



Review and Evaluation of the National Dam Safety Program

A Study Conducted for the Federal Emergency Management Agency by the Water Policy Collaborative, Department of Civil and Environmental Engineering, Clark School of Engineering, The University of Maryland

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Oroville Dam and Lake

Feather River, California

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A Report for the Federal Emergency Management Agency
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EXECUTIVE SUMMARY

The National Inventory of Dams (NID) contains over 84,000 dams. In addition to the dams listed in the NID, there are thousands more whose size is not sufficient to trigger their inclusion in the inventory. Of the NID dams, 13,990 are classified as high hazard and 12,662 are labeled as significant hazard. Nearly half of the dams are more than 50 years old. The American Society of Civil Engineers (ASCE), in its 2009 Report Card on the nation's infrastructure, indicates that overall the condition of dams is rated at the "D" level and that there are more than 4,000, dams, including 1,819 high-hazard dams whose condition is considered to be deficient.

Large dam failures, while rare, have severe consequences. A succession of dam failures in the 1970s and 1980s led to a series of congressional actions to address what was perceived as a serious national problem. These culminated in the National Dam Safety Program (NDSP), established by the National Dam Safety Program Act of 1996, a part of the Water Resources Development Act of that year. The NDSP, led by the Federal Emergency Management Agency (FEMA), is a partnership of the States, federal agencies, and private owners to encourage dam safety. The Program was reauthorized in 2002 and 2006. The challenge is not trivial.

In July, 2011, the US Geological Survey awarded a grant, on behalf of FEMA, to a team from the University of Maryland to review the mission and accomplishments of the NDSP with respect to program "cost, effectiveness, and potential for improvement." In the initial phase of the 4-month study, the team conducted a literature review and met with key personnel in FEMA, United States Army Corps of Engineers (USACE), and other agencies. Subsequently, the team interviewed key personnel in dam safety and related fields. The formal interviews were supplemented by meetings at conferences and seminars. The team distributed a nationwide survey to dam safety officials, floodplain managers and emergency managers, professionals working in the dam safety field, and others with an interest in dam safety. Approximately 600 individuals were contacted and 250 of them responded. The team was also able to discuss dam safety with members of committees involved in ongoing National Research Council studies in related fields.

The overall observation of these interviews, surveys, and other inquiries is that the majority of NDSP stakeholders believe that the NDSP and its predecessor activities have been successful or highly successful in reducing the potential for and occurrence of dam failures.

The study led to a set of six overarching conclusions regarding the NDSP and its further directions:

1. The NDSP has been a positive influence in improving the status of dam safety in the nation. Given the limited resources available and its modest status within FEMA, the NDSP has had a significant impact. It should be continued. While the NDSP has been an effective force, ironically, due to aging infrastructure, low investments, and environmental change, the risk of losses continues to in-

crease and will not be arrested without significant attention at senior leadership levels of the Federal and State governments.

2. The NDSP requires strong leadership to bring together the professional talents of the National Dam Safety Review Board (Board), Interagency Committee on Dam Safety (ICODS), and the National Program office in a collaborative effort with State dam safety officials, dam owners, and Federal and State agencies with responsibilities for emergency and floodplain management. This will necessitate active participation of senior FEMA leaders in both a management and an advocacy role and the stabilization of program resources at current or higher levels. FEMA should seek a new framework for collaboration among stakeholders to better leverage funding in related areas such as security and emergency management.

3. The NDSP and its impact are limited by its strategic vision. Although the current governance model is adequate, the program must focus on the continued evolution of a holistic, long-term strategic approach to dam safety within the Federal and State communities that fully incorporates emergency and floodplain management. This should in no way dilute the critical ongoing efforts to minimize dam failures. The Board and ICODES have migrated toward operational issues with less focus on the big picture. These bodies host extensive expertise within the domain of dam safety, and going forward, they need to invest their unique talents in an effective vision for the larger program.

4. The current framework for classifying dams and establishing standards for their safety has served the nation well but is outmoded and too simplistic. To meet the needs of the future this classification framework should embrace a risk-informed and holistic approach that incorporates the condition of dams and the potential consequences of dam failures.

5. State grants and training have been the most beneficial aspects of the program. Emphasis on supporting State programs is appropriate and should continue. Criteria for eligibility to participate in the annual NDSP grant program should be kept simple, but States should show that they are inspecting dams regularly and requiring dam operators to comply with State safety regulations.

6. Efforts to create public awareness and to reach out to those affected by dams lag other aspects of the NDSP. This situation reduces the effectiveness of and support for emergency planning. Because the public is ignorant of dam safety issues, its support of these programs is also diminished. The NDSP should take advantage of the outreach experiences of the National Flood Insurance Program (NFIP) and the National Earthquake Hazards Reduction Program (NEHRP)—and most recently the FEMA Risk Mapping, Assessment, and Planning (RiskMAP) effort—to partner with these activities and build on their successes.

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CHAPTER ONE—INTRODUCTION

On July 26, 2011, the U.S. Geological Survey, on behalf of the Federal Emergency Management Agency (FEMA), awarded the University of Maryland a grant to evaluate the National Dam Safety Program (NDSP) with respect to program “cost, effectiveness, and potential for improvement.” In subsequent discussions between FEMA dam safety leadership and the University of Maryland team (team), it was agreed that the team would focus on the following questions:

- Is NDSP performing the mission for which it was established?
- How could it accomplish that mission better?
- Is the established mission the correct one?
- Are the NDSP office, the National Dam Safety Review Board (Board), and the Interagency Committee on Dam Safety (ICODS) the right organizations for the task?
- Is the NDSP shaping the national approach to dam issues?
- What are NDSP successes and shortcomings?
- What is the state of engagement of the affected parties in the NDSP?
- Are identified dam safety problems being addressed?
- How do those outside the NDSP perceive the NDSP, and who is the program’s voice?
- Are there real national dam safety risks?

FEMA requested the team to consider in its evaluation the factors shown in Table 1.

Table 1. NDSP Evaluation Considerations

- The involvement and the direction by FEMA leadership and management
- Budget, budget management, and resources constraints
- ICODES and Board governance structure
- ICODES and Board membership and their unique advisory roles
- NDSP objectives and the Dam Safety Act
- Effectiveness of program components (i.e., State-assistance, research, training)
- Existing and potential program performance metrics
- The existing strategic plan
- State assistance eligibility criteria
- National Inventory of Dams (purpose, use, benefits, data integrity, etc.)
- Effectiveness of the program and the board in meeting the Dam Safety Act and achieving national dam safety hazard reduction

The evaluation methodology developed in this effort will be applicable to other similar national infrastructure safety and resilience programs.

The Team and the Process

The University formed a study team composed of Dr. Gerald Galloway, PE, PhD; Dr. Gregory Baecher, PhD; Dr. Lewis (Ed) Link, PhD; Dr. Kaye Brubaker, PhD; Mr. Jeffrey Brideau; Ms. Vasavi Mantha; and Mr J. Trevor Cone. The following consultants joined the team to provide breadth: Mr. Denis Binder, Esq., Chapman University School of Law; Mr. Hans Kallam, former director of the Col-

orado Division of Emergency Management; Mr. Larry Buss, PE, CFM, former chair of the United States Army Corps of Engineers (USACE) National Nonstructural/Flood Proofing Committee and Chief Hydrologic Engineering, Omaha District, USACE; Dr. Timothy Tinker, DrPH, MPH, Director, Booz Allen Hamilton Center for Risk Communication; and Mr. Neil Parrett, former Dam Safety Officer, U.S. Bureau of Reclamation (USBR). Biographical information on team members is provided in Appendix J.

During the first 45 days of the study, the team conducted a literature review and met with key personnel in FEMA, USACE, and other agencies. In early September, the team began interviews with key personnel in dam safety and related fields, and continued these through mid-November. During the course of the study over 50 individuals were interviewed by one or more of the team or met with team members at relevant conferences and seminars. Members of the team participated in the Dam Safety Research and Development Summit, the Dam Safety Training Summit, and attended the October meetings of the Board and ICODS. Members of the team also attended the annual meeting of the Association of State Dam Safety Officials (ASDSO) held at National Harbor, Maryland, in October to meet with the association's leaders and to observe the meeting of the ASDSO training committee. In late September, the team held a 2-day workshop at the University of Maryland to bring together the University of Maryland members and the consultants less Mr. Parrett.

Also in September, the team distributed a nationwide survey (Appendix D) to dam safety officials, floodplain managers, emergency managers, professionals working in the dam safety field, and others with an interest in dam safety. The team contacted approximately 600 individuals and received responses from more than 250. The survey focused on the effectiveness and potential for improvement of the dam safety program at both the Federal and State level and provided opportunities for open-ended responses to many of the survey questions. The team was also able to discuss dam safety with members of committees involved in ongoing National Research Council studies in related fields. Study conclusions were drawn from analysis of the literature in the field, the interviews, and the survey responses.

Report structure

Following this introduction, Chapter 2 describes the background and initiation of the NDSP. It also describes the current organization of the program. Chapter 3 reviews the major elements of the NDSP and provides an analysis of those indicators used to measure relative success of the program, efforts to foster State activity, the training program, assessment of dam condition, research and development, the National Inventory of Dams, and efforts to improve outreach for the program. Chapter 4 defines the challenges that NDSP faces and provides recommendations for dealing with them. The chapter identifies issues that are currently being addressed, those on the horizon, and those meriting special attention. Chapter 5 answers the question, "Is the NDSP successful?" and provides the overarching conclusions of the study. The team consultants provided white papers on those topics that the team believes are relevant to the future NDSP. These white papers are provided as appendices (E through I) and are referenced in the text.

CHAPTER TWO—THE PAST

To evaluate the state of the NDSP, it is important to understand its historical context (see Table 2). Past decisions and events condition and inform the alternatives available to contemporary decision makers. While it is obvious that dams provide many benefits to society, they also pose the potential of significant social, economic, and ecological disruption should they fail.

Legislative history

Large dam failures, while rare, can have severe consequences. For example, the South Fork Dam failure in 1889 resulted in the “Johnstown Flood” that killed 2,209 people and caused millions of dollars in damages. Similarly, the St. Francis Dam failure in 1928 claimed more than 450 lives, engendered 13 separate panels of inquiry, and led to a reexamination of dam safety practices in California. The results included establishing rudimentary standards for dam design and construction, increasing inspections and the review of current projects, and establishing the nation’s first comprehensive State dam safety program. The St. Francis failure is instructive because it demonstrates that significant regulatory change is often provoked by catastrophic incidents. The same can be said of Federal dam safety efforts.

National Dam Inspection Act of 1972

The first significant Federal dam safety legislation, the *National Dam Inspection Act* (NDIA, P.L. 92-367, August 8, 1972), was enacted shortly after the catastrophic failures of three coal-slurry impoundment dams on February 26, 1972, near Buffalo Creek, West Virginia, where the resulting flood killed 125 people, injured 1,121, and left thousands homeless; and the subsequent failure of Canyon Lake Dam, near Rapid City, South Dakota, on June 9, 1972, which caused 238 deaths and more than \$100 million in damages. In response, the NDIA authorized the Secretary of the Army to “undertake a national program of inspection of dams.”

With some exceptions, the NDIA required the USACE to inspect every dam in the United States “for the purpose of protecting human life and property.” However, this formidable task was never undertaken because of lack of appropriations and constitutional ambiguity. The NDIA’s legacy was the creation of the National Inventory of Dams (NID), first published in 1975. The NID collected information on the size, location, and types of dams nationwide. It institutionalized the definition of a dam as “...any artificial barrier, including appurtenant works, which impounds or diverts water, and which (1) is 25 feet or more in height from the natural base of the stream or watercourse measured at the downstream toe of the barrier, or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of 50 acre-feet or more.”

Table 2. Dam Safety History

1972	Failure of Buffalo Creek Dam, West Virginia; 125 deaths
1972	PL 92-367 the National Dam Inspection Act of 1972
1976	Failure of Teton Dam; \$1 billion in losses and 14 deaths
1977	Failure of Kelly Barnes Dam; 39 deaths
1978	USACE begins the National Inspection Program
1979	Federal Guidelines for Dam Safety prepared
1979	Executive Order 12148 from President Carter created FEMA; FEMA Director to coordinate Federal dam safety efforts
1979	Memorandum from President Carter requiring the head of each Federal dam safety agency to implement the Federal Guidelines
1982	The National Program of Inspection of Non-Federal Dams completed and National Inventory updated by USACE; Final Report to Congress
1985	The Interagency Committee on Dam Safety (ICODS) publishes charter and operating rules
1986	Water Resources Development Act of 1986 includes National Dam Safety Program administered by the Secretary of the Army; Never implemented due to lack of appropriations. Provided for—
	<ul style="list-style-type: none"> • National Dam Safety Review Board (7 members) • State dam safety program assistance (\$13 million) • Maintenance and update of the NID (\$500,000) • Research (\$2 million).
1996	National Dam Safety Program Act included in the 1996 Water Resources Development Act (PL 104- 303): Administered by the Director of FEMA—
	<ul style="list-style-type: none"> • National Dam Safety Review Board (11 members) • State dam safety program assistance (\$4 million) • Maintenance and update of the NID (\$500,000) • Research (\$1 million) • Training (\$500,000).
2002	National Dam Safety and Security Act of 2002 (PL 107-310): Reauthorizes the NDSP—
	<ul style="list-style-type: none"> • National Dam Safety Review Board (11 members) • State dam safety program assistance (\$6 million) • Maintenance and update of the NID (\$500,000) • Research (\$1.5 million) • Training (\$500,000) • Security added to critical dams safety issues
2006	National Dam Safety Program reauthorized as P.L. 109-460.

Source ASDSO

The NDIA also served as the basis for Federal dam safety legislation until the National Dam Safety Act of 1996.

Federal Guidelines for Dam Safety (1979)

The late 1970s witnessed another series of catastrophic dam failures—notably, Teton on June 5, 1976; Laurel Run on July 20, 1977; and Kelly Barnes on November 6, 1977. These failures provoked a series of congressional hearings and Federal and State investigations. Following Kelly Barnes, which killed 39 students and college staff in Toccoa Falls, Georgia, President Jimmy Carter instructed USACE to conduct investigations into the nation’s non-Federal high-hazard dams. The ensuing “Phase I Inspection NDSP” identified serious safety deficiencies (one-third of the dams inspected were deemed “unsafe”), and helped encourage States to establish dam safety programs. Contemporaneously, President Carter signed Executive Order 12148, effective July 20, 1979, which created the FEMA, and assigned the Agency’s director responsibility “for the coordination of efforts to pro-

mote dam safety [...].” This order effectively placed FEMA at the head of Federal dam safety initiatives, a position which it continues to occupy.

One of FEMA’s first actions in this capacity was to publish the *Federal Guidelines for Dam Safety* (FEMA 93, 1979), which established basic principles for Federal dam safety. These guidelines were produced under the auspices of an Ad Hoc Interagency Committee of the Federal Coordinating Council for Science, Engineering, and Technology, as ordered by Presidential memorandum on April 23, 1977 (following the Failure of Teton). This ad hoc interagency committee was established as ICODS in 1980.

FEMA also commissioned a National Research Council Committee on the Safety of Non-Federal Dams, whose report, issued in 1982, reaffirmed the deficiencies in sub-Federal dam safety efforts. Similarly, FEMA sponsored a report by Dr. Bruce Tschantz, *Report on Review of State Non-Federal Dam Safety Programs to Federal Emergency Management Agency* that was published in 1983 and made it clear that over half of the States either lacked the necessary statutory authority to effectively regulate dams or did not have State dam safety programs. Significantly, both these reports concluded that there was a need for interstate communication and the dissemination of dam safety information. This perceived vacuum was addressed, in part, by the establishment of ASDSO in 1983.

Dam Safety Act of 1986

ASDSO held its first conference in Denver in June 1984, with more than 300 attendees and 35 States represented. The organization was formally established on June 20th, with the approval of its constitution and by-laws. ASDSO’s role in advocacy, coordinating the States’ dam safety initiatives, interfacing with Federal programs and Congress, and providing a venue for information dissemination and training opportunities has expanded greatly since its inception. Much of its earliest advocacy at the Federal level centered on updating the NID and ensuring the passage of the *Dam Safety Act of 1986* (DSA), under the auspices of the *Water Resources Development Act* (WRDA) of the same year.

The DSA (P.L. 99-662, Title XII, November 17, 1986) included the most comprehensive Federal dam safety initiatives to date, and set a template for future efforts in this area. The DSA amended the NDIA of 1972 and provided \$13 million in assistance to qualifying States (Section 7); established the Board (Section 9); set terms of Federal-State cooperation (section 10); and provided \$500,000 annually for training State dam safety officials (section 11), \$2 million annually for research (Section 12), and \$500,000 annually for the maintenance and periodic updating of the NID (Section 13). The DSA explicitly forbade the use of these funds for dam construction or repair (Section 14), and did not require Federal inspections, thereby avoiding constitutional obstacles that encumbered the NDIA.

The DSA was meant to be in effect between 1988 and 1992. However, despite the efforts of ASDSO and other advocates, necessary funds were never appropriated. Congress made available only the funds necessary for USACE to maintain the NID. This is where the national program remained for nearly a decade, until WRDA ‘96 established the current program.

The Model State Dam Safety Program was published in April 1987 and since that time it has been used as an effective policy and practice transition avenue. As recommended changes are made to the model program, they are uniformly communicated to the States within the context of their overall program architecture and content.

The NDSP was established under Title II, Section 215 of the WRDA 1996 (P.L. 104-303). The NDSP has since been reauthorized and updated twice—under the *Dam Safety and Security Act of 2002* (P.L. 107-310, December 2, 2002) and the *Dam Safety Act of 2006* (P.L. 109-460, December 22, 2006). The stated purpose of the NDSP was “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 of the NDSP

After reaffirming and augmenting the definitions established by the NDIA, the DSA defined a set of specific objectives for the NDSP (Section 8(c)). These objectives are to—

- (1) 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
- (2) Encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness
- (3) Encourage the establishment and implementation of effective dam safety programs in each State based on State standards
- (4) Develop and encourage public awareness projects to increase public acceptance and support of State dam safety programs
- (5) Develop technical assistance materials for Federal and non-Federal dam safety programs
- (6) Develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector
- (7) Develop technical assistance materials, seminars, and guidelines to improve security for dams in the United States [added by the *Dam Safety and Security Act of 2002*]

Organization

The DSA further established that FEMA administer the program to achieve the objectives stated above (Section 8(a) paragraph 1), in consultation with ICODS, the Board, and State dam safety agencies. ASDSO is not explicitly mentioned in any portion of the enabling or reauthorization legislation, but its de facto participation and role in supporting various elements of the program (especially training initiatives) has continued to increase in scale and scope.

The official organization of the program comprises three interdependent groups—FEMA, ICODS, and the Board. FEMA administers the program, but it also chairs both ICODS and the Board. ICODS was founded in 1980 when the Ad Hoc Interagency Committee of the Federal Coordinating Council for Science, Engineering, and Technology was made permanent. However, the DSA formally established ICODS (Section 7) as a constituent part of the program. ICODS has representation from all the

Federal agencies that maintain or operate dams (Table 3). It is tasked with encouraging the establishment and maintenance of effective Federal dam safety programs through coordination and information exchange among Federal agencies, concerning the implementation of the *Federal Guidelines for Dam Safety*.

This Act (Section 8(h)) similarly established the Board, which was initially tasked with monitoring State implementation of the Act's objectives. It comprises 11 members: 5 from specifically designated Federal agencies, 5 from among the dam safety officials of the States, and 1 from the United States Committee on Large Dams (now the United States Society on Dams). Both ICODS and the Board report directly to the Administrator¹ of FEMA or a designated representative.

Table 3. Membership on ICODS and the Board

<i>ICODS</i>	<i>Board</i>
<p>"ICODS, which was established in 1980, encourages the establishment and maintenance of effective Federal programs, policies, and guidelines to enhance dam safety and security. ICODS serves as the permanent forum for the coordination of Federal activities in dam safety and security. FEMA also chairs ICODS." (Source: FEMA.gov)</p>	<p>"The Review Board provides the Director of FEMA with advice in setting national dam safety priorities and considers the effects of national policy issues affecting dam safety." (Source: FEMA.gov)</p>
<p>ICODS agencies: Department of Agriculture (NRCS) Department of Defense (USACE) Department of Energy Department of the Interior (USBR) Department of Labor (MSHA) FEMA Federal Energy Regulatory Commission Nuclear Regulatory Commission Tennessee Valley Authority U.S. Section of the International Boundary and Water Commission</p>	<p>Board Members: FEMA, the Chair of the Board Representatives of four Federal agencies that serve on ICODS (USDA, DOD, DOI, FERC) Five State dam safety officials (WV, MI, AZ, NH, CA) One member from the private sector</p>

The roles of the Board and ICODS have changed significantly since the program's inception in 1996. The *Dam Safety and Security Act of 2002* substantially revised these roles: It removed most of ICODS's interactions below the Federal level and invested the Board with these responsibilities. The Board's role expanded from "monitor[ing] State implementation" to "monitor[ing] the safety of dams in the United States, to monitor State implementation [...] and to advise the Director on national dam safety policy" (P.L. 107-310, Section G). Moreover, the Board's composition of members

¹ The DSA designates the FEMA Director; however, in 2009, the head of FEMA was re-titled as Administrator.

was changed to include voting and non-voting members, removed the representative from the United States Committee on Large Dams, and substituted this position with a representative from the private sector. The Board's duties were similarly expanded to include coordinating and exchanging information among Federal and State dam safety programs (P.L. 107-310, Section G, Paragraph 5); establishing workgroups under the Board to help it achieve its goals; and replacing ICODS as the entity under which the NDSP's research function is carried out.

Activities

The program, as intended by the DSA, consists of three functional activities. First, FEMA should provide leadership, by chairing ICODS (and the Board, as amended by P.L. 107-310), to coordinate Federal efforts in cooperation with State dam safety officials. Second, the program should provide technical assistance and the transfer of technical knowledge between Federal and non-Federal entities. Finally, the program should foster public awareness about the hazards of dam failure and related matters (Section 8(d) Paragraph 3). After these larger functions, the NDSP also includes a series of other activities discussed below.

The first of these specific activities is to support the continued maintenance, updating, and publication of the NID. With reference to the NDIA of 1972, the DSA reaffirms that the "Secretary of the Army shall maintain and update information on the inventory of dams in the United States. Such inventory of dams shall include any available information assessing each dam based on inspections completed by either a Federal agency or a State dam safety agency" (Section 6, Amended by P.L. 109-460).

The majority of the NDSP's funding is distributed through a grant program aimed at assisting State dam safety programs. The purpose of this assistance was to "encourage the establishment of effective State programs intended to ensure dam safety, to protect human life and property, and to improve State dam safety programs..." (Section 8(e), Paragraph 1). This was to be undertaken in accordance with the requirements and standards established by the Board and Director of FEMA and with the assistance of established criteria such as the *Model State Dam Safety Program* (FEMA 123, April, 1987), and its subsequent amendments. In order to qualify for this assistance, the 1996 Act established 10 criteria the States had to meet (Section 8(e)). Qualifying States can enter an agreement with the Director of FEMA to receive funding, upon submission and approval of a "work plan." Moreover, using the expertise of the Board, the Director is instructed to periodically review State dam safety programs; and, if they are found inadequate, their funding can be withheld, until they again meet the requirements for approval (Section 8(e), Paragraph 6).

