Report of a Workshop on

Dam Safety Research Needs

Hosted by the Association of State Dam Safety Officials
April 11, 1999
Washington D.C.

Introduction

The National Safety of Dams Act was passed in 1996 to promote, in part, research initiatives for Dam Safety. The research intent of the act may be summarized as follows:

> This Act may be cited as the `National Dam Safety Program Act':
>
> (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 . . .
>
> . . .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 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; and (6) develop mechanisms with which to provide Federal technical assistance for dam safety to the non-Federal sector . . .
>
> . . .RESEARCH. (a) In General.--The Director, in cooperation with ICODS, shall carry out a program of technical and archival research to develop -- (1) improved techniques, historical experience, and equipment for rapid and effective dam construction, rehabilitation, and inspection; and (2) devices for the continued monitoring of the safety of dams.(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 . .
>
> . . .(d) Research.--There is authorized to be appropriated to carry out section 9 $1,000,000 for each of fiscal years 1998 through 2002.

As a response to the act, the Subcommittee for Research within ICODS was formed. ICODS roles are reiterated in the act::

> . . . 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 the 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 Commission; and (2) chaired by the Director. (b) Duties.--ICODS shall 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--[[Page 110 STAT. 3688]] (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 . . .

The Association of State Dam Safety Officials (ASDSO) was formed to serve six functions within the dam safety community:

1) Provide a forum for the exchange of ideas and experiences on dam safety issues
2) Foster interstate cooperation
3) Provide information and assistance to state dam safety programs
4) Provide representation of state interests before state legislatures and Congress
5) Help improve state dam safety programs
6) Foster public awareness of dam safety

In its fulfillment of these goals, ASDSO maintains many programs to heighten public awareness, to train state personnel in technical areas of interest and to maintain channels of communication between states, between government levels, and between the public and private sectors. ASDSO produces research documents to keep the dam safety community abreast of current technical and policy issues and ideas.

FEMA contracted with ASDSO as follows:

Objective - to convene a workshop to assess and prioritize needs of the States with respect to research and development, and to develop an agenda to address the needs.

Scope - The Association of State Dam Safety Officials (ASDSO) will develop the workshop as the vehicle in which to initiate the effort to "assess and prioritize needs of the States with respect to research and development, and to develop an agenda to address the needs." The work will involve formulation of a steering committee, composed of individuals recognized from public and private sectors, to guide these efforts. The workshop will be held in a place convenient to the majority of participants and be of sufficient duration and content to allow for meaningful work to be accomplished and useful products to be produced.

Tasks - The following tasks will be performed:

Task 1. ASDSO in coordination with ICODS Research Subcommittee will assemble a steering committee consisting of members from the public and private sectors of the dam safety community to develop the agenda for the workshop. Candidates for membership on this committee should be chosen from State and Federal Officials, private sector professionals, academia, dam owners, and private consultants who have expertise and insight into dam safety research needs and policy issues.

Task 2. Identify the site and select the time and duration of the workshop.

Task 3. Draft report. A draft report documenting workshop proceedings and accomplishments will be prepared. The report will contain the State dam safety research needs identified at the workshop and recommended action(s) to meet the needs.

Task 4. Report review. The draft will be distributed for review. Distribution of the draft report will be coordinated with the ICODS Research Subcommittee.

Task 5. Final Report. The draft will be updated to accommodate comments received during the review period. Final editing will be accomplished by workshop participants and submitted to ICODS for approval. Upon approval the report will be submitted to FEMA for publication and distribution as a working document to all interested parties.

Preliminary to this project, a questionnaire was given to state representatives to develop possible research issues. This survey was completed by ASDSO in 1997. This information is included in Appendix 1 and was supplied to the workshop participants as described later in the report.

Process

A workshop was convened in Washington, D.C. on April 11, 1999 prior to the quarterly ICODS meeting. Each state dam safety office was offered the opportunity to send a representative. Federal agencies represented within ICODS were also invited. The participants of the workshop are listed in Table 1.

