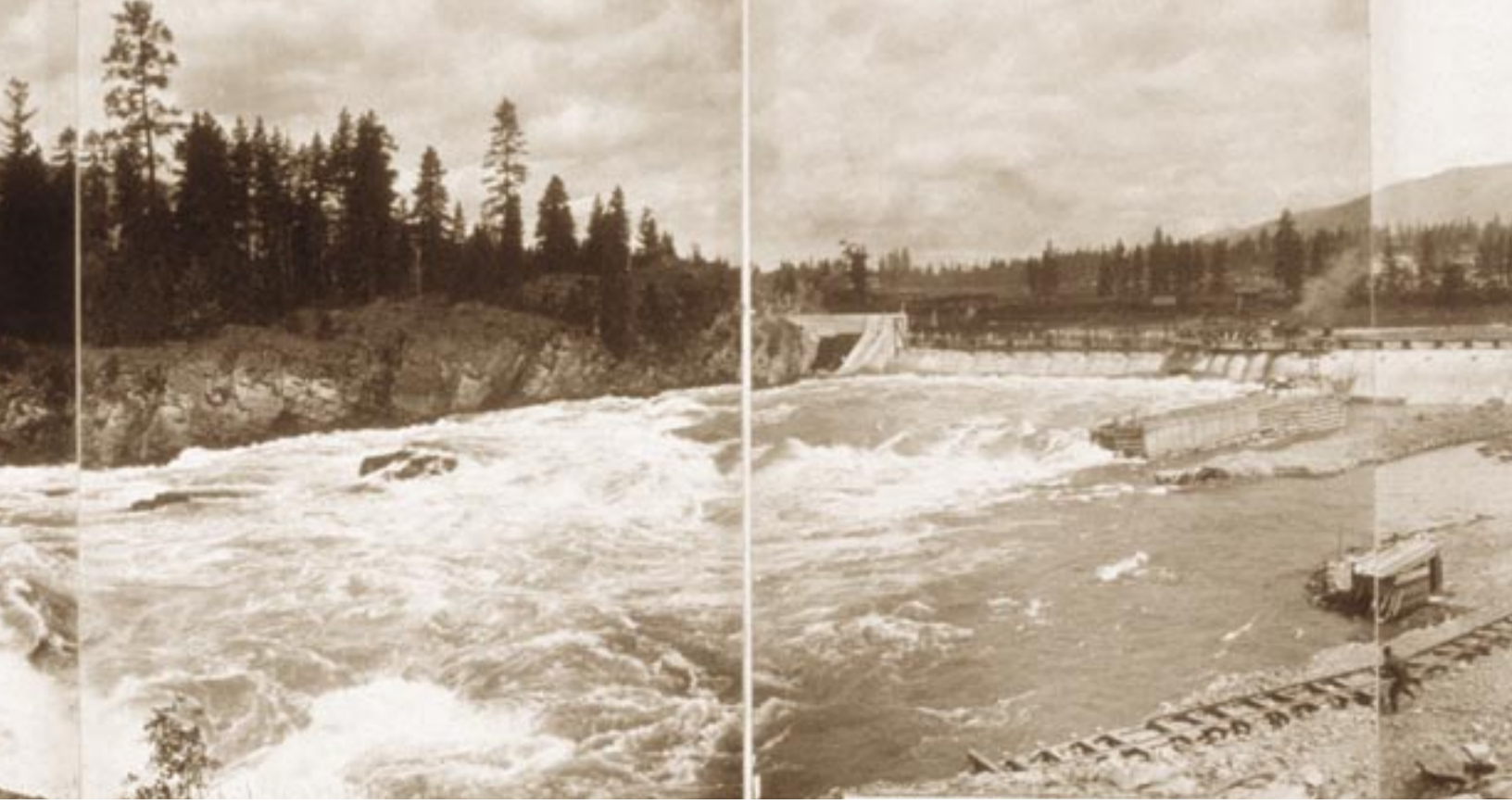
The DOE reports that rehabilitation efforts are currently taking place at Pond B Dam at the Savannah River Operations Office Site. The project is in final design phase to correct seepage problems on Pond B. It is anticipated that construction will start in the second quarter of FY 2004.

The NRC reports that two embankment dams at Ambrosia Lake, New Mexico, that were added to the program have maintenance issues that would normally require rehabilitation. Both dams, however, are currently under reclamation and are expected to be decommissioned in the next reporting period.