In accordance with the objective of disseminating safety information, the NDSP is tasked with providing dam safety training "at the request of any State that has or intends to develop a State dam safety program" (Section 10, Amended in 2002). Moreover, the Director, in cooperation with the Board, is instructed to "carry out a program of technical and archival research, to develop and support (1) improved techniques, historical experience, and rehabilitation, and inspection; and (2) devices for the continued monitoring of the safety of dams" (Section 10). Finally, the NDSP has to report on its activities in a biennial report that describes the status of the program and progress

Dam Safety and Security Act of 2002 (Public Law 107-310)

Program Area	FY 2003		FY 2004		FY 2005		FY 2006	
	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual
State grants	6	3.5	6	3.2	6	3.1	6	3.2
Training	0.5	0.39	0.5	0.5	0.5	0.45	0.5	0.48
Research	1.5	0.78	1.5	0.5	1.5	0.9	1.5	0.74
FEMA staff	0.4	0.4	0.6	0.4	0.6	0.4	0.6	0.4
Total	8.4	5.07	8.6	4.6	8.6	4.85	8.6	4.82

Dam Safety Act of 2006 (Public Law 109-460)

Program Area	FY 2007		FY 2008		FY 2009		FY 2010		FY 2011	
	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual	Auth	Actual
State grants	6.5	3.2	7.1	3.21	7.6	7.65	8.3	7.79	9.9	7.54
Training	0.55	0.52	0.6	0.48	0.65	0.93	0.7	0.25	0.75	0.30
Research	1.6	0.7	1.7	0.79	1.8	1.43	1.9	1.96	2	0.88
FEMA staff	0.7	0.4	0.9	0.44	0.9	0.436	1	0.436	1.1	0.436
Total	9.35	4.82	10.3	4.92	10.95	10.44	11.9	10.44	13.75	9.16

Current Management of the NDSP

The Act charges the FEMA Administrator with responsibility for establishing and maintaining a coordinated national dam safety program. Over time, operation of the NDSP has rested in several organizational elements of FEMA. Currently, the NDSP office is located within the Assessment and Planning Branch of the Risk Analysis Division of the Federal Insurance and Mitigation Administration (FIMA), a major subordinate element of FEMA. The director of FIMA is a Presidential appointee. The NDSP office is authorized to have a staff of three: the lead engineer and two program specialists. It is supported by contracts with several companies that provide assistance in program management, training, and outreach. The NDSP Office is responsible for the day-to-day operation of the program and coordination, for the Administrator, of the activities of the Board, ICODS, and management of assistance to the States. Although the Administrator is the designated chair of both ICODS and the Board, this role is typically carried out by the FIMA deputy, who is a member of the Senior Executive Service (SES) or his/her designated representative.

Before the Department of Homeland Security (DHS) was established, appropriations for the NDSP were separately identified in legislative documents and, as a result, the NDSP appeared as a sepa-

rate line item in FEMA budget documents. After the establishment of DHS, appropriations to support the NDSP were subsumed in a general-purpose line item under a FEMA headquarters account and lost their specific identity outside of FEMA. Funding authorizations in the 2006 reauthorization of the National Dam Safety Act continued to separately identify the program and its components.

The NDSP is subject to the oversight of the staff and leadership of FEMA, DHS, and the Office of Management and Budget (OMB). The Senate Environment and Public Works and the House Transportation and Infrastructure committees exercise authorization responsibility over the program. Appropriations fall under the House and Senate Appropriations committees.

Current Dam Statistics

The NID contains more than 84,000 dams. In addition to the dams listed in the NID, there are thousands more whose size is not sufficient to trigger their inclusion in the inventory. Of the NID dams, 13,990 are classified as high hazard, and 12,662 are labeled as significant hazard. Nearly half of the dams are more than 50 years old. The American Society of Civil Engineers (ASCE), in its 2009 Report Card on the nation's infrastructure, indicates that overall the condition of dams is rated at the D level and that there are more than 4,000 dams, including 1,819 high-hazard dams whose condition is considered to be deficient.²

² <http://geo.usace.army.mil/pgis/f?p=397:5:2248169969452984::NO;>
http://www.asce.org/uploadedFiles/Publications/ASCE_News/2009/02_February/0209ReportCard.pdf

CHAPTER THREE—PROGRAM REVIEW

This chapter reviews current activities of the NDSP and evaluates the success of NDSP in achieving the objectives of the National Dam Safety Act. The evaluation is based on information provided during the interview process and through survey results and team analysis of the data and information made available to it. The topics in this chapter reflect the objectives of the program.

Reducing Dam Failures

OBSERVATION: The majority of people interviewed and surveyed believe that the NDSP and its predecessor activities have been successful in reducing the potential for and occurrence of dam failures.

OBSERVATION: The majority also believe, however, that this situation could easily be reversed given changing conditions (Chapter Four) and increasing hazards, unless increased resources are provided to support the program.

The purpose of the NDSP and earlier Federal programs was to reduce loss of life and property from dam failures through actions that would ensure, to the extent possible, the safety of existing dams and of those to be constructed. These actions would combine outreach, training, increased awareness, and the development of reactive capability on the part of those who might be adversely affected by a dam failure.

Eighty-four percent of survey respondents indicated that the NDSP has been very successful or successful in achieving the objectives specified in the DSA.³ The positive responses paralleled the comments of those interviewed. Respondents were also asked to comment on the success of the program in meeting its objectives. Results are indicated in Table 5 and discussed in this and subsequent sections of the current chapter.

Table 5. NDSP Success by Objective

NDSP Objective	Percent of respondents indicating very successful or successful
a) Ensuring the development of programs and procedures to reduce national dam safety hazard	81
b) Ensuring use of acceptable engineering policies and procedures	81
c) Encouraging the establishment and implementation of dam safety programs in each State	77

³ Because of the diversity of organizational positions held by respondents and the possibility that some respondents might be unfamiliar with a specific topic, in several questions respondents were given the option of offering "no opinion" or of not responding to the question. When "no opinion" was given as an answer, it was scored as "no response."

d) Developing and encouraging public support and acceptance of State dam safety programs	47
e) Developing technical assistance materials for Federal and State dam safety programs	93
f) Developing mechanisms to provide Federal technical assistance on dam safety to the non--Federal sector	57
g) Carrying out a program of technical and archival research	78
h) Providing training, when requested, for State dam safety staff and inspectors	92

Dam failures continue to occur but their severity has been limited, and most failures have occurred in dams with low-hazard potential or dams that are below the minimum threshold for inclusion in the NDSP. The failure of such non-included dams continues to receive attention in the media. Figure 2 is illustrative of the failures over time of US dams.

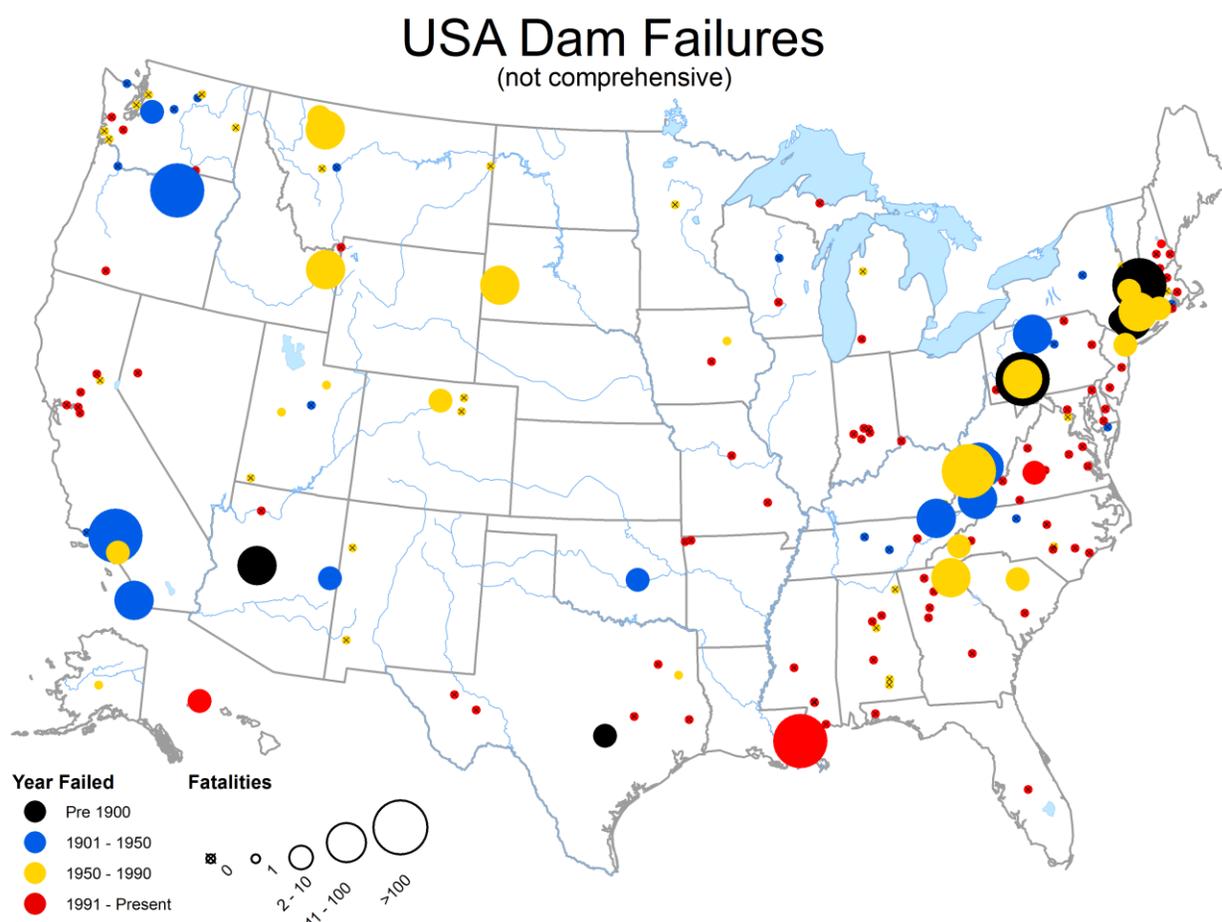


Figure 2. Failures of US Dams. The large red dot represents levee failures during Hurricane Katrina. Flood control levee failures are not considered as dam failures but are included in this map for comparison purposes. (Map courtesy of James S. Halgren, Office of Hydrologic Development, National Weather Service, National Oceanic and Atmospheric Administration, December, 2011).

Review of Federal and State activity over the past 20 years indicates that attention to dam safety has significantly increased (see Mr. Neil Parrett's report on the program's history provided in Appendix E.). Where State dam safety programs existed prior to the DSA and its predecessors, the strength of those programs has generally improved. Where there were no programs, programs have been developed (with the single exception of Alabama where no program has been developed). Through the efforts of the NDSP and ASDSO, a sense of community has developed, and this community has continuously improved its professionalism. Whatever the limitations of the program, absent the NDSP, dam safety in the nation would be less satisfactory.

Those interviewed also saw the *Model State Dam Safety Program* as a success. Most States strive to achieve as many of the tenets of the Program as they can.

More than three quarters of the respondents found that the program was successful or very successful in carrying out program and policy development, encouraging the establishment of State programs, developing technical assistance, carrying out technical and archival research, and providing training for State officials. NDSP efforts in developing technical assistance materials and providing training were the most highly rated. NDSP efforts providing Federal technical assistance and outreach were considerably less well rated. The results of the interviews paralleled those of the survey. NDSP efforts in support of States, training, technical assistance, research and development, and outreach are discussed in subsequent sections and the next chapter.

Responses to many questions frequently included concern about the inadequate funding available to carry out the activities required of an effective national dam safety program and successful State programs.

Fostering State Activity

OBSERVATION: The program provides funding incentives and encouragement which ensure that all States but one have developed and execute dam safety programs, and these funding incentives and encouragement promote a common approach to dealing with the threat of dam failures.

OBSERVATION: At a minimum, the program brings the owner, State, and Federal communities together to deal collectively with common issues. The role of ASDSO in facilitating this communication cannot be over stated.

Most people interviewed or surveyed believe that dam safety should be the responsibility of the States, while the Federal Government should play a role of encouragement and support. The NDSP does this. Yet, the provision of Federal support to inherently State programs creates at least an appearance of conflict. States have limited resources, and most respondents recognize that Federal support often depends on conformance to Federal guidance. On the other hand, most individuals interviewed expressed concern over any potential growth in Federal involvement.

FEMA provides resources for "seeding" the development of State programs and related support activities, such as technical assistance and training. The reality that FEMA does not have the funds

needed to increase the level of inspection, emergency preparation, or infrastructure repair is sometimes taken as a sign of FEMA's lack of support for dam safety needs at the State level, but should not be. FEMA finds itself criticized for not becoming directly involved in funding the construction or repair of dams. This criticism is misdirected because the funding of remediation is specifically contrary to provisions of the DSA.

The NDSP has clearly resulted in improved and more effective State dam safety activities. Although 77 percent of respondents indicated that the NDSP was very successful or successful in encouraging the establishment and implementation of State dam safety programs, many of those indicating a lack of success also noted that without the NDSP some States might not have identifiable dam safety programs. The presence of Federal guidelines and criteria for program participation create an incentive to move some State legislatures and executives to deal with dam safety.

A principal mission of the DSA is to foster communication among the professionals involved in the programs through technical activities, distribution of commonly needed materials, conduct of targeted research and unique training, and provision of opportunities to meet as a community. Over the years, the NDSP has played a major role in supporting such activities. Credit must also be given to ASDSO and its membership for their role in bringing the community together. A minority of respondents expressed concerns about the lack of sufficient information exchange among dam safety officials, owners, and operators; emergency management officials; and the public.

Many survey responses and interviewees questioned the effectiveness of the governance structure and the program relationships that exist between FEMA, its advisory boards, and State dam safety officials. This topic is discussed in further detail in Chapter Four.

Training

OBSERVATION: Program efforts to support training of professionals within the dam safety field generally have been successful and provide the core of specialized training related to dam programs at the State level. Efforts through the training summit and training reviews by ASDSO continue to improve the quality and responsiveness of this training.

Section 10 of the Act requires FEMA to provide training for State dam safety staff and inspectors at the request of any State that has or intends to develop a dam safety program. The NDSP office, in coordination with ASDSO, provides support for training at three levels: national, regional, and local.

More than 92 percent of respondents indicated that the training component of the program was successful or very successful. One survey response stated that, "*The training my coworkers and I have been able to attend would probably not have been possible without FEMA Dam Safety Grant funding. This is very positive.*" This is a representative response and was supported by the comments of those interviewed. Those in the field see NDSP-supported training as essential to the continued growth of professionalism among dam safety program participants. Concern was expressed that the general cutbacks in Federal programs could result in reductions in the funding levels available through the NDSP. This would create severe problems for those States that rely on FEMA grants to

support a substantial amount of their offsite training. ASDSO is credited with having a major impact on the training program and its success.

National training opportunities are typically conducted at FEMA's Emergency Management Institute (EMI) in Emmitsburg, Maryland. An annual workshop for Dam Safety professionals includes technical seminars on topics such as filters, drains, and geotextiles in dams and levees; instrumentation and remote operations; and handling emergencies at dams. The NDSP has also organized multi-day courses on hydrologic modeling at EMI, with enrollment limited to dam safety professionals. The National Dam Safety Review Board has a training workgroup, which includes a liaison member from ASDSO. It also plans the annual Technical Seminar held in Emmitsburg.

Regional training is conducted by ASDSO and private vendors. With financial support from the NDSP, ASDSO contracts with experts to offer day-long and multi-day seminars once a year in four regions of the country. Local training is supported through direct assistance to the States through annual NDSP grants. ASDSO provides webinars for distance learning in real time, as well as on-demand through a web-accessible archive. With NDSP support, ASDSO has also developed training workshops for dam owners, which are delivered by trained instructors around the country and are available on request from the States. ASDSO maintains an online Training Calendar, which is "a fully searchable database of conferences, symposiums, short courses, and seminars offered by a variety of providers, including universities, national and international organizations."⁴

FEMA hosted a training summit in Washington, D.C., in August 2011 to develop, with the assistance of several stakeholder groups, a National Dam Safety Training Plan. Participants included Federal representatives, academics, Board members, and representatives from emergency management agencies and ASDSO. A summary of the summit is in preparation and will be distributed in the near future. ASDSO has developed and published a list of core knowledge on various topics that is important to dam safety professionals and a matrix identifying training course offerings, organizations that offer courses, and the appropriate audiences within the dam safety profession.

Federal Technical Assistance

OBSERVATION: Provision of Federal technical assistance to the non-Federal sector is needed, but because of the variety of agencies involved and the agencies' focus on their internal programs, sufficient mechanisms for provision of assistance have not been established.

The DSA requires the program to develop mechanisms through which Federal technical assistance for dam safety can be provided to the non-Federal sector. Both the ICODS and the Board share responsibility with the program office for oversight of this function. Since the Federal agencies are responsible for most of the very large dams in the United States and have large technical staff to deal with issues as they arise, they are seen as the logical sources of such technical assistance for States

⁴ <http://damsafety.org/conferences/calendar.aspx>

and dam owners who lack the capacity to deal with new issues as they arise. Board and ICODS oversight of technical publications produced within the Federal community can identify those materials of use to the non-Federal sector. In addition, both the Board and ICODS provide guidance to the program office on preparation of FEMA technical documents for distribution to the States.

Those in the field do not see the same attention given to Federal technical assistance as is given to training. Only 57 percent of respondents say that NDSP is effective in developing mechanisms necessary to ensure the availability of needed technical assistance.

Because of the differences in the missions of the Federal agencies and their stated need to maintain separate technical approaches, State programs are frequently confronted by differing recommendations from the agencies that operate within their States, and there is a call for more consistent messages from the Federal level on technical issues. "... When the Federal agencies cannot agree among themselves as to approaches to risk analysis, EAPs [emergency action plans]... etc. it is difficult for representatives of those agencies to convey consistent messages..." to non-Federal participants.

Many Federal agencies attempt to provide technical assistance at the regional or local level but there may be inconsistencies between the approaches taken at the Federal level with large dams and those needed to handle problems in smaller dams at the local level. Within their individual programs, USACE, USBR, the Federal Energy Regulatory Agency (FERC), and the Natural Resources Conservation Service (NRCS) are seen as setting the example for quality programs; but once again, the concern rests with the ability of both Federal and non-Federal activities to continue to improve the technical interchange during periods of low funding.

Research and Development

OBSERVATION: The NDSP research and development (R&D) effort has been productive in generating meaningful applied technical summaries and guidance based on emerging technologies. Meager funding and limited management assets limit the scope and impact of NDSP's R&D efforts. Currently defined R&D needs far exceed what the available resources can address.

Section 9 of the Act directs FEMA to carry out a program of archival and technical research for improving techniques and equipment for dam construction rehabilitation and inspection, monitoring the safety of dams, developing information resources for management of dam safety, and initiating a guide for the formulation of effective public policy. R&D activity levels have been directly correlated to the level of funding available, which typically has ranged from \$500 thousand to \$1million per year. The requirements for R&D are developed through a series of workshops and meetings and are focused on specific needs in various topical areas. These needs are combined into a 5-year plan, the most recent of which was published in 2003. Investments are based on recommendations of a research working group (RWG) chartered by the Board and on FEMA's priorities. FEMA manages the financial aspects of R&D projects, and the RWG manages the technical aspects. The results of these R&D efforts are typically disseminated in the form of reports published by FEMA and sometimes serve as updates to training programs.

Seventy-eight percent of survey respondents indicated that the program was successful in meeting its research objectives. Most respondents did not have detailed knowledge of the research program or its results. Those respondents with knowledge of the program were more focused on the distribution of technical material developed as a result of ongoing research and translation of technical information into user-friendly documents. Respondents and interviewees suggested that closer collaboration between the Federal agencies, the NDSP's research efforts, and ASDSO might provide greater synergism and reduce potential duplication. Those familiar with the program pointed out that funding is limited and that the research program would benefit from a strategic vision. .

Research topics funded have largely been oriented toward evolving new technical guidance or addressing pressing questions by developing summary reports of emerging technology or new practice. They have primarily focused on topics related to prevention of dam incidents or failure. More recently, a significant emphasis has been placed on emergency action plans. Available funding is not sufficient to support long-term technical development or significant discovery. As such, the focus is on integration and adoption of new or emerging knowledge and capabilities that are fundamentally developed by other sources.

R&D products largely have been summaries of emerging technologies, or knowledge or guidance on the application of technologies, or methods relevant to RWG-defined requirements. Few investments have represented technology development or discovery; occasionally they represent a study of policy issues. Overall, given the level of resources available, the program has been not only productive but also relevant.

NDSP R&D summits were held in 2010 and 2011 and recommended significant increases in the scope of R&D to deal with resilience and emergency management as well as the ongoing focus on dam infrastructure. The potential reduction in funding available in the near term will be a significant challenge to NDSP R&D efforts. To either maintain the current level of effort or to achieve a broader scope, the program will need a new strategy and business model and, if more is to be expected of the program, an increase in resources. The 2003 research plan needs to be upgraded and aligned with the forthcoming NDSP Strategy. Any expansion of the scope of research should not dilute the ongoing emphasis on dam failure prevention.

Strength of State Programs

OBSERVATION: There are large differences in the level of internal support for and the resultant quality and outcomes of State programs.

The NDSP is a program for which the Federal Government provides general guidelines and access to Federal technical resources and training, and provides general support to the States which are ultimately responsible for the conduct of their own programs. Each participating State and territory has its own program, which is subject to the directions contained within State legislation. These programs are a function of not only the State's interest in dam safety but also the number and char-

acteristics of dams within the jurisdictions. Some States have programs that are well supported politically and fiscally. Others have programs that are less well supported.⁵

Eighty percent of respondents indicated that State programs were either very successful or successful in carrying out their mission. They noted, however, that the level of performance was a function of the interest within the State, and that some States were at the margin of the required support. Respondents and those interviewed pointed out that several States—specifically, California, New Jersey, Ohio, and Colorado—have programs that are supported at a high level and are able to carry out required dam safety inspections in a highly professional manner. On the other hand, where resources were limited, the frequency and thoroughness of inspections are diminished. *“They do the best they can with what they have. They try to take care of the most critical projects.”*

Those who operate and work with State programs understand the requirements of the program. They note that the presence of Federal criteria for participation in the program assists dam safety officials in pointing out national standards to their legislatures and executive leaders. Although they understand the program, most if not all are quick to point out that the absence of resources limits their ability to carry out an optimal inspection program; develop or coordinate the development of EAPs; and address the need for structure repair, removal, or upgrade.

The presence or absence of State enabling legislation to provide the dam safety officials with authorities recommended under the dam safety program, as well as the adequacy of State fiscal support for dam safety programs are seen by all as a differentiator between successful and marginally successful and unsuccessful programs. High-quality individuals can be found in all programs but their numbers are a direct function of adequate funding.

In short, where State officials, legislative and executive, provide sufficient authority and resources to their dam safety officials, the programs are more likely to be seen as successful by both those regulating and operating within the program and those associated with programs such as emergency and floodplain management.

NID

OBSERVATION: NID is useful but its utility is a function of its completeness and the accessibility of data needed by government officials and the public to carry out their respective activities and to know of and understand any risks that exist.

The DSA of 2006 authorizes an NID. The inventory was first authorized in 1972 in separate legislation and has been reauthorized by several succeeding acts. The 2006 Act directed the Secretary of the Army to maintain and update the inventory of dams in the United States and provided that the inventory include the available information “assessing each Dam based on inspections completed by either a Federal agency or a State dam safety agency.” The USACE maintains the NID as a web-

⁵ Association of State Dam Safety Officials, 2011 Annual Report, Lexington, KY: ASDSO

based tool. Most of the data in the NID is available online to the general public.⁶ Accessibility to data concerning the condition of dams is limited to those with a specific need to know and is obtainable through USACE. The site also contains the USACE Dam Safety Management Tool, access to which is limited to USACE employees.

Those who are in or associated with the dam safety program see the availability of a NID as a benefit in not only managing the program, but also in carrying out emergency management, floodplain management, land use planning, and other related activities of State and local governments. It is labeled crucial to effective management of the dam safety program. *“The NID is an essential tool [...] to educate policymakers.”*

Data on more than 84,000 dams must be maintained within the database, and there are occasional problems in entering and maintaining the data. In the past, the system has been characterized as not being user-friendly, but USACE’s recent efforts to improve the simplicity of data input are having positive effects. (Users seeking information about dams also have access to State dam safety offices where more recent information is normally available, as is information for some dams not included in the NID.)

The inaccessibility to dam condition information is seen by many as a serious drawback in the NID because it prevents those that could be affected by dam problems from being aware of any issues. Although it is possible for private citizens to request this information through their local officials, the task is not easy and does not support community involvement in dam monitoring. This topic is addressed in the subsequent chapter.

Outreach

OBSERVATION: Outreach efforts to inform the public of the need for dam safety programs and of the risks it faces have not been effective. Residents do not know the risks they face, and the public is generally unaware of the existence of the State, Federal, or national dam safety programs.

Under the DSA, the NDSP includes a public awareness component to “provide for the education of the public, including State and local officials, in the hazards of dam failures and related matters.” This generally has been interpreted as focusing on two elements of outreach: developing public acceptance and support of the programs and developing public awareness of the risks associated with dams and the actions to be taken in response to potential or actual dam failures.

None of the survey respondents characterize as “very well” the public’s understanding and support of dam safety programs, and only 7 percent characterize it as “well.” Sixty-three percent of the respondents believe that public understanding and support falls into the “not well” or “not at all” categories. One respondent reported that *“our experience is that the public has no awareness of dam*

⁶ <http://geo.usace.army.mil/pgis/f?p=397:12:3238200096705262>

safety or the NDSP.” Another indicated that the general public “*probably [doesn’t] know that the State offices are not manned [sic] properly and have inadequate funding to do their jobs.*” These opinions were echoed by those interviewed.