Table 1 - List of Attendees

Long	WV	DEP-OWR 1201 Greenbriar St. Charleston, WV 25311	blong@mail.dep. state.wv.us	(304) 558-0320
Jim Alexander	MO	PO Box 250, Rolla, MO 65402	nralexJ@mail.dnr. state.mo.us	(573) 368-2175
Ralph Ezelle	AR	101 E. Capital, Suite 350 Little Rock, AR	ralph.ezelle@ASWCC. state.ar.us	(501) 682-3958
Larry Ferns	NM	PO Box 25102 Santa Fe, MN 87504	lferns@seo.state.nm.us	(505) 827-6137
Don Lopez	NM	PO Box 25102 Santa Fe, NM 87504		
Dale Frink	ND	900 East Boulevard Bismark, ND 58505	dfrink@water.swc. state.nd.us	(701) 328-4998
Meg Galloway	WI	PO Box 7921 Madison, WI 53707	galloon@dnr.state.wi.us	(608) 266-7014
Jon Phillippe	VA	Suite 33 98 Alexandria Pike Warrenton, VA 20186	jphillippe@dnr.state .va.us	(540) 347-6420
Jason King	NV	123 W. Nye Lane Carson City, NV 89	jking@gov.state.nv.us	(775) 687-3861
Don Martino	PA	P.O. Box 8554 Harrisburg, PA 171	martino.donald@a1. dep.state.pa.us	(717) 787-8568
Dave Gutierrez	CA	2200 X St. Sacramento, CA 95818	Daveg@water.ca.gov	(916) 323-0248
Alan Pearson	CO	1313 Sherman St #818 Denver, CO 80203	alan.pearson@state.co.us	(303) 866-3581
Steve Partney	FL	2051 E Dirac Dr. Tallahassee, FL 32310	Parney_s@dep.state.fl.us	(850) 488-8217
Sterling Yong	HI	1151 Punchbowl St	dowaldpm@pixi.com	(808) 587-0248

		Rm 221 Honalulu, HI 96813		
Charles Clevenger	MS	P.O. Box 10631 Jackson, MS 39289-0631	charlie_clevenger@dep.	(601) 961-5204
John Moyle	NJ	P.O. Box 419 Trenton, NJ 08625	jmoyle@dep.state.nj.us	(609) 984-0859
John Ritchey	NJ	P.O. Box 419 Trenton, NJ 08625	jritchey@dep.state.nj.us	(609) 984-0859
Mike Stankiewicz	NY	50 Wolf Rd Albany, NY 12233	mrstanki@gw.dec.state.ny.us	(518) 457-0834
Mark Ogden	OH	1939 Fountain Sq. Columbus, OH 43224	mark.ogden@dnr.state.us	(614) 265-6727
Cecil Bearden	OK	3800 N. Classen Oklahoma City, OK 73118	crbearden@owrb.state.ok.us	(405) 530-8800
Mike Lowe	TX	PO Box 13087 Austin, TX 78711	mlowe@trncc.state.tx.us	(912) 239-4763
Matt Lindon	UT	PO Box 146300 Salt Lake City, UT 84114	mlinden@state.ut.us	(801) 538-7372
Doug Johnson	WA	PO Box 47600 Olympia, WA 98504	djsd461@ecg.wa.gov	(360) 407-6623
Dave Benner	WY	Herschler Bldg. 4E Cheyenne WY 82002	dbenne@missc.state.wy.us	(307) 777-6153
Leon Smothers	KY	14 Reilly Road Frankfort, KY	leonsmothers@mail.state.ky.us	(502) 564-3410

Visiting:

Don Bathurst	FEMA
Gene Zeizel	FEMA
David Achterberg	ICODS

Facilitators/Administrative Support:

David Harris	BOR
Caroline Mohorovic	BOR
Lori Spragens	ASDSO
Susan Sorrell	ASDSO
Sarah Mayfield	ASDSO

In the interest of collecting as many ideas as possible, but yet, preparing a workable list of possible topics for funding to ICODS, a special process was developed and used in the workshop. This process was a variation of the Strategic Planning Process known as MetaPlan developed by the IBM Corporation. The steps of this process are summarized below with accompanying outcome from the workshop.

Question to Resolve:

A single question was developed for attendees to address:

What research is needed in the dam safety area?

The question is intended to be specific to the desired outcome, but somewhat vague so as to not influence input into predetermined categories.

For this conference, resource information was supplied to the participants while brainstorming. This information included the results of the ASDSO survey that state representatives previously completed. The distribution is included in this report as Appendix 1.

Input from attendees - the brainstorming phase

Input from attendees is collected on index cards, a few words per card. This is done by all simultaneously. The intent of this step is to collect as many ideas as possible from a fairly large group in a time efficient manner.