Management Effectiveness Reviews

During this reporting period, the Mine Safety and Health Administration (MSHA) completed an internal review of its impoundment safety program. The review was prompted by an accident that occurred in Martin County, Kentucky, on October 11, 2000, when slurry broke into an underground mine from an impoundment and flowed into two tributaries of the Big Sandy River. As a result of the internal review, MSHA is adopting new guidelines to make sure that significant new impoundment plans get prompt and thorough review by Technical Support specialists, while eliminating backlogs of plans waiting approval. MSHA also will issue a new impoundment inspection handbook by March 2004 and review technology to help verify the exact extent of underground workings shown on mine maps. The October 2000 slurry release accident also prompted Congress to provide funding for the National Research Council to examine ways to reduce the potential for similar accidents. The Council appointed a Committee on Coal Waste Impoundments, which issued a report in 2001 that contained a number of recommendations for MSHA and the Office of Surface Mining (OSM). In response to the report, MSHA and OSM established several work groups to address the issues. Reports prepared by the work groups are currently being reviewed within the agencies in preparation for responding to Congress and the Council.

In FY 2002, Reclamation participated in a benchmarking exercise organized by TVA that addressed the costs of administering a dam safety program. Approximately 15 major dam owners participated in the study.



Dam Safety Training Activities

Training continues to be a strong component of the federal programs in dam safety. The main thrust of TVA's training continues to be on-the-job training under the supervision of experienced engineers and inspectors. In addition, TVA conducts Dam Safety Awareness and Emergency Preparedness training programs that are required curriculum (including both classroom and hands-on instruction) for staff in all TVA organizations who could be involved in a dam safety event. Technically qualified TVA project personnel are trained in inspection procedures, problem detection, evaluation, and appropriate remedial (emergency and non-emergency) measures.

The Corps has an extensive program for training personnel in all matters related to its missions in water resources development; much of the training is directly or indirectly related to dam safety. The program, which provides training for engineers and dam operation and maintenance personnel, consists of seminars and conferences, formal classroom training, and periodic on-site training. Practical on-the-job-training is continually provided using formal exercises simulating dam safety emergencies. Alert notification tests, which are conducted at the project level, involve various levels of the Corps organization as well as other federal, state, and local officials. The Corps' 2003 Infrastructure Systems Conference included 3 full days of dam safety specific presentations and many additional presentations related to the various structural, mechanical, and electrical elements of dams.

Headquarters NRCS conducted three regional workshops for employees last year on the needs, program requirements, watershed planning policies, and design criteria applicable to rehabilitating existing project dams under new small watershed rehabilitation authorities. Oklahoma NRCS conducted a workshop on dam hazard classification for employees in several surrounding states and Utah NRCS reported dam inspection training of 20 employees. Many NRCS staff also cooperate with their state dam safety agency and other organizations to conduct joint training seminars and workshops, such as national workshops with the National Watershed Coalition.

At the FERC, internal staff training courses during the reporting period included a HEC-RAS course held at Penn State University, a Dam Safety Performance Monitoring Program (DSPMP) Workshop, and Security and Vulnerability Assessment training. FERC staff also developed and conducted a 2-day emergency preparedness and security workshop that was held in conjunction with the United States Society on Dams (USSD) annual conference in Charleston in April 2003.

Reclamation continues to perform, support, and participate in a variety of dam-safety related training activities. The Department of the Interior (DOI) held annual DOI Dam Safety Coordinators Meetings in May 2002 and April 2003. Representatives from the DOI Bureaus, various Tribes, the Corps, NRCS, the Forest Service (FS), FEMA, and the Association of State Dam

Electric Power Dam at Thompson Falls, Montana. 1915

Safety Officials (ASDSO) attended both meetings. Reclamation continued to participate in a cooperative effort with DOI, ASDSO, the Louisiana Department of Transportation, and Southern University at Baton Rouge, Louisiana to provide a Dam Safety Training Program as part of the University's curriculum. Reclamation also sponsored weeklong seminars on the Safety Evaluation of Existing Dams (SEED) in May 2002 and 2003. Although the seminars are based on Reclamation's SEED program, many other state and federal agencies participate in the seminar. Reclamation also continues to administer the Training Aids for Dam Safety (TADS) program.

Historically, the U.S. Fish and Wildlife Service (FWS) has provided training to refuge and hatchery staffs, dam tenders, and regional dam safety representatives. As a result of a previous DOI Peer Review recommendation, the FWS has initiated a servicewide dam safety training program. The objective was to provide dam safety training to all field stations where high- and significant-hazard potential dams are located. The FWS has completed the training and plans to repeat the training cycle on a 5-year interval.