Given the relatively limited amount of funding allocated to dam safety activities nationally and, in general, for the State level, many dam safety officials have been reluctant to divert meaningful resources to outreach to enhance public understanding of the overall dam safety program at either level. When resources are not available to carry out inspections and develop EAPs, these officials find it difficult to put effort into what is seen as “public relations,” even though those efforts might garner additional support from the legislative and executive elements of State governments.

When asked if those people who live in areas that could be inundated or affected by dam failures understood the potential extent of inundation and the resultant risks, the results of the survey paralleled the survey question on program understanding and support discussed in the previous paragraphs. None of the respondents felt the public understood “very well” and only 9 percent felt that they understood “well” the extent of inundation and the resultant risks. Sixty-three percent of the respondents believe the understanding is at the “not well” or “not at all” levels.

Given the efforts made by FEMA and local officials since Katrina to improve public understanding of the threats to people living behind levees, survey respondents offered several suggestions to improve public understanding of dam risks:

- Sending annual notices or postcards to households to remind them of their location in the inundation zones and to explain what action should be taken under various circumstances
- Having citizens participate in emergency action exercises involving dam inundation scenarios
- Including the extent and depth of an area’s potential inundation in FEMA flood insurance rate maps
- Including those in dam failure inundation zones in the National Flood Insurance Program (NFIP)
- Having realtors disclose that a property being sold is in the dam failure inundation zone (an approach legislated in California)
- Including inundation information in land use and zoning plans.

Concern was expressed by many respondents and interviewees that governments seem reluctant to share inundation mapping with the general public for fear that the information would not be understood, cause unnecessary alarm, or aid terrorists in planning attacks on dams. There was strong sentiment among respondents for making inundation maps readily available to the public.

CHAPTER FOUR—CHALLENGES AND OPTIONS

NDSP faces challenges in the years ahead but options are available to deal with those challenges.

Future Conditions

Any Federal program document addressing the future provides a litany of factors that will influence the manner in which activities will be carried out and defines the challenges that will have to be faced. The NDSP must also address such factors. These include:

- **Deteriorating Infrastructure.** The ASCE's 2009 report card on national infrastructure assigns a grade of "D" to dams and estimates that more than \$5 billion will be required in the next 5 years to deal with immediate infrastructure needs. A similar low grade for levees, as well as a requirement for nearly \$50 billion to deal with levee repairs and necessary upgrades, dramatically increases the potential impact of dam breaks on levee areas located below dams.
- **Growing Population and Increasing Development.** The U.S. Census Bureau estimates a population increase of 130 million persons within the United States by 2050.⁷ Assuming some relief from the current recession, such population growth will in many cases move development further away from current urban centers into previously unpopulated areas below dams. Dams that have long been rated as low or significant hazard may soon find themselves in the high-hazard category with the potential for increases in infrastructure costs or operation and maintenance activities.
- **Changing Climate.** Recent reports by the Intergovernmental Panel on Climate Change and a special committee of the National Research Council indicate that climate change could bring more intense rainfall events with an increased probability of flooding. Preliminary reports from FEMA's current study of climate change impacts on the NFIP point out significant increases in areas subject to flooding. An ongoing NOAA study of the capacity of the atmosphere to hold moisture in higher temperature environments is confirming the potential for future storm events to be more intense than in the past and with specific potential for increasing probable maximum precipitation.
- **Changing Uses and Demands on Dams and Associated Water Infrastructure.** Some dams are facing challenges not only in the magnitude of their inflow hydrographs, but also in the roles they are asked to play in managing water. This may cause some changes in the initial operating rules to accommodate the new roles, for example, providing less flood storage or hydroelectric power for the sake of improving recreation or ecosystem sustainability.
- **Changing Public Communication Realities, Readiness, and Rules.** Challenges and opportunities for communicating with the public have grown exponentially as new and advanced technologies come online virtually every day. Importantly, social media's proliferation and ubiquitous influ-

⁷ <http://www.census.gov/population/www/projections/2009projections.html>

ence is shaping how individuals and entire communities understand real versus perceived risk and how officials build trust and credibility and motivate action to reduce risk and protect public safety.

RECOMMENDATION: Given the above factors, the NDSP must be prepared to operate in an environment where many current dam operating plans may no longer be viable. Hydrologic challenges will increase and structure conditions will continue to deteriorate without a new infusion of funding. These conditions will create significant challenges for States and for their dam safety programs. A strong case must be made for increasing the support for the program to enable it to deal with these challenges. Although responsibility for deteriorating infrastructure does not fall directly under the National Dam Safety Act, FEMA as the agency most cognizant of the national condition must become an advocate for addressing the infrastructure problem. It cannot be ignored.

Federal vs. State Interest

The NDSP was established to provide Federal support and encouragement for State-level activity to deal with the safety of nonfederal dams and to ensure the execution of strong programs to maintain the safety of Federal structures. While the focus of the latter mission has remained at the Federal level, calls for greater Federal involvement in nonfederal dam safety activities continue to grow. The misperception that at some point the Federal Government will provide additional resources or will assume greater responsibility for nonfederal dam safety continues to deter some States from taking a more active role in dam rehabilitation activities. The Federal Government has a strong interest in ensuring dam safety at all levels, if for no other reason than to reduce the potential for disasters and the resultant disaster assistance requirements. To ensure that States clearly recognize their role, FEMA must make every effort in publications and exchanges with States to clearly define the roles of the two levels of government.

It is also important to keep in mind the interests of nongovernmental dam owners and stakeholders. Based on our review and survey, many nongovernmental owners are unaware of the NDSP and, if the State regulates their dams, see only the regulatory framework of the State. In addition, many stakeholders associated with dams are subject to the hazard the dam represents, but have no input to the safety program. Most private owners will continue to depend on dam safety officials for guidance and information. Nongovernmental organizations such as ASDSO play a critical role as both a source of information and a resource for identifying issues.

RECOMMENDATION: Under the current act, dealing with nonfederal dams is fundamentally a State function and States must take the lead. The Federal role is to encourage State program development, provide technical assistance and training, ensure knowledge sharing, and support States in ensuring that communities below dams are adequately prepared for potential emergency activities.

Governance

Given the organization of the NDSP, the program is based on a collaborative model, not a hierarchical model. This is likely the appropriate model for the future as well given that the majority of

dams managed (95 percent) and the relevant dam safety authorities reside within the State governments. It is also relevant that only the States and local governments have authorities that are important for consequence management (land use and zoning). As such, other than the 5 percent of the dams managed and regulated by Federal agencies (albeit many of the largest of the dams), the rubber meets the road at the State level.

The language of the DSA uses the terms “encourage” and “develop” in describing the NDSP objectives, making the States the controlling partners in how they use the NDSP outputs that include grants, training, research, guidance, and the NID. This has the benefit of encouraging the NDSP to focus on the needs of the States, but also increases the challenge to implement uniform standards or practices across the States. It is important to note that FEMA has leadership and oversight of the NDSP, not leadership and oversight of dam safety for the nation.

Given that the States and Federal agencies that have responsibilities for dam safety have governing authorities and resources to operate or regulate dams, the role that the NDSP plays is unique in encouraging the collaboration between Federal and State entities and developing information and capabilities that will assist in unifying the organization and implementation of dam safety programs. Since the Federal agencies are more holistically funded, they often become the sources of new opportunities to improve capabilities across the dam safety arena.

FEMA and the NDSP activities need to focus on the big picture. The NDSP cannot afford to dwell on details—the States and Federal agencies are doing that. Organizations such as the ASDSO also provide an effective means for communication and collaboration among States with respect to governance, policies, and practice within the States and provide an effective venue for communicating to the Federal agencies and the NDSP. The ASDSO involvement in policy development and training has been a significant benefit to activities at the national level by providing representation of State needs and positions for consideration. The NDSP must rise above this level and focus on strategic issues that cannot be adequately addressed below the national scale.

ICODS

ICODS provides a means for fostering interagency cooperation, and it has served that purpose. It has also fostered the development of guidance that has served as an overarching resource for the States and public and private dam owners. Through ICODES, agencies can not only work together to create more uniformity and consistency across agencies, but create the foundation for transition of new policies and practices to the State and local levels. ICODES is not seen to directly affect many at the State and local level, and as a result its functions are not well understood.

Nearly two-thirds of the respondents to the surveys had no opinion about the work of ICODES. Seventy-seven percent of those responding indicated that ICODES was successful or very successful in carrying out its mission of Federal coordination. However, several respondents and interviewees were concerned over the failure of ICODES to resolve ongoing technical differences among Federal agencies with respect to dam issues and suggested that ICODES should also oversee peer review of Federal agency dam safety programs, noting that not all agencies are at the same level of perfor-

mance. ICODS could also provide greater vision and leadership in the evolution and transition of new capabilities developed under the Federal programs to the States and private owners. ICODS could increase its overall impact by focusing more of its efforts on strategic issues that will impact the national stature of dam safety.

Given the very broad scope of issues and challenges facing the dam safety community, it is essential that the limited resources and energies of ICODS be focused strategically on the most important technical needs of the Federal dam safety community and those areas where Federal capabilities can assist the nonfederal programs and activities. Unlike the Board, which has an advisory role to the FEMA Administrator, ICODS must serve as an independent advisor to all Federal dam safety programs and as a resource for the NDSP.

The Board

The Board has been the forum for communication across the dam safety community. It provides a unique venue for defining and elevating strategic issues. The Model NDSP concept has been particularly useful as has the overall package of Federal guidelines. The consistent emphasis on inspection and EAPs has reaped significant success based on the ASDSO performance metrics. However, many survey respondents and interviewees found that the Board was moving in too many directions at the same time and that it needed more focus. More than a third of survey respondents indicated that the Board was ineffective or somewhat ineffective. Strong concern was expressed that FEMA, which chairs the Board, was not taking full advantage of the capabilities of the group, the advice of the Board was not being considered in decisions of the agency, and feedback to the board on such issues was minimal. Although under the Act, the Board is exempt from the Federal Advisory Committee Act, which opens meetings to the public, public awareness of important dam safety issues and confidence in the Board would be increased by opening Board meetings to the public.

The Act indicates that FEMA, using the expertise of the Board, may periodically review State dam safety programs to determine whether the programs are adequate. The Board has had little involvement with the formal evaluation of State programs and providing its advice on these programs to the NDSP office and the FEMA Administrator.

The Board should focus on trends and challenges that are national in scope and it should remain informed but separated from issues at the State or local level. If an agenda item is not potentially of interest to the most senior management level of FEMA or of participating agencies, it is likely something that should be handled by a subordinate working group or in another venue such as ASDSO. FEMA, as Board chair, must provide the collaborative direction of these efforts. All board members should be senior individuals within their organizations and be familiar with the strategic directions of their respective organizations.

High-Level Leadership of the NDSP

For the most part, senior leadership within FEMA has had minimal visibility in the direction and fostering of the dam safety program. To those in and affected by the dam safety program, the impression is created that the NDSP is a minor administrative element within the larger FEMA/DHS

organization, and that the attainment of the goals and objectives of the program is of little direct concern to the FEMA leadership. Unfortunately, this lack of visible, high-level leadership is taken by the leadership of many States as a further sign that the NDSP is of minor significance and that therefore, minimal attention needs to be directed to it at the State level. At the 2011 ASDSO conference, attended by more than 1,000 individuals from the dam safety community, no senior FEMA official appeared on the plenary program or participated in the conference activities. If the program is to succeed and the Federal Government is to be seen as the advocate for State dam safety programs, then senior FEMA leadership needs to be involved on a continuous basis in all big-picture activities.

RECOMMENDATION: FEMA and the NDSP activities need to focus on the big picture. The Board and ICODS should spend a majority of their time dealing with issues of significance to the executive levels of FEMA and State governments. It is imperative that FEMA senior leaders chair the Board and ICODS to provide appropriate stature to their activities and recommendations and to the NDSP as a whole. Although the governance framework will not likely change, a more strategic focus and high-level FEMA leadership will provide greater visibility and awareness of the importance of the program.

Resource Requirements—Program and Dam Safety

Resource challenges affecting national dam safety fall into two categories: funding required to carry out dam safety programs at the Federal and State level, and funding needed to address the significant shortfalls in dam maintenance, upgrade, or eventual removal.

Federal support of dam safety programs at Federal and State level at FY 2012 levels is marginally adequate to provide the kind of support envisioned in the legislation that establishes the Federal Government as a facilitator and coordinator and leaves to the States the responsibility for establishing and operating their individual State programs. Federal funding to States was designed to assist in the establishment of State programs and to provide minimal supplemental funding to encourage continuation of these programs. The Federal Government assumes responsibility for oversight of dams constructed under Federal programs and leaves the remainder to the States. As indicated earlier, some States provide significant funding for the support of their programs of dam safety and related functions, but others give it little emphasis. Provision of adequate funding for State programs is a State responsibility. At the Federal level, the FEMA Administrator and the NDSP should take every opportunity to encourage States to address the dam safety office resourcing problem. Actions under outreach programs will assist in improving local understanding of the necessity for dam safety programs, and conceivably could lead to increased funding.

In addition to identifying responsibility for appropriate emergency and mitigation planning, resources must be provided at the State level to meet dam operating requirements regarding public safety. Subject matter experts and funding for the activities in development have to be allocated to ensure successful community programs. Costs in response to and recovery from a dam failure without adequate planning and mitigation will heavily outweigh those upfront costs used for areas to prepare.

RECOMMENDATION: National program resourcing is marginal even if funded at FY 2012 levels, which is a historical high. Given its purpose, Federal support of State activities is just enough to provide some flexibility to the States. However, any changes in program scope to accommodate expansion of R&D efforts or to deal with emergency and flood-plain management activities that cannot be accomplished within other FEMA programs will require increases in funding. Changes in program scope should not be at the expense of the ongoing efforts to minimize dam failures.

The most glaring weakness in national dam safety is the lack of funding to maintain, repair, remove, or upgrade dams that are unsafe or in marginal condition and whose condition will only degrade in the years ahead. This is the same problem facing States in dealing with the tens of thousands of miles of levees that are in poor condition. Ideally, the beneficiaries of both dams and levees should pay for costs associated with the structures; but in reality, it appears that many structure owners and operators do not have the resources available to them to carry out such activity. The NRCS has a risk-based Watershed Rehabilitation Program for repair of dams constructed under its auspices. This cost-shared program has received annual appropriations of \$10 million to \$17 million in recent years. However, it is doubtful that the Federal Government has the ability to directly fund additional dam and levee repairs at the State level given the demands on resources by Federal agencies for similar maintenance, repair, and upgrade activities. It therefore becomes incumbent on the Federal and State governments to address the issue and develop options for dealing with a problem that will not go away. State programs that provide loans to dam owners for repair or removal are few in number and only periodically funded. Ambassador Felix Rohatyn and Senator Warren Rudman's Commission on Public Infrastructure recommended the creation of a national infrastructure bank, but Congress continues to mull over the proposal.⁸ Development of such a bank could provide support for the most critical repairs. In 2009 a bill was introduced in the House of Representatives to include funds for repair in the DSA but the bill went nowhere.

RECOMMENDATION: Inadequate resources are being applied to operations and maintenance (O&M) and remediation by those responsible for dams. Consideration should be given at the State and Federal levels to creating or expanding financing facilities through which repayable loans or grants can be made to dam owners for the repair or removal of dams judged to be unsafe. The infrastructure challenge cannot be ignored as the problem is growing.

Training

The dam safety community is diverse. NDSP does not have the resources to address the topical training needs of every professional specialty relevant to dam safety. The approach discussed at the 2011 Training Summit appears sound and practical: collect and maintain a clearinghouse of available training opportunities, organized by topic and by audience, and keyed to a body of knowledge.

⁸ <http://csis.org/testimony/felix-rohatyn-infrastructure-investment-bank>

Build on the Complementary Relationship With ASDSO

The present survey and interviews indicated that some, but not all, in the Dam Safety community recognize NDSP's role in developing and coordinating training programs through ASDSO. As part of improving the visibility of NDSP, frequent and consistent statements of the nature of this partnership are recommended.

The annual training events run by NDSP at EMI are positively reviewed. In the current funding climate, however, State dam safety professionals are finding it difficult or impossible to travel for training. Funding constraints at NDSP also threaten to curtail these offerings. We recommend that NDSP continue to work closely with ASDSO to leverage available resources. Webcasts and self-paced study using print and other media should continue to be explored and developed. However, in-person events may still be best for some topics and audiences.

Develop a Body of Knowledge

NDSP in conjunction with ASDSO should identify the knowledge and skills that a dam safety practitioner should possess. It is likely that this body of knowledge represents an intersection of the various specialties involved. An integrated analysis should identify what knowledge within that intersection each specialty could be assumed to possess, and what additional knowledge that particular specialty would need to master. Knowledge dissemination should include not only classic fundamentals, but also new findings, especially from NDSP-supported R&D. Any resources available to develop or conduct new courses should focus on gaps identified in the clearinghouse database.

An appropriate function for NDSP and ASDSO is to maintain and continue developing the excellent professional resource guide that ASDSO now publishes on its website. It provides an overview, recommended proficiencies, available classes, and references for each of 14 topics.⁹

Little Need for Certification

There seems little pressing need for dam safety certification. Dam safety practitioners include engineers, operators, floodplain managers, and emergency managers, among others. Engineers obtain certification as Engineer in Training (EIT) or Professional Engineer (PE). Dam operators can obtain certification. Floodplain managers can be Certified Facility Managers (CFM), emergency managers can be Certified Emergency Managers (CEM), and so forth. Each certified professional will require additional knowledge to work effectively in dam safety, but it would appear that the incremental knowledge would be different for each.

⁹ For example, its page for Dam Safety Program Management:
<http://www.damsafety.org/resources/?p=267c8699-6d24-4aaf-856a-b47a8e863885>

RECOMMENDATION: The NDSP under FEMA direction is generally doing a good job in meeting its training objective. It should continue in its current direction, further cementing its complementary relationship with ASDSO. Part of this relationship could probably be directed toward developing a body of knowledge for dam safety professionals.

Integration of Dams, Levees, and Floodplain Management

Since initiation of the FEMA map modernization program in 2003 and the Katrina disaster in 2005, considerable attention has been focused nationally on the condition and use of levees and their role in floodplain management. In 2007, the Association of State Floodplain Managers (ASFPM) conducted a seminar to address management of the floodplain in the 21st century. Its report, *Floodplain Management 2050*, highlighted the close relationship between dams, levees, and floodplain management, and the significant influence that dams, both in their operation and their failure potential, have on occupants of the floodplain.

At the same time, the Association itself issued its periodic report, *National Flood Programs and Policies in Review 2007*, identifying the challenges being faced in managing floodplains and reducing the risk to those in those floodplains. This report recommended that “...flood hazard maps should depict the failure zones of all dams, levees, diversions, and reservoirs. Not only is this identification important for notification and warnings, but also development in these zones should have added flood protection in the form of appropriate development standards, and flood insurance should be mandatory...” The report also recommended that—

- “Zoning below dams should be tied to failure zones to prevent low-hazard dams from becoming high-hazard ones...”
- Dams that cannot be appropriately maintained should be removed. Federal agencies should provide incentives to encourage States to remove such dams...
- When an older dam is being evaluated for safety and repair needs, consideration should be given to whether the dam is still needed, whether some or all of its functions could be economically replaced by nonstructural measures, and how the impacts of the dam on the river ecosystem could be lessened. Federal agencies should provide incentives to encourage States to adopt such evaluation procedures...
- Any program for addressing aging [dam]projects in small watersheds should include a watershed-based, multi-objective planning process to assess the full range of structural and non-structural approaches for water management in the entire affected basin.”

The team’s consultant on floodplain management, Mr. Larry Buss, formerly head of the USACE Non-structural/Flood Proofing Committee, points out the significant impacts that dams have on floodplains above and below the structures under both normal operating conditions and in the event of dam failures or severe weather events that result in uncontrolled flows below the dam (see Appendix D). This latter situation resulted in significant damages in areas below main stem dams on the Missouri River in 2011. Few of the affected parties had understood that such flow events could oc-

cur and the risks that they would face. No matter what the purpose of a dam might be, its failure or its passage of exceptionally high and unanticipated flows create downstream impacts.

The State of Wisconsin has recognized the potential danger to those located below dams and has established regulations (NR 116) that require developed areas downstream of high-hazard dams to be zoned and regulated assuming that the dam is nonexistent during a 100-year flood. (Several States have considered this approach and found it difficult, for perceived legal reasons, to gain support for its implementation). An even broader concept might be managing land use below all dams to prevent current low- or significant-hazard dams from inadvertently becoming high-hazard dams because of continued development in the floodplain. This would not only manage risk, but also reduce the potential for the dam owners to incur the expense of complying with high-hazard standards.

While not discussed in any detail in this report, the challenges faced by increasing sediment buildup behind dams only adds to the challenge of ensuring dam safety or of funding dam removals when the dams can no longer serve their original purposes. Higher sediment levels reduce the storage capacity of dams, increase the opportunity for discharge of sediments containing legacy toxic material, and complicate analysis of dam failures. This topic should be more closely examined by both the Board and ICODS.

RECOMMENDATION: The operation and existence of dams have significant impacts on floodplains above and below the structures. Dam safety programs must be closely integrated with floodplain management to provide a systems approach to dealing with the combined challenges. FEMA should continue to integrate dam safety information in every aspect of Risk Mapping, Assessment, and Planning (RiskMAP) and similar programs. Efforts to integrate land use planning with floodplain management below dams similar to those being carried out in Wisconsin should be encouraged in all States.

Outreach

As indicated in Chapter Three, even those in and associated with the dam safety community do not believe that the communities that may be impacted by dam failures or who need knowledge of the dam safety program are receiving the needed information.

Communication of Risk to Those at Risk

This lack of knowledge about dam safety risks exists because little is being done within the program at either the national or State level to share information about dam failure inundation areas and the condition of dams with those that could be affected. Those affected by dams also should understand the importance of dam maintenance and the relative risk of a well-maintained dam as compared to one whose condition is substandard or unknown.

Where communication does exist, it is mainly with community officials rather than the public at large, leaving the public officials with the responsibility for passing on the information. This is the same problem that the NFIP faced initially; however, since the initiation of map modernization and

the RiskMAP program, the public appears to be slightly more aware of both the general flood risk and levee risks they face. A useful consideration would be to include dam-failure inundation areas on FEMA's Flood Insurance Rate Maps. The availability of the Flood Insurance Rate Map increases public knowledge of zones of flooding, and, as was learned in post-Katrina communication in New Orleans, maps indicating inundation areas have been shown to increase community awareness of risk. The RiskMAP program recently conducted a nationwide survey of public officials located in areas subject to flooding. For the first time, two questions concerning knowledge of dam risk were included in the survey. The results indicated that—

- Sixty-nine percent of those living behind a dam and 71 percent of those behind a levee thought their community was at risk of flooding, compared to 41 percent of those who did not live behind a dam or levee.
- While just 12 percent of respondents thought their home was at risk of flooding, more than one-third (35.5 percent) of those located behind a levee and more than one-fourth (26.7 percent) of those located behind a dam thought their home was at risk.

Although the term 'located behind a dam' can be confusing, the survey results point to an uptick in public awareness and knowledge of the risk. Because the questions did not identify the availability of inundation maps, it is difficult to relate the answers to specific issues with dam safety outreach. It is interesting to note, however, that even though many individuals surveyed by RiskMAP indicated awareness of risk, they did not necessarily believe that they as individuals were at the same level of risk as the community at large.

As previously stated, those living in the floodplain below a dam face the risk of flooding from riverine or coastal events and the risk of flooding from a dam failure. At the local level, the same individuals are responsible for mitigating both types of risk. In addition, where dam failures occur in areas that are leveed, a dam failure not only would cause its own identified flooding, but could cause damages to downstream levees or dams that would result in their failure and additional flooding.

RiskMAP is working to develop appropriate methods for improving communication with those at risk. Its National Outreach Strategy suggests that the following activities improve community knowledge of these risks:

- Engage communities early and often.
- Agree upon and document project outcomes and responsibilities.
- Coordinate with other programs operating within the same community.
- Leverage associations to provide a third-party perspective.
- Use local media and language that people understand.