The cards are collected by the facilitator as completed, or at any time during the meeting. The cards are read one at a time and sorted into columns of similar topics at the front of the room, with everyone participating. A perfect distinction is not necessary at this phase.

Identifying the categories of research

With all cards sorted into columns, the test of distinction was to determine if a topic heading could be established for each column. Some movement of initial cards was necessary during this process. New cards could be added at any time as participants thought of new ideas, clarified their ideas, or found items that belonged in more than one category. The continued intention was to collect as much information as possible within the time limit. A short description was sought for all items listed in any given column. This column then became a research area with possible individual tasks within the column. Results from this phase of the workshop are in Table 2.

Table 2. - Research Areas/Topics

A. Outlet/Gates Evaluation & Repair

- Analysis of gates
- Inplace outlet repair
- Inspection of outlet works
- Un-encased outlets
- Cheap conduit rehabilitation
- Mid-level vs. low-level gates

B. Spillways

- Low head spillway design
- Spillway underdrain design
- More efficient emergency spillways
- Spillway design imp.
- Retrofit spillway
- Spillway
- Fuse plug use design & analysis for spillway sizing, etc.

C. Vegetation & Maintenance

- Vegetation overgrowth
- Grass
- Trees on dams

D. Hydrology modeling & analysis

- CN evaluation
- Update precipitation data
- Extreme storm analysis
- Paleo hydrology
- Flood hydrology
- PMP/PMF reductions
- NWS vs. consultants on PMP
- High elevation storms
- PMP and PMF
- Calibrate Western watersheds
- Aerial reduction factors
- Extreme flood frequency of occurrence
- PMP development
- PMF
- Extreme Precipitation
- PMP meteorology updated regionally
- PMF & reality
- Storm spatial analysis

E. Dam Failure Analysis

Dam break discharges
Dam breach inundation determination for small dams
Breach impacts
Mud flow characteristics of tailings dams
Failure time of embankment dams from overtopping
Refine dam break analysis
Failure modeling for small dams
Methods of failures
NWS Fldwv
Failure time
Comparison of breach programs
2-D dam breach assessment
Overtopping failure duration

F. Reclamation

Dam removal procedures
Emergency channel
Environmental impacts of dam removals

G. Seepage

Seepage/piping along pipes through dams
Seepage
Geotextile filter drain clogging potential
Seepage rehab techniques
Developing methods to detect voids
Non-destructive analysis of defects

H. Funding

Funding of repairs
Funding of repairs
Costs of repairs
Cost estimates for repairs
Rehabilitation costs
Old dams
Money for private owners
Money
Sources of money
Dam life cycle costing (maintenance cost estimating & dam removal costs, etc.)

I. Standards & Guidelines

Seismic guidelines
Spillway guidelines
Conduit evaluation standards
Database development
Embankment guidelines

Model inspection training program
Dam safety performance measures
Hazard classification

J. Risk Assessment

Acceptable risk
Risk quantification
D/S population vs. LOL

K. Seismic

Seismic risk assessment & small dams
Embankment deformation & earthquakes
Blind fault (seismic)

L. Emergency Action Planning

How do we get dam owners to prepare EAPs?
EAP standardization
Public awareness
Keep people out of dam break areas

M. Soils

Consolidation levels of tailings dams
Soil analysis
Decay rate of organic soil

N. Nuisance animals

Burrowing animals
Control rodents

O. Concrete Evaluation & Repairs

Concrete repairs
Life span of post-tension anchors

P. Monitoring and Instrumentation

Instrumentation
Non-intrusive seepage testing
Electro-potential embankment analysis
Early detection of piping/seepage problems
Standard piezometer programs

Q. Overtopping

Minimize overtopping effects
Overtopping protection
Overtopping protection/different methods
Overtopping design