Dam Failures and Remedial Actions

During the week of May 4, 2003, rainfall resulted in a major flood event on the Tennessee River System. The system of TVA dams was operated to ensure the safety of all dams while minimizing flood damage to flood prone areas. Activities conducted during the flood event included providing flood warning notifications to state and local emergency management agencies and providing flood information to communities, businesses, and individuals in response to numerous requests. The operation of the reservoir system resulted in over $440 million in averted flood damage. The flooding triggered inspections at 26 TVA dams, reading of structural and geotechnical instrumentation at all projects, and analyzing the data for any problems. Over 1,000 instrumentation readings were taken and analyzed. Even though some damage was incurred, the safe operation of the reservoir system was not jeopardized.

Emergency Action Planning

The FERC training program is highly acclaimed and both nationally and internationally recognized. The National Dam Safety Program has identified FERC as the national expert on emergency action planning and the agency has taken the lead in guiding a national program on emergency action planning and implementation. The FERC program was the first to be fully developed for dam owners, and 99.9 percent of FERC jurisdictional dams requiring an Emergency Action Plan (EAP) have one, compared to a national average of only 29 percent.

Although there are practical considerations that limit the feasibility of conducting full-scale exercises of an EAP, FERC is requiring its licensees to conduct functional exercises to involve emergency preparedness agencies in EAP testing. The functional exercise, which is preceded by orientation seminars, annual drills, and a tabletop exercise, includes representatives from licensees and all involved agencies to test the EAP under stressful, timed conditions. The exercise evaluates the effectiveness of the notification plan, inundation maps, and actions that local agencies take after they receive notification that an emergency is occurring at a dam. FERC continues to aggressively pursue the higher-level EAP exercise (tabletop and functional) to incorporate the local and state disaster preparedness agencies. Under the FERC EAP exercise program, each licensee and exemptee with a high-hazard potential dam conducts a tabletop and a functional exercise of an EAP on at least one of its dams during a 5-year period.

Recently, FERC made special efforts to increase the spirit of cooperation and coordination between dam owners and the local response agencies associated with their EAP's. As a result, representatives from state dam safety offices, local and state emergency response agencies, floodplain managers, the National Emergency Management Association (NEMA), FEMA, and the National Weather Service (NWS) have been invited to FERC EAP training courses. The exchange of information among these agencies and licensees has resulted in an improved understanding of the needs of each participant, and will greatly improve the likelihood of saving lives if an emergency should occur. FERC also has recently initiated efforts to encourage

licensees to develop EAP exercises that include active participation by upstream and downstream dam owners. The latest EAP initiative undertaken by FERC was the pre-conference USSD workshop on emergency preparedness and security at dams held in Charleston, South Carolina in April 2003. This workshop was a follow-on event from the International EAP Worskshop co-sponsored by FERC and ASDSO in Niagara Falls, New York.

The U.S. Section of the IBWC has an EAP in place for each of its two large storage dams (Amistad and Falcon) as well as Anzalduas and Retamal International Diversion Dams. In FY 2002, a series of four International Sister Cities Exchange Workshops were held at Amistad Dam, Falcon Dam, Mercedes Texas, and Nuevo Laredo. The workshops were attended by a wide spectrum of civil and political authorities from the United States and Mexico. Because of internal training requirements, participation in FY 2003 will be restricted to IBWC, U.S. and Mexico, and the NWS. Wider participation is planned for FY 2004.

TVA conducted two functional level exercises during the reporting period (Blue Ridge Dam and Guntersville Dam). TVA personnel participating in the drills and exercises included engineers, police, reservoir system forecasters, hydro operations and maintenance staff, land specialists, and media relations and communications staff. Area representatives from local and state emergency management agencies also participated at the invitation of TVA. TVA also conducted 43 Dam Safety Awareness classroom training sessions for TVA project, security, and field personnel during the reporting period.

The DOE reports that EAP's have been prepared and approved for all dams that are hydrologically defined as high- or significant-hazard potential. All plans have been tested and retesting is planned every 3 years.

As noted above, the Navy reports an increase of 15 dams in its inventory from the last reporting period. Of the 31 dams, 6 are classified as high- or significant-hazard potential. However, the Navy does not indicate that any of the six dams has an EAP in place. The Air Force lists six significant-hazard dams in its inventory, and states that the dams, all located at the Air Force Academy, are being studied to determine if an EAP is required.