Other organizations are also pursuing improvements in risk communication. In *National Flood Policies and Programs in Review—2007*, the ASFPM recommends that—

“Communication of the residual risk associated with structures, including dams, levees, diversions, and reservoirs, should be an explicit component of all aspects of proposed and

current structural projects. It should include notification to all property owners of the risk (e.g., a notice in an annual water bill or tax bill) and other steps such as posting signs in all land areas “protected” by structures stating clearly that the area is protected by structures that may fail or be overtopped, that the area is a floodplain, and with indications of the depth of flooding when the structure fails or is overtopped. Communication to the property owners should provide clear information on their role if an evacuation is ordered.”

The NDSP has no community outreach efforts underway similar to those being conducted by RiskMAP. If communities are to become aware of the risks they face from dams, the NDSP must either establish its own high-level program or piggyback its program on RiskMAP, which may be a more feasible solution, given resource shortages. In most flood-prone communities, consideration is already being given to emergency management and communications during flood events such as integration of emergency management efforts for both floods and dam breaks to improve communication with local officials and eventually the public at large. The team consultant on risk communication, Dr. Timothy Tinker, suggests a variety of approaches that the NDSP could pursue to enhance dam safety risk communications (see Appendix D).

One such approach is engaging “credible third parties” as conduits for sending and receiving information. For example, at the State level, California (California Government Code Section 8589.4) requires that “ a person who is acting as an agent for a transferor of real property that is located within an area of potential flooding shown on an inundation map... shall disclose to any prospective transferee the fact that the property is located within an area of potential flooding.” This applies to both flood and dam failure inundation maps. Implementation of this requirement has greatly increased public knowledge of the dam risks that may affect them and has been given credit by some for support of the California dam safety program.

Communication of National Dam Risk

The second aspect of outreach involves proactively getting out the message on the importance of dam safety to the nation in general and States in particular to gain both the support of public officials and the public at large for the dam safety programs. In the 18 years since the 1993 Mississippi River Flood, FEMA and the NFIP have embarked on a major media program to alert the nation to the dangers of flooding and the attention that must be paid to its mitigation. Consideration should be given to development of a similar program for dam safety or the integration of the dam safety message into the larger flood message that FEMA already uses.

Limited Resources

Concern exists within the dam safety community that any diversion of resources to outreach will have undesirable consequences on the other components of the NDSP. Recognizing this competition, it will be important to develop joint and creative solutions to risk communications that leverage partnerships, pool resources, expand incentives, and demonstrate return on investment and

benefit for all involved. These solutions should take full advantage of existing flood risk awareness programs of downstream governments that are funded by other programs.

RECOMMENDATION: The public is not familiar with the NDSP and is generally unaware of the potential risks they face in living below a dam and what actions have been taken to mitigate these risks. They and public officials are also generally unaware of the existence of and reasons for dam safety programs and as a result express little concern about and little support for these programs. The NDSP needs to develop, in conjunction with other FEMA activities and related Federal and State activities, an outreach strategy that would work in a collaborative manner to remedy these challenges.

Hazard and Risk Classifications

In 1994, the ICODS established a task group to review existing hazard classification systems for dams and to propose a new system given that there were several systems in existence and that the systems appeared to be overly complex. The task group proposed the establishment of a three-level system as shown in Table 6.

Table 6. Three-Level Classification System

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None Expected	Low and generally limited to owner
Significant	None Expected	Yes
High	Probable, one or more expected	Yes (but not necessary for this classification)

Source: FEMA 333, *Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams*, October 1998

The hazard potential classification system that was developed met the intent of the charter: to be simple, clear, concise, and adaptable to any agency's system. The intent was to provide straightforward definitions that could be "applied uniformly by all federal and State dam safety agencies and can be readily understood by the public."

This classification system has well served the dam safety community over a period of nearly 17 years and enabled the rapid classification of thousands of high- and significant-hazard potential dams. While its simplicity has been a virtue, the system has also created an undifferentiated system within the classification areas. As the team emergency management consultant, Mr. Hans Kallam, points out, a large dam that threatens a major community receives the same classification as a more modest one that threatens a single occupied structure below it (see Appendix I).

Over the same period, resources for maintenance and remediation of dams have become less available, the complexity of inspections has increased, and the number of inspectors available to evaluate dam safety has remained low. The need to establish consequence-based priorities has emerged.

All high-hazard dams are not equal in terms of the risks they pose considering both their probability of failure or unintended operation and the consequences that would result. As indicated earlier, post-Katrina examination of levees across the country has revealed the same challenges and has resulted in the acknowledgment within the dam and levee safety community that attention must be paid to those structures that offer the most significant threat to those below or above them.

In a subsequent section, use of contemporary assessment techniques is discussed. A revised hazard classification system needs to be based on more current concepts of risk and public policy that address both the chance of dam failures and a more nuanced measure of the potential consequences for economic losses and potential loss of life. Such approaches are in widespread use in Europe, the Commonwealth countries, and by U.S. Federal agencies.

Recommendation: ICODS should charter an appropriate task group to develop a classification system that is based on a risk informed gradation of probability and consequence and that would permit prioritization of dam safety activities based on the risks. As the first step, low-cost methods to expediently evaluate possible consequences of dam failure or unintended operation should be developed and the information provided used as a surrogate for the eventual, more comprehensive risk potential information.

State Assistance Eligibility Criteria

Current FEMA funding to the States through the NDSP is based on the number of dams in the State's inventory. This is straightforward and easily judged, but may not optimally distribute funding. On the other hand, NDSP grants are small compared to the operating needs of most State dam safety offices, and the current application process is time-consuming and demanding. Federal grant programs should incentivize good programs and good behavior, but more complex eligibility criteria may be counterproductive unless the impact of the resulting grants significantly impacts State programs. Many State officials prefer greater simplicity and fewer eligibility criteria, and further argue that eligibility criteria should not be designed to micro-manage State programs. Some officials, principally from smaller States, argue that minimum assistance should be given to all States regardless of eligibility criteria.

Modest modifications could be weighted toward numbers of high-hazard or high-risk dams or the numbers of deficient dams. However, the number of deficient dams often has more to do with infrastructure funding from State legislatures, dam owner resources, and State enforcement. Many State officials argue that simplicity in eligibility criteria and an efficient application process are essential.

Among the criteria suggested by survey respondents to reflect success of State programs and thus continuing eligibility for participation in the program are the following:

- States should show that they are inspecting dams regularly and requiring compliance with the State safety regulations.
- Programs should be run in compliance with a State's authorizing legislation if effective, or efforts made to strengthen the authorities if deficient.
- Programs should engage local communities ("in some States there are local agencies that probably can do a better job than the State office").

Programs should be judged by improvements in relationship to the size and budget of the program. A percentage of EAPs for dams in the State, inspector/dam ratio, number of dams inspected linked to quality of the inspection, number of high-hazard dams, and active mitigation on dams.

Other things that could be considered in reviewing criteria for participation in continuing eligibility could include consistency in design requirements criteria for aging dams; better inspections, enforcement, and assistance to ensure that EAPs are prepared and understood by emergency management; and closer ties between emergency management and dam safety programs at State and local levels.

Each State should show that it meets a minimum standard for funding, staffing, and regulatory practices. It must show that it is getting dams inspected regularly within a reasonable time. It must show that it has EAPs in place for a minimum percentage of high-hazard dams. States should show that dam owners are completing repairs identified during inspections or are removing their dams. The repairs should be completed within a reasonable, well-defined timeframe or the States should levy meaningful fines or otherwise pursue enforcement. Criteria for eligibility of Federal assistance might be expanded to include not only rehabilitation of existing high-hazard dams, but also in addressing significant and low-hazard structures by implementing measures that would prevent hazard creep, such as buyouts or development controls of areas below and above structures, that could lead to problems later down the road.

RECOMMENDATION: Criteria for eligibility to participate in the annual NDSP grant program should be kept simple. Complex eligibility criteria may be counterproductive, especially for smaller States. At a minimum, however, States should show that they are inspecting dams regularly and are requiring dam owners and operators to be in compliance with State safety regulations. Each year the Board should review reports of the States and determine whether the programs being executed are adequate.

Metrics

A majority of management experts will attest that “if you do not measure it, you will not get it.” Current metrics have evolved that paint a fair portrait of the progress being made by States with respect to the primary objectives of the NDSP. The metrics emphasize the frequency and scope of inspections, the completion of EAPs, and the identification of and remedial actions for dams specified to be deficient with respect to safety. The ASDSO has tracked the metrics and provided meaningful performance assessments for the States.

This same set of metrics could be enhanced to include some index of the quality of the information and the actions taken. This would be particularly relevant to EAPs. For example, are they exercised; do they include appropriate outreach or consideration of consequence management with respect to downstream communities?

The next generation metrics should add risk. Current taxonomy that separates dams into categories of high-, significant-, and low-hazard potential focuses on the types of potential consequences, but not the likelihood or magnitude of losses (risk). Routinely adding the condition (in terms of reliabil-

ity) of dams and the magnitude of losses given a failure event would provide a more powerful decision aid for prioritizing inspections, maintenance, and rehabilitation.

The good news is that there are a number of new risk assessment tools and methods emerging that would at least provide a screening level of information. Unfortunately, there is a huge gap between the relatively simple screening tools and the full-blown quantitative risk assessment approaches. Few if any intermediate-level methods exist at present. Risk would also provide a significant tie between dam performance and downstream community resilience and preparedness.

RECOMMENDATION: FEMA should formally adopt performance metrics to monitor progress toward the major objectives of the NDSP. The metrics should evolve to include risk and become a component of the calculus of NDSP budgeting and resource allocation to include grants, research, and training.

Dam Safety Assessments

A challenge facing State dam safety organizations is conducting high-quality inspections of large numbers of dams within the limited funding and limited numbers of professional staff at the disposal of the organization. This situation can differ considerably from that faced by Federal dam safety organizations. More than 80 percent of respondents to the survey of stakeholders indicated that the NDSP has been “successful” or “very successful” in ensuring the use of acceptable engineering policies and procedures. This is success that can be built upon. It is important to highlight that not all dams with significant- or high-hazard potential are being monitored or regulated. Missouri, for example, restricts its oversight to dams with heights over 30 ft. Other States do not oversee embankments associated with mining operations, and still others have recently attempted to exclude some categories of dams or embankments (e.g., Virginia). While this management of the scope of State programs certainly assists in management and budgeting of programs, it creates a significant blind spot and source of undocumented risk. The NDSP may be the only opportunity (perhaps in association with ASDSO) to define this risk and attempt to develop a strategy to address it.

USBR, USACE, and FERC have invested significantly in developing tools for evaluating dam safety. These are mature, tested, and practical. But these are too complex and expensive for routine use in State-level inspections and assessments. It is not unusual for a dam safety assessment of a large Federal dam to cost well into the hundreds of thousands of dollars. This cost cannot be afforded at the State level. There is a need to develop simpler approaches, guidance, and training to support dam safety evaluation for use at the State level.

Risk-informed approaches are needed for ranking priority inspections and making regulatory decisions, especially for smaller dams. The decisions made by dam safety organizations involve public costs that should be balanced against alternate public purposes and optimized even within the narrower purview of dam safety. Federal agencies have invested significantly in developing risk analysis methodologies for dam safety, but these also are too complex for State-level use. Nevertheless, the advantages of a risk-informed approach are real and increasingly recognized in the field. Developments at the Federal agency level should be built upon to create a practical, cost-effective, and

uniform risk-informed protocol for State-level programs. Documented guidance and training are needed to build technical capacity at State and local levels, and within the consulting engineering community. One of the deficiencies mentioned by respondents to the stakeholder survey is the inadequate supply of experts to support local dam safety assessments, especially given the increasing use of risk-informed methods. The NDSP can develop programs to address these shortfalls.

Better analysis tools are of two types: Those that help assess the likelihood of dam failure, and those that assess potential downstream consequences. Reasonably good progress has been made on the latter category resting on developments in inundation mapping and damage estimation (e.g., HAZUS) arising out of the NFIP. These continue to develop and to become more cost-effective with time. Less progress has been made on the former category, and the appraisal of likelihoods of failure is less amenable to automation than is the appraisal of consequences. FEMA has invested in developing simple (and public-domain) risk-ranking tools for use by the States, but further development is needed to produce tools that deliver approximate, relatively inexpensive, but evidence-based appraisals of the likelihoods of dam failure. Other agencies and jurisdictions have developed such more advanced tools. Examples include the USACE's and USBR's Screening Portfolio Risk Analysis tool and the Province of Ontario's Dam Safety Prioritization Tool. Lessons learned from these developments could profitably be applied to the NDSP.

RECOMMENDATION: FEMA's efforts to develop simple, low-cost, analytic tools to support State dam safety offices in risk-informed dam safety evaluations should be continued and leveraged by learning lessons from similar efforts at Federal agencies and other political jurisdictions inside and outside the United States.

Reporting

Section 11 of the Act requires FEMA to submit a report to Congress, not later than 90 days after the end of each odd-numbered fiscal year, describing the status of the program and progress that has been achieved and providing recommendations for legislative or other action. FEMA prepared biennial reports in 2005 and 2007 but has yet to submit the 2009 report. These reports tend to be descriptions of the utility of dams, the general nature of the dam safety program at both the national and State level, and some statistics about existing dams. They have not represented a critique of the Federal or State dam safety programs and have not identified the issues that are being faced at both the Federal and the State levels. They have not provided an appraisal of where the country stands with respect to dam safety.

If the biennial report is to be of any service to the Administration, the Congress, the States, and the nation, it must be timely and uncompromising. It is difficult for State dam safety administrators to get tough issues in front of their State executive and legislature, just as raising issues to Congress is often frowned upon within the Executive Branch at the national level. The changing conditions ahead represent threats to continued dam safety and must be identified and addressed at Federal

and State levels, and the report offers an appropriate vehicle for bringing the challenge to the attention of national leadership.

In between submission of annual reports, issues may arise that merit direct contact between FEMA and State leaders. On occasion letters are sent from FEMA to governors pointing out specific problems within their States. Such communications, when they not only point out deficiencies but offer advice on potential solutions, provide strong support to meeting the objectives of the NDSP. Political sensitivities should not be permitted to reduce the use of this communications channel.

RECOMMENDATION: The NDSP biennial report must be a timely, accurate, and uncompromising report to the nation on the status of the programs and dams. When problems arise FEMA must be prepared to directly communicate concerns to the States and to the public.

Special Purpose Impoundments

Modern interest in dam safety began with the 1972 failure of a coal slurry impoundment in Buffalo Creek, West Virginia, resulting in the death of 125 persons and the destruction of more than 500 homes. Today, there are many impoundments similar to the Buffalo Creek structure located across the country. Some are related to extraction of coal and other material; others store liquids from movement of slurry, waste material from water treatment, and water used in operations such as hydraulic fracturing. Some of these facilities are very large. The Sundial, West Virginia, coal waste impoundment contains more than 2.8 billion gallons of sludge. In 2000, when the coal sludge impoundment of a mine in Martin County, Kentucky, broke through to an abandoned underground mine, more than 3 million gallons of sludge made its way into nearby creeks and rivers. When TVA's Kingston Energy Plant's fly ash impoundment failed in 2008, more than 1.1 billion gallons of fly ash slurry spilled into nearby rivers, creating an environmental incident and damaging homes in its path. The 2010 failure of a sludge containment facility at an aluminum plant in Hungary sent millions of gallons of toxic material down on nearby villages, killing three persons and injuring 123 others. The material eventually entered the Danube River, creating significant pollution problems.

Several people interviewed and respondents to the survey indicated that not all States include oversight of some of these types of impoundments in their programs (and some are legislatively prohibited from including them) and expressed concern that there is a significant potential for hazardous impoundments to go uninspected by either Federal or State officials.

The National Dam Safety Act of 2006 defines dams as "any artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water" and, subject to some specific exceptions, is more than 25 feet high and impounds more than 50 acre-feet. It also permits the FEMA Administrator to include in the definition, any structure that "is likely to pose a significant threat to human life or property if the barrier fails..."

The Surface Mining Control and Reclamation Act of 1977 assigns the Office of Surface Mining in the Department of the Interior with the responsibility of permitting all existing and new coal mine

waste piles consisting of mine wastes, tailings, coal processing wastes, or other liquid and solid wastes, and used either temporarily or permanently as dams or embankments. The Federal Mine Safety and Health Act of 1977 (Mine Act), Public Law 91-173, directs the “Secretary of Labor to make inspections of underground and surface coal mines in their entirety.” Impoundment facilities, retention dams, and tailings ponds are included in the definition of a coal mine... and are required to be included in these inspections. Under the Federal Power Act, FERC exercises “oversight of design, construction, operation, maintenance, use, repair, or modification” of water power projects or project works. Under its regulations a dam is defined as “any structure for impounding or diverting water.”

The operation of hazardous impoundments without some form of oversight would be contrary to the spirit if not the letter of the above legislation and the intent of the NDSP. The increasing use of impoundments for new natural resource extraction activities and waste material storage may be creating new hazards for those downstream of the activities.

RECOMMENDATION: The Board, ICODS, and the NDSP office, in coordination with the States, should carefully review the oversight of special purpose impoundments to ensure that any structures creating hazardous situations fall within the oversight responsibilities of an appropriate Federal or State activity.

Emergency Planning

The safety of those living and working below a dam is highly dependent not only on the integrity of the dam, but also on the quality of the EAP that would be put into play in the event of a potential dam failure and the effectiveness of the emergency management program that must exercise the EAP. Over the last few years, there has been a significant effort on the part of State and Federal dam safety officials to increase the number of EAPs in place for high-hazard dams. Unfortunately, it would appear that, in many cases, the connection between those preparing the EAPs and emergency management personnel is limited and that joint exercise of the plans by owners/operators and emergency management personnel is rare. In almost every case, the preparation of the EAP is accomplished by the owner/operator with the assistance of the dam safety personnel with little involvement by the emergency management structure. In at least one State, however, responsibility for EAP preparation has been assigned to the State emergency management organization, which not only works with the plan but is also responsible for the exercise of the plan.

The team’s emergency management consultant, Hans Kallam, finds that at the State level, dam safety officials are frequently separated from State emergency management officials and as a result coordination between the two is limited (see Appendix I). He points out that at Federal and State levels there is need for greater collaboration between stakeholders in the dam safety and emergency management communities and increased participation by the latter in dam safety planning. Interviews with those in the emergency management field see that EAPs are more focused on operations at the dam and not linked to activities and the community level. FEMA’s current efforts to link the dam safety program with FEMA preparedness activities should greatly assist in integrating EAP preparation and use into the overall emergency management community. Dam owners/operators

must gain familiarity with the National Incident Management System (NIMS) that is used by emergency management personnel nationwide.

It is also important for operators of dams to recognize that preparation of an EAP is more than just an administrative responsibility. The team legal consultant, Mr. Denis Binder, in reviewing case law with respect to documents such as the EAP, points out the importance of the EAP in lessening the impact of a dam failure (see Appendix F). Were an owner's EAP to fail in its execution because of poor planning, inadequate testing, or lack of updates, the owner might well be exposed to attendant liability.

RECOMMENDATION: Success in reducing human losses and property damages in a dam failure is to a large degree dependent on the strength of the collaboration between dam safety officials and owners and the emergency management personnel who on a day-to-day basis must deal with disastrous events. The linkage between these two groups must be improved through joint exercises, collaborative planning, and continuous association. Current FEMA efforts to more closely link dam safety and emergency management are moving in the correct direction. Dam safety activities, particularly EAPs should be aligned with NIMS.

Information Security

Those living or working below dams and those responsible for evacuating the same individuals in the event of a potential or real dam failure have a vested interest in knowing the nature of the risk they are taking or with which they must deal. There is a distinct difference between deciding to live below a dam whose condition is excellent and one whose condition is marginal or unsatisfactory. The seriousness with which an individual plans for dealing with an emergency is directly reflected in his or her knowledge about the risk. If the risk is great and that fact is known to them, affected parties are much more likely to be better prepared in the event of an incident.

At present, information on dam condition contained in the NID is not releasable to the public. The decision not to release this information is administrative. According to the USACE, "The searchable database comprising the NID (National Inventory of Dams) concerns dams that meet the definition of 'critical infrastructure' as defined by the USA Patriot Act of 2001 [...]" and "[...] contains certain information that constitutes a vulnerability assessment."¹⁰

In the past, media representatives unsuccessfully have sought access to the restricted data. In requesting the information it noted that, in the face of major flood incidents, the public has a need to know this information. If the information in the database does in fact identify vulnerabilities in selected dams, it is difficult to justify withholding that information from the public that may be direct-

¹⁰ The DHS, Security Classification Guide, "Protection of Critical Infrastructure and Key Resource Information for Dams and Related Facilities" (DHS SCG OS-003, Oct 2004) is the definitive document that outlines the constraints on management of sensitive information concerning dams and is the basis for the USACE management of the information in the NID.

ly affected by this vulnerability. No assessments have been made of the relative vulnerability to the hostile activity versus the vulnerability to the public. Knowledge that a particular dam's condition was unsatisfactory would create local support for remediation of the conditions that created the unsatisfactory rating and might well effectively emphasize to public officials the need for support of dam safety. Limiting access to this information to emergency management officials, puts them into the position of withholding important information from their clients, the public, and could threaten the development of needed trust.

RECOMMENDATION: For outreach and emergency management activities to be successful, both the public and public officials must have open access to information concerning the location and condition of the structures that affect them. The present limitations within the NID and State programs on public access to dam condition information is a barrier to public safety and must be addressed.

Strategic Plan

The Act directs the FEMA Administrator to prepare (and by inference) maintain, a strategic plan to establish goals, priorities, and performance measures to assist in the administration of the Act and to establish cooperation and coordination with assistance to interested governmental entities in all States. The NDSP office, in coordination with the Board, is in the process of developing the Strategic Plan for the NDSP. We have reviewed the working documents—vision, mission, goals and objectives, and performance measures—now under consideration and are concerned that as a whole the documents do not provide a clear path forward for the NDSP. Strategic plans are difficult to prepare because they must contain high-level aspirational visions, missions, and goals, as well as the more specific objectives to be accomplished within the near term.

The working documents are a reasonable first step toward development of the plan, but at this point do not meet the needs of the NDSP. In some aspects, the plan under consideration does not reflect the necessity for the NDSP to be tied closely to the floodplain and emergency management communities as well as the public at large and to develop a strategic approach to communications and awareness. In other cases, the objectives are insufficiently specific leading to the development of inadequate performance measures. Of greater concern, the NDSP is operating without a plan at a point in its history where the availability of such guidance would be of great utility. We are also concerned that the process of developing the plan has been insufficiently open and as a result the planning effort has not brought into the process relevant stakeholders noted in the authorizing legislation. The review team will provide specific comments on the working documents directly to the Program office.

RECOMMENDATION: The NDSP should move rapidly, in a collaborative manner, to complete preparation of its strategic plan and should, in its preparation, take into account the recommendations of this report.

The National Dam Safety Act

We have reviewed the National Dam Safety Act of 2006 to determine if, based on information gathered in this study process, changes in the Act should be considered. The Act in force appears to pro-

vide the FEMA Administrator with sufficient authority to carry out the missions envisioned in the purpose section of the legislation and specified in the program objectives. The stated purpose of the Act focuses on reduction of the risks to life and property from dam failures and does not limit activities under the Act to just dams. There are several sections where the wording should be “modernized,” but the absence of this wording does not directly impact any of the critical content of the document.

RECOMMENDATION: Other than to deal with authorizations of appropriations, there is no pressing need for an immediate rewrite of the Act. However, when it becomes necessary to modify the Act for any reason, several sections of the report can be modified to accommodate contemporary language and intentions.

Focusing Research and Development

Future research and development should be driven by specific bottom-up derived needs of dam safety operators and top-down big picture objectives. The strategy will have to include a more deliberate effort to leverage ongoing research in Federal agencies, academia, and non-governmental organizations. One option might be to mimic the R&D model of the Center for Energy Advancement through Technological Innovation (CEATI), which solicits funds from stakeholders interested in a specific research product. Another option would be for FEMA (and Congress) to significantly increase resources (people and dollars) available for management of the programs and have the Board and its research working group take on a more general oversight role rather than hands-on management of projects. The key issue is that a different business model involving more funding sources and greater levels of coordination and integration of efforts will require more management. With reduced funding, resources should be focused entirely on transitioning emerging technologies and capabilities from Federal and academic programs into products useful to the State dam safety programs, and especially to those topics that will maintain state-of-art training. These investments will to some extent be limited to the emerging technologies available and must be guided by a more comprehensive overarching vision and strategy for the NDSP.

RECOMMENDATION: NSDP R&D is at an inflection point. Recent FEMA-hosted summits have broadened the scope of research interests to appropriately include upstream and downstream factors; however, no additional resources are available to cover these topics. The NDSP will need to develop and implement a new strategy and management model to address these expanded needs.