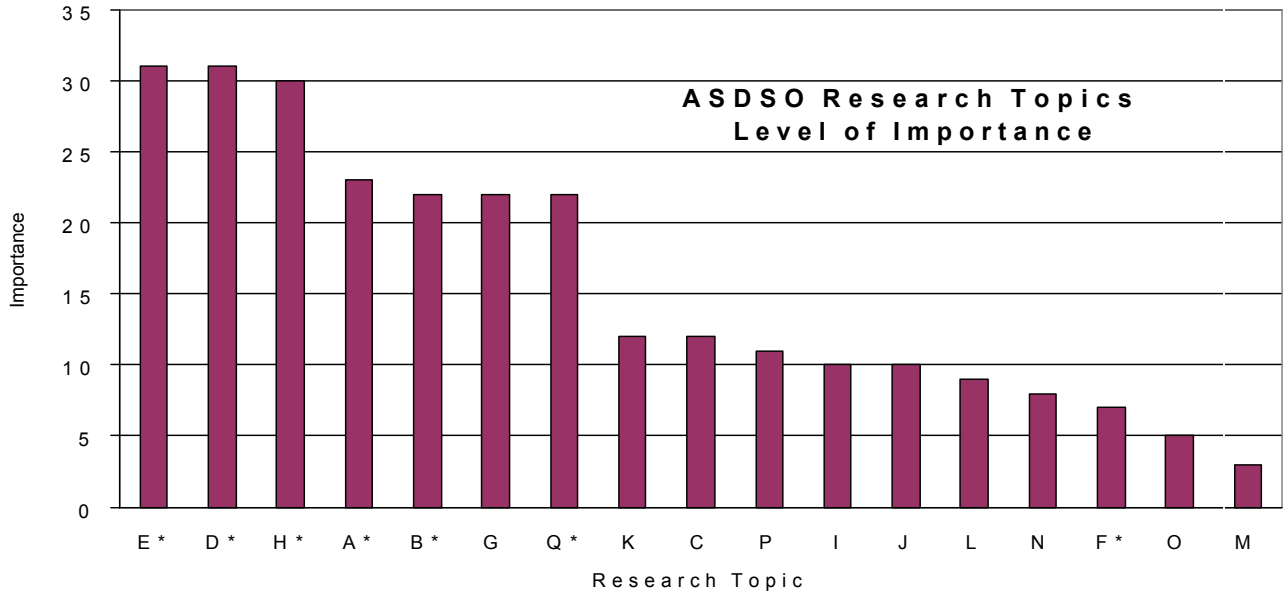
Prioritizing the categories

Individuals are then asked to define their own priority (importance) for the categories using a multi-vote. In this case ten glued dots are provided to each participant. A participant may split their priorities within the following rules:

1. May use any or all of the dots distributed throughout the categories
2. As many as 3 dots may be used on any one category to represent increased importance of any particular category to the participant.

All votes are counted for each category. This voting creates a typical Pareto distribution of the categories. The distribution of importance is shown in Figure 1 below:

Figure 1. - Pareto Distribution of Research Categories by Participant



In a Strategic Planning Context, additional information can be useful. This is an estimate of difficult any particular category may be. Difficult may mean expensive, technically challenging, complex, or any definition that the participant chooses for any given category. In this case each participant gives EACH category a score of 0 to 10, with 0 being easy and 10 being really hard. In this case participant scores are averaged. *Final* results are shown in Table 3:

Table 3. - Research Topics, Level of Importance and Level of Difficulty

Legend Item	Topic	Importance	Average Difficulty
A.*	Outlets/	23	4.3
B.*	Spillways	22	4.1
C.	Vegetation	12	3.0
D.*	Hydrology Modeling Analysis	31	7.6
E.*	Dam Failure Analysis	31	6.1
F.*	Reclamation	7	5.7
G.	Seepage	22	5.1
H.*	Funding	30	7.2
I.	Standards and Guidelines	10	4.7
J.	Risk Assessment	10	8.1
K.	Seismic 12	6.4	
L.	Emergency Action Plans	9	4.7
M.	Soils	3	5.1
N.	Nuisance Animals	8	2.6
O.	Concrete Evaluation and Repairs	5	4.2
P.	Monitoring Instrumentation	11	3.6
Q.*	Overtopping	22	4.4

(Items in Table 3 that are marked with an asterisk were further developed by workgroups. The results are provided in the next section of this report.)