The Corps reports that dam safety emergency exercises were conducted at a number of Corps dams during the reporting period to test Flood Emergency Action Plans (FEAP's). The exercises simulated a dam failure or a condition that could lead to a failure if appropriate action were not taken. In addition, a number of EAP's were tested at a number of other Corps dams by actual extreme flood events. Several smaller scale emergency exercises were held with other agencies and state and local governments.

The NRCS has no authority to require the development of EAP's on existing dams, but does have current policy to require development of plans before construction is initiated on new or rehabilitated dams. However, recent dam inventory data still shows that over 1,000 NRCS-assisted high-hazard potential dams do not have EAP's. NRCS recently updated and issued a revised National Operation and Maintenance Manual that contains extensive new policy, guidance, and examples of EAP's. NRCS also constantly assists dams owners to develop EAP's. For example, Alabama NRCS reported completing an EAP for a dam on the U.S. Army Annison Ordnance Depot and assisting in EAP development on 17 other dams. Arkansas NRCS reported assisting with EAP development on one dam and assisting with a tabletop exercise on another dam.

The FS reports that all FS-owned dams that require an EAP have an EAP. The agency notes that some EAP's are in need of review and update, and few are tested on a routine basis. FS policy requires coordination with local officials.

The Bureau of Indian Affairs (BIA) states that one of its objectives is the implementation of an EAP for all of its high- and significant-hazard potential dams. The BIA currently has 48 dams with EAP's in place; however, many of these existing documents require revisions to meet current guidelines for EAP's. BIA also reports that the number of dams requiring EAP's continues to increase as dams are reclassified from a low-hazard to either a high-hazard or significant-hazard potential classification. Early Warning Systems are in place for 57 BIA dams.

The National Park Service (NPS) cooperates with other dam owners whose structures affect the National Park System by preparing and annually updating early warning, search/rescue, and evacuation plans for affected NPS areas in the event of large releases from, or the failure of, a non-NPS dam. The NPS has informal agreements with some local owners and communities to ensure the safety of the public and the protection of the resource.

The FWS reports that all high- and significant-hazard potential dams have EAP's. The FWS continues to implement an annual testing program for EAP's that consists of a simplified test. The simplified test determines if the EAP is available and up-to-date and if the communication network is current. The FWS is in the process of updating the EAP's for all high- and significant-hazard potential dams to ensure that they are in conformance with current Reclamation, FEMA, and ICODS guidelines.

Reclamation reports that all of its high- and significant-hazard potential facilities have EAP's in place. The EAP's are annually updated and exercised every 3 years, according to Reclamation's directives. State and local government officials, emergency management personnel, and law

enforcement agencies are encouraged to participate. During this reporting period, Reclamation continued to strengthen its Emergency Management Program.

Research and Development and Special Initiatives

Today's challenge of security threats, aging dams, limited resources, and the future increased reliance on the services that dams provide are among the most complex issues faced by the dam safety profession. Many federal agencies have active research and development programs that address these issues.

