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REFERENCE MANUAL 40
Dam Safety Program

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Dam Safety Program

Reference Manual 40

This guideline provides an outline of responsibilities for National Park Service (NPS) personnel for the management of risks associated with NPS dams in accordance with Director's Order 40: *Dam Safety and Security Program*. The planning, design, preservation, rehabilitation/construction, maintenance and operation, inspection, acquisition or disposal of dams is included. Instructions are also provided for coordination with local officials and non-NPS dam owners. This document is not intended to be a technical manual, but as a management guideline.

Application of the guideline by NPS personnel should be commensurate with size, complexity, operational importance, hazard potential classification, risks, and ownership for each dam. Questions about the application of the guideline may be made to the park, regional, or Washington Support Office. A list of contacts is available on the NPS Dam Safety Web page at: http://inside.nps.gov/waso/contacts.cfm?lv=3&prg=158

CONTENTS

CHAPTER 1: APPLICABILITY AND AUTHORITIES 1

APPLICABILITY 1

CRITERIA TO DETERMINE IF A WATER IMPORTING BARRIER IS A DAM USING DEFINITIONS CONTAINED IN PL 92-367 AND PL 99-662 3

PROGRAM MISSION 4

DOCUMENT PURPOSE 4

AUTHORITIES 4

CHAPTER 2: DAMS AND DAM SAFETY IN NPS 6

DAMS IN PARKS 6

DAM FAILURE HISTORY 7

LAWN LAKE DAM FAILURE 7

DAM SAFETY PROGRAMS 7

ABOUT THE NPS DAM SAFETY PROGRAM 9

LOW-HAZARD DAMS 10

CHAPTER 3: SUMMARY OF ROLES AND RESPONSIBILITIES 11

GENERAL 11

DECISION MAKING 11

ROLES AND RESPONSIBILITIES 12

CHAPTER 4: DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION 13

HAZARD CLASSIFICATION SYSTEM 13

POLICY 14

HAZARD CLASSIFICATION POTENTIAL DESCRIPTIONS 14

High 14
Significant 14
Low 15
Nonjurisdictional Size 15

PERFORMANCE OF DOWNSTREAM HAZARD CLASSIFICATION STUDIES 15

DAM SAFETY PROGRAM FOCUS 16

ASSESSMENT OF DOWNSTREAM AREAS AND IMPACTS 16

CHAPTER 5: LOW-HAZARD POTENTIAL DAMS 17

GENERAL 17

PERIODIC SURVEYS OF AREAS DOWNSTREAM 18

PARK PLANNING DOWNSTREAM FROM LOW-HAZARD DAMS 18

ASSET MANAGEMENT INSPECTIONS 18

EXAMINATIONS AND EVALUATIONS 18

FUNDING 18

CHAPTER 6: DAM REMOVAL AND RESTORATION 19

POLICY 19

FUNDING 19

CANDIDATE DAMS 19

BENEFITS OF DAM REMOVAL 20

Cost Savings 20
River/Stream Restoration 20
Landscape Enhancement 21
Removal of Safety Hazards 21

COSTS OF REMOVAL 21

PROCESS 21

DAM REMOVAL DECISION DOCUMENT 22

REMOVAL DESIGN AND CONSTRUCTION 22

CHAPTER 7: DAM INVENTORY MANAGEMENT 23

POLICY 23

PURPOSE 23

GENERAL 24

TYPES OF STRUCTURES 24

NONJURISDICTIONAL STRUCTURES 24

INVENTORY DATA: THE DAM SAFETY DATABASE 25

ACCESS AND DATA ENTRY 25

DATA REVIEW AND UPDATING 25

ADDITION OF DAMS 26

NONJURISDICTIONAL DAMS IN DATABASE 26

DEACTIVATED STATUS DAMS 26

CHAPTER 8: ACQUISITION OF DAMS 27

POLICY 27

REVIEW OF DAMS ON LANDS CONSIDERED FOR ACQUISITION 27

PROCESS 28

CHAPTER 9: DAM EXAMINATIONS 29

POLICY 29

PURPOSE 30

EXAMINATIONS AND MONITORING INSPECTIONS 30

LOW-HAZARD DAM EXAMINATIONS 30

PARTICIPATION OF PARK PERSONNEL 30

SUMMARY OF EXAM TYPES 31

SPECIAL EXAMINATIONS 31

INTERMEDIATE EXAMINATIONS 32

FORMAL EXAMINATIONS 33

COMPREHENSIVE REVIEWS 33

INACCESSIBLE FEATURES EXAMINATIONS 34

CHAPTER 10: EMERGENCY MANAGEMENT AND EMERGENCY ACTION PLANS 35

GENERAL 35

EMERGENCY RESPONSIBILITIES 36

INCIDENT RESPONSE 36

EMERGENCY ACTION PLAN 37

General 37
Policy 38
Emergency Action Plan Content 38
Decision Making 39
Notifications 39
Warning and Evacuation 40
Response Level System 40
Expected Actions 40
Incident Command System 41
Emergency Action Plan Development 41
Exercising 41

POST-INCIDENT ACTIONS 42

INUNDATION MAPPING 43

CHAPTER 11: DAM OPERATIONS AND MAINTENANCE 44

POLICY 44

GENERAL 45

DAM OPERATION AND MAINTENANCE MANUAL 45

DAM OPERATIONS 46

LARGE RELEASES 46

DAM MAINTENANCE 47

DAM OPERATING STAFF 48

LOGBOOK 48

OCCUPATIONAL AND PUBLIC SAFETY 48

CHAPTER 12: DAM MONITORING 49

GENERAL 49

VISUAL INSPECTIONS 50

SCHEDULE FOR PERIODIC MONITORING 50

DATA ACQUISITION AND REVIEW 51

EXPECTED PERFORMANCE 51

REPORT OF PROBLEMS 51

CHAPTER 13: RISK ESTIMATION AND ANALYSIS 52

OVERVIEW OF MANAGING THE RISKS OF DAMS 52

NONLOSS OF LIFE CONSEQUENCES 53

DAM FAILURE MODES 53

Subsurface Erosion or Piping Due to Seepage Flows at an Embankment Dam 53
Overtopping of an Embankment Dam 54
Spillway Failure During a Flood Event 54
Earthquake-related Failure of an Embankment Dam Due to Slope Instability 55
Earthquake-related Failure of an Embankment Dam Due to Seepage Erosion Failure 55
Foundation-related Failure of a Concrete Dam 56

RISK ASSESSMENT: THE RISK CHART 56

TIMELINESS IN RESPONSE TO ELEVATED RISKS 57

DEPTH OF RISK ANALYSIS 57

SCREENING LEVEL RISK ASSESSMENT 57

COMPREHENSIVE REVIEW 58

ISSUE EVALUATION 58

CHAPTER 14: RISK ASSESSMENT AND MANAGEMENT 60

GENERAL 60

Dam Safety Priority Rating 61

MAKING THE DAM SAFETY CASE 61

USE OF THE DAM SAFETY RELIABILITY RATING 61

PORTFOLIO RISK MANAGEMENT 62

DECISION MAKING 62

CHAPTER 15: OVERSEEING RISK REDUCTION 63

GENERAL 64

DAM SCALE AND COMPLEXITY 64

IMPLEMENTING RESERVOIR RESTRICTIONS 64

IMPLEMENTING BREACHES 65

RELOCATING PEOPLE DOWNSTREAM 65

INCREASED DAM MONITORING 65

OVERVIEW OF REPAIR DESIGN 66

Designer Qualifications 67
Designer Role 67
Efficient Design and Construction for Small Dams 67
Federal/Independent Technical Review 68

CONCEPTUAL DESIGN 68

ENVIRONMENTAL COMPLIANCE 68

FINAL DESIGN 69

CHAPTER 16: OVERSEEING RISK REDUCTION: CONSTRUCTION 70

INTRODUCTION 70

ROLES 71

Contracting Officer (DSC) 71
Contracting Officer's Technical Representative (DSC) 71
Designer/Design Team 71
Construction Liaison 71
Inspector 72
Contractor 72