CHAPTER FIVE - CONCLUSIONS

Introduction

Chapter Three provided observations on the current status of the NDSP and how well it has achieved the objectives of the Dam Safety Act. Chapter Four examined challenges currently facing the NDSP and offered recommendations on how to deal with these challenges. Rather than restating the multiple observations, findings, and recommendations of the earlier chapters, this chapter identifies six overarching conclusions that represent the team's collective evaluation of the state of the NDSP.

The Conclusions

1. The NDSP has been a positive influence in improving the status of dam safety in the nation. Given the limited resources available and its modest status within FEMA, the NDSP has had a significant impact. It should be continued. While the NDSP has been an effective force, ironically, due to aging infrastructure, low investments, and environmental change, the risk of losses continues to increase and will not be arrested without significant attention at leadership levels of the Federal and State governments.
2. The NDSP requires strong leadership to bring together the professional talents of the Board, ICODS, and the National Program office in a collaborative effort with State dam safety officials, dam owners, and Federal and State agencies with responsibilities for emergency and floodplain management. This will necessitate active participation of senior FEMA leaders in both a management and an advocacy role and the stabilization of program resources at current or higher levels. FEMA should seek a new framework for collaboration among stakeholders to better leverage funding in related domain areas such as security and emergency management.
3. The NDSP and its impact are limited by its strategic vision. Although the current governance model is adequate, the program must focus on the continued evolution of a holistic long-term strategic approach to dam safety within the Federal and State communities that fully incorporates emergency and floodplain management. This expansion in scope should in no way dilute the important efforts focused on preventing dam failures. The Board and ICODS have migrated toward operational issues with less focus on the big picture. These bodies host extensive expertise within the domain of dam safety, and going forward, they need to invest their unique talents in an effective vision for the larger program.
4. The current framework for classifying dams and establishing standards for their safety has served the nation well but is outmoded and too simplistic. To meet the needs of the future, this classification framework should embrace a risk-informed and holistic approach that incorporates the condition of dams and the potential consequences of dam failures.

5. State grants and training have been the most beneficial aspects of the program. Emphasis on supporting State programs is appropriate and should continue. Criteria for eligibility to participate in the annual NDSP grant program should be kept simple, but States should show that they are inspecting dams regularly and requiring dam operators to comply with State safety regulations.

6. Efforts to create public awareness and to reach out to those affected by dams lag other aspects of the NDSP. This situation also reduces the effectiveness of and support for emergency planning. Because the public is ignorant of dam safety issues, its support of these programs is also diminished. The NDSP should take advantage of the outreach experiences of the NFIP and the National Earthquake Hazards Reduction Program (NEHRP)—and most recently the RiskMAP effort—to partner with these activities and build on their successes

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Appendix B: List of Acronyms and Abbreviations

ASCE	American Society of Civil Engineers
ASDSO	Association of State Dam Safety Officials
ASFPM	Association of State Floodplain Managers
Board	National Dam Safety Review Board
CEATI	Centre for Energy Advancement Through Technological innovation
CEM	Certified Emergency Manager
CFM	Certified Facility Manager
DHS	Department of Homeland Security
DSA	Dam Safety Act of 1986
EAP	Emergency Action Plan
EMI	Emergency Management Institute
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIMA	Federal Insurance and Mitigation Administration
ICODS	Interagency Committee on Dam Safety
NDIA	National Dam Inspection Act
NDSP	National Dam Safety Program
NEHRP	National Earthquake Hazard Reduction Program
NFIP	National Flood Insurance Program
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
OMB	Office of Management and Budget
PE	Professional Engineer
R&D	Research and Development
RiskMAP	Risk Mapping, Assessment, and Planning
RWG	Research Working Group
SES	Senior Executive Service
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
WRDA	Water Resources Development Act

Appendix C: National Dam Safety Act of 2006

SEC. 215. NATIONAL DAM SAFETY PROGRAM.

(a) **PURPOSE.**-The purpose of this section 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. It is not the intent of this section to preempt any other Federal or State authorities nor is it the intent of this section to mandate State participation in the grant assistance program established under this section.

(b) **EFFECT ON OTHER DAM SAFETY PROGRAMS.**-Nothing in this section (including the amendments made by this section) shall preempt or otherwise affect any dam safety program of a Federal agency other than the Federal Emergency Management Agency, including any program that regulates, permits, or licenses any activity affecting a dam.

(c) **DAM SAFETY PROGRAM.**-This Act entitled "An Act to authorize the Secretary of the Army to undertake a national program of inspection of dams," approved August 8, 1972 (33 U.S.C. 467 *et seq.*) is amended [as follows.]

(d) **CONFORMING AMENDMENT.**-Section 3(2) of the Indian Dams Safety Act of 1994 (25 U.S.C. 3802(2); 108 Stat. 1560) is amended by striking "the first section of Public Law 92-367 (33 U.S.C. 467)" and inserting "section 2 of the National Dam Safety Program Act."

SEC. 1. SHORT TITLE; AMENDMENT OF NATIONAL DAM SAFETY PROGRAM ACT.

(a) **SHORT TITLE.**- This Act may be cited as the 'Dam Safety Act of 2006.'

(b) **AMENDMENT OF NATIONAL DAM SAFETY PROGRAM ACT.**-Except as otherwise expressly provided, whenever in this Act an amendment or repeal is expressed in terms of an amendment to, or a repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of the National Dam Safety Program Act (33 U.S.C. 467d *et seq.*)

SEC. 2. DEFINITIONS.

In this Act, the following definitions apply:

(1) **BOARD.**-The term 'Board' means a National Dam Safety Review Board established under section 8(f)."

(2) **DAM.**-The term 'dam'-

(A) means any artificial barrier that has the ability to impound water, wastewater, or any liquid-borne material, for the purpose of storage or control of water, that-

(i) is 25 feet or more in height from-

(I) the natural bed of the stream channel or watercourse measured at the downstream toe of the barrier; or

(II) if the barrier is not across a stream channel or watercourse, from the lowest elevation of the outside limit of the barrier; to the maximum water storage elevation; or

- (ii) has an impounding capacity for maximum storage elevation of 50 acre-feet or more; but
- (B) does not include-
 - (i) a levee; or
 - (ii) a barrier described in subparagraph (A) that-
 - (I) is 6 feet or less in height regardless of storage capacity; or
 - (II) has a storage capacity at the maximum water storage elevation that is 15 acre-feet or less regardless of height; unless the barrier, because of the location of the barrier or another physical characteristic of the barrier, is likely to pose a significant threat to human life or property if the barrier fails (as determined by the Director).
- (3) **DIRECTOR.**-The term 'Director' means the Director of FEMA.
- (4) **FEDERAL AGENCY.**-The term 'Federal agency' means a Federal agency that designs, finances, constructs, owns, operates, maintains, or regulates the construction, operation, or maintenance of a dam.
- (5) **FEDERAL GUIDELINES FOR DAM SAFETY.**-The term 'Federal Guidelines for Dam Safety' means the FEMA publication, numbered 93 and dated June 1979, that defines management practices for dam safety at all Federal agencies.
- (6) **FEMA.**-The term 'FEMA' means the Federal Emergency Management Agency.
- (7) **HAZARD REDUCTION.**-The term 'hazard reduction' means the reduction in the potential consequences to life and property of dam failure.
- (8) **ICODS.**-The term 'ICODS' means the Interagency Committee on Dam Safety established by section 7.
- (9) **PROGRAM.**-The term 'Program' means the national dam safety program established under section 8.
- (10) **STATE.**-The term 'State' means each of the several States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, Guam, American Samoa, the Commonwealth of the Northern Mariana Islands, and any other territory or possession of the United States.
- (11) **STATE DAM SAFETY AGENCY.**-The term 'State dam safety agency' means a State agency that has regulatory authority over the safety of non-Federal dams.
- (12) **STATE DAM SAFETY PROGRAM.**-The term 'State dam safety program' means a State dam safety program approved and assisted under section 8(e).
- (13) **UNITED STATES.**-The term 'United States,' when used in a geographical sense, means all of the States.

SEC. 3. INSPECTION OF DAMS

- (a) **IN GENERAL.**-As soon as practicable, the Secretary of the Army, acting through the Chief of Engineers, shall carry out a national program of inspection of dams for the purpose of protecting human life and property. All dams in the United States shall be inspected by the Secretary except (1) dams under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, or the International Boundary and Water Commission, (2) dams which have been constructed pursuant to licenses issued under the authority of the Federal Power Act, (3) dams which have been inspected within the twelve-month period immediately prior to the enactment of this Act by a State agency and which the Governor of such State requests be excluded from inspection, and (4) dams which the Secretary of the Army determines do not pose any threat to human life or property. The Secretary may inspect dams that have been licensed under the Federal Power Act upon request of the Federal Power Commission and dams under the jurisdiction of the International Boundary and Water Commission upon request of such Commission.
- (b) **STATE PARTICIPATION.**-On request of a State dam safety agency, with respect to any dam the failure of which would affect the State, the head of a Federal agency shall-
- (1) provide information to the State dam safety agency on the construction, operation, or maintenance of the dam; or
 - (2) allow any official of the State dam safety agency to participate in the Federal inspection of the dam.

SEC. 4. INVESTIGATION REPORTS TO GOVERNORS.

As soon as practicable after inspection of a dam, the Secretary shall notify the Governor of the State in which such dam is located of the results of such investigation. The Secretary shall immediately notify the Governor of any hazardous conditions found during the inspection. The Secretary shall provide advice to the Governor, upon request, relating to the timely remedial measures necessary to mitigate or obviate any hazardous condition found during an inspection.

SEC. 5. DETERMINATION OF DANGER TO HUMAN LIFE AND PROPERTY.

For the purpose of determining whether a dam (including the waters impounded by such dam) constitutes a danger to human life or property, the Secretary shall take into consideration the possibility that the dam might be endangered by overtopping, seepage, settlement, erosion, sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboards, gates on conduits, or other conditions which exist or which might occur in any area in the vicinity of the dam. [Section 5]

SEC. 6. NATIONAL DAM INVENTORY.

The Secretary of the Army shall maintain and update information on the inventory of dams in the United States. Such inventory of dams shall include any available information assessing each dam based on inspections completed by either a Federal agency or a State dam safety agency.

SEC. 7. INTERAGENCY COMMITTEE ON DAM SAFETY.

- (a) **ESTABLISHMENT.**-There is established an Interagency Committee on Dam Safety-

(1) comprised of a representative of each of the Department of Agriculture, the Department of Defense, the Department of Energy, the Department of Interior, the Department of Labor, FEMA, the Federal Energy Regulatory Commission, the Nuclear Regulatory Commission, the Tennessee Valley Authority, and the United States Section of the International Boundary and Water Commission; and

(2) chaired by the Director.

- (b) **DUTIES.**-ICODS shall encourage the establishment and maintenance of effective Federal programs, policies, and guidelines to enhance dam safety for the protection of human life and property through coordination and information exchange among Federal agencies concerning implementation of the Federal Guidelines for Dam Safety.

SEC. 8. NATIONAL DAM SAFETY PROGRAM.

- (a) **IN GENERAL.**-The Director, in consultation with ICODES and State dam safety agencies, and the Board shall establish and maintain, in accordance with this section, a coordinated national dam safety program. The Program shall-

(1) be administered by FEMA to achieve the objectives set forth in subsection (c);

(2) involve, to the extent appropriate, each Federal agency; and

(3) include-

(A) each of the components described in subsection (d);

(B) the strategic plan described in subsection (b); and

(C) assistance for State dam safety programs described in subsection (e).

- (b) **DUTIES.**-The Director shall prepare a strategic plan--

(1) to establish goals, priorities, ~~and target dates~~ to performance measures, and target dates toward effectively administering this Act in order to improve the safety of dams in the United States; and

(2) to the extent feasible, to establish cooperation and coordination with, and assistance to, interested governmental entities in all States.

- (c) **OBJECTIVES.**-The objectives of the Program are to:

(1) 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;

(2) encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness;

(3) encourage the establishment and implementation of effective dam safety programs in each State based on State standards;

(4) develop and encourage public education and awareness projects to increase public acceptance and support of State dam safety programs;

(5) develop technical assistance materials for Federal and State dam safety programs;

- (6) develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector; and
 - (7) develop technical assistance materials, seminars, and guidelines to improve security for dams in the United States.
- (d) **COMPONENTS.-**
- (1) **IN GENERAL.-**The program shall consist of-
 - (A) a Federal element and a non-Federal element; and
 - (B) leadership activity, technical assistance activity, and public awareness activity.
 - (2) **ELEMENTS.-**
 - (A) **FEDERAL.-**The Federal element shall incorporate the activities and practices carried out by the Federal agencies under section 7 to implement the Federal Guidelines for Dam Safety.
 - (B) **NON-FEDERAL.-**The non-Federal element shall consist of-
 - (i) the activities and practices carried out by States, local governments, and the private sector to safety build, regulate, operate, and maintain dams; and
 - (ii) Federal activities that foster State efforts to develop and implement effective programs for the safety of dams.
 - (3) **FUNCTIONAL ACTIVITIES.-**
 - (A) **LEADERSHIP.-**The leadership activity shall be the responsibility of FEMA and shall be exercised by chairing the Board to coordinate national efforts to improve the safety of dams in the United States.
 - (B) **TECHNICAL ASSISTANCE.-**The technical assistance activity shall consist of the transfer of knowledge and technical information among the Federal and non-Federal elements described in paragraph (2).
 - (C) **PUBLIC AWARENESS.-**Public awareness activities shall provide for the education of the public, including State and local officials, in the hazards of dam failures and related matters.
- (e) **ASSISTANCE FOR STATE DAM SAFETY PROGRAMS.-**
- (1) **IN GENERAL.-**To encourage the establishment and maintenance of effective State dam safety programs, to protect human life and property, and to improve State dam safety programs, the Director shall provide assistance with amounts made available under section 13 to assist States in establishing, maintaining, and improving dam safety programs in accordance with the criteria specified in paragraph (2).
 - (2) **CRITERIA AND BUDGETING REQUIREMENT.-**For a State to be eligible for assistance under this subsection, a State dam safety program must be working toward meeting the following criteria and budgeting requirement:

- (A) **CRITERIA.**-A State dam safety program must be authorized by State legislation to include, at a minimum-
- (i) the authority to review and approve plans and specifications to construct, enlarge, modify, remove, and abandon dams;
 - (ii) the authority to perform periodic inspections during dam construction to ensure compliance with approved plans and specifications;
 - (iii) a requirement that, on completion of dam construction, State approval must be given before the operation of the dam;
 - (iv) the authority to require or perform periodic evaluations of all dams and reservoirs to determine the extent of the threat to human life and property in case of failure;
 - (v) (I) 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 to failure to determine the continued safety of the dams and reservoirs; and (II) a procedure for more detailed and frequent safety inspections;
 - (vi) a requirement that all inspections be performed under the supervision of a State-registered professional engineer with related experience in dam design and construction;
 - (vii) the authority to issue notices, when appropriate, to require owners of dams to perform necessary maintenance or remedial work, install and monitor instrumentation, improve security, revise operating procedures, or take other actions, including breaching dams, when necessary;
 - (viii) regulations for carrying out the legislation of the State described in this subparagraph;
 - (ix) provisions for necessary funds-
 - (I) to ensure timely repairs or other changes to, or removal of, a dam in order to protect human life and property; and
 - (II) if the owner of the dam does not take action described in subclause (I), take appropriate action as expeditiously as practicable;
 - (x) a system of emergency procedures to be used if a dam fails or if the failure of a dam is imminent; and
 - (xi) an identification of-
 - (I) each dam the failure of which could be reasonably expected to endanger human life;
 - (II) the maximum area that could be flooded if the dam failed; and
 - (III) necessary public facilities that would be affected by the flooding.

- (B) **BUDGETING REQUIREMENT.**-For a State to be eligible for assistance under this subsection, State appropriations must be budgeted to carry out the legislation of the State under subparagraph (A).
- (3) **WORK PLANS.**-The Director shall enter into an agreement with each State receiving assistance under paragraph (2) to develop a work plan necessary for the State dam safety program to reach a level of performance specified in the agreement.
- (4) **MAINTENANCE OF EFFORT.**-Assistance may not be provided to a State under this subsection for a fiscal year unless the State enters into such agreement with the Director as the Director requires to ensure that the State will maintain the aggregate expenditures of the State from all other sources for programs to ensure dam safety for the protection of human life and property at or above a level equal to the average annual level of such expenditures for the 2 fiscal years preceding the fiscal year.
- (5) **APPROVAL OF PROGRAMS.**-
- (A) **SUBMISSION.**-For a State to be eligible for assistance under this subsection, a plan for a State dam safety program shall be submitted to the Director for approval.
- (B) **APPROVAL.**-A State dam safety program shall be deemed to be approved 120 days after the date of receipt by the Director unless the Director determines within the 120-day period that the State dam safety programs fails to meet the requirements of paragraph (1) through (3).
- (C) **NOTICE OF DISAPPROVAL.**-If the Director determines that a State dam safety program does not meet the requirements for approval, the Director shall immediately notify the State in writing and provide the reasons for the determination and the changes that are necessary for the plan to be approved.
- (6) **REVIEW OF STATE DAM SAFETY PROGRAMS.**-Using the expertise of the Board, the Director may periodically review State dam safety programs. If the Board finds that a State dam safety program has proven inadequate to reasonably protect human life and property and the Director concurs, the Director shall revoke approval of the State dam safety program, and withhold assistance under this subsection, until the State dam safety program again meets the requirements for approval.
- (f) **BOARD.**-
- (1) **ESTABLISHMENT.**-The Director shall establish an advisory board to be known as the 'National Dam Safety Review Board' to monitor the safety of dams in the United States, to monitor State implementation of this section, and to advise the Director on national dam safety policy.
- (2) **AUTHORITY.**-The Board may use the expertise of Federal agencies and enter into contracts for necessary studies to carry out this section.
- (3) **VOTING MEMBERSHIP.**-The Board shall consist of 11 voting members selected by the Director for expertise in dam safety, of whom-
- (A) 1 member shall represent the Department of Agriculture
- (B) 1 member shall represent the Department of Defense

- (C) 1 member shall represent the Department of Interior
 - (D) 1 member shall represent FEMA
 - (E) 1 member shall represent the Federal Energy Regulatory Commission
 - (F) 5 members shall be selected by the Director from among State dam safety officials; and
 - (G) 1 member shall be selected by the Director to represent the private sector.
- (4) **NONVOTING MEMBERSHIP**-The Director, in consultation with the Board, may invite a representative of the National Laboratories of the Department of Energy and may invite representatives from Federal or State agencies or dam safety experts, as needed, to participate in meetings of the Board.
- (5) **DUTIES-**
- (A) **IN GENERAL**-The Board shall encourage the establishment and maintenance of effective programs, policies, and guidelines to enhance dam safety for the protection of human life and property throughout the United States.
 - (B) **COORDINATION AND INFORMATION EXCHANGE AMONG AGENCIES**-In carrying out subparagraph (A), the Board shall encourage coordination and information exchange among Federal and State dam safety agencies that share common problems and responsibilities for dam safety, including planning, design, construction, operation, emergency action planning, inspections, maintenance, regulation or licensing, technical or financial assistance, research, and data management.
- (6) **WORK GROUPS**-The Director may establish work groups under the Board to assist the Board in accomplishing its goals. The work groups shall consist of members of the Board and other individuals selected by the Director.
- (7) **COMPENSATION OF MEMBERS.-**
- (A) **FEDERAL EMPLOYEES.**-Each member of the Board who is an officer or employee of the United States shall serve without compensation in addition to compensation received for the services of the member as an officer or employee of the United States.
 - (B) **OTHER MEMBERS.**-Each member of the Board who is not an officer or employee of the United States shall serve without compensation.
- (8) **TRAVEL EXPENSES.-**
- (A) **REPRESENTATIVES OF FEDERAL AGENCIES**-To the extent amounts are made available in advance in appropriations Acts, each member of the Board who represents a Federal agency shall be reimbursed of appropriations for travel expenses by his or her agency, including per diem in lieu of subsistence, at rates authorized for an employee of an agency under subchapter I of chapter 57 of title 5, United States Code, while away from home or regular place of business of the member in the performance of services for the Board.
 - (B) **OTHER INDIVIDUALS**-To the extent amounts are made available in advance in appropriations Acts, each member of the Board who represents a State agency, the member of the Board who represents the private sector, and each member of a work

group created under paragraph (1) shall be reimbursed for travel expenses by FEMA, including per diem in lieu of subsistence, at rates authorized for an employee of an agency under subchapter 1 of chapter 57 of title 5, United States Code, while away from home or regular place of business of the member in performance of services for the Board.

- (9) **APPLICABILITY OF FEDERAL ADVISORY COMMITTEE ACT.**-The Federal Advisory Committee Act (5 U.S.C.App.) shall not apply to the Board.

SEC. 9. RESEARCH.

- (a) **IN GENERAL.**-The Director, in cooperation with the Board, shall carry out a program of technical and archival research to develop and support-

- (1) improved techniques, historical experience, and equipment for rapid and effective dam construction, rehabilitation, and inspection;
- (2) devices for the continued monitoring of the safety of dams;
- (3) development and maintenance of information resources systems needed to support managing the safety of dams; and
- (4) initiatives to guide the formulation of effective public policy and advance improvements in dam safety engineering, security, and management.

- (b) **CONSULTATION.**-The Director shall provide for State participation in research under subsection (a) and periodically advise all States and Congress of the results of the research.

SEC. 10. DAM SAFETY TRAINING.

At the request of any State that has or intends to develop a State dam safety program, the Director shall provide training for State dam safety staff and inspectors.

SEC. 11. REPORTS.

Not later than 90 days after the end of each odd-numbered fiscal year, the Director shall submit a report to Congress that-

- (1) describes the status of the Program;
- (2) describes the progress achieved by Federal agencies during the 2 preceding fiscal years in implementing the Federal Guidelines for Dam Safety;
- (3) describes the progress achieved in dam safety by States participating in the Program; and
- (4) includes any recommendations for legislative and other action that the Director considers necessary.

SEC. 12. STATUTORY CONSTRUCTION.

Nothing in this Act and no action or failure to act under this Act shall-

- (1) create any liability in the United States or its officers or employees for the recovery of damages caused by such action or failure to act;
- (2) relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam; or
- (3) preempt any other Federal or State law.

SEC. 13. AUTHORIZATION OF APPROPRIATIONS.

(a) NATIONAL DAM SAFETY PROGRAM.-

(1) **ANNUAL AMOUNTS.**-There are authorized to be appropriated to FEMA to carry out sections 7, 8, and 11 (in addition to any amounts made available for similar purposes included in any other Act and amounts made available under subsections (b) through (e)), \$6.5 million for FY07, \$7.1 million for FY08, \$7.6 million for FY09, \$8.3 million for FY10, and \$9.2 million for FY11, to remain available until expended.

(2) ALLOCATION.-

(A) **IN GENERAL.**-Subject to subparagraphs (B) and (C), for each fiscal year, amounts made available under this subsection to carry out section 8 shall be allocated among the States as follows:

- (i) One-third among States that qualify for assistance under section 8(e).
- (ii) Two-thirds among States that qualify for assistance under section 8(e), to each State in proportion to-
 - (I) the number of dams in the State that are listed as State-regulated dams on the inventory of dams maintained under section 6; as compared to
 - (II) the number of dams in all States that are listed as State-regulated dams on the inventory of dams maintained under section 6.

(B) **MAXIMUM AMOUNT OF ALLOCATION.**-The amount of funds allocated to a State under this paragraph may not exceed 50 percent of the reasonable cost of implementing the State dam safety program.

(C) **DETERMINATION.**-The Director and the Board shall determine the amount allocated to States.

(b) **NATIONAL DAM INVENTORY.**-There is authorized to be appropriated to carry out section 6 650,000 for FY07, \$700,000 for FY08, \$750,000 for FY09, \$800,000 for FY10, and \$850,000 for FY11.

(c) **RESEARCH.**-There is authorized to be appropriated to carry out Section 9 1.6 million for FY07, \$1.7 million for FY08, \$1.8 million for FY09, \$1.9 million for FY10, and \$2 million for FY11, to remain until expended.

- (d) **DAM SAFETY TRAINING.**-There is authorized to be appropriated to carry out section 10 \$550,000 for FY07, \$600,000 for FY08. \$650,000 for FY09, \$700,000 for FY10, and \$750,000 for FY11.
- (e) **STAFF.**-There is authorized to be appropriated to FEMA for the employment of such additional staff personnel as are necessary to carry out sections 8 through 10 \$700,000 for FY07, \$800,000 for FY08, \$900,000 for FY09, \$1,000,000 for FY10 and \$1,100,000 for FY11.
- (g) **LIMITATION ON USE OF AMOUNTS.**- Amounts made available under this Act may not be used to construct or repair any Federal or non-Federal dam.