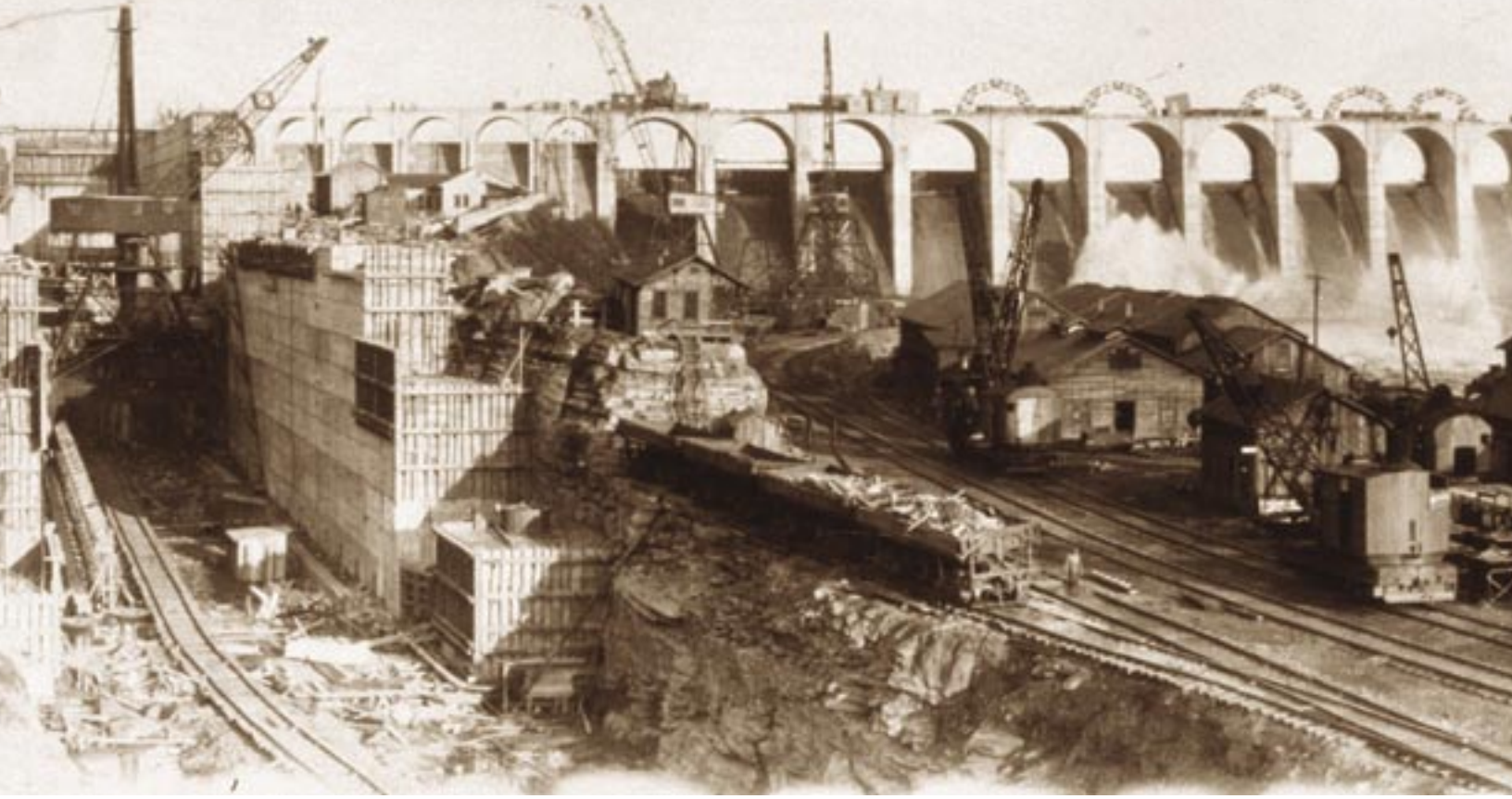
MSHA is now exploring the possibility of updating its Engineering and Design Manual: Coal Waste Disposal Facilities. The manual was published in 1975 following the Buffalo Creek waste dam failure. Significant changes have occurred over the years in the design of mining impoundments. Areas of interest include design measures to deal with underground mine workings and the seismic stability evaluations of upstream construction dams. As these and other design aspects are unique to mining impoundments, an updated design manual would be highly beneficial to the mining industry, impoundment designers, and regulatory reviewers. Recognizing the unique challenges associated with ensuring the seismic stability of coal waste impoundments, MSHA co-sponsored a workshop with the National Science Foundation (NSF) and Case Western Reserve University in October 2003 on the seismic stability of coal mine waste impoundments. As a result of incidents where mining operations have accidentally cut into unmapped or inaccurately mapped underground workings, Congress has appropriated funds to MSHA for digitizing mine maps and for funding projects to develop and demonstrate technology for the detection of underground mine voids. This effort will promote technology that will improve the safety of mine tailings dams by improving the industry's ability to locate abandoned mines. The results of test programs will be disseminated throughout the mining industry.

A special initiative of the FERC dam safety program during this reporting period was its ongoing work in the development of a dam safety performance monitoring program. About 70 percent of the approximately 2,600 dams under FERC regulation are over 50-years-old. In light of the aging of FERC dams and construction and design standards that were not in existence when the dams were built, FERC is developing a program to properly monitor dams so that they remain in safe operating condition. FERC has progressed through the analysis phase of the program, which examined all high- and significant-hazard potential dams under current engineering criteria, and has substantially completed the remediation phase, which implemented any needed repairs and improvements. In October 2001, FERC initiated a cooperative effort among licensees, independent consultants, and FERC staff to develop a program that includes failure mode and consequences analyses as a feature of its performance monitoring program, with the goal of identifying those performance parameters that need to be monitored. The committee developed guidelines that were tested on eight dams in 2002. FERC's Dam Safety Performance Monitoring Program (DSPMP) guidelines were published in March 2002 and have been incorporated into its Engineering Guidelines as Chapter 14. Beginning in the first quarter of calendar year 2002, the DSPMP has been made a part of FERC's Part 12D Independent Consultant's Safety Inspection Program.