ACQUISITION 72

Acquisition Milestones 72

POST AWARD ACTIVITIES 73

Notice to Proceed 73
Contract Administration 73

CONSTRUCTION SAFETY 74

CONSTRUCTION MANAGEMENT 74

General 74
Scheduling 74

CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL 75

Inspection 75
Testing 75
Foundation Approval 75
Support from Design Team During Construction 76
Daily Reports 76
As-built Drawings 76
Contract Modifications 76

FIRST FILLING AND POST-CONSTRUCTION ACTIVITIES 77

First Filling 77
Final Construction Report 77

CHAPTER 17: PROGRAM MANAGEMENT 78

GENERAL 78

MANAGEMENT OF PROGRAM AUTHORITIES AND GUIDELINES 79

MANAGEMENT OF RISKS 79

FINANCIAL ADMINISTRATION 79

PROGRAM PERFORMANCE MEASUREMENT AND REPORTING 80

PROJECTS OVERSIGHT 80

PARTICIPATING ON DEPARTMENTAL AND OTHER WORKING GROUPS 80

PARTICIPATION IN PROGRAM REVIEWS 81

RECORDS AND INFORMATION MANAGEMENT 81

MAINTENANCE OF STAFF CAPACITY 81

CHAPTER 18: FUNDING 82

GENERAL 82

DAM SAFETY FUNDING SOURCES 82

NONAUTHORIZED PROJECTS 83

PROGRAM ACTIVITIES AND SOURCES OF FUNDING 83

METHODS 84

Cost Accounting 85

CHAPTER 19: TRAINING 86

GENERAL 86

CHAPTER 20: PROTECTION FROM NONOWNED DAMS 88

GENERAL 88

Policy 89

Inventory of Nonowned Dams 89

Dam Ownership and Regulation 89

Strategies for Protecting Parks from Failure of Nonowned Dams 90

CHAPTER 21: RECORDS MANAGEMENT 91

GENERAL 91

RECORDS STATIONS 91

Dam Safety Officer 91

Regional Dam Safety Coordinator 92

Park 92

RECORDS RETENTION SCHEDULE 92

Records Security 92

CHAPTER 22: DAM SECURITY 93

GENERAL 93

DAM SECURITY SCREENING AND PLANS 93

DAM SECURITY MEASURES 94

DOCUMENT AND INFORMATION SECURITY 94

CHAPTER 23: PROGRAM PERFORMANCE AND REPORTING 95

INTRODUCTION 95

PROGRAM PERFORMANCE RATINGS 95

ANNUAL REPORT 96

APPENDIX A: ACRONYMS 97

APPENDIX B: GLOSSARY 99

FIGURES

Figure 1. Dam Site Criteria 3

Figure 2. 1982 Lawn Lake Dam failure; a private dam within Rocky Mountain National Park, Colorado. Erosional damage from the failure of the 26-foot-high Lawn Lake Dam. The erosion scar and the alluvial fan downstream are still visible today. 8

Figure 3. Seepage leading to piping (internal erosion) through the foundation on an embankment dam 54

Figure 4. Dam overtopping and failure process via erosion of the downstream slope 55

Figure 5. Dam Failure Risk Chart 56

Figure 6. Failure Modes Plotted on the Risk Chart 57

TABLES

Table 1. Summary Roles and Responsibilities for Applicability and Authority 1

Table 2. Summary of Roles and Responsibilities 6

Table 3. Summary of Roles and Responsibilities for Dam Safety 11

Table 4. Summary of Roles and Responsibilities for Downstream Hazard Potential Classification 13

Table 5. Downstream Hazard Potential Classification System 14

Table 7. Summary of Roles and Responsibilities for Low-hazard Potential Dams 17

Table 8. Summary of Roles and Responsibilities for Dam Removal and Restoration 19

Table 9. Summary of Roles and Responsibilities for Dam Inventory Management 23

Table 10. Summary of Roles and Responsibilities for Acquisition of Dams 27

Table 11. Summary of Roles and Responsibilities for Dam Examinations 29

Table 12. Summary of Examination Types for NPS High and Significant Hazard Potential Dams 31

Table 13. Summary of Roles and Responsibilities for Emergency Management / Emergency Action Plans 35

Table 14. Emergency Responsibilities by Hazard Classification and Dam Owner 36

Table 15. Summary of Roles and Responsibilities for Dam Operations and Maintenance 44

Table 16. Summary of Roles and Responsibilities for Dam Monitoring 49

Table 17. Summary of Roles and Responsibilities for Risk Estimation and Analysis 52

Table 18. Summary of Roles and Responsibilities for Risk Assessment and Management 60

Table 19. Summary of Roles and Responsibilities for Overseeing Risk Reduction 63
Table 20. Roles and Responsibilities for Overseeing Risk Reduction: Construction 70
Table 21. Summary of Roles and Responsibilities for Program Management 78
Table 22. Summary of Roles and Responsibilities for Funding 82
Table 23. Program Activities and Sources of Funding for High and Significant Hazard Potential 83
Table 24. Program Activities and Sources of Funding for Low-hazard Potential Dams 84
Table 25. Summary of Roles and Responsibilities for Training 86
Table 26. Summary of Roles and Responsibilities for Protection from Nonowned Dams 88
Table 27. Summary of Roles and Responsibilities for Records Management 91
Table 28. Dam Safety Program Records Retention Schedule 92
Table 29. Summary of Roles and Responsibilities for Dam Security 93
Table 30. Security Issues and Solutions for NPS Dams 94
Table 31. Summary of Roles and Responsibilities for Program Performance and Reporting 95

CHAPTER 1: APPLICABILITY AND AUTHORITIES

1. Applicability
2. Mission
3. Document purpose
4. Authorities

TABLE 1. SUMMARY ROLES AND RESPONSIBILITIES FOR APPLICABILITY AND AUTHORITY

Entity	Roles and Responsibilities
Dam Safety Officer (DSO)	1. Develops and updates policies and guidelines for each hazard classification. 2. Reviews/develops policies and guidelines. 3. Manages dam safety risks.
Regional Dam Safety Coordinator (RDSC)	1. Participates in development and updating of policies and guidelines. 2. Conducts program activities consistent with policies and guidelines.
Park Staff	1. Conducts program activities consistent with policies and guidelines.

APPLICABILITY

There are a variety of dam and other water structures within the national park system. The structures vary in size, purpose, and capacity. While all of these structures should be considered as assets to be managed, the Dam Safety Program (DSP) manages the risks of dams sufficiently large as to present a potential hazard. When dams fail, they rapidly release large amounts of water. This wall of water can destroy parklands/facilities and cause injuries and loss of life. The DSP focuses on those structures that have the potential to cause risk to people, property, and the environment. It is a public safety program.

There are approximately 50 National Park Service (NPS)-owned dams in the parks. Most chapters of this guideline apply to these dams. There are also many non-NPS-owned dams whose failure could harm people, property, or resources in the parks. Chapter 20 provides guidelines for risk management of these nonowned dams.

Dams must be of a certain height or reservoir capacity to be considered for inclusion in the Dam Safety Program. See figure 1 for additional explanation.

The program also supports the removal of dams (including small nonjurisdictional dams (see chapter 6).

Finally, other hydraulic structures (e.g., levees and canals) have the potential to cause damage to parks following their failure. These structures are not included in this guideline.

This document addresses the following structures:

1. NPS owned dams: High, Significant, or Low potential hazard dams. Any artificial barrier, including appurtenant works, which impounds or diverts water, and which

   - is 25 feet or more in height from the natural bed 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
   - has an impounding capacity at maximum water storage elevation of 50 acre-feet or more.