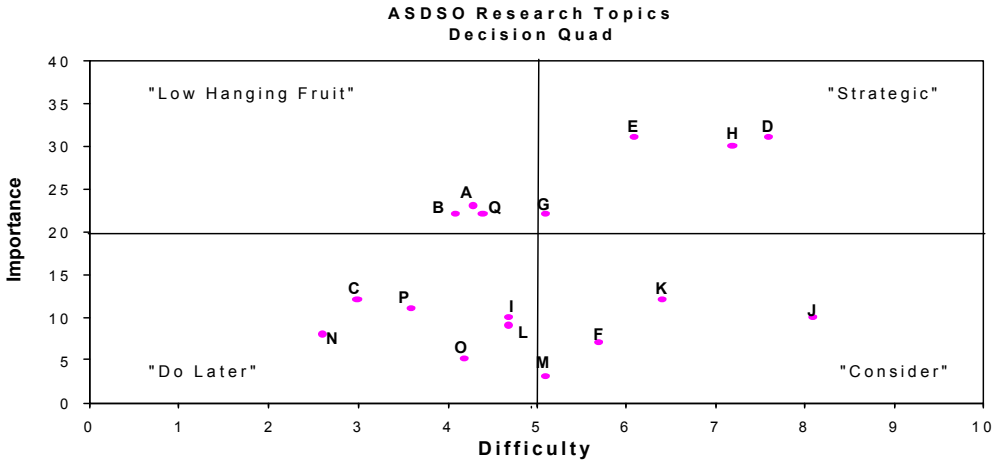
These data provide a second dimension for plotting of the category data. This produces a decision quad of the data. The quad is formed by four quadrants in the data, each of which is given a descriptive name.

Quad : Easy and important : Low Hanging Fruit
Hard and important: Strategic
Easy but less important: Do later
Hard and less important: Consider

Data from this workshop are shown in Figure 2:

Figure 2. ASDSO Research Topics and Decision Quad

Work Groups



The full caucus of members was asked to work on the categories, to further develop the ideas to a level, which could be understood and considered for funding by the ICODS Research Subcommittee. Each individual chose what category he or she was interested in and was assigned a location for a small group activity. Small groups needed a minimum of 3 members, categories which did not achieve this level of interest were not developed further.

The groups were asked to produce two products; 1) why a category was important and 2) the expected outcome that would be produced by funding a research category. As a framework, it was suggested that a format of the 6 "W's" be used:

- Who
- What
- Why
- Where
- When
- Who

The following categories were further developed, producing twelve potential research topics on the following pages:

1. Outlets/Gates
2. Spillways
4. Hydrology Model Analysis
5. Dam Failure Analysis
6. Reclamation
8. Funding
17. Overtopping

The twelve proposals for each follow.

Topics Developed for Research/ Workshop - #1

Title: Dam Failure Analysis

Description:

To define the mechanism of dam breach failures

Project Tasks and Needs:

Why important: We have to know the mechanism of failure to determine the hazard classification of the dam. Too many assumptions have to be made to perform a breach analysis. These variables need to be quantified and clarified for us to do a better job of determining hazard potential.

Need to address:
1. Failure time -- Based on historical events, for both piping and overtopping
2. Breach geometry failures
3. Flow characteristics of various types of tailings for use in DAMBRK.
4. Develop 2-D breach model.
5. Full-scale modeling of dam failures.

Project Lead and Contract:
USGS-Water Resources in Rolla and the University of Missouri-Rolla along with the University of Illinois have done some work to identify flow characteristics of various types of tailings.
USBR and CSU have done some work on modeling dam failures.
NRCS Agricultural Research Service, Stillwater, OK

Topics Developed for Research/ Workshop - #2

Title: Methods of Inspection, Evaluation and Repair of Existing Conduits

Description:

A high percentage of conduits within embankments are in poor condition.

Failure of conduits has often led to failure of dams.

Identify problems with conduits before they become critical.

Identify remaining life of conduit so owner can plan for repairs.

Project Tasks and Needs:

1. Methods of inspection need to be identified.
   Poll state and federal agencies for current inspection techniques.
   Identify special equipment available.
   Develop inspection methodologies.

Evaluation criteria for degraded pipes and their materials
   Research previous studies on conduit conditions, longevity and failures.
   Determine any additional studies needed, for identifying longevity of conduit materials.
   Identify conditions that can lead to conduit failure.

Innovative methods available to repair conduits within embankments
   Poll state, federal and industry for methods previously used.
   Evaluate which methods are successful.
   Develop detailed engineering guidelines of each method.

End product: New engineering manual on inspection, evaluation and repair of conduits.