Two Corps research studies focus directly on dam safety: the Risk Analysis for Dam Safety Research Program and the Earthquake Engineering Research Program. The objective of the Risk Analysis for Dam Safety Research Program is to develop and implement risk analysis methods to (1) prioritize dams requiring initial investigations and subsequent analyses; (2) prioritize funding for crucial repairs, rehabilitation, or modifications; (3) select and justify the optimal plan to protect human life, reduce property damage, and mitigate environmental damage; (4) minimize the disruptions of services; and (5) maximize the effectiveness of infrastructure investments. The objective of the Earthquake Engineering Research Program is to reduce damage from a potential devastating earthquake by advancing state-of-the-art knowledge of earthquake hazard assessment, seismic design, and remediation of Corps dams and other infrastructure. Dam safety-related studies conducted during this reporting period in the risk analysis program include prioritization procedures for dam safety projects; estimating loss of life from dam failure; assessing hydrologic loading uncertainty; statistical analysis of dam failures; and probability of failure of gates, equipment, and warning systems.

The results of Corps research and development efforts are directly incorporated into practice within the Civil Works Program through the Civil Works Guidance Maintenance Program. The Corps also has the lead in the coordination and maintenance of the National Inventory of Dams (NID) and in coordinating the development of the Dam Safety Program Management Tools (DSPMT) software, both of which are described in the previous section.

The NRCS and the Agricultural Research Service (ARS) are continuing a major, long-term research and development effort to model erosion processes in earth spillways during flood flows and on embankment dams during overtopping flows. NRCS and the ARS have monitored earth spillway performance during flood flows since 1983 and continue to build a database of performance based on spillway geometry, flood flow, and soil and rock parameters. ARS also has conducted extensive laboratory and field research



at its research facility in Stillwater, Oklahoma to define erosion thresholds and headcut advancement processes. This work culminated in a mathematical model to predict initial failure of spillway vegetation, initial gully formation, and progressive advancement of the headcut through the spillway. This model has been documented in many ARS journal papers and several NRCS technical handbooks. The earth spillway erosion model has been incorporated into existing NRCS dam design software and the software renamed SITES. NRCS and ARS continue work to extend these erosion threshold and headcut advancement models to predict the performance of earth dams during overtopping and breaching flows. ARS researchers also have collaborated with researchers doing similar work in Europe and have observed their test failures. Initial findings will be presented at professional meetings as results are analyzed.

Reclamation continues to emphasize the use of risk analysis in its evaluation processes. Collaboration with the Canadian Electric Association, especially British Columbia Hydro, and Australian interests continues as Reclamation further develops and refines risk analysis approaches. Reclamation also is collaborating with the Corps on risk analysis. In FY 2003, Reclamation revised its *Guidelines for Achieving Public Protection in Dam Safety Decision Making*, which was previously transmitted in 1997. The document provides risk guidelines for dam safety issues and has been successfully incorporated into Reclamation's dam safety process. Reclamation also continues to develop and refine a guideline entitled *Dam Safety Risk Analysis Methodology*, a working guideline on risk analysis methods and associated appendices that define procedures for estimating risk. Reclamation also had the lead in planning and hosting two workshops supported by ICODS on spillway issues and hydrologic research needs.

In FY 2002, the BLM entered into a service agreement with Reclamation to have a hazard risk analysis performed on high-hazard and significant-hazard potential dams in the BLM inventory. Reclamation uses its Risk-Based Profile System (RBPS) with information from the BLM's Technical Priority Rating report to conduct the analysis. BLM recently received a copy of the RBPS report and is reviewing the findings and recommendations.

The FWS has used Reclamation's RBPS to evaluate all of its high- and significant-hazard potential dams. The FWS plans to evaluate the RBPS and other risk analysis tools and to continue to incorporate risk analysis in the dam safety evaluation and decision-making process. The FWS also plans to develop a risk-based indexing system to serve the specific needs of all of its inventoried dams.

State Dam Safety Agency Involvement

Over the past 2 years, TVA has increased efforts to establish and maintain contact with state and local emergency management agencies (EMA's) located in areas affected by TVA dams. Activities by TVA emergency preparedness staff include attending state-sponsored regional meetings where revised EAP's are distributed and current dam safety activities are discussed with local and state EMA

Wilson Dam, Tennessee River, Tennessee. 1924

representatives; conducting visits with county EMA's to build working relationships and for EAP distribution and exercise planning and coordination; and expanding the scope of functional exercises to involve state and local EMA's, including activation of local emergency operation centers and involvement of local government officials.