Appendix D: Survey Questionnaire

The survey instrument was developed using *Survey Monkey*,TM a web-based provider of survey solutions. Email invitations to complete the survey were sent to over 600 individuals representing the dam safety, emergency management, floodplain management, and related fields at national, state and local levels. Recipients of the invitation were asked to go to a designated URL where the survey was located and to complete the survey on line. Over 260 surveys were completed. Re and responses were collected by *SurveyMonkey*TM and made available to the review team.

Sixteen percent of the respondents are part of state dam safety offices; 20 percent work with dam safety issues outside of the National Dam Safety Program; 12 percent work in floodplain management; 20% work in emergency management; 11% are dam owners or operators; and 2% are local officials. Nineteen percent of the respondents did not specify an affiliation.

National Dam Safety Program Review

1. Introduction and Respondent Information

The University of Maryland Water Resources Collaborative has been awarded a grant by the Federal Emergency Management Agency to conduct a review and evaluation of the National Dam Safety Program's cost, effectiveness and potential for improvement and its relationship to related supporting and supported programs such as the National Inventory of Dams and State dam safety programs.

This survey is designed to solicit information concerning your opinions on national dam safety. Your name or organization will not be associated your response unless we contact you and you give us permission. We may list the major organizations that have responded.

We would appreciate your assistance in completing the survey. You may complete part of the survey, sign out and then return later to complete, although we would urge you to complete in one session.

If you do not want to answer a particular question or are unfamiliar with the topic, please skip to the next question.

If you have questions, please feel free to contact Dr. Gerry Galloway at gegallo@umd.edu

*** 1. Name**

2. What is the title of your position?

3. Email Address (Optional)

4. In what state is your base of operations?

National Dam Safety Program Review

5. What is your relationship to the National Dam Safety Program (NDSP)?

- My office receives dam safety grants from the NDSP
- I work with dam safety issues outside of the NDSP
- I work in floodplain management and related activities
- I work in emergency management
- I am a dam owner/operator
- I am a local official affected by dam safety issues
- Other (specify below)

Other relationship to NDSP

6. What is your primary discipline? (OPTIONAL RESPONSE)

- Engineering
- Physical Science
- Life Science/Ecology
- Economics
- Sociology
- Anthropology
- Law
- Public Administration
- Other (specify below)

Other discipline (please specify)

2. QUESTIONS

OBJECTIVES.—The National Dam Safety Act of 2006 establishes the objectives of the Act to be:

- (1) 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;
- (2) encourage acceptable engineering policies and procedures to be used for dam site investigation, design, construction, operation and maintenance, and emergency preparedness;
- (3) encourage the establishment and implementation of effective dam safety programs in each State based on State standards;

National Dam Safety Program Review

- (4) develop and encourage public education and awareness projects to increase public acceptance and support of State dam safety programs;
- (5) develop technical assistance materials for Federal and State dam safety programs;
- (6) develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector; and
- (7) develop technical assistance materials, seminars, and guidelines to improve security for dams in the United States.

PLEASE ANSWER THE FOLLOWING QUESTIONS CONCERNING THE NDSP. (Space is provided following each question for you to provide any specific comments you might have relating to the question topic.)

1. In general, do you believe the National Dam Safety Program has been successful in achieving the objectives specified in the NDSP Act?

- Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

2. Do you believe that, over the last decade, the National Dam Safety Program and related State programs have been successful in reducing the threat of dam failures?

- Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

3. What do you see as the principal strengths of the NDSP?

National Dam Safety Program Review

4. What do you see as the principal weaknesses of the NDSP?

THERE ARE SEVERAL ELEMENTS OF THE NDSP. PLEASE RATE THE SUCCESS OF THE NDSP IN CARRYING OUT THE MISSIONS COVERED BY THE FOLLOWING QUESTIONS. (THERE IS SPACE BELOW EACH QUESTION FOR OPTIONAL COMMENTS)

5. The NDSP is successful in ensuring development of programs and procedures to reduce national dam safety hazard.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

6. The NDSP is successful in ensuring use of acceptable engineering policies and procedures.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

7. The NDSP is successful in encouraging the establishment and implementation of dam safety programs in each state.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

National Dam Safety Program Review

8. The NDSP is successful in developing and encouraging public support and acceptance of state dam safety programs.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

9. The NDSP is successful in developing technical assistance materials for federal and State dam safety programs.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

10. The NDSP is successful in developing mechanisms to provide federal technical assistance on dam safety to the non-federal sector.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

11. The NDSP is successful in carrying out a program of technical and archival research.

Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

National Dam Safety Program Review

12. The NDSP is successful in providing training, when requested, for state dam safety staff and inspectors

- Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

FEDERAL AGENCIES CARRY OUT PROGRAMS TO ENSURE THE SAFETY OF DAMS THEY OPERATE OR LICENSE AS WELL AS PROVIDING ADVICE TO STATES AND DAM OWNERS AND OPERATORS. THE FOLLOWING QUESTION ADDRESSES THAT ROLE.

13. Are federal agencies effective in carrying out their roles in improving national dam safety? Please provide any examples of successful activities or gaps in federal programs.

- Very effective Somewhat effective No opinion Somewhat ineffective Ineffective

Examples of Successes and Gaps

National Dam Safety Program Review

THE STATES PLAY A SIGNIFICANT ROLE IN DAM SAFETY. TO BE ELIGIBLE FOR FEDERAL ASSISTANCE, STATES MUST MEET MINIMUM CRITERIA. PLEASE RATE THE SUCCESS OF THE STATES IN MEETING THE FOLLOWING CRITERIA:

(A) CRITERIA.—For a State to be eligible for assistance under this subsection, a State dam safety program must be authorized by State legislation to include, at a minimum—

- (i) the authority to review and approve plans and specifications to construct, enlarge, modify, remove, and abandon dams;
- (ii) the authority to perform periodic inspections during dam construction to ensure compliance with approved plans and specifications;
- (iii) a requirement that, on completion of dam construction, State approval must be given before the operation of the dam;
- (iv) the authority to require or perform periodic evaluations of all dams and reservoirs to determine the extent of the threat to human life and property in case of failure;
- (v) (I) 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 (II) a procedure for more detailed and frequent safety inspections;
- (vi) a requirement that all inspections be performed under the supervision of a State-registered professional engineer with related experience in dam design and construction;
- (vii) the authority to issue notices, when appropriate, to require owners of dams to perform necessary maintenance or remedial work, install and monitor instrumentation, improve security, revise operating procedures, or take other actions, including breaching dams, when necessary;
- (viii) regulations for carrying out the legislation of the State described in this subparagraph;
- (ix) provisions for necessary funds-
- (l) to ensure timely repairs or other changes to, or removal of, a dam in order to protect human life and property; and
- (ll) if the owner of the dam does not take action described in subclause (l), take appropriate action as expeditiously as practicable;
- (x) a system of emergency procedures to be used if a dam fails or if the failure of a dam is imminent; and
- (xi) an identification of:
 - (I) each dam the failure of which could be reasonably expected to endanger human life;
 - (II) the maximum area that could be flooded if the dam failed; and
 - (III) necessary public facilities that would be affected by the flooding.

14. How successful are the states in meeting the above criteria?

- Very Successful Successful No opinion Unsuccessful Very Unsuccessful

Optional Comments

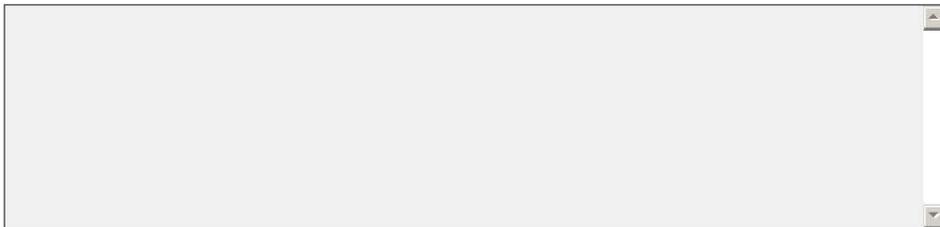
15. In what areas are the states most successful?

16. In what areas are the states least successful?

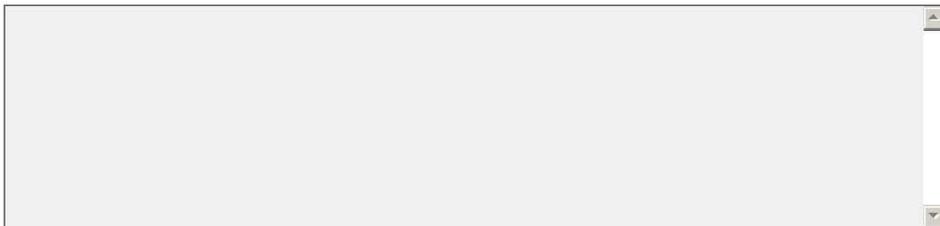
National Dam Safety Program Review

WHILE THE STATES PLAY A SIGNIFICANT ROLE IN DAM SAFETY, EACH STATE OPERATES UNDER ITS OWN PROGRAM. PLEASE ANSWER THE FOLLOWING TWO QUESTIONS CONCERNING THE STRENGTHS AND WEAKNESSES OF STATE PROGRAMS.

17. What are the main attributes of states with effective programs?

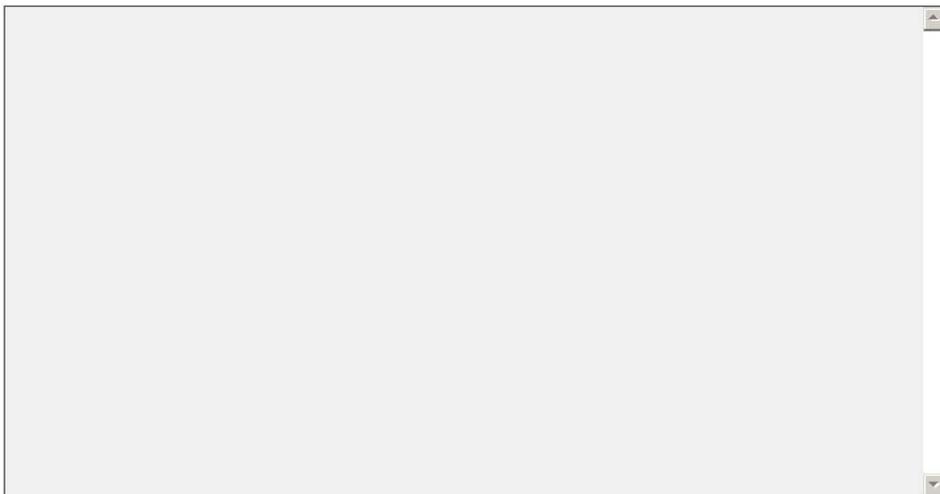
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18. What are the principal gaps for those that do not have effective programs?

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National Dam Safety Program Review

19. What changes, if any, do you believe should be made in the criteria for eligibility for federal assistance in order to make the national program more effective?



The National Dam Safety Program Act established the National Dam Safety Review Board (Board) to monitor State implementation of the program. The Board shall have 4 federal members, 5 members from the states and one from the US Committee on Large Dams. The Act also establishes the Interagency Committee on Dam Safety (ICODS). The ICODS is established to encourage the establishment and maintenance of effective Federal and State programs, policies, and guidelines intended to enhance dam safety for the protection of human life and property through—

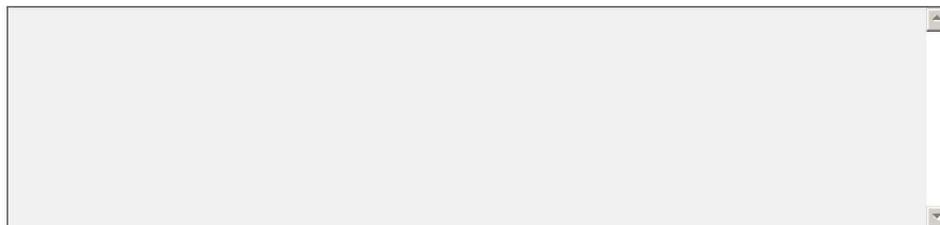
- (1) coordination and information exchange among Federal agencies and State dam safety agencies; and
- (2) coordination and information exchange among Federal agencies concerning implementation of the Federal Guidelines for Dam Safety.

PLEASE ANSWER THE FOLLOWING QUESTIONS PERTAINING TO THE BOARD AND ICODS.

20. How effective do you believe the National Dam Safety Review Board is in carrying out its mission to monitor State implementation current state responsibilities?

- Very effective Somewhat effective No opinion Somewhat ineffective Ineffective

Optional Comments



National Dam Safety Program Review

21. What suggestions would you make concerning the functioning of the Board?

22. How effective do you believe the Interagency Committee on Dam Safety (ICODS) is in carrying out its missions?

- Very effective Somewhat effective No opinion Somewhat ineffective Ineffective

Optional Comments

23. What suggestions would you make concerning the functioning of ICODES?

UNDER THE NATIONAL DAM SAFETY PROGRAM ACT THE SECRETARY OF THE ARMY SHALL MAINTAIN AND UPDATE INFORMATION ON THE INVENTORY OF DAMS IN THE UNITED STATES. SUCH INVENTORY OF DAMS SHALL INCLUDE ANY AVAILABLE INFORMATION ASSESSING EACH DAM BASED ON INSPECTIONS COMPLETED BY EITHER A FEDERAL AGENCY OR A STATE DAM SAFETY AGENCY.

THE FOLLOWING QUESTION PERTAINS TO THE NATIONAL INVENTORY OF DAMS AND ITS ASSOCIATED PROGRAMS.

National Dam Safety Program Review

24. Do you have any comments or suggestions concerning the National Inventory of Dams and its value to the National Dam Safety Program?

THE FOLLOWING QUESTIONS PERTAIN TO THE EFFORTS OF THE NATIONAL DAM SAFETY PROGRAM AND THE DAM SAFETY EFFORTS OF THE STATES.

25. What actions, beyond those already being taken, do you believe could be taken to reduce the risk to life and property from dam failures?

26. Does the public understand and support what the National Dam Safety Program and related state programs are doing?

- Very well Well A little Not Well Not at all

Other (please specify)

National Dam Safety Program Review

27. Do people who live in areas that could be inundated by dam failures or who have an interest in those areas understand the extent of the potential inundation and the risks that exist? If they do not, what could be done to improve their understanding of and preparedness for a potential failure?

Very well Well A little Not Well Not at all

Other (please specify)

28. Do you have any other comments you would like to make about the NDSP?

THANK YOU VERY MUCH FOR YOUR PARTICIPATION IN THIS SURVEY

Appendix E: Establishment of the National Dam Safety Program

Neil F. Parrett

Formerly with the United States Army Corps of Engineers (1957-1978)

Formerly with the United States Bureau of Reclamation (1978-1994)

Discussion on the 1960s and 70s; prior to the *Federal Guidelines for Dam Safety-1979*

The first question I was asked to discuss was philosophy and engineering practice in perspective to dam safety during the period prior to the establishment of the National Dam Safety Program (NDSP).

In the 1960s, the only legislated and staffed dam safety programs were in the States of Arizona and California. Several States had safety of non-Federal dams as an inferred responsibility for their State Engineer. The most formalized Federal agency program with a focus toward dam safety was the Federal Power Commission's licensing review office.

All engineers, whether agency employees or contract engineering firm employees, considered dam safety to be an "inherit responsibility" of the individual designer, construction inspector, or operator. The interfaces between design, construction, and operation activities were usually informal or documented with a transition letter of little if any technical information. As a dam designer, I twice wrote into transfer documents the design philosophies and assumptions and observations of concern during construction that should be observed during operation of the dam. This documentation was not required nor was it a regular practice to produce such a document. Most dams passed across these design-construction and construction-operation transitions with very limited if any documented technical communications.

Interface discussions within the engineering community responsible for dams occurred through professional societies, such as the American Society of Civil Engineers (ASCE), and national and international committees of the International Committee of Large Dams (ICOLD). Numerous other professional associations periodically included programs to present or discuss dam design, construction, and operational subjects. While dam safety was inherent in the subjects, it was not usually the direct subject from a management, program, or technical perspective. It would be addressed only as related to a specific dam failure or incident and evaluated back toward the processes within the responsible organization. The closest experience to only discussing technical problems associated with dam safety was the Corps of Engineers annual geotechnical conference focused on incidences and "lessons learned." This conference had mostly an "in-house" focus, but other Federal agencies regularly sent one to four attendees and occasionally provided a presenter. As a co-MC for this conference, I experienced the most difficulty in keeping presenters willing to be vulnerable about their technical oversights; although I asked participants not to personally accuse the presenters with their comments, some unfortunately did just that.

Federal agencies were required to meet annually to coordinate research studies to verify that overlaps in efforts were not occurring. One year I substituted for the Corps of Engineers geotechnical member. The conference was unique in its predictability in that before departing for the meetings, I was presented a draft copy of the minutes of the sessions I was about to attend. After the actual

meetings, I prepared my minutes with minor editing to two sentences and adding one paragraph of about three sentences. Another personal experience of this period worth mention to illustrate the isolation by agency philosophy of the time took place following a serious seepage incident that occurred during initial reservoir filling at a Federal agency large dam. The incident was reported in *Engineering News Record*, but was not broadly presented nor discussed in the dam design-construct profession. The only Corps of Engineer employee who persisted in visiting the subject dam site was the chief geotechnical engineer in the Corps of Engineers, Missouri River Division. The following week, he, the Chief, Foundations and Materials Branch, Kansas City District and I visited all KC District dams under construction and reviewed all dam designs in progress. The design changes made were extended filter zones and tighter specification controls on materials to be placed in filter zones. This Corps District also instituted for each new dam an informal design review of construction experience and of extent of soil pore pressure dissipation prior to initial reservoir filling and when determined appropriate issued instructions on rate of initial reservoir filling.

Developers of new products, such as filter cloths, geomembranes, and instrumentation devices, frequently visited all Federal agency design offices to influence design policy or selection. Trade organizations also met individually and collectively with Federal agencies to provide information and to present alternative specifications for agency consideration. The most influential was probably the Association of General Contractors (AGC), which confronted the Federal agencies' discrepancies in specification documents from the various agencies.

The second question was to recall what I could related to "founding fathers," behind the scenes, thoughts while participating in establishing the initial NDSP. The purpose for doing this is to identify their expectations, anticipations, and hopes for the NSDP when now considering what should maybe be added going forward in time.

The development of law to establish initial safety of dam practices has always been a legislative response to dam failures experienced. This was true of the first State laws established in the 1930s and each progressive advance in legislation until the NDSP was established within the Federal and State governments.

Before launching into discussion for the NDSP, I want to present the initial Federal legislation for dam safety, which is Public law (P.L.) 92-367, dated 8 August 1972. This law was titled *The National Dam Inspection Act*. It provided the Corps of Engineers authority for several activities associated with dams in the nation, but the only responsibility funded for the years immediately following the bill's passage was for the Corps to facilitate, oversee, and fund when appropriate the activities to establish an inventory of the nation's dams. The inventory provided general information on each named dam's location, purpose, structural features, ownership, and also assigned to each dam in the inventory a hazard classification.

Following additional dam failures in the mid-1970s, President Carter, in a letter dated April 23, 1977, to secretaries of the Interior, Agriculture, and the Army; the Director of Management and Budget; the President's Advisor on Science and Technology; Chairmen, Federal Power Commission, and Tennessee Valley Authority; and Commissioner, U.S. Section, International Boundary and Water Commission asking for several events to begin. The heads of agencies with any responsibilities for dams were to immediately initiate a review in detail of all the technical criteria and management processes being employed and ... "to ensure the adequacy of his agencies dam safety program." The letter requested the Chairmen of the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) to "convene an ad hoc interagency committee to coordinate dam safety

programs, seeking consistency and commonality as appropriate, and providing recommendations as to the means of improving the effectiveness of the Government-wide dam safety effort. The FCCSET effort will include preparation of proposed Federal dam safety guidelines for management procedures to ensure dam safety. ...”

President Carter also requested funding from Congress to launch the additional provisions in P.L. 92-367 and to use the findings from those activities to define the needs for a more comprehensive national dam safety program (Office of the White House Press Secretary, release dated December 2, 1977). By December 30, 1977, the Office of the Chief of Engineers, U.S. Army Corps of Engineers issued Circular No. 1110-2-188 titled, National Program of Inspection of Non-Federal Dams. The four stated objectives in the circular included—

1. Update the National Inventory of Dams.
2. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
3. Provide data for better definition of a viable national dam safety program, including the Federal role.
4. Encourage and prepare the States to initiate quickly effective dam safety programs for non-Federal dams.

The initial response of the members who composed the FCCSET ad hoc committee was the great difficulty of the assigned task for a unified approach because great disparities existed in the practices of dam planning, design, construction, and operations. The breath of difference between agency programs stemmed somewhat from the agencies having very different legislative authorities specified in the Law that assigned to them responsibilities for dams. They also observed the other sources of disparity related to the aspect of “inherent responsibility” of designers, constructors, and operators had resulted in varied approaches influenced by both agency culture and the agency scope of responsibility for dams varying by legislation from near total responsibility to specialized assistance to dam owners. It was accepted that these differences would not be overcome nor resolved easily nor quickly; therefore, the suggestion was made that the goal laid out in the President’s letter must establish some oversight or coordinating responsibility to continue following phase out of the White House office of FCCSET. The recommendation from FCCSET was that such assignment go to the new agency being established, FEMA. FEMA, soon to be established, was a logical choice and was an easier choice to accept than would have been any of the existing Federal agencies.

The FCCSET ad hoc committee decided that developing the assigned federal guidelines for dam safety would establish a tool for better management in dam programs by defining established boundaries for acceptable practice, and that the guidelines could also provide Federal agencies support with congressional sub-committees as they had opportunities for reauthorization or to improve their dam safety programs with minor tweaking toward clarity in authority when submitting supporting documents along with requests for annual funding.

The FCCSET ad hoc committee, made up of high-level representatives from the targeted agencies, organized the teams to draft the Federal Dam Safety Guidelines. The sub-teams were to develop a

draft guideline document for their assigned section of the draft index developed by the FCCSET ad hoc committee. Members to each sub-team were named by their agencies. Each agency could be represented on any sub-team it wished. After sub-teams submitted drafts, all in different formatting, the FCCSET ad hoc committee established one last sub-team to draft guidelines in a single narrative format. This team's work coordinated with chairpersons of the previous sub-teams to maintain management and technical intent into this final proposed draft. This final draft was reviewed by agencies with comments submitted to the FCCSET ad hoc committee for decision. After review and comment by an Independent Review Panel to the FCCSET, the *Federal Guidelines for Dam Safety* (FGDS), dated June 25, 1979, were finally published and distributed from the President's White House Office, Federal Coordinating Council for Science Engineering and Technology.

Discussion on the 1980s implementation of the Federal Guidelines for Dam Safety, dated 1979

By this time, FGDS were published and the Federal agencies were moving to improve management and oversight of dam practices. The Federal agencies had submitted reports of review of the agency dam safety practices to FCCSET by October 1, 1978, and had participated in drafting the Federal Guidelines. The individual agency reviews of practices had highlighted for top managers in the agencies inconsistencies in internal processes and practices, individual project anomalies and problems, and weaknesses in legislative authorities. While top management in Federal agencies was convinced as to needs to improve and change organizational policy and practice toward the Guidelines, it found the transitions difficult especially when the agency legal authority was involved, needs to staff new disciplines or just to increase staff in critical areas existed, and improved communications were needed for about every element in the organization. Also, not all technical staff, especially those who were not involved in the evaluation process, were enthusiastic about changes that impacted them: "My dam did not fail and is serving well."

Following Federal agency implementation of the FGDS, many changes have occurred in policy, procedural and technical processes, or activities to engineering of dams. Some changes were difficult to implement. Only four of several issues are briefed from this time period:

Hydrology had been a deterministic process. Now probabilistic and "paleo-flood" philosophies were being proposed. The scope of responsibility was being expanded beyond the structural safety of the dam to require dam failures scenarios, and dam break flood waves and inundation maps and emergency action plans (EAP) coordinated with authorities responsible for safe evacuation of populations downstream of dams. This required Federal agencies to coordinate with several in-house or new technical disciplines or outside organizations not previously interfaced. The State of California Dam Safety Office staff was a valuable resource as they had pioneered in this arena and had an operational EAP process.

Forensic studies find that all identified potential problems are adequately provided for by designers; therefore, to improve dam safety, the process needed to ensure that unidentified threats would be discovered. Interface communications between designers, constructors, and dam operators needed to be more formalized and documented. Designers needed to communicate better to constructors the assumptions about geology and material properties. Constructors and designers needed to inspect open foundations to verify or determine additional special measures to address minor geological features. Potential observable behaviors that may reflect less than satisfactory performance occurring from problems identified and treated during construction needed to be

documented and highlighted to dam operational staff even if it is a dam where operational personnel are present at the site only periodically.

Probably the most controversial and initially rejected guideline related to risk-based analysis. During the 1980s, risk-based analysis was mostly shunned. The only Federal agency that used risk-based analysis was the Nuclear Regulatory Commission, and a review of its application was not particularly feature-specific to dam properties apart from the dam's performance in contribution to the operations of the nuclear power plant. During these years, some risk-management analysis was applied to setting priorities for inspection of dam frequencies, and setting priorities for which dam should first receive detailed studies for deficiencies. Especially for small dams, risk management was considered when evaluating incremental consequences from a failure during a hydrological event, such as what damages can be attributed to the failed dam. For example, comparison of damages due to volume of reservoir (sunny day failure) to damages from volume of natural flood with the solution usually being to extend the period of overtopping of the dam so discharge from failure of dam occurs during the trailing edge of the natural flood peak flow.

The fourth issue discussed is how a Federal agency that provides only technical design and construction services to a private owner ensures continuing operational responsibilities set forth in the Guidelines for things like instrumentation, periodic inspections, and emergency response actions. This fourth issue highlights the Federal agencies' need in the 1980s to assist FEMA, each other, and the States in establishing within all States the NDSP for non-Federal dams.

Non-Federal Dams

Parallel to the initiated activities on dam safety, the President proposed legislation to establish the Federal Emergency Management Agency (FEMA) to consolidate all sub-organizations providing response and assistance after natural or man-caused disasters from several Federal agencies under a single new agency. The FGDS addressed: 1) all dams in the nation; 2) no Federal agency with legislative authority to coordinate Federal agencies on dam practices; 3) no Federal agency with authority to address non-Federal dams deeper than inventory; and 4) dam failure causing need for a large disaster response. Thus, the assignment of coordinating dam safety between a Federal agency and for encouraging States toward dam safety programs for non-Federal dams should appropriately be assigned to FEMA.

Federal agencies all agreed that the greatest threat to public safety from dam failures in the United States is from non-Federal dams, especially for the time period going forward from the FGDS. Not only the Federal agencies mentioned above that contributed only technical services of design and construction to privately owned dams, but all Federal dam agencies concurred in this position. The agencies pledged assistance to the FEMA Dam Safety Officer for getting legislation for dam safety established in all States. The pledge came from both their concern for dam safety and desire that the FEMA Dam Safety Officer not establish technical staff of regulatory "mind-set" to hinder their programs.

The Association of State Dam Safety Officials (ASDSO) was established in 1984. The ASDSO added a significant new coordinating entity focused on dams, engineering, policy, and legislation.

Summary Statement:

The elements in the NDSP have greatly reduced threats to the nation from failure of dams. Procedures in place will greatly reduce the experienced loss of lives when the failure of a high-hazard dam occurs. Regular coordination occurs between the Federal agencies responsible for dams and with State dam safety organizations overseeing the non-Federal dams. Most research projects and new or revised technical standards are now accomplished with teams that are multi-agency and multi-disciplined (a change for the better). The climate in the dam industry has improved in quality of product, openness of communications, and sharing of trust between individuals and organizations.

Appendix F: The Legal Risks of a Major Dam Failure

Denis Binder
Chapman University School of Law

We live in a litigious society. One of the risks of a major dam failure resulting in a loss of life or substantial property damage is litigation. The victims will seek compensation for their losses and the State may bring criminal prosecutions.

By way of example, the Teton Dam failure in 1976 resulted in 11 deaths and substantial property damage. Congress appropriated \$400 million to compensate the victims. A Texaco drilling rig on Lake Peigneur in Louisiana on November 20, 1998, pierced an underground salt mine. No loss of life or personal injuries ensued, but the settlements totaled \$44.8 million. The TVA Keystone Coal Ash Dam failed on December 22, 2008, spewing out one billion gallons of contaminated waters. No lives were lost, but the estimated cleanup costs will be \$1 billion.

Losses for accidents are often covered by insurance, but owners and operators of dams and reservoirs may either lack insurance or have inadequate coverage. Obtaining insurance by small and medium-sized owners has been a recurring problem for decades. The premiums for adequate coverage may be out of financial reach for these owners.

The primary purpose of Tort Law today is victim compensation—to compensate an innocent victim for injuries caused by the wrongdoers. Potential claimants could include residents, guests, tourists, travelers, recreational users, and workers. Direct losses could be incurred by downstream residences, commercial enterprises, agricultural operations, utilities, and government facilities. Indirect losses include government and private responder costs in cleanup and response efforts, water users, hydroelectric operators, lost tax revenues by the government, and a general decline in the economic activity of the community. Losses could include environmental, natural resources, and fish, wildlife, and flora, as well as cultural resources and public health and sanitation.

We need initially to distinguish between governmental liability and that of private parties. The Federal Government will usually be immune from liability due to sovereign immunity, the discretionary function exception of the Federal Tort Claims Act, and §3 of the Mississippi River Flood Control Act of 1928. If the Federal Government is liable under the Federal Tort Claims Act, then the courts will apply the law of the State where the accident occurred.

The extent of the immunity for State and local governments depends on the statutes of each State. No general rule exists.

A maxim of the law is “Sue ‘em all.” Thus, the potential liability of private parties extends to owners, operators, architects, designers, engineers, contractors, sub-contractors, inspectors, and perhaps regulators of the dams. Liability may exist for the design, construction, operations, maintenance, repairs, or modifications of a dam. The theory for an inspector’s liability is that a timely or careful inspection would have prevented the failure.

The two general theories of liability are negligence and strict liability. Negligence is the failure to exercise reasonable care under the circumstances. It involves the existence of a duty with the failure to fulfill the duty (breach), causing damages. Duty is normally based on the reasonable foresee-

ability of the risk with the question being how should a reasonable person act in light of those risks? The duty normally extends to all those foreseeably at risk.

The breach of duty can be established through expert testimony, circumstantial evidence, discovery, or even common sense in some situations. For example, we may assume someone is at fault if a dam fails on a sunny day. The legal presumption is known as *res ipsa loquitur*, “the thing speaks for itself.”

Defendant’s breach of duty must be a cause of plaintiff’s injuries. It does not have to be “the cause,” but more likely than not by a preponderance of the evidence “a” cause of the incident. Major tragedies often have several causes. Under the common law principle of joint and several liability, any defendant found liable is jointly and severally liable, which means any one wrongdoer is potentially liable for up to 100 percent of the victim’s damages.

Compensatory damages are not measured by the income, revenues, profits, resources, capital, or insurance of the defendant, but by the injuries incurred by the victims. If the defendant’s conduct is especially egregious, such that it can be labeled “willful, wanton, and reckless disregard of the rights of another,” then punitive damages might be awarded in addition to the compensatory damages.

The great jurist, Judge Learned Hand, proposed a balancing test to assess the standard of care: 1) What is the risk of an accident occurring; 2) what is the potential magnitude of the resulting damages should the risk materialize; and 3) what alternatives exist? When applied to dams and reservoirs, the questions should be: What is the risk of the facility failing; what are the potential injuries and damages should it fail; and what measures can be undertaken to reduce the risk?

Negligence is a flexible standard. It varies with the risk, population at risk, and technology. In reality, the greater the risk, the higher the duty of care. For example, a much higher standard of care applies to a reservoir overlooking an urban area than a small stock watering pond in the middle of open space. If downstream development occurs where no one lived before, then the risk calculus substantially changes, as does the duty of the dam owner.

Liability can result even if the major cause, an act of nature, in law an “Act of God,” coalesces with a negligent human act, such as inadequate design or maintenance.

An alternative theory of relief is strict liability for an ultrahazardous or abnormally dangerous activity. Some activities pose such a substantial risk that the operator essentially proceeds as an insurer. Fault or a failure to exercise reasonable care under the circumstances is irrelevant. If the accident results, then liability ensues. Several courts in recent decades have applied strict liability principles in dam failures because of the potential magnitude of the risk.

A recent development in the duty of dam owners is to prepare an adequate emergency action plan (EAP). EAPs are often part of broader business continuity plans. They are not intended to reduce the risk of an accident occurring, but to minimize the impacts, mitigate the consequences, and facilitate recovery should the incident occur.

EAPs may be required by statutes, regulations, agency guidelines, professional and industry standards, as well as judicial decisions in the ever-evolving common law. The plans are dynamic instruments that should be periodically reviewed, tested, and upgraded. Lessons should be learned and implemented from the tests and incidents elsewhere.

An oft-repeated saying, attributed to General Eisenhower before D Day, is that "Failing to plan is planning to fail." The reality is that EAPs may not always perform as planned, but flexibility honed in preparing the EAP will help in responding to the unexpected. If though the EAP fails because of poor planning, inadequate testing, or failing to update it, then a court may well find negligence.

Appendix G: National Dam Safety Program—Risk Communications

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Holistic and Dynamic Dam Safety Risk Communications (DSRC). Delivering DSRC messages may appear to be straightforward—decide what the National Dam Safety Program (NDSP) wants to say, to whom they want to say it, and then say it. The problem, however, is that the message NDSP audiences actually receive is not just a matter of words and imagery; its meaning and impact is affected by the NDSP’s ability to clearly articulate the relationship between its policies and programs and its communications in the context in which the message is delivered, including who (key spokespersons) delivers it and how (channels) it is delivered. The ostensible message may be clear and simple, but it may be interpreted differently depending upon varying audiences’ values, attitudes, and perceptions concerning dam safety risk.

Adding to the operational and communications complexity are numerous forces and trends that are constantly shaping the 5WH (Who, What, When, Where, How) of DSRC, including dynamic risk communication modeling, which shows how urgent and emergent dam safety incidences can increase the chances of initial communication failures or missteps, and the interconnectedness and interdependence of the NDSP and its State and local partners.

NDSP and its operations and communications partners recognize that effective DSRC is a powerful force in helping communities and the media understand real versus perceived risk; build trust and credibility; drive a multi-faceted communications strategy on how NDSP and its State-by-State affiliates should communicate risk to the public; and further develop and encourage public support and acceptance of State dam safety programs. There is, therefore, a need as well as an opportunity for the NDSP to communicate about dam safety risks (and benefits) in a way that informs without frightening, educates without provoking alarm, and moves people to act before, during, and after a dam safety emergency.

Converting Public Apathy Into Public Action Through Effective DSRC. To ensure communication success, NDSP needs to blend both the “offensive (opportunity/benefit)” and “defensive (issue/perceived threat)” components into its broader communication strategy. To do this, NDSP should consider using a 3-part approach to *assess, manage, and communicate* the depth and breadth of DSRC opportunities and issues:

- **DSRC Assessment.** Defining and assessing “dam safety” through the risk lens of *threat* (e.g., real and perceived), *probability* (high, moderate, and low), *vulnerability* (strengths and weaknesses) and *consequences* (e.g., worst case, best case, and most probable case). Assessment results inform potential strategic communication priorities, audiences, developing and comparing communication options, and informing overall communication strategy.
- **DSRC Management.** Based on assessment findings, a communications management strategy can be developed and would include core elements which address NDSP’s 5M communications enterprise (refer to Table 1) such as ensuring there is an executive-approved strategy, escalation procedures if a dam safety threat moves from emergent to urgent, pre-scripted and tested messages, rumor control and correction techniques, and engaging subject matter experts (SME) and credible third parties.
- **DSRC Communications.** Both the communications assessment and management strategy feed into NDSP’s broader communications readiness and response, such as ensuring NDSP can effectively adapt its spokespersons and messages to earn trust and gain credibility; manage the risk perception factors that distort people’s views of real versus perceived risks; offset the dominating power of negative words and images; and use techniques for acknowledging uncertainty and communicating dam risk information in understandable and usable formats.

Table-1 NDSP’s Communications Enterprise

NDSP’s 5Ms:

- **Matters** are dam safety issues and opportunities that may harm/help or that powerful others (e.g., Congress) believe could pose operational, budgetary, or reputational risk.
- **Markets** (audiences) are the groups or communities that are potentially affected either positively or negatively.
- **Messengers** are the NDSP spokespersons who communicate and represent the organization before, during, and after a dam incidence.
- **Messages** are specific to dam safety risk and benefit and alert, educate, motivate, support decision making, compel behavior, and more.
- **Media** are both internal and external, as well as traditional (print/broadcast) and social media channels that key audiences (employees) access, monitor, and use for information exchange.

Ultimately, and when systematically planned and applied, this 3-part approach will help NDSP to maximize its top DSRC opportunities and achieve an ideal communications future State such as developing a values and behavior-based outreach and communications plan; disseminating actionable and results-driven messages; identifying and developing high-yield communications tools and tactics; optimizing communications resources for maximum results; and implementing impact measures, including behavior adoption rates.

NDSP’s Enterprise-Wide Communications Strategy. Fundamental to NDSP’s communications strategy (refer to Table 2) is the ability to translate solid dam safety science and information into communication best practice that is—

- **Audience-Based.** Developing and maintaining consistent relationships with NDSP stakeholders through clear, consistent, and regular communication is a key component of supporting NDSP's communications objectives. Knowing how and when to navigate in these audience circles, as well as understanding their positions and interests and how each audience is either acting or being acted on via policy decisions and actions, is also vital.
- **Message-Based.** Consistency in messaging—in print, broadcast, and electronic formats—is often the most important practice an organization can undertake to increase the effectiveness of its communications strategy. Messaging provides a context for offensively communicating NDSP's safety initiatives, events, or ideas with communities and media and establishes a messaging platform for its defensive communications in response to urgent and, often, emotionally charged and controversial issues. Sample concepts and issues for risk-based messaging include: level of community and media understanding of dam safety issues and hazards; extent of individuals' and community's understanding; perceptions of dam safety risk and personal vulnerability; trust in information-providing sources; expectations about responsibility for dam safety risk and prevention; sources of existing information and knowledge; personal experience with actual dam safety; and preventive actions already taken, contemplated, or maintained.
- **Performance-Based.** For both existing and future NDSP spokespersons, informing and influencing risk communication policy and strategy is critical. NDSP's spokespersons do and will continue to find themselves responding to high-stress, high-concern issues, and as such, need to develop (and practice) the unique knowledge and communications skills needed in this demanding arena. Once mastered, communicating about uncertainty and message consistency (realizing the message may change over time) can even bolster communications and create new and positive opportunities to tell NDSP's story.

Table-2 Sample Risk Communications Strategy	
Audiences	<ul style="list-style-type: none"> • Adequacy of target audience definition and segmentation; preferred sources of information for each target audience • Interface between different target audiences
Communication Strategy	<ul style="list-style-type: none"> • Alignment of NDSP communications goals with operations strategy; triggers for adjusting risk communication strategy • Inventory of risk communication tools and vehicles in current use; leveraging the NDSP brand in all risk communications • Assessment of existing dissemination methods
Messaging Alignment and Strategy	<ul style="list-style-type: none"> • Messages NDSP needs to communicate to meet its risk communication objectives; alignment of activities to support key messages, overall risk communication goals; and balance of offensive and defensive communications
Communications Vehicles and Recommendations for New Communications Vehicles	<ul style="list-style-type: none"> • Methods of message delivery: analysis of pull and push approaches in use; and effectiveness of print, web, broadcast media, and social media relative to message and desired outcome
Awareness and Call-to-Action Triggers	<ul style="list-style-type: none"> • Triggers for each target audience (e.g., communities and media) to take action as a result of risk communications; incentives for certain target audiences to take action or communicate messages accurately; time lapse between exposure to information and taking action (all audiences); and overall reach, frequency, and duration of communications
Other Strategic Drivers	<ul style="list-style-type: none"> • Opportunities for repurposing messages and materials across NDSP's risk communications platforms • Communication breakdowns, conflicts, and misunderstandings; leveraging third-party support • Processes used to determine which communication strategies and initiatives to actively promote and support • Analysis of news coverage and stakeholder assessment versus communications output

Best Practices—Convergent Communications for Building Public Awareness and Support.

Key to ensuring achievement of its goals is the execution of a strategy that aligns NDSP's operational and communication objectives, such as using new visualization and social media techniques to communicate the complex nature (e.g., uncertainty) of dam safety risk to diverse audiences. Also essential is applying best practices for effective messages and channels; employing proven, rigorous, reproducible, and repeatable methodologies, strategies, and tools; applying newer methods,

techniques, and innovative concepts; and incorporating lessons learned to inform the continued development of better, faster, and more cost-effective communication methods such as—

- **Social Marketing.** Social marketing, which has evolved to include risk concepts and principles, augments NDSP's current public communications through the use of commercial marketing applications and internationally recognized best practices. Over the last 30 years, social marketing has been successfully used to create awareness and change norms for numerous and well-publicized social issues, such as seatbelt use, designated driver, sunscreen use, and many other campaigns aimed at changing behaviors. With grounding in commercial marketing, NDSP can apply the **7 Ps** in its approach to dam safety risk communication strategy development: **Price** (e.g., costs in both monetary and non-monetary terms, time, money, or other barriers to engaging in the desired behavior and risk reduction); **Product** (e.g., information and materials or what NDSP is offering to help the audience adopt the desired behavior (dam safety decisions and actions)); **Place** (e.g., communications channels NDSP uses to reach the target audience); **Promotion** (e.g., techniques NDSP uses to persuade the audience to make the behavior change); **Publics** (e.g., external and internal groups that have a vested interest in the desired change); **Partnerships** (e.g., engaging credible like-minded groups, associations, and government agencies to extend resources); **Policy** (e.g., procedures and guidelines set up to sustain and motivate change); **Purse Strings** (e.g., funds provided by other sources such as foundation and government grants, donations, and individual gifts). For example, to change perceptions and attitudes concerning dam safety risk and protective behaviors, and from a strategy perspective, NDSP should consider assessing the socio-media landscape, understand safety culture and the distinct variations that exist among varying audiences, and understand existing policies that might impact individual and group decisions to seek information and take action.
- **Media Interaction and Social Media.** Effective media interaction and harnessing social media are strategic components of NDSP's broader risk communications strategy. When optimally combined and deployed, both offline (e.g., print, broadcast, and radio) and online media (e.g., social networks) should assume a central role from the start. Both media interaction and social media are integral to NDSP's larger process of information exchange aimed at relevant issues and actions such as building, maintaining, or restoring trust; improving consumer and media knowledge and understanding; guiding and encouraging appropriate and protective attitudes, decisions, and actions; and encouraging collaboration and cooperation. This can be achieved through clear and proactive explanations of laws and regulations, informing and advising communities about risks they themselves can control, or dissuading individuals or groups from unsafe dam safety decisions, actions, and behaviors. Ultimately, effective media interaction and social media tools and techniques provide NDSP's key stakeholders with timely, accurate, and consistent dam safety and risk information.
- **Data Visualization.** Numerous institutes and organizations have developed state-of-the-art methods for conveying information through visual representations. Harvard University, for one, has developed visual representation methods and techniques that increase the understanding of complex data such as dam safety science and practice. Harvard's methods have proven that good visual interpretations of data improve comprehension, communication, and decision making; specifically, how the human visual system processes and perceives

images and its implications for critically assessing visualizations and identifying design principles used to create them and their application to perception, color, statistical graphs, maps, trees and networks, high-dimensional data, and visualization tools.

Appendix H: Floodplain Management and the National Dam Safety Program

Floodplain Management and the National Dam Safety Program

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Floodplain management can be defined very simply as the management of the use of a floodplain either by nature or by man or by both. Flood risk management can also be very simply defined as managing the overall risk to all interests from floods. A floodplain is the normally dry land that is located within varying degrees of adjacency to a riverine, lake, reservoir, or coastal water source. It is within these basic definitions that the National Dam Safety Program (NDSP) should consider means to influence implementation of sound floodplain management principles both upstream and downstream from dams. This required implementation is to insure to the highest degree human safety in terms of both life and property.

Historically, dam safety has been interpreted as safety to the dam itself. While this is highly important, it is not the only aspect of a true dam safety program. Other components of high importance to dam owners and to those living in association with a dam are discussed in the following paragraphs.

Upstream From the Dam. Is development allowed to occur upstream from the dam that is sited at elevations that are lower than the top of the dam and/or at elevations that are lower than the water surface profile at the upstream end of the reservoir where riverine elevations merge with reservoir elevations? This can jeopardize a dam safety program by the incurrence of flood damages during dam operations and can ultimately influence the actual dam operations.

Too often, especially in areas of high growth, strong pressure exists to allow development at elevations that expose people and property to maximum water surface elevations upstream from the dam. Such development pressures are often greater than in non-dam conditions due to the presence of a reservoir that provides high aesthetic values in terms of water access and water views. Politics also often play a heavy role in such development pressure, especially when the dam and reservoir is owned by government entities that can be influenced more by politics. In cases where such development has been allowed to occur, it can influence operation of the dam in the sense that political pressure is exerted on the dam owners to release more water downstream so as not to flood upstream development.

The NDSP must not allow any development that can be damaged by flood water and that can endanger human safety to occur in areas upstream from the dam that is located at elevations below those of the maximum water surface elevation that can ever be influenced by the dam. This should be well within the ability of the dam owner to prevent by purchasing either in fee title the land or with permanent easement the development rights of all property at or below the maximum water surface elevation that can occur upstream from the dam as a result of the presence of the dam. Is development already in place that is too low based on the above criteria? If this is the case, a NDSP should require that dam owners to take steps in the future to purchase real estate instruments that will allow removal of damageable property. A step to this end would be purchase of flood ease-

ments as an interim basis measure. Whatever the case is in terms of preventing new development or moving towards removing existing development, this concept must be part of a strong NDSP.

Downstream From the Dam. Dams exert great influence in terms of floodplain development on areas downstream from the dam if the dam has flood frequency reduction capability. This influence is both positive and negative. The positive influence is the reduced frequency of flooding. Ironically, the negative influence is also the reduced frequency of flooding. This is explained by examining the flood risk equation; that is basically flood risk is equal to the frequency of flood occurrence times the consequences, with consequences related to the amount of development located in the floodplain.

When first closed, a dam that has downstream flood frequency reducing capability will reduce flood risk because the flood frequency is reduced for the consequences that exist at the time the dam is closed. This is the positive aspect. However, historically the potential for negative consequences has increased over time as local land use managers have allowed and developers have used the reduced flood frequency component of a dam to increase development within that floodplain. Flood risk is actually increased with the dam as development has allowed the consequences part of the flood risk equation to increase. This is the negative aspect.

A very recent example of this is the 2011 Missouri River flood. Prior to closure of the Missouri River dams in the 1930's, 1950's, and 1960's, flood frequency was such that flood plain construction was limited. However, with closure of the dams, a major flood event above Omaha, Nebraska had not occurred since 1952. Because of this, local land use managers and developers treated the flood plain as no longer a flood plain and allowed and promoted development along the river especially near existing urban areas to the extent that consequences increased. Most of this development was built as if a flood plain no longer existed meaning that the 100 year flood that is the basis of the National Flood Insurance Program and is the basis of flood plain land use in the United States was often within the Missouri River channel or close to it. Since the influence of reduced flood frequency can occur many, many miles downstream from a dam, it is difficult for a dam owner to exert flood plain management within communities in which the dam owner has no jurisdiction. It can only occur through communication of the flood risk which will be discussed later

Downstream from the Dam. The NDSP should be proactive in preparing downstream areas for a possible future without the flood frequency reduction capabilities of a dam in place. This reduction in flood frequency reduction capability of the dam would occur due to either loss of reservoir storage due to sedimentation and/or the removal of the dam. This is just prudent long-term planning. As discussed above, this downstream aspect of floodplain management cannot normally be influenced directly by the dam owner, but it can be through communication of the flood risk by the dam owner in terms of what flood risk exists today and what flood risk will exist in the future. Within this type of thinking, a floodplain management plan that is future thinking, in terms of diminishing flood frequency reduction by a dam, would encourage downstream floodplain managers and land use managers to require any new development to be built as if the flood frequency reduction capabilities of the present dam did not exist. This concept is applicable in all cases where structural flood risk reduction measures such as dams and levees were built to reduce flood frequency to existing development.

Any new development should be built as if the structural measure was not in place so at a time in the future the structural measure would no longer be needed. What this is really saying is that in terms of sound long term flood plain management, reliance on structural measures to reduce flood risk should only be considered for existing development [not to promote new development] and

then only if no other flood risk reduction measure such as nonstructural measures are considered feasible or implementable. While this thinking is very proactive for solid long term flood plain management and flood risk reduction, it is very politically difficult to attain since most all politicians and land use managers focus on short term objectives only. Those short term objectives are generally not reduction of flood risk but rather increasing the local tax base via flood plain development.

Communication of Flood Risk. Communication of flood risk to those areas that can be impacted negatively by an unsafe dam that could result in either failure or rapid release of stored water to prevent a dam failure is extremely important for at least two reasons--1] so those in harm's way can take actions within their level of jurisdiction and authority to improve their level of safety via alternate measures of risk reduction such as evacuation both temporary and permanent, elevation, warning, etc and 2] so those in harm's way can exert pressure on those that can influence the safety of the actual dam by increasing the priority for dam safety actions and/or to increase the opportunities for funding to correct dam safety issues. In these two reasons, those at risk can be such downstream entities as individuals, communities, etc.

Communication of downstream flood risk is also essential for dams that are currently considered safe by NDSP standards. The importance of this is extremely high if those located downstream are to be proactive in floodplain management as discussed in the above paragraphs.

In terms of communication of downstream flood risk, a negative to doing what seems extremely logical for sound flood plain management exists. That is communication of downstream flood risk to those that could use the dam for terrorist activities. While this is a highly important consideration, it is a factor that should be overridden by the extreme necessity to communicate downstream flood risk for the reasons stated above. Terrorist organizations that would use dams to perpetuate their mission can be highly sophisticated in terms of intelligence gathering to further their mission meaning they probably know the downstream implications of any terrorist activities at the dam that would cause downstream flooding. This means that non communication of downstream flood risk that would result in not effectuating a positive downstream flood plain management program is highly negative to achieving the aspects of a NDSP that has impacted people fully aware of issues they face. By not communicating the downstream flood risk for reasons of potential terrorist activities, dam owners can actually, if a dam safety issue becomes paramount threatening downstream areas, further the mission of terrorist organizations by achieving unnecessary downstream flood damages and human suffering and death.

In summary, flood plain management both upstream from and downstream from a dam must be an integral part of a good NDSP. Focusing just on the dam to achieve dam safety has never been appropriate and certainly is not appropriate in 2011 and beyond. Emergency action plans must be part of every dam safety program and flood plain management must be part of every dam safety emergency action plan. If holistic human safety is the objective of a dam safety program within the NDSP and it is, flood plain management as discussed briefly in this paper is not just a logical conclusion, it is a necessary conclusion for required implementation within the National Dam Safety Program!

Appendix I: National Dam Safety Program—An Emergency Management Perspective

Hans Kallam

Introduction—The Challenge

Today in America, there are approximately 26,000 dams that pose a hazard to downstream communities.¹¹ Major actions to recognize and reduce the hazard posed by dams began in the 1970s and evolved into the dam safety programs in place today. Dam safety, in a simple definition, is the process of ensuring that dams do not fail, while also preparing for the consequences if they do fail. While simple in definition, there are many challenges impacting dam safety.

America's dam owners and the government entities that oversee dam safety are facing an aging infrastructure and ever-decreasing budgets. The majority of our nation's dams are more than 40-years-old.¹² Preventing these dams from failing is a very costly process involving regular technical inspections, maintenance, and rehabilitation. The Association of State Dam Safety Officials estimates that it would take \$16 billion to complete necessary rehabilitation on the nation's most critical high-hazard dams.¹³ In the *2009 Report Card for America's Infrastructure*, the American Society of Civil Engineers gave America's dams a "D" grade and identified that the number of newly identified deficiencies with hazardous dams was rapidly outpacing the number of repairs.¹⁴ Dams that present a downstream hazard are required to maintain an emergency action plan (EAP), which helps impacted communities prepare for the consequences of a dam failure. Unfortunately, this area, too, is challenged. Data collected by the U.S. Army Corps of Engineers (and reinforced by the Association of State Dam Safety Officials) indicates that more than 7,000 hazardous dams do not have EAPs¹⁵. Given our nation's current fiscal environment, these challenges will more than likely continue to plague dam safety programs, and the likelihood of dam failures may increase.

This paper provides an emergency management perspective for dam safety given the current environment. Up to this point, the success of dam safety programs in reducing the potential for dam failures (along with the infrequency of dam failures) has created an environment of limited interaction between emergency management and dam safety officials. The risk from dams is perceived to be low in the emergency management community. At the same time, the professional organizations involved in dam safety feel strongly that risk is increasing. Government and the whole community share responsibility for risk management and preparedness. This paper suggests an increased col-

¹¹ U.S. Army Corps of Engineers National Inventory of Dams: <http://www.usace.army.mil/Library/Maps/Pages/NationalInventoryofDams.aspx>.

¹² Ibid.

¹³ Association of State Dam Safety Officials: <http://www.damsafety.org/>. About Dam Safety; Dam Safety 101; Top Issues Facing Dam Safety.

¹⁴ American Society of Civil Engineers, *2009 Report Card for America's Infrastructure*.

¹⁵ National Inventory of Dams: <http://www.usace.army.mil/Library/Maps/Pages/NationalInventoryofDams.aspx>.

laboration between emergency management and dam safety officials to better understand risk associated with dams and to better prepare communities for potential dam failures.

Understanding Risk

Understanding risk is a fundamental responsibility. It informs decision making and drives community preparedness activities. In today's constrained resource environment, it helps prioritize efforts and investments in order to gain the greatest level of preparedness with available resources. As our nation's efforts toward preparedness progress, we recognize the need to present and assess risk in a similar manner in order to provide a common understanding of the hazards we face. In the area of dam safety, there is one commonly accepted classification system, the *Hazard Potential Classification System for Dams*.¹⁶ Unfortunately, this system does not measure risk. So when considering the whole community, beyond just dam safety officials, the risk of dam failure is not easily understood. This ambiguity, especially in an environment where the potential for dam failure may be increasing, has the potential to degrade community preparedness efforts.

We need to understand the risk dams present to our communities. The structural integrity of our dams, if not properly maintained, degrades over time. We know that States and dam owners are having difficulty keeping up with inspections, maintenance, and rehabilitation. We also know that in many cases, it is difficult to stop community development both below and above dams. So, the likelihood of dams failing over time is not static, nor are the consequences if they fail. As risk increases, so do the resource requirements for preparedness and risk management. Better clarity in understanding risk serves as a powerful enabler for the whole community to better participate in preparedness activities. Today, we lack a common understanding of risk related to dams that is needed to guide effective preparedness. Community preparedness is critical to national preparedness and can only be achieved when the whole community understands the risks that are most relevant and urgent for them. The professional communities of dam safety and emergency management bear responsibility for understanding the risk of dam failure and communicating those risks to the communities impacted.

The current *Hazard Potential Classification System for Dams* is not useful in determining risk and is not adequate for guiding preparedness actions, especially in the current fiscal environment. Under the current system, consequences are measured in three levels (low, significant, and high) based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. A dam is rated High-Hazard Potential if its failure or mis-operation would probably cause loss of life. Within the United States, there are approximately 14,000 High-Hazard Potential dams.¹⁷ Approximately 10 percent of those dams have had their structural condition assessed as "poor" or "unsatisfactory."¹⁸ But the current classification system does not account for the condition of the dam (excellent or poor). It also does not account for the likelihood of the dam failing during flood-

¹⁶ FEMA Federal Guidelines for Dam Safety: Hazard Potential Classification System for Dams, April 2004.

¹⁷ National Inventory of Dams: <http://www.usace.army.mil/Library/Maps/Pages/NationalInventoryofDams.aspx>.

¹⁸ Based on survey data of State dam safety officials conducted by the Association of State Dam Safety Officials.

ing/overtopping¹⁹ or seismic activity. As for measuring consequences, the system does not distinguish between the loss of one life or the loss of thousands, or the loss of one building or the loss of an entire city. Nor does it take into account the potential for cascading effects. The vagueness of this system creates challenge for dam safety officials and emergency managers when you consider that most States have hundreds of High-Hazard Potential dams but no commonly understood process for distinguishing which dams pose a greater risk to the public. In the words of one State Dam Safety Official, “Under the current classification system, we are regularly directed away from dams we believe pose a greater public safety risk and required to work on smaller dams that have more politically contentious issues.” We are in need of a new system that distinguishes which dams pose the greatest risk. Until such a system exists, dam safety officials and emergency managers need to work together so they share an understanding of risk within the State.

An Opportunity for Collaboration

In September 2011, the U.S. Department of Homeland Security published the *National Preparedness Goal*. The *Goal* introduces a “whole community” concept which encourages broader participation in preparedness activities. The *Goal* also emphasizes the importance of understanding risk as a critical step in preparedness and identifies dam failures as one of the hazards that pose a significant risk to the nation.²⁰ Emergency managers at the State and local levels are among the principal agents driving community preparedness in support of the *Goal*. As we look at the challenges facing dam safety across our nation, there is a need for greater coordination between emergency management and dam safety.

At the Federal level, the Federal emergency manager (Administrator of the Federal Emergency Management Agency) is responsible for the National Dam Safety Program (NDSP).²¹ At the State level, responsibility for dam safety shifts to the State agency that has regulatory authority over the safety of non-Federal dams (this agency is normally not associated with the State emergency management function). By law, the Administrator receives consultation from the Interagency Committee on Dam Safety and the National Dam Safety Review Board. The members of these two groups are principally Federal agencies that build, own, operate, or regulate dams and, in the case of the Board, also include five State Dam Safety Officials who are appointed by the Administrator. As you look at the positions on the Committee and the Board, they mostly represent organizations focused on reducing the likelihood of a dam failure. There is an absence of the critical stakeholders that must prepare for, respond to, and recover from the consequences of dam failures. As we look at possible enhancements to the NDSP, inclusion of a broader range of stakeholders at all levels of responsibility within the program could provide value.

There may also be opportunities to advance dam safety at the State and national level. Many State emergency management agencies (or associations) conduct annual emergency management conferences. These conferences draw State, tribal, local, and community leaders who are engaged in emergency response and preparedness activities. These conferences present an opportunity for

¹⁹ Flooding and Overtopping are the top cause for dam failure based on data for all dam types and sizes collected from 1975-2001. Stanford University, Department of Civil and Environmental Engineering, National Performance of Dams Program.

²⁰ Department of Homeland Security, National Preparedness Goal, September 2011.

²¹ Water Resources and Development Act of 1996, Public Law 104-303 dated October 12, 1996.

State dam safety officials to provide updates on dam safety issues in the State and around the country. There are similar events at the national level. Both the National Emergency Management Association and the U.S. Chapter of the International Association of Emergency Managers host annual conferences with their members. These also provide tremendous opportunities for increasing awareness, partnering, and building networks that enhance dam safety. Similar to these emergency management associations, the Association of State Dam Safety Officials is a national organization dedicated to supporting State dam safety programs. Their risk reduction concerns are similar to those of emergency management. There may be partnering opportunities for these associations. Collaboration between emergency management and representatives in dam safety can help to enhance the dam safety program.

Conclusion

Incidents of dam failures are rare largely as a result of the collective efforts of engineers, dam owners, State and federal regulators, and a well-established NDSP. But our aging dam infrastructure and struggling economic environment present large challenges for the future of dam safety. Dams have failed in the past and as a result, our main focus has been with engineering and regulatory entities working to prevent dam failures. Their success to this date has created a bit of ambivalence toward the risk from dams. And today, the possibility that we will experience dam failures in the future may be increasing. With this understanding and some reflection on our current dam safety program, there are some opportunities to improve our preparedness.

Working together, the professions of emergency management and dam safety have the opportunity to improve the preparedness of communities exposed to the hazard potential of dams. Collaboration and coordination at all levels of responsibility must increase as the likelihood of dam failure increases. Both professions need a better system for determining which dams pose the greatest risk. Today's hazard classification system was not designed to be an aid for prioritizing effort or understanding risk and provides little utility to emergency management. EAPs for dams are important but without an understanding of risk, they do little to impact community preparedness actions. Stakeholders who represent the consequence side of dam risk need to be included in the dam safety program. They can help to broaden the perspective on dam safety issues. Dam safety, like community preparedness, is a shared responsibility with the whole community, and for communities impacted by dams, safety and preparedness go hand-in-hand. Our dam infrastructure is getting older, and we do not have enough money to solve all of our problems, but we do have established professions rich in intellectual capital. We have tremendous opportunity for identifying efficient and effective solutions for ensuring our communities impacted by dam hazards remain safe and prepared.

Appendix J: Team and Consultant Biographies

Principal Investigators

Gregory B. Baecher, PhD, is a Glenn L Martin Institute Professor of Engineering in the Department of Civil and Environmental Engineering, University of Maryland, College Park. He holds a BS from UC Berkeley, and MSc and PhD from MIT. His work addresses the reliability of civil infrastructure and risk management, especially in geological and water resources engineering. Dr. Baecher is a member of the National Academy of Engineering and a recipient of the Commander's Award for Public Service, HQ US Army Corps of Engineers. Dr. Baecher spent 15 years as Professor of Civil Engineering at MIT, 10 years in industry, and has been at UMD since 1995. He is the author of four books on risk, safety, and protection of civil infrastructure, and of eight National Research Council reports. He served on the Interagency Performance Evaluation Taskforce on Katrina, and serves currently on the Science and Engineering Board of the Louisiana Office of Coastal Protection and Restoration. He is also currently involved in a longitudinal joint industry project on spillway systems reliability supported by hydropower operators in Canada, Scandinavia, and the US; in the development of a systems risk assessment for the Panama Canal Authority; and in the development of the new dam safety standard for the Province of Ontario. He is a member of the National Academy of Engineering.

Kaye L. Brubaker, PhD is Associate Professor in the Department of Civil & Environmental Engineering at the A. James Clark School of Engineering, University of Maryland, College Park (UMCP), and Director of the Maryland Water Resources Research Center. She earned her B.S. in Civil Engineering (1989) from UMCP, and her S.M. (1991) and Ph.D. (1995) from the Massachusetts Institute of Technology. Her graduate research focused on atmospheric water vapor transport and the links between water and energy transfers at the land surface. She worked with the U.S. Department of Agriculture (Hydrology Laboratory, Beltsville [Md.] Agricultural Research Center) as a postdoctoral research associate before joining the UMCP faculty as an assistant professor in 1996. Fascinated with all aspects of water from an early age, Dr. Brubaker pursues a variety of teaching and research interests in hydrologic science and its applications. Her research program centers on the theme of hydroclimatology -- examining the important role of water in the Earth's climate system and the effects of climate variability and change on regional precipitation (rain and snow), stream flow, and, ultimately, the availability and quality of water supply for environmental and societal sustainability. She and her students explore these issues using tools such as numerical models, remotely sensed data (satellite multispectral, airborne LiDAR, ground-based radar), Geographic Information Systems, and the theory of space-time random fields.

Gerald E. Galloway, PE, PhD, a Glenn L Martin Institute Professor of Engineering and Affiliate Professor of Public Policy at the University of Maryland where he teaches and conducts research in national water resources policy and management, flood mitigation, and disaster management. He has served as a consultant to national and international government and business organizations. He is currently an advisor to The Nature Conservancy on its Yangtze River Program, a member of the Louisiana Governor's commission on coastal protection, and was recently appointed by The Secretary of State as one of three inaugural Energy and Climate Partnership of the Americas Fellows. He has been Presidential appointee to the Mississippi River Commission and was assigned to the White House to lead a study of the 1993 Mississippi River Flood. As District Engineer for the Corps of Engineers Vicksburg District he was responsible for the operation and safety of seven large dams on tributaries of the Mississippi including one of the first hydraulically built US dams. He served in the US Army for 38 years retiring as a Brigadier General and Dean of Academics at West Point. He is a

member of the National Academy of Engineering and a Fellow of the National Academy of Public Administration.

Lewis E Link, PhD, is a research professor in the Department of Civil and Environmental Engineering, University of Maryland. He holds a BS degree with high honors in Geological Engineering from N. C. State University, an M. S. in Civil Engineering from Mississippi State University and a Ph.D. in Civil Engineering from Penn State University. He formerly served as the Director of Research and Development and Principal Scientific Advisor, U.S. Army Corp of Engineers. Previously he was the Director of the U S Army Cold Regions Research and Engineering Laboratory, the Assistant Chief of the Coastal Engineering Research Center and the Chief of the Environmental Systems Division of the Environmental Laboratory. He retired in 2002 and worked as a senior advisor to Toffler Associates conducting strategic futures studies for government and industry before joining the faculty at the University of Maryland. Dr. Link served as the Director of the Interagency Performance Evaluation Task Force, performing the principal forensic analysis of the Katrina flooding in New Orleans. He is also serving as one of five international advisors to the Netherlands for the development of their new Delta Model, an approach to provide sustainable and climate-resistant water management for the next century. He is a Certified Professional Hydrologist. Dr Link was the recipient of the McGraw Hill Engineering News Record Award of Excellence in 2006 and the Gold Order of the DeFluery from the U. S Army Engineer Association in 2010.

Research Assistants

Jeffrey Brideau is a PhD candidate in the Department of History, at the University of Maryland, with a bachelor's and a master's degree from the University of Ottawa. His dissertation research focuses on the environmental history of the Great Lakes and St. Lawrence River, specifically on the planning and construction of the St. Lawrence Seaway and power project. More broadly, he is interested in the history of human-hydrologic interaction within and across national boundaries. He became directly involved in interdisciplinary water research in 2010, through an NSF funded research project under the auspices of the Northeast Consortium for Hydrologic Synthesis. This was an effort to explore five hundred years of human-hydrologic interaction, in the Northeastern United States, within a broad interdisciplinary framework. This experience led him to further pursue interdisciplinary opportunities and incorporate the tools and perspectives they offer into his own research. He became involved in the current project as a graduate researcher, who was uniquely positioned to explore the history of dam safety in the United States and contribute a historically informed perspective to the project. He hopes to continue working on this topic and contributing to the discourse on dams, dam safety, and associated communities or institutions.

J. Trevor Cone is pursuing a MS degree in Water Resources Engineering at the University of Maryland, College Park. He received a BS degree in Civil and Environmental Engineering from Brigham Young University in the fall of 2009. His research for his thesis focuses on modeling pluvial flooding in small urban watersheds and estimating the resulting damages. In addition to working on the National Dam Safety Program Review, he has recently been working on a multi-university study with Drs. Galloway, Brubaker, and Baecher assessing flood risks in the National Capital Region. He has also worked as a Teaching Assistant for Drs. Galloway's and Link's undergraduate course entitled Managing Natural Disasters. A Maryland native, he and his wife now reside in the District of Columbia.

Vasavi Mantha:

Vasavi Mantha is a graduate student in the Civil and Environmental Engineering department at the University of Maryland with a major in Project Management. She received her undergraduate de-

gree in Civil Engineering from National Institute of Technology, Rourkela, India. While pursuing her undergraduate course of study, she interned at National Geophysical Research Institute, India and did her research on the contamination of underground water channels. Upon graduation, she worked at Accenture Services as a Quality Assurance Analyst for two years before joining the masters program at UMD. Her research interests primarily include Risk Management in Projects and Statistical Analysis of Financial data. She is part of NDSP Review program as the Program Management Assistant.

Consultants

Denis Binder is. Professor Binder's career teaching Antitrust, Environmental Law, Torts, and Toxic Torts at law schools nationwide spans 40 years. He has served as a consultant to a variety of organizations, ranging from the Army Corps of Engineers to Cesar Chavez and the United Farm Workers. In September 1996, Professor Binder received the National Award of Merit from the Association of State Dam Safety Officials for his contributions to promoting dam safety over the preceding two decades. He graduated first in his class at the University of San Francisco School of Law and received his LL.M. and S.J.D. degrees from the University of Michigan Law School. Professor Binder served as the President of the Chapman University Faculty Senate during the 2006-2007 academic year. He is Chair-elect of the Environmental Law Section of the American Association of Law Schools.

Larry S. Buss, P. E., CFM, D. WRE, is a national expert in the areas of flood risk management and nonstructural flood risk reduction. He retired from the US Army Corps of Engineers, after over 40 years service, last serving as Chief of Hydrologic Engineering, Omaha District. In that position, he led a team of 50 people with expertise in such areas as Water Control, Water Quality, Hydraulic Structure Design, Statistical Analysis, River Ecosystem Restoration, Flood Plain Management, Emergency Flood Fighting, Flood Control Design, Sediment/Erosion Control, Watershed Modeling, Flood Warning Systems, Nonstructural and Structural Flood Mitigation, and Hydrographic Surveys. Prior positions with the Corps of Engineers included Chief, Flood Plain Management Services; Chief, Planning; Assistant Chief, Planning; and Chief, Civil Works all within the Omaha District. He is past Chair of the U Corps of Engineers National Nonstructural/Flood Proofing Committee. This committee promotes the development, implementation, and proper use of non-structural flood mitigation techniques including relocation/buyout, flood proofing, flood warning/preparedness, flood plain regulation, flood insurance, etc and provides a source of expertise in the use of non-structural techniques throughout the United States. Documents developed by this committee have been used both nationally and internationally.

Hans Kallam has over 25 years of operational and leadership experience in Emergency Management, Homeland Security and Military Support to Civil Authorities. He most recently served as the Director of the Colorado Division of Emergency Management and before that, Director of Joint Operations for the Colorado National Guard. In 2010, he served as a member on the Department of Homeland Security's Preparedness Task Force charged with recommending changes to local, state, tribal and federal preparedness programs. His leadership, vision and experience have helped build and improve capabilities in Information Fusion Center Operations, Pre Disaster Mitigation, Emergency Operations Center Response, Disaster Recovery and Public/Private Sector Preparedness Partnerships. While serving as Director of Colorado's Emergency Management Agency, in addition to his normal duties, his accomplishments include: developed performance metrics that were used by two national level emergency management associations (NEMA and IAEM) to demonstrate grant

effectiveness to Congress; achieved national accreditation for the state's emergency management program; oversaw the state's emergency management actions in support of the highly successful 2008 Democratic National Convention.

Neil Parrett is a consulting engineer with a nationally and internationally recognized expertise in dam safety. He assumed his current position following a 38 year career with the US federal government serving in positions of increasing responsibility within the Army Corps of Engineers and the US Bureau of Reclamation. As *Chief the Bureau's Dam Safety Office*, he was responsible for establishing policies, Developing and implementing procedures, managing budgets, setting priorities and providing overall direction for the Safety of Dam program within Reclamation. He developed efficient work processes to provide enhanced technical investigation and evaluation services to clients and represented the DOI to other Departments of the Federal Government involved in safety of dams. And provided managerial consulting and arranged technical assistance for other DOI agencies with a safety of dams responsibilities. He also served as the management sponsor for the Bureau's developmental work in risk assessments, overtopping protection for embankment. He also served internationally as a dam engineer consultant for a roller compacted concrete (RCC) and embankment dams on the Daguangba Hydroelectric and Irrigation Project, Hainan, Peoples Republic of China and worked with Mexico, India and Thailand on safety of dams programs.

Timothy Tinker, MPH, DrPH, is a Senior Associate with Booz Allen Hamilton's Strategy and Organization and is Director of the firm's Center for Risk and Crisis Communication. As a nationally and internationally recognized expert in risk and crisis communications, He works in both public and private sectors such as homeland security, defense, emergency preparedness, public health, health care, energy, environment, to successfully help clients anticipate, prepare and practice science based and system-wide risk and crisis communication. Prior to joining Booz Allen, he was a federal communicator at the Agency for Toxic Substances and Disease Registry, a sister agency of the Centers for Disease Control and Prevention. As Chief of Communications and Research he helped federal, state and local agencies develop solutions for complex and challenging communications issues. In the early 1990's, he provided congressional testimony and worked with the Departments of Defense and Veterans Affairs to develop a comprehensive communications strategy to address concerns about Gulf War Illness and anthrax vaccine safety. As a risk and crisis communication expert, he has consulted with national and international organizations such as the National Academies of Science, the United Nations World Health Organization, the Scientific Affairs Division of the North Atlantic Treaty Organization, and the Embassies of Italy and France. In his consultation and practice, he interacts frequently with the news media and popular press. His comments on controversial issues such as the global toy recall, child labor practices in India, and possible ecoli contamination from a national restaurant chain appeared in MSNBC, Forbes, PR News, PR Week, and Homeland Protection Professional. His communications research has been published in peer-reviewed journals such as Biosecurity and Bioterrorism, Journal of Health Communication and the Risk Policy Report.