2. dams, owned by others that would inundate parklands if they were to fail
3. low hazard potential dams, including review of areas downstream of low-hazard potential dams for new development
4. dams on lands considered for acquisition
5. dams considered for removal and restoration

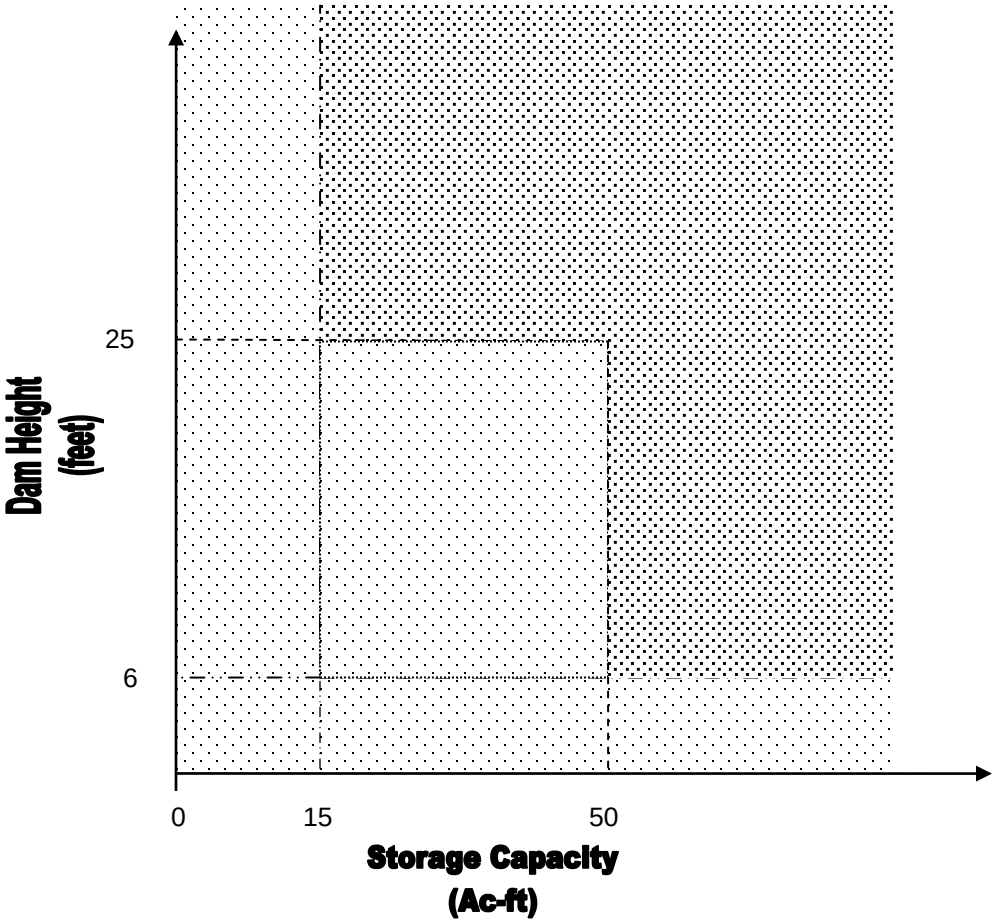
These guidelines do not apply to any such barrier that is not in excess of 6 feet in height, regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of 15 acre-feet regardless of height. However, this lower size limitation should be waived if there is a potentially significant downstream hazard. For further information, refer to the Federal Emergency Management Agency (FEMA) Federal Guidelines for dam safety, Glossary of Terms (143) and DM 753.

This document does not address the following structures:

1. Nonjurisdictional dams (also known as pond dams). These structures do not meet the minimum size criteria for a dam as described in the section above.
2. Other hydraulic structures: canals, canal plugs, locks, tunnels, and levees.

These dams and structures should be operated and maintained so as to maintain benefits and prevent structural failure consistent with asset management practices. Parks and regions can contact the DSP staff for technical assistance for these structures.

CRITERIA TO DETERMINE IF A WATER IMPORTING BARRIER IS A DAM USING DEFINITIONS CONTAINED IN PL 92-367 AND PL 99-662



Barrier meets definition of “dam” based on dam height and storage capacity. The dam is assigned a hazard potential classification of Low, Significant, or High and is included in the National Inventory of Dams (NID).

Barrier does not meet definition of “dam” based on dam height and storage capacity and is not included in the NID. The barrier is considered to be of nonjurisdictional size. However, the barrier is considered a dam if, due to its location or other physical characteristics, it is likely to pose a significant threat to human life or property in the event of its failure. The dam is then assigned a hazard potential classification of significant or High and included in the NID.

FIGURE 1. DAM SITE CRITERIA

PROGRAM MISSION

The NPS Dam Safety Program Mission is:

> *The National Park Service Dam Safety Program will protect the National Parks by managing the risk posed by dams and water impoundment structures to people, facilities, park resources, and the environment.*

DOCUMENT PURPOSE

Dams and their appurtenant works represent a valuable resource to the national park system. The purpose of this guideline is to outline management responsibilities for the maintenance, operation, and safety of dams under NPS jurisdiction as respectively required by Statute 16 *United States Code* (USC) 1 and U.S. Department of the Interior (USDI) – Departmental Manual Part 753.

These responsibilities include, but are not limited to:

- inventorying the dams
- assigning downstream hazard potential classifications
- examining dams
- evaluating and assessing dam risks
- making decisions to manage dam risks including temporary actions or decisions to construct dam modifications
- overseeing risk reduction actions (e.g., dam repair planning, design, and modification)
- preparing for dam-related emergencies
- monitoring dam performance

The guideline is not intended as a standard for technology of dams. The guideline may be used, as appropriate, when coordinating with non-NPS dam owners.

Application of this guideline by NPS employees should be commensurate with each dam's size, complexity, operational importance, hazard potential, and ownership as articulated in this manual.

AUTHORITIES

Authorities serve as the formal foundations of a program within an individual organization and within larger organizations of which a particular organization is a part. For dam safety, there are federal, Department of the Interior, and NPS authorities.

Federal Guidelines for Dam Safety 1979 (FEMA 93 2005). This guideline recommends a systematic program for the maintenance, operation, safety, or disposal of (nonessential) federal dams. http://www.fema.gov/plan/prevent/damfailure/publications.shtm#0

Executive Memorandum, October 4, 1979, Implements *Federal Guidelines for Dam Safety* as appropriate for each agency.

Public Law 107-310 (The Dam Safety and Security Act of 2002). This act reauthorizes the National Inventory for Federal and non-Federal dams, safety inspections of nonfederal dams, development of a comprehensive program for the inspection and regulation of dams for safety purposes, and inclusion of security.

Department of the Interior Dam Safety Program, DM753, chapters 1 and 2, includes requirements for each bureau dam safety program.

Chapter 1 - http://elips.doi.gov/app_dm/act_getfiles.cfm?relnum=3662

Chapter 2 - http://elips.doi.gov/app_dm/act_getfiles.cfm?relnum=3663

NPS Management Policies 2006, section 9.5 "Dams and Reservoirs" includes:

- Dams are subject to annual safety inspections.
- Emergency action plans (EAPs) are to be prepared.
- The park's Emergency Operations Plan will include park activities for warning and evacuating people at risk from dams owned by others upstream of the parks. [Note that NPS *Management Policies 2006* incorrectly states that the park's dam Emergency Action Plan will address dams owned by others.]
- An inventory of dams and other stream flow control structures will be maintained (including nonowned dams).
- Dams and reservoirs will not be constructed in parks.
- The National Park Service will not seek to acquire and operate dams.
- The National Park Service will deactivate existing dams unless they contribute to the park's "cultural, natural, or recreational resources bases of the area or are a necessary part of a park's water supply."

Two other management policy sections apply to risks presented by dams: 1.5 External Threats and Opportunities and 8.2.5.2, Emergency Preparedness and Emergency Operations http://www.nps.gov/policy/MP2006.pdf

16 USC 1: General legislative authority for the management and operation of park areas. It includes the maintenance and rehabilitation of those facilities designated as an integral part of the park operation.

The program policy is Director's Order 40: *Dam Safety and Security Program*

This is not a comprehensive list. Other authorities not listed may apply.

CHAPTER 2: DAMS AND DAM SAFETY IN NPS

1. Dams in parks
2. Dam failures
3. Lawn Lake dam failure
4. Dam safety programs
5. About the NPS Dam Safety Program
6. Low-hazard dams

TABLE 2. SUMMARY OF ROLES AND RESPONSIBILITIES

Entity	Roles and Responsibilities
DSO	1. Attends dam safety training and professional dam safety conferences. 2. Provides funds to train regional and park personnel involved in the Dam Safety Program.
RDSC	1. Attends dam safety training. 2. Coordinates participation of park staff in dam safety training.
Park Staff	1. Attends dam safety training.