The Corps reports that it developed a partnership agreement with ASDSO in September 2003. The goals and objectives of the agreement include encouraging a continuing dialogue between the Corps and ASDSO on national and state issues of importance to dam safety, the promotion of professional and ethical dam safety engineering practices, and an increase in the diversity in the dam safety engineering profession.

NRCS policy is to support and complement strong state dam safety programs and to establish working arrangements in each state. NRCS Headquarters and ASDSO have a MOU to regularly exchange information on dam safety activities, provide data to the NPDP, maintain data in the NID, and share research and technology. The MOU further encourages each NRCS State office to develop individual memoranda with their state agencies. Most NRCS States have met with state agencies to discuss the NRCS aging watershed issue and recent rehabilitation authorities.

The FS encourages involvement with the states in all aspects of dam safety and the FS regions have MOU's with most states. The FS encourages the states to assume jurisdiction for permitted dams and to become involved in the management of FS-owned dams.

Reclamation continues to maintain strong working relationships with state dam safety agencies. Reclamation has MOU's with each of the 17 Western states where it has facilities. Annual meetings between Reclamation and the states are conducted and state representatives participate with Reclamation staff on dam safety inspections. The states also participate with Reclamation on specific issues associated with individual structures, such as modifications, reservoir restrictions, and environmental concerns.

During all formal NPS and Reclamation evaluations, the states are invited to participate. State dam safety and environmental program representatives provide helpful suggestions in managing NPS dams and monitoring non-NPS dams. Those states that have been particularly active with the NPS Dams Program are Massachusetts, Pennsylvania, New York, New Jersey, Virginia, North Carolina, Florida, Ohio, Wyoming, Washington, Tennessee, and Colorado.

Stanely Lake Dam Dedication, Colorado. 1911

Focus on the Future

There are challenges ahead for everyone in the dam safety community. The challenges will affect every aspect of the way we do business, from our organizational structures and partnerships to the new information we will have to acquire to perform our jobs effectively. Most importantly, we are being challenged to adapt our philosophy of how to best protect the national infrastructure. Under the leadership of the Federal Emergency Management Agency (FEMA), the National Dam Safety Program is well positioned to meet these challenges.

The September 11 terrorist attacks have brought an increased focus on infrastructure protection nationwide, including the security of dams. Addressing this most important issue is a priority of the national dam safety agenda. The *National Strategy for the Physical Protection of Critical Infrastructures and Key Assets* identifies two major challenges for dams: limitations in resources and assessment and management of risk. The resources available to protect dam property vary greatly from one category to the next. The distributed nature of dam ownership also complicates assessment of the potential consequences of dam failure for certain categories of dams. Given these realities, the need to develop more comprehensive mechanisms for assessing and managing risks to dams is clear. The integration of security safeguards for dams into sector-wide initiatives identified by the U.S. Department of Homeland Security (DHS) is a major opportunity for the National Dam Safety Program. The initiatives for dams that are listed in the National Strategy will all have major consequences for mitigation, and will require that the DHS/FEMA work in close cooperation with other federal departments, agencies, and programs, state agencies, and the private sector on cross-sector initiatives to identify, assess, and protect dams and other vulnerable structures. The National Dam Safety Program has already begun the transfer of best practices on threat assessment and will continue to enhance and expand these efforts.

The aging of dams in the United States presents another challenge. The 2003 *Progress Report for America's Infrastructure* (American Society of Civil Engineers, September 4, 2003) states that there are now more than 2,600 unsafe dams in the United States, an increase of 23 percent from 2 years ago. The 2003 *Progress Report* also states that the number of high-hazard potential dams has increased since 2001 from 9,921 to 10,049 in 2003. These statistics focus on the crux of one of the most important issues: the aging of the Nation's water infrastructure and how we will cope with the problem. The dam safety community is working on a number of options to address the issue, including model loan programs for the repair of dams, dam removal projects, and rehabilitation programs. Some progress is being made through the repair of small watershed dams constructed with assistance from the United States Department of Agriculture since 1948.

Other issues relate to the identification and classification of dams, including the number of unregulated dams that have not been reported to the National Inventory of Dams; the number of dams that have not been classified correctly; and whether the classification of a dam has changed over time, particularly in light of increases in downstream populations. A number of federal agencies are increasing their focus on the development of risk analysis methods and the best ways in which to incorporate risk analysis into evaluation and decision-making processes. This is one of the six initiatives for dams discussed in the *National Strategy*.