Project Lead and Contract:

Who is working in this area? Kansas State University, NRCS

Who might be able to lead the project? NRCS, Kansas State

Who are good candidates to complete the w
Most universities, Bureau, NRCS

Topics Developed for Research/ Workshop - #3

Title: Guidelines for Financial Responsibility for New Dams

Description:

Why? Owner to assure adequate financial resources through life of project.

What? Guidelines for revisions of current state standards for permitting new dams or transfer of ownership.

Expected: Written guidelines for state program use (model rule)

Project Tasks and Needs:

Develop committee.

Develop guidelines.

Project Lead and Contract: ASDSO

Topics Developed for Research/ Workshop - #4

Title: Dam Removal

Description:

Dams have limited life span and usage, and as with the rest of the aging national infrastructure, safety concerns are often the impetus for change.

Dam removal is an emerging trend, used to address dam safety concerns.

Dam removal has a significant physical and emotional impact on the local community with competing social, environmental and economic values.

Project Tasks and Needs:

Address sediment control and site stabilization

Decision criteria and public education materials

Removal procedures to minimize/maximize environmental impacts

Project Lead and Contract:

Purdue
River Alliance
ASCE Guidelines
Fish and Wildlife
Trout Unlimited (and many other fish groups)
FERC
Bureau of Reclamation
CDE

Topics Developed for Research/ Workshop - #5

Title:
Spillway Inadequacy: Economical Spillway Enlargement of Existing Dams (SIESEED)

Description:

Inadequate spillway capacity causes 40% or more of dam failures. Due to changes in watershed characteristics, hydrologic requirements & downstream flood plain development, frequently spillways have inadequate capacity.

Needs to be fulfilled:
Mitigate loss of life
Reduce costs of spillway retrofit to the owner.

Outcome
Increased compliance with state dam safety law
Populate NPDP database
Increase awareness of spillway design alternatives.

Project Tasks and Needs:

Project cost analysis of the following:
Case histories (fed, state, private)
Lab tests (Vicksburg, Stillwater, Denver)
Manufacturers (gabions, mats)
Field tests (universities, states, etc.)

Project Lead and Contract:

Who is working in this area? Consulting engineers, NPDP

Who might be able to lead the project? Experienced dam safety engineer/firm

Who are good candidates to complete the work? Consulting engineers, state dam safety organization, universities, and federal agencies Topics developed for Research

Topics Developed for Research/ Workshop - #6

Title: Overtopping Design

Description: Study of Causes & Effects of Overtopping

Initial Construction
Overtopping
- Initial Design
- Retrofit
- Change in hazard classification
- (Caused by urbanization)

What needs are to be fulfilled?
- Public safety
- Optimization of funds
- Technical assistance

Expected Outcome
- Design guidelines
- Economical alternatives

Project Tasks and Needs:

Tasks to be done
- Modeling range - overtopping
- Mathematical & physical models
- Case studies

How is this problem solved?
- Result of math & physical models
- Preparation of a design manual

Project Lead and Contract:

US Bureau of Reclamation / US Army Corps of Engineers
Academia
NRCS Agricultural Research Service, Stillwater, OK
Engineering school w/hydraulic labs - complete work

Topics Developed for Research/ Workshop - #7

Title: Emergency Measures to Prevent Overtopping Failures

Description: Public Safety Issues

Expand available methods to prevent overtopping failure
Decision Matrix

Project Tasks and Needs:

mited options and high risk.

Need method for quick analysis using sound engineering principals to select location and configuration of wet breach and prevent uncontrolled release.
Practical guidelines/parameters for field implementation.

Project Tasks & Needs:

Compile historical data research on past attempts
Define parameters that control performance (soil erodibility, geometry, timing)
Practical correlations (rules of thumb, nomographs), including decision criteria.
Physical modeling/scale testing (calibrate any historic info)
Final guidance

Project Lead & Contract:

Use NPDP for historical data
NWS Breach Model (FLDWAV?)
UNET
Both currently working in this area.

Who? University research

Topics Developed for Research/ Workshop - #9

Title: Development of funding programs

Description:

Why? Lack of funds by owners to make necessary improvements
What? Provide the mechanisms to finance repairs of existing dams
Expected Outcome: A viable source of info (white paper) to assist states in developing a funding program.