DAMS IN PARKS

Because dams are man-made structures within parks, existing dams must demonstrate benefits to the park or they should be decommissioned. Dams in parks create reservoirs which may provide one or more following benefits:

- fish and wildlife habitat
- water supply for facilities
- scenery
- recreational use
- fishing/camping
- flood control

Particularly in the arid West, dams create precious surface water and storage of storm runoff water. Some dams are historical structures and are important park interpretive assets.

Certain dams no longer contribute to the cultural, natural, or recreational bases of the area or are not a necessary part of a park's water supply system. These dams should be breached and permanently removed (deactivated). No new dams are to be constructed in parks.

Most of the dams in parks are small embankment dams. However, there is a wide variety of other types of structures including masonry and concrete structures.

DAM FAILURE HISTORY

Dams are high potential energy structures. If dams are not designed, constructed, operated, and maintained properly, natural events (such as floods and earthquakes) or the erosive nature of water flowing through soil can cause a dam to fail.

When the water stored behind dams is released in a flood surge, it can cause loss of life and devastation. In general, the potential for devastation is proportional to the height of the dam, the volume of the reservoir, the size of the failure breach, the rapidity of breach formation, and the depth/velocity of the failure flood wave.

In 1889, 2,209 lives were lost when the South Fork Dam failed above Johnstown, Pennsylvania. Between 1918 and 1958, 33 major U.S. dam failures caused 1,680 deaths. From 1959 to 1965, nine major dams failed worldwide. The 1928 St. Francis Dam failure killed more than 500. During the 1970s, the Buffalo Creek, Teton, and Kelly Barnes dam failures collectively cost 175 lives and more than $1 billion in financial losses. Dams continue to fail in more recent times. Since 2000 there have been failures of Big Bay Dam, Taum Sauk Upper Reservoir, Silver Lake, and Ka Loko Dam. According to the National Performance of Dams Program, there were 29 dam failures in the period between 2003 and 2004.

The number of people that lose their lives in a dam failure is dependent on their distance from the dam site, the depth/velocity of the flood wave, and their ability to be warned and evacuated in advance of the flood. It should be noted that the size of a dam and reservoir are only one factor in the number of lives lost in dam failures. The failure of small dams and reservoirs upstream of vulnerable populations can lead to high loss of life.

The dam failure flood wave can also create large permanent erosion scars (see figure 2). This is of particular concern to the parks that have as their mission the stewardship of park resources for future generations.

LAWN LAKE DAM FAILURE

Unfortunately, the National Park Service has experienced one dam failure that led to the deaths of three people, long-term damage to the park, and $31 million (in 1982 dollars) in costs to the government—the Lawn Lake Dam failure of 1982. See figure 2.

DAM SAFETY PROGRAMS

A dam safety program is a function within an organization with the mission of managing the risks of one or more dams. These programs are dedicated to leading and managing integrated activities to ensure dams do not present unacceptable risks. They are public safety programs that hold protection of human life as the primary purpose and also have the responsibility to help prevent other losses from dam failures.

FIGURE 2. 1982 LAWN LAKE DAM FAILURE; A PRIVATE DAM WITHIN ROCKY MOUNTAIN NATIONAL PARK, COLORADO. EROSIONAL DAMAGE FROM THE FAILURE OF THE 26-FOOT-HIGH LAWN LAKE DAM. THE EROSION SCAR AND THE ALLUVIAL FAN DOWNSTREAM ARE STILL VISIBLE TODAY.

Dam safety programs usually address an inventory of dozens or hundreds of dams. They allocate available organization resources (staff and budget) to monitor the performance of dams, formally

examine dams, estimate safety/risks, evaluate risks, and make decisions. When risks exceed guidelines, the risks are reduced through repair, reservoir restriction, or breaching. There is an emphasis on coordinating and prioritizing available resources across projects, offices, and regions to ensure that they are used to the maximum extent to accomplish the mission. They serve as a focal point for the organization of all matters related to dam safety, responding to dam incidents, and ensuring high risk situations are addressed in a timely way.

These programs reduce potential liability from dam failure by exercising due diligence in the care and protection of dams.

Federal agencies with dams are required to establish and operate dam safety programs. The Department of the Interior requires each bureau with dams to have a dam safety program. The NPS Dam Safety Program is authorized by NPS *Management Policies 2006*, section 9.5, and Director's Order 40.

ABOUT THE NPS DAM SAFETY PROGRAM

There are approximately 60 dams in the national park system throughout the continental United States. About 20 dams could cause life threatening or destructive flooding if they were to fail. These 20 dams are referred to as either High- or Significant-hazard dams, and are the primary concern of the NPS Dam Safety Program. The NPS dam safety officer allocates funding appropriated by the federal government to take actions at these High- or Significant-hazard dams to reduce the potential for dam failure resulting in loss of life. There are also about 30 confirmed Low-hazard dams.

The Dam Safety Program uses a variety of program activities to reduce the risk of catastrophic flooding due to dam failure. Some of those activities include:

- Park staff visit the dam periodically to look for developing dam safety problems.
- Park staff keeps the dam in a serviceable condition, perform repairs, and control vegetation.
- Park staff collects instrumentation readings of performance monitoring equipment and distribute the data to dam safety engineers who evaluate the performance of the dam.
- Registered, professional engineers perform periodic and thorough examinations of the dam.
- Dam safety engineers obtain/gather/collect and evaluate information about the dam to determine which physical mechanisms could lead to failure of the dam and estimate risks.
- Managers review dam risks and prioritize and accomplish temporary and permanent risk reduction actions.
- Dam design engineers develop designs of dam modifications to permanently reduce dam risks.
- Construction contractors build modifications to the dam to reduce risks and make the dam safer.

Despite the best efforts of the Dam Safety Program, because of inherent risks with dams, and because of acts of nature, a dam may still fail and cause life-threatening releases. To protect the public downstream from High- and Significant-hazard dams, the program requires a system of emergency management for each dam. Emergency management helps to ensure that if a threatening event occurs, the event is detected and, if necessary, people downstream from the dam are warned and evacuated. Emergency management requires close coordination among the park, the dam safety

officer, and other officials responsible for the safety of the public downstream of the dam. Emergency management includes incident response, internal notifications, and emergency action plans development and exercising. For emergency management to be successful, these plans must be updated regularly (usually on an annual basis).

There is also a public safety concern for the safety of the public that visits the dams and reservoirs. Dangers due to physical injuries or drowning at dams do exist and the National Park Service seeks to reduce these risks. The Dam Safety Program also seeks to reduce specific risks to NPS personnel at dams such as entering confined spaces; climbing into gate shafts; and operating mechanical, electrical, and other equipment.

LOW-HAZARD DAMS

Low-hazard dams can fail and produce damage to park resources. While the failure of these dams present little risk of loss of life, the parks must protect lands, infrastructure, and other resources from the potential damage from Low-hazard dams.

Low-hazard dams are generally greater than 25 feet in height or have reservoirs with greater than 50 acre-feet of water storage (see figure 1).

The DSP funds risk studies, examinations, monitoring, and dam repairs of Low-hazard dams. However, High- or Significant-hazard dams generally have a higher funding priority. Emergency action plans are not normally required for Low-hazard dams.

One important activity is to review the area downstream from Low-hazard dams at least every five years to ensure that the dam failure flood zone continues to be free from additional human occupation. Should a new campground or house be built in the dam failure floodplain, the dam should be reviewed to determine whether it should be reclassified as a High- or Significant-hazard dam.

See chapter 5 for more information on Low-hazard dams.

CHAPTER 3: SUMMARY OF ROLES AND RESPONSIBILITIES

1. General
2. Decision making
3. Roles and responsibilities

TABLE 3. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM SAFETY

Entity	Roles and Responsibilities
DSO	1. Developing and maintaining documents describing roles and responsibilities. 2. Developing training for regional dam safety coordinators and park staff.
RDSC	1. Supporting the parks in assignment of dam safety roles and responsibilities. 2. Supporting the parks in establishing an identified Park Dam Safety Coordinator. 3. Coordinates training for park staff. 4. Supporting regional management responsibilities for the program.
Park Superintendent	1. Dam safety decision making. 2. Identification of staff to perform dam safety activities, including roles and responsibilities into position descriptions. 3. Training park staff.

GENERAL

Many offices and staff combine to operate an effective NPS Dam Safety Program. The roles and responsibilities are documented so that the entire program operates effectively at all levels. Documented authorities also allow new employees to learn about their new jobs. Presented here are the broad roles and responsibilities. See also the roles and responsibilities defined in Director's Order 40. Other sections of this manual include specific roles and responsibilities. The below individuals may delegate authority to their staffs to fulfill the program responsibilities. The dam safety officer can assist offices with specifics for carrying out these roles and responsibilities.

DECISION MAKING

To properly manage dam risks, decisions need to be made and documented. Some dams may have high risks that warrant risk reduction actions. Often several alternatives are available to address high risk, including temporary reservoir restriction, temporary/permanent breach, or moving populations at risk. The park superintendent is the key decision maker in this process with advice and programmatic/technical input from the dam safety officer. The region also shares in this decision making.

Major decisions will be documented in writing. Alternatives considered and reasons for the selected alternative will also be documented as appropriate.

ROLES AND RESPONSIBILITIES

[See Director's Order 40 for a comprehensive list of responsibilities by role.]

CHAPTER 4: DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION

1. Hazard potential classification system
2. Policy
3. Performance of downstream hazard classification (DHC) studies
4. Dam safety program focus
5. Consequence surveys of areas downstream from dams

TABLE 4. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION

Entity	Roles and Responsibilities
DSO	1. Schedules, funds and procures needed DHC studies and consequence surveys. 2. Completes assessments of areas downstream from Low-hazard dams no less frequently than every five years. 3. Reviews draft hazard classification reports.
RDSC	1. Contacts dam safety officer for new downstream hazard classification studies (as identified from downstream area assessments or at other times). 2. Assists parks with DHC issues. 3. Supports the park in the accomplishment of assessments of areas downstream dams (when required and no less than every five years).
Park	1. Maintains maps showing vulnerable areas downstream from dams. 2. Plans park development to avoid (when prudent) permanent and overnight occupancy of areas downstream from Low-hazard dams. 3. Notifies the regional dam safety coordinator and the dam safety officer of any changes in use to the downstream area that might impact the hazard classification. 4. In cooperation with the regional dam safety coordinator, performs (or assists when dam safety technical experts are used) assessments of areas downstream of dams (as needed but no less than every five years). 5. Provide description of impacts to park if the dam were to fail.

HAZARD CLASSIFICATION SYSTEM

Because of the vast array of sizes of dams and the consequences of dam failure, the dam safety industry uses a hazard potential classification to separate any given dam into one of several categories. This allows dam safety programs to focus on the dams that present risks and not on the hundreds or thousands of small dams that present very little or no risks.

Each dam is reviewed and receives one of the following hazard classification ratings (ratings of High, Significant, and Low are determined from FEMA technical standard 333):

TABLE 5. DOWNSTREAM HAZARD POTENTIAL CLASSIFICATION SYSTEM

Hazard Potential Classification	Loss of Life	Significant Economic or Park Resource Losses
High	Expected, probable	Yes or No
Significant	Not expected, not probable	Yes
Low	Not expected, not probable	No
Unknown	Not yet determined	Not yet determined
Decommissioned	None	None
Nonjurisdictional (very small water barriers that are not included in the Dam Safety Program)	Remote	Remote

Notes:
1. If the failure of a dam could contribute to the failure of one or more downstream dams, the upstream dam must be classified at least as high as the highest classification of the downstream dam(s).
2. The downstream hazard classification is not an indication of the condition of the dam, or of the potential for failure of the structure. The DHC represents the potential threat to human life and property in the event of a sudden (catastrophic) failure of the dam.

POLICY

The following policy is from Director's Order 40:

> *Although the NPS will not seek to acquire structures that impound waters, if a structure should be acquired, it will be evaluated to determine if it meets the definition of a dam by the Washington Dam Safety Program (DSP). If the structure meets the definition of the dam and is owned by NPS, the structure will be assessed using current federal guidelines to determine its hazard potential classification. The hazard potential classification will identify the probable impacts to property and probable loss of life in the event of a dam failure. The hazard classification process used will identify the dam as either High, Significant, or Low hazard. Hazard classifications for all High, Significant, and Low hazard dams will be reassessed at no more than every five years or sooner if downstream conditions change.*

HAZARD CLASSIFICATION POTENTIAL DESCRIPTIONS

One hazard classification is assigned per dam. Hazard classification will be reassessed at least every five years.

High

Failure of the dam would cause flooding that would probably result in loss of life.

Significant

It is not expected that failure would result in loss of life, but loss of life is plausible (not remote); or failure of the dam would cause flooding that would result in appreciable and/or long-term impacts to a park's visitation/resources/mission; or the flooding causes significant damage to substantial nonpark infrastructure.

A case for a Significant hazard needs to be made by considering all of the consequences. Examples that would contribute to a Significant hazard classification include:

- The flood failure flows could wash out a well-traveled road, but it is unlikely (but plausible) that someone would lose their life.
- The park has only one (or only a few) key water features.
- The dam and reservoir are highly visited. Loss of the dam would result in major impacts to park visitation and resource access.
- The dam failure would create a flood wave that damages key roads, utility lines, cultural, or natural resources within the park.
- The flood would severely hamper park operations, impairing a park's ability to fulfill its purpose and mission per enabling legislation.
- Damages and impacts are long term (e.g., greater than one year).
- The dam failure would damage major nonpark roads, lifelines, or key infrastructure.
- Repair of the dam and re-establishment of the reservoir would be a major undertaking.

Low

Loss of life from dam failure is remote and failure of the dam is not expected to result in appreciable damage to park or nonpark resources.

Nonjurisdictional Size

The dam is below the federal criteria for size of the dam. The dam is too small to present any public safety or resource risk.

PERFORMANCE OF DOWNSTREAM HAZARD CLASSIFICATION STUDIES

To perform the hazard classification, a technical specialist with experience with dams and flood hydraulics travels to the dam, makes dam measurements, and reviews the areas downstream from the dam. Any houses, structures, bridges, roads, and campgrounds are documented. The park provides a list of impacts to the park from dam failure (e.g., loss of visitation, endangered species, dam repair cost, loss of utilities). Back in the office, using the data obtained in the site visit, the technical specialist performs dam break modeling and routes the flood downstream.

- Should the dam break flood model or other analysis indicate that loss of life is expected or probable, than the dam will receive a *High* downstream hazard classification.
- Should the model or other analyses indicate no probable loss of life, but would cause significant damage to park or off-park resources or infrastructure, the dam would be classified as "*Significant*."
- Should the model indicate little risk to people and little damage to park or off-park resources, the dam would receive a "*Low*" hazard classification.

- Should the dam and reservoir be below jurisdictional size, the dam will be declassified and termed "*Nonjurisdictional.*"
- A dam that has not yet had its jurisdictional status or downstream hazard classification completed will be assigned an "*Unknown*" classification.

DAM SAFETY PROGRAM FOCUS

The first focus of dam safety programs and this RDSR project are the *High* and *Significant* potential hazard dams. To ensure that the High and Significant hazard potential inventory is complete, inventories of all dams that meet the criteria for a jurisdictional dam must be performed.

The second focus is on *Low-hazard* potential dams. These dams are above a minimum height and/or reservoir size. They are reviewed a minimum of every five years to verify no one is occupying the downstream floodplain or the need for them to be reclassified. The program will also examine and review the risks of Low-hazard dams to park lands/resources and manage the risks of these structures.

Downstream area assessments and reviews of the hazard classification will not be performed for non-jurisdictional dams unless they are structurally modified or some special hazard is discovered downstream from them. If this occurs the park will be responsible to contact the regional dam safety coordinator to request re-evaluation of the structure's hazard classification.

ASSESSMENT OF DOWNSTREAM AREAS AND IMPACTS

The Dam Safety Program has a requirement for reviewing the downstream hazard classification of all High-, Significant-, and Low-hazard dams no less than every five years.

During the downstream area assessment, the potential dam failure inundation zone is reviewed for new homes, bridges, public use areas, or other structures. The condition survey is documented in a short report with photos of downstream areas.

Impacts to parks are also assessed, usually with a great amount of park input. Potential impacts can be short or long term and include loss of reservoir habitat, trail impacts, costs of dam repair, endangered or threatened species impacts, visitation levels, land erosion scaring, impacts to partners or other stakeholders, loss of roads or utilities.

CHAPTER 5: LOW-HAZARD POTENTIAL DAMS

1. General
2. Periodic survey of areas downstream
3. Park planning downstream from Low-hazard dams
4. Asset management inspections
5. Examinations and evaluations
6. Funding

TABLE 7. SUMMARY OF ROLES AND RESPONSIBILITIES FOR LOW-HAZARD POTENTIAL DAMS

Entity	Roles and Responsibilities
DSO	1. Maintains policies, guidelines, and procedures for Low-hazard dams. 2. Completes assessments of areas downstream from Low-hazard dams no less frequently than every five years. 3. Provides technical assistance to parks upon request. 4. Conducts exams and evaluations of the dams. 5. Funds repair construction of the dams (at a lower priority than funding of repairs of High- and Significant-hazard dams).
RDSC	1. Supports parks in the periodic surveys of areas downstream from Low-hazard dams. 2. Provides technical assistance to parks upon request.
Park Staff	1. Operates, maintains, inspects, and repairs Low-hazard dams. 2. Notifies the regional dam safety coordinator and dam safety officer of any changes in use to the downstream area that might impact the hazard classification. 3. Performs asset management condition assessments of Low-hazard dams per Facility Management Software System (FMSS) Inspection Guidance 6100. 4. Updates the NPS Dam Safety Database as needed.

GENERAL

Low-hazard dams are those structures that are above the Federal Guidelines for Dam Safety size criteria, but do not at the present time have people or significant resources/structures at risk downstream should the dams fail.

“Low hazard” does not mean “no hazard.” It is important that the parks monitor and assess the condition of these Low-hazard dams consistent with good facility management practices. Although these dams do not have probable loss of life or significant losses of park resources, Low-hazard dam failures should be avoided. Dam failures result in an uncontrolled release of reservoir waters and there is a small chance someone could be downstream. Dam failure flood flows can create economic damage including negative impacts to cultural resources. Dam breaches and downstream damage are expensive to repair. The loss of the reservoir results in the loss of the water resource including habitat for fish and wildlife.

The regional dam safety coordinator and the dam safety officer are available for technical assistance in the management of Low-hazard dams.

PERIODIC SURVEYS OF AREAS DOWNSTREAM

Per Director's Order 40, the lands downstream from Low-hazard dams will be reviewed no less than every five years. The purpose of the survey is to determine if there are new people, structures, or resources that are at risk from the dam failure. An example is if someone builds a home along the channel downstream from the dam. If such new populations/structures/resources are potentially at risk, a formal downstream hazard study shall be prepared. This could lead to the dam being reclassified as a High- or Significant- hazard dam.

PARK PLANNING DOWNSTREAM FROM LOW-HAZARD DAMS

Parks should map Low-hazard dam flood inundation areas downstream from Low-hazard dams. They should use these maps in the planning for the park. When possible, the parks should avoid development downstream from Low-hazard dams. For example, if a park were to develop a campground in the area below a Low-hazard dam, the dam would likely be reclassified as High hazard requiring an emergency action plan, monitoring inspections, examinations, risk evaluation, and higher repair standards. Technical and financial assistance in developing these maps is available from the dam safety officer.

ASSET MANAGEMENT INSPECTIONS

The annual asset management condition inspections should be performed by park staff familiar with the operation, maintenance, monitoring, and safety of dams. Since dams are complex civil engineering structures, condition inspection staff should consult with the regional dam safety coordinator about their level of experience with dams and any training that they should have (also see "Chapter 19: Training"). These inspections are conducted using the FMSS Dam Inspection Guidance 6100 document.

Any emerging condition found should be brought promptly to the attention of the superintendent. The regional dam safety coordinator and the dam safety officer are available for technical assistance for Low-hazard dam issues/incidents.

EXAMINATIONS AND EVALUATIONS

Low-hazard dams should be initially examined and evaluated for risk of failure. The exam/evaluation should develop a plan for operation and maintenance (O&M) and a plan for monitoring the dam. The dam should be evaluated based on dam-specific failure modes and conditions at the dam.

FUNDING

Funding for Low-hazard dam maintenance, operation, and FMSS condition assessments are from the park base maintenance budget. The Dam Safety Program will fund the repair of Low-hazard dams, however repairs to High- or Significant-hazard dams will normally receive a higher priority.

Should a park wish to permanently breach, decommission, or remove a Low-hazard dam, funds are available from the servicewide dam safety program budget administered by the dam safety officer.

CHAPTER 6: DAM REMOVAL AND RESTORATION

1. Policy
2. Funding
3. Candidate dams
4. Process
5. Dam removal decision document
6. Removal design and construction
7. Guidance

TABLE 8. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM REMOVAL AND RESTORATION

Entity	Roles and Responsibilities
DSO	1. Funds dam removals. 2. Develops and maintains program policies, guidelines, and procedures for dam removal. 3. Consults with regional dam safety coordinator and parks on dam removals.
RDSC	1. Guides parks through the process of dam removal.
Park Staff	1. Identify dams for removal. 2. Participates in data collection, environmental studies, and reviews of breach designs. 3. Develops and approves a dam breach decision document in consultation with the dam safety officer and the regional dam safety coordinator.

POLICY

According to NPS *Management Policies 2006*, section 9.5 "Dams and Reservoirs," the National Park Service "…will seek to deactivate existing [dam] structures unless they contribute to the cultural, natural, or recreational resource bases of the area or are a necessary part of a park's water system."

FUNDING

Funding is available from the NPS Dam Safety Program for permanent removal of dams. The park should contact the regional dam safety coordinator to request funding. The regional dam safety coordinator will coordinate with the dam safety officer.

CANDIDATE DAMS

A park may choose to permanently remove and deactivate a dam because

- the reservoir has filled in with sediment and the remaining pond is not a significant park resource.

- the dam has a combination of marginal benefits and high dam safety risks that would be very expensive to repair
- the dam and reservoir no longer fulfill a purpose for the park
- the dam detracts from the scenic beauty of the park
- the dam or reservoir presents a hazard to the visiting public or park or nonpark resources
- dam repair, operation, and maintenance costs are prohibitive
- a desire to return the stream to its natural free-flowing condition

However, dams may have benefits not immediately apparent. For example, the removal of a dam may result in more frequent/severe downstream flooding. This may necessitate the need for enlargement of hydraulic structures downstream including bridges and culverts. Reservoirs also provide water habitat for fish, amphibians, water-loving plants, as well as for water fowl. Some dams may have historical or cultural value.

The positive and negative effects of a particular dam/reservoir should be carefully evaluated during the dam removal decision-making process, including NEPA. Candidate dams may be found through review of the Asset Priority Index, the Facility Condition Index, and the NPS Dam Safety Database.

Decisions about dam removals should be consistent with NPS policies, NEPA, park authorities/purposes, and the park general management plan.

BENEFITS OF DAM REMOVAL

Cost Savings

Dams are expensive to operate, maintain, evaluate, repair, and to plan for emergencies. By permanently breaching a dam, the following costs are saved:

- annual maintenance costs
- annual operation costs
- annual monitoring costs
- examination costs
- dam evaluation costs
- repair costs
- emergency action plan costs

River/Stream Restoration

Dams create blockage to fish or other living organisms. Removal of the dam allows transport of these organisms between formally segmented stream sections. Some organisms (such as fish) travel along the stream during certain times of the year and dam removal allows these processes to resume. Dam removal can result in a healthier stream habitat.

Landscape Enhancement

Dams are human-made structures within parks and thus are an interruption in the natural landscape. While some dams blend into the surrounding landscape, others are obviously out of place in a natural landscape. Dam removal restores the natural landscape.

Removal of Safety Hazards

The dam may present hazards such as falling, tripping, slipping, getting caught in spillway flows, and being an attractive nuisance to children. Because of these hazards, the area may have to be fenced or signed. These signs and fences detract from natural scenic beauty.

The reservoir may attract unsupervised swimmers. Boaters may be drowned by going over the spillway. Dam removal completely removes these safety concerns with the dam and reservoir.

COSTS OF REMOVAL

The costs of removal include the actual cost for deconstruction, but also the loss of the benefits provided by the dam and reservoir. The benefits lost may include:

- loss of the scenic beauty of the reservoir to the landscape. In most areas of the western United States, little surface water exists in nature and the reservoirs provide park visitors with rare water-related resources and scenic beauty
- loss of water habitat to fish and water fowl
- loss of lakes for trail destinations
- loss of reservoir-related recreation including fishing, swimming, and boating
- loss of flood-control benefits

PROCESS

An example process to use for permanently removing a dam is

1. Identify the candidate dam.
2. Form a team with the regional dam safety coordinator and park staff.
3. Research the costs/benefit of removal.
4. Identify funding sources.
5. Develop and approve a dam removal decision document (see below).
6. Receive funding.
7. Perform the breach design.
8. Finalize/sign needed environmental compliance activities.
9. Execute deconstruction.
10. Officially remove the dam from the NPS dam inventory.
11. Consider the completion of a follow-up report.

DAM REMOVAL DECISION DOCUMENT

With the assistance of the regional dam safety coordinator and the dam safety officer, the park should develop a dam removal decision document. This document will ensure that the dam's existing benefits and costs are considered and that the removal is needed. In some cases, data or surveys will be required to collect information about the dam/reservoir physical and social benefits and costs. Funding sources are identified. The Planning, Environment, and Public Comment (PEPC) / National Environmental Protection Act (NEPA) process should be followed, including the participation of stakeholders. The document should be endorsed by the regional dam safety coordinator and the dam safety officer and approved by the park.

REMOVAL DESIGN AND CONSTRUCTION

The design of the breach and removal should be performed by a qualified engineer. The design and construction should include:

- Collect needed dam data including dam/reservoir sediment soil samples and surveys.
- Develop of breach alternatives and selected alternative.
- Control of reservoir waters during dam breaching (commonly accomplished by pumping or siphoning the reservoir down before construction).
- Control and remove groundwater (removal of saturated soils can be problematic and expensive).
- Control reservoir sediments during construction.
- Dispose of dam materials.
- Plan for return of the stream through the reservoir basin, including provisions to prevent erosion.
- Plan for return of natural vegetation to the reservoir basin.

CHAPTER 7: DAM INVENTORY MANAGEMENT

1. Policy
2. Purpose
3. General
4. Types of structures
5. Definition of a dam and nonjurisdictional structures
6. Inventory data
7. Access and data entry
8. Data review and updating
9. Addition of dams
10. Declassifying dams in database
11. Deactivated dams

TABLE 9. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM INVENTORY MANAGEMENT

Entity	Roles and Responsibilities
DSO	1. Receives, reviews, and approves Dam Safety Database (DSD) updates. 2. Ensures updates are made to dam records after dam examinations (data may be provided by Reclamation or A/Es following the examinations). 3. Provides inventory updates to National Park Service, Department of the Interior, Federal Emergency Management Agency, and the *National Inventory of Dams*. 4. Updates the Dam Safety Database to meet changing program needs. 5. Manages and funds staff to maintain the Dam Safety Database.
RDSC	1. Provides parks with assistance in operation of the Dam Safety Database. 2. Reviews draft updates and passes updates to the dam safety officer.
Park Staff	1. Provides information to the RDSC and dam safety officer for updating the DSD.

POLICY

The Dam Safety Program will update and maintain the NPS Dam Safety Database.

NPS-owned dams and nonjurisdictional structures in Financial and Business Management System (FBMS) and the Facility Management Software System (FMSS). These assets will be maintained in FMSS per the requirements set forth in Director's Order 80: *Real Property Asset Management* and related guidance.

PURPOSE

In order for the National Park Service to meet the requirements of the management policies and Director's Order 40, the National Park Service must maintain a broad inventory of water-related structures. The National Park Service is required by federal law to maintain and update the inventory

of NPS-owned dams and their hazard classification. Inventories must be both established and maintained over time.
The data is used for the following purposes:

- program performance measurement and improvement
- formulization of annual program work
- budget justification
- Department of the Interior and federal reports
- emergency and incident management
- timely NPS senior-level reporting
- asset management
- updating the *National Inventory of Dams*

GENERAL

In compliance with Public Law 107-310 and Departmental Manual Part 753, the National Park Service has developed an inventory of dams based on information from the U.S. Army Corps of Engineers (USACE) *National Inventory of Dams* (NID), Bureau of Reclamation Inspections, and NPS field reports.

The inventory provides information regarding inspections, corrective actions, emergency action plans, EAP exercises, and corrective actions.

TYPES OF STRUCTURES

According to Director's Order 40, the National Park Service will maintain a database of:

- The High-, Significant-, and Low-hazard, deactivated, nonjurisdictional, and removed dams it owns. The database will also include:
  - non-NPS-owned dams upstream from NPS boundaries that would have a potential impact on NPS resources
  - other stream flow control structures whose failure could threaten people or negatively impact park resources

The database is administered by the WASO Dam Safety Office. Field personnel will inform RDSCs of any needed change to the inventory, including provide updates as identified in RM-40 for annual updates, when structural or downstream conditions change or when new dams become part of park/regional real property inventories. This information will be used to update the *National Inventory of Dams*, as required per 753 DM 2.

NONJURISDICTIONAL STRUCTURES

Refer to chapter/section 1.1 for nonjurisdictional dam size criteria.

Structures that do not meet the above size criteria are nonjurisdictional dams and are not reported to the *National Inventory of Dams* and are not included in the NPS Dam Safety Program, but are recorded in the NPS Dam Safety Database.

INVENTORY DATA: THE DAM SAFETY DATABASE

The NPS Dam Safety Database was developed to meet dam inventory requirements and for providing the bi-annual NID report to the U.S. Army Corps of Engineers. Parks, regions, and WASO play an important role in maintaining the accuracy and currency of the data as required for each dam hazard classification type. As conditions in the field change, inspections are completed, or as emergency action plans are updated, the database should be updated.

Over 60 fields of data are available in the Dam Safety Database. The required fields are: Dam Name, Hazard Classification Code, Park Alpha, Region, State, Owner Name, Non-Federal Dam on Federal Property, and Boundary Code. There is an option for entering in a FMSS ID number and the Dam Safety Database will generate a unique NPS Dam ID number. The Dam Safety Database allows for standard and custom reports.

Nonjurisdictional, deactivated, and removed dams are included for reference purposes (not actively used by the Dam Safety Program). Non-NPS owned dams whose failure would threaten people or park resources are also included.

For all dams (NPS and non-NPS owned), general and attribute information about the dam can be recorded such as: NID ID, height, crest length, dam type, reservoir capacity, downstream hazard potential classification, and purpose.

Because of the public safety emphasis of the Dam Safety Program, the following additional information is included for High- and Significant-hazard potential dams: inspections, condition, safety of dams recommendations, O&M recommendations, emergency action plan status, and federal agency involvement.

ACCESS AND DATA ENTRY

The NPS Dam Safety Database can be accessed via the WASO Park Facilities and Lands, Park Facility Management Division, Dam Safety Program website.

The Dam Safety Database is username and password protected. The entry screen prompts the user to request a username and password, which is provided by e-mail.

DATA REVIEW AND UPDATING

Parks are able to update information for their park, or regional dam safety coordinators can update the information for their region, and the dam safety officer can update all dam information throughout all of the parks/regions.

The dam safety officer will update the DSD following engineering inspections, when corrective actions are taken (e.g., reservoir restrictions or breaching), when there are changes to the inventory, or when requested by parks or the regional dam safety coordinator.

The database will maintain an audit history of the system for data integrity purposes.

ADDITION OF DAMS

If new dam structures are acquired or discovered on existing NPS lands, these new dams will be added to the inventory (see "Chapter 18: Acquisition of Dams"). Dams will be identified in the database as either active with specified hazard classification, deactivated, nonjurisdictional, removed, or unknown—to be determined after inspections.

NONJURISDICTIONAL DAMS IN DATABASE

All dams entered in the database will not be removed. Dams that do not meet the federal definition criteria will be identified as nonjurisdictional after they have been inspected by field personnel and their hazard classification analyzed to show virtually no risk to property or life. The dam safety officer will change the status of the dam in the database. Documentation of the analysis will be maintained at the WASO office. Nonjurisdictional dams will not require informal, interim, or formal inspections. Nonjurisdictional dams will be evaluated via condition assessments, see asset management guidance.

DEACTIVATED STATUS DAMS

Completed deactivation projects will be retained in the database by the dam safety officer once all project documentation is provided by the park and region. The dam safety officer will change the downstream hazard classification field to "Deactivated." Deactivated dams will not require informal, interim, or formal inspections. The park will notify the regional dam safety coordinator if conditions change with the dam in the field that would impact deactivation.

CHAPTER 8: ACQUISITION OF DAMS

1. Policy
2. Review of dams considered for acquisition
3. Process

TABLE 10. SUMMARY OF ROLES AND RESPONSIBILITIES FOR ACQUISITION OF DAMS

Entity	Roles and Responsibilities
DSO	1. Coordinates with land acquisition offices when dams are on lands targeted for acquisition. 2. Assists with evaluation of dams considered for acquisition including the downstream hazard classification and costs of ownership estimates. 3. Recommends actions to be taken on dams prior to acquisition.
RDSC	1. Serves as the initial point of contact for the land acquisition office if dams are involved.
Park Staff	1. Provides any local knowledge to regional dam safety coordinator that may impact acquisition decisions.

POLICY

According to NPS *Management Policies 2006*, "The National Park Service will not seek to acquire and operate dams…Dams and reservoirs shall not be constructed in parks." However, occasionally, the National Park Service acquires new dams through acquisition of lands which have existing dams.

According to NPS Director's Order 80, section 4.3, "Prior to acquisition by any means, including but not limited to purchase, donation, construction, or exchange, the National Park Service will perform a detailed analysis of the cost of operation, maintenance and repair, recapitalization/replacement, and overall sustainment of facilities proposed or planned for its use. This will be conducted in conjunction with the National Park Service and federal agency acquisition processes and cultural resources staff will be involved for real property heritage assets. Information obtained by this analysis will be used to determine whether it is appropriate or feasible to acquire or continue to own and operate the facilities based on cost of ownership over time. In assessing the cost of ownership, parks must evaluate the costs of individual assets and consider their implications to the overall operating budget and resources available to sustain the asset in acceptable condition."

REVIEW OF DAMS ON LANDS CONSIDERED FOR ACQUISITION

Acquired dams can represent a significant financial cost to the National Park Service. Dams require annual expenditures for their maintenance, operation, monitoring, and emergency management (emergency action plan). In addition, periodic or one-time costs include dam evaluation, one-time repair and major dam safety modifications. Modification of moderately sized structures is often extremely expensive, easily running into the millions of dollars.

Because of these dam costs, and the potential liability if a dam fails, dam owners will sometimes want to "unload" the dam onto another entity.

Consistent with NPS Director's Order 80, the National Park Service will review lands for consideration for acquisition for dams and evaluate the potential upgrade and long-term costs of dam ownership before acquiring the lands. Dams will be analyzed to document their hazard classification, condition, and risks. Costs will be estimated for recurring operation and maintenance, equipment replacement, emergency management, dam examinations, dam monitoring, and to reduce any unacceptable dam risks. Dam removal costs can also be considered. This information will be documented and incorporated into decisions as to whether to acquire new lands.

PROCESS

The regional dam safety coordinator and the dam safety officer will coordinate with the offices responsible for parks, the acquisition of lands to identify and evaluate lands for potential acquisition. In addition, land acquisition offices should proactively seek out the advice of the regional dam safety coordinator when a property contains a dam. The total costs of ownership (or deactivation of dams) will be identified in the land acquisition decision documents. The regional dam safety coordinator will assist the land acquisition offices in determining the appropriate actions regarding dams, including, but not limited to, the removal, lowering of the reservoir, or repairs of the dam prior to NPS acquisition. The dam safety officer is available for technical assistance in determining costs of required dam safety activities.

It some cases, the park may negotiate with the landowner to have the dam(s) removed before acquisition. In other cases, the park may acquire the land with the intension of removing the dam(s).

CHAPTER 9: DAM EXAMINATIONS

1. Policy
2. Purpose
3. Examinations and monitoring inspections
4. Low-hazard dam examinations
5. Participation of park personnel
6. Summary of exam types
7. Special examinations
8. Annual examinations
9. Intermediate examinations
10. Formal examinations
11. Comprehensive dam reviews
12. Inaccessible features examinations

TABLE 11. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM EXAMINATIONS

Entity	Roles and Responsibilities
DSO	1. Maintains a multiyear schedule for recurring examinations. 2. Develops annual examination program. 3. Provides annual funding for examinations. 4. Procures dam examination technical specialists. 5. Updates database following exams.
RDSC	1. Serves as the initial point of contact for the dam examiner. 2. Participates in the examinations of High- and Significant-hazard dams (as able). 3. Reviews completed examination reports. 4. Assist parks with implementation of recommendations.
Park Staff	1. Coordinates with the examiner and the regional dam safety coordinator for site visit logistics. 2. Provides equipment needed to access dam appurtenances (e.g., keys to locks). 3. Reviews safety issues with examination participants. 4. Provides staff to participate in the examination and any dam tender training provided. 5. Before embankment dam examinations, mows the dam slopes and removes any brush to allow for a complete examination. 6. Reviews completed examination reports and makes necessary recommended changes to dam monitoring and O&M practices.

POLICY

The National Park Service will adhere to the dam examination guidelines as defined by federal, Department of the Interior, and National Park Service dam safety requirements. Dam examination requirements are determined by hazard classification. The effort required for performance of the exams varies with the scale of the dam, the number/complexity of dam features, and the extent/ number of issues found during the exam.

PURPOSE

The purpose of this reference manual section is to establish the examination requirements and frequency of examinations to verify throughout the dam operating life cycle, structural integrity of the dam and appurtenant structures which assure the protection of human life and property.

Dam examinations consist of preparing for the exam, conducting the exam and preparing/transmitting an exam report. Dam safety examinations are classified into several types—each with their own frequency, report format, and examiner qualification. Dams are examined to

- determine their current condition
- detect any concerns
- evaluate the status of maintenance/operations
- collect information used in further analysis
- identify important changes over time
- make recommendations
- update the NPS Dam Safety Database

EXAMINATIONS AND MONITORING INSPECTIONS

Examinations are formal on-site dam reviews by dam safety engineers. Examinations produce a formal written report with narratives, review of outstanding recommendations and new recommendations.

Dam monitoring inspections are regularly (e.g., monthly) recurring visits to the dam by trained park staff. Inspections produce completed visual inspection checklists of two to three pages in length. (See "Chapter 11: Dam Monitoring.")

LOW-HAZARD DAM EXAMINATIONS

Low-hazard dams must be examined no less that every five years. The dam safety officer may determine that inspections are needed more frequently if a Low-hazard dam has a higher than normal risk.

PARTICIPATION OF PARK PERSONNEL

Park personnel are encouraged to participate in the dam examinations and to maintain documentation on the examinations. The examiner will likely need assistance in accessing dam appurtenances. He/she may need other equipment. Park personnel provide the examiner with information on the dam's location, access, performance, monitoring, operation and maintenance. Park personnel must review hazards at the site and ensure that procedures and equipment provide all participants a safe examination.

A two-hour training presentation and on-site dam tender training is available for the NPS-hired examiner. This is an excellent opportunity to provide park personnel with dam safety training specific to their park's dams.