Emergency action planning continues to be of critical importance to the safety and security of dams in the United States. Over 60 percent of non-federal high-hazard potential and significant-hazard potential dams do not have an Emergency Action Plan (EAP) to address the potential for loss of life and damage to property and the environment should the dam become a target of terrorist attack and fail. EAP's are the principle tool used by first responders to warn and evacuate the vulnerable population below the dams. The states are being strongly urged to develop and exercise EAP's for dams that may be targets. This is one of the six initiatives for dams discussed in the *National Strategy*. The exemplary emergency action planning program established by the Federal Energy Regulatory Commission (FERC) incorporates all of the procedures and products needed for the implementation and exercise of EAP's among all sectors. The FERC program can be readily adapted to incorporate security safeguards.

Meeting information resource needs in dam safety continues to be a challenge. It is clear that a comprehensive information resource system is now needed. The National Dam Safety Program has developed a Strategic Plan to establish a national dam information resource system that will bring together a great amount of information with the goal of improving dam safety nationally. The development of a national dam information resource system is important as the system can be used for future developments and improvements in dam safety, with the ultimate goal of benefiting society and, in particular, protecting the public. The proposed eDams network, if implemented, must be integrated within a sector-wide critical infrastructure database envisioned by the National Strategy.

To address these and other challenges, FEMA has set a number of priorities for the next 2 years. The priorities include the following:

- FEMA will review the protocols for safety inspections of dams and security inspections of dams to determine how the protocols can be combined for maximum efficiency.

- In 2003, FEMA released a new multi-hazard version of HAZUS that includes revisions to the earthquake loss estimation and adds capabilities to estimate losses from flood and hurricane wind hazards. HAZUS is a valuable risk assessment tool for planners, including dam safety officials.

- As part of the Flood Mapping Modernization Program, FEMA is looking at ways that map modernization can enhance dam safety.

- A major opportunity will be to study and develop improved safety monitoring and surveillance tools and techniques. Through the National Dam Safety Review Board, FEMA will look at tools designed to enhance the ability of dam owners to monitor the safety and performance of dams, including dams in remote sites, and to conduct surveillance from a secure standpoint.

- The training of all stakeholders on advances in the industry will continue to be a major focus of the National Dam Safety Program.

This progress report for Fiscal Year 2002 and 2003 presents the opportunity to assess and document progress made since the passage of the National Dam Safety Program Act and to plan for the future. From the reports submitted by the states and federal agencies, it is clear that the Act is resulting in significant improvements in the Nation's dam safety and security. By building on these and other accomplishments, FEMA and its partners in the National Dam Safety Program will continue to keep our dams safe and secure.

We are being challenged to adapt our philosophy of how to best protect the national infrastructure. Under the leadership of the Federal Emergency Management Agency, the National Dam Safety Program is well positioned to meet these challenges.

List of Acronyms

ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers
ASDSO	Association of State Dam Safety Officials
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
CEDSPMT	Corps of Engineers Dam Safety Program Management Team
DHS	Department of Homeland Security
DOE	Department of Energy
DOI	Department of the Interior
DSPMT	Dam Safety Program Management Tools
DSPPM	Dam Safety Program Performance Measures
EAP	Emergency Action Plan
EMA	Emergency Management Agency
EMI	Emergency Management Institute
EPRI	Electric Power Research Institute
FEAP	Flood Emergency Action Plan
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FS	United States Forest Service
FTE	Full-Time Equivalent
FWS	United States Fish and Wildlife Service
FY	Fiscal Year
GIS	Geographic Information System
GPS	Global Positioning System
HEC-HMS	Corps Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Corps Hydrologic Engineering Center River Analysis System
IBWC	International Boundary and Water Commission
ICODS	Interagency Committee on Dam Safety
ISAC	Information Sharing Analysis Center
MBDSI	Multi-Hazard Building Design Summer Institute
MOU	Memorandum of Understanding
MSHA	Mine Safety and Health Administration
NEMA	National Emergency Management Association
NID	National Inventory of Dams
NPDP	National Performance of Dams Program
NPS	National Park Service
NRC	Nuclear Regulatory Commission
NRCS	Natural Resources Conservation Service
NSF	National Science Foundation
NWS	National Weather Service
OSM	Office of Surface Mining
RBPS	Risk-Based Profiling System
SEED	Safety Evaluation of Existing Dams
SSLE	Security, Safety, and Law Enforcement
TADS	Training Aids for Dam Safety
TVA	Tennessee Valley Authority
USDA	United States Department of Agriculture
USSD	United States Society on Dams