Tasks:

A. Identify needs ($ amounts) per state. Total costs of all repairs (estimates)
B. Develop draft legislation
C. Develop stakeholder support (owners, engineers, OEM's, construction industry, environmental groups, press, insurance)
D. Research by economists to establish cash flow of the program to set pace for orderly management of funds to meet identified needs (time frames)
E. Development of rules and guidelines for program administration (eligibility, ranking, disbursement)

Lead and Contract:

ASDSO Steering committee - Lead
A. State programs
B. ASDSO committee
C. Lobbyist, PR firm
D. Economists, universities
E. ASDSO subcommittee

Topics Developed for Research/ Workshop - #10

Title: Rehabilitation and Maintenance Costs

Description:

Why? Assist dam owners, state programs, etc., in estimating repair and/or annual maintenance costs, (and other life cycle costs, including decommissioning)
What? Provide up-to-date dam rehab and maintenance cost throughout the U.S.
Expected Outcomes: Establish cost estimating software

Tasks:

A. Establish committee for project oversight
B. Develop specifications for software
C. Obtain existing data of costs of repairs to develop economic predictions of future maintenance costs
D. Develop software

Lead & Contract:

Players: Old ASDSO cost of upgrade project - Gannett Fleming software
NPDP
Lead: ASDSO/NPDP
Who?
A. ASDSO
B. Committee
C. state programs/NPDP/engineering consultants
D. Contractor

Topics Developed for Research/ Workshop - #11

Title: Estimate of PMF from PMP

Description:

From the large rainfall events that have occurred and the resultant flood events, assess the relationship as it relates to AMC, peak flows, runoff volumes, watershed size, etc. Present runoff estimate and methodologies may be too conservative and provide an unnecessary factor of safety on top of the PMP. The cost of providing this level of protection is cost-prohibitive and unnecessary. The data needs to be credible and acceptable to the public.

Project Tasks & Needs:

Review and evaluate the large event gage rainfall & runoff records, watershed parameters, paleo hydrology, etc. to establish regression equations for estimates of the PMF at any site.

Project Lead and Contract:

Working in area: Mel Schaefer
Lead: USGS, NWS, USACE, USBR
Candidates: Mel Schaefer, USBR, USGS, NWS, USACE, universities, consultants based on qualifications.

Topics Developed for Research/ Workshop - #12

Title: Review Probable Maximum Precipitation (PMP) Values Nationwide

Description:

Review the PMP values throughout the U.S. Include the assessment of regional influences, storms in mountainous areas, and probability of occurrence for the regionalized areas (west of the Rocky Mountains versus east face of the Rocky Mountains versus Mississippi Valley, etc). The present estimates may be conservative. Based on old and inadequate data, society cannot afford to provide this level of dam safety. The data used needs to be credible and acceptable to the public.

Project tasks and needs:

Review of previous storm data in more detail to establish more site-specific PMP values and temporal distribution where warranted rather than broad brush values (Doppler radar).

Project lead and Contract

Those working in the area -- National Weather Service, Universities, Consultants..

Lead: NWS and USGS
Coordinate with universities and consultants chosen based upon qualifications

Network Contacts

At the workshop participants volunteered to serve as contacts in developed areas. The following Table identifies contacts within each area:

Area	Name	Org	Address	Phone	E-Mail
PMP/PMF	Alan Pearson	CO	CO DWR 13135 Herman #818 Denver 80203	303-866-3581	alan.pearson@state.co,us
Overtopping reclamation	Steve Partney	FL	2051 E. Dirac Dr. Tallahassee FL 32310	850-413-8192 ext 24	partney_s@dep.state.fl.us
Reclamation 2-D	Matt Lindon	UT	UT DNR - Dam Safety PO Box146300 Salt Lake City, UT 84114	801-338-7372	mlindon@state.vt.us
Conduit Inspection Evaluation	Doug Johnson	WA	Dam Safety Office Dept. of Ecology PO Box 47600 Olympia, WA 98504	360-407-6623	djsd461@ecy.wa.gov
Dam Break Analysis	Jim Alexander	MO	PO Box 250 Rolla, MO 65401	573-368-2175	
PMP/PMF Hydrology and Funding	Jon Phillippe	VA	DCR-Div of Dam Safety 98 Alexander Pike, Sta. 33 Warrenton, VA 20186	540-347-6420	jphillippe@dcr.state.va.us
PMP/PMF	Bob Dalton	IL	Illinois Dept. of Natural Resources 524 S. 2nd St. Springfield, IL 62701-1787	217-782-3863	bdalton@dnrmail.state.il.us
Breach Spillways	Cecil Beardan	OK	3800 N. Classen Okalahoma City OK 73118	405-530-8862	crbeardon@owrb.state.ok.us
Dam Break Modeling	Doug Johnson	WA	see above		
Funding & Reclamation	Meg Galloway	WI	PO Box 7921 Madison, WI 53707-7921	608-266-7014	gullom@dnr.state.wi.us
Funding	John Ritchey	NJ	NJDEP Dam Safety Section PO Box 419 Trenton, NJ 08625	609-984-0859	jritchey@dep.state.nj.us

Appendix 1:
Annual Survey of State Dam safety programs 1997-1998
Prepared by: Association of State Dam Safety Officials

Section IX. Miscellaneous
1. Please list the top five research topics which you would like the NDSPA Research Subcommittee to consider in future years.

AZ: (1) Embankment stability (2) Embankment cracking (3) Site specific PMP (4) Spillway design

AK: Tailing dams (hardrock mining)

AR: (1) Regional risk analysis studies (2) Study of geofabrics use in overtopping (3) Funding sources for dam repair (4) Enhanced web site for dam safety

CO: Extreme precipitation at high elevations

GA: (1) Seepage/bacteria growth/clogging (2) Siphon (PVC) limitations (3) Engineer qualifications

IL: (1) Overtopping protection, testing of new products (2) Geosynthetics in dams - history of performance (3) Addition of drawdown conduits in existing dams by directional drilling (4) Seepage collars - history and performance and problems (5) Comparison of current upstream face protection design methods and recommendations for modifications if warranted

IN: (1) ways to increase safety at lowhead in-channel dams for people *near* the structure (2) Rehab methods for old metal pipes

LA: (1) Risk-risk analysis method, consequence of failure (2) Analysis-analysis of pipes, safety evaluation (3) Monitoring - Cost effective monitoring & implementation (4) Floods- Determine PMP, PMF with return frequency criteria (5) Field conditions - Effects of deterioration, steel, concrete

MD: (1) Evaluation of NWS Dambreak vs. HEC 1 (2) Non-destructive methods of investigating embankment sinkhole precursors (3) Investigation of RCP crack failures C-361

MA: (1) Seepage (2) PMF definitions

NE: (1) Trees on dams - leave, cut, remove (2) Reinforcement/ armoring systems for overtopping (3) beaver control at inlets

NV: (1) Hydrology & hydraulics (2) Increasing spillway sizes (3) outlet pipe construction techniques (4) Seepage monitoring (5) Slope stability

NJ: (1) Funding dam rehabilitation projects (2) Overtopping protection for earth dams (3) RCC performance (4) Longterm monitoring of soil anchors (5) Labyrinth spillway design

NC: Longevity of different types of pipes in dams (2) Longevity of geotextiles used in dams (3) What to do about trees on dams (4) Design of features to discourage beavers from clogging spillways (5) Determining Regional runoff Characteristics for SCS Runoff Curve Number Method (6) Also, updating Rainfall Atlas TP-40 and HYDRO-35

OK: Spillway capacity enlargement

PA: Design and remediation of spillway underdrain systems

SC: (1) Economical ways to line failed spillway pipes (2) Economical overtopping protection (3) Economical ways to *keep* 4-wheel vehicles off rural dams (4) New *ways* to handle beaver infestations

TX: (1) Fund completion of NWS FLDWAV (2) Overtopping capabilities of NRCS (Formerly SCS) flood control dams

UT: (1) Seismic analysis (2) Incremental damage criteria (3) Lining of outlets/methods (4) Uniform standards (5) Instrumentation monitoring program

VA: (1) PMP/PMF regional study (2) Inundation mapping (3) Watershed flood forecasting (4) Hydrology through GIS/GPS (5) Risk management

WA: (1) Seismic risk analysis (2) Monte Carlo stimulation of floods (3) outlet conduit inspection and rehab (4) dam break analysis (5) Use of geotextiles in dams

WI: (1) overtopping protection methods (2) Nondestructive evaluation techniques (3) Analysis of embankments (better methods) (4) Effects of deterioration on concrete

WY: (1) Updating NOAA Atlas 2 &TP40 (2) Continue work on extreme rainfall events (3) Fund paleo flood studies at individual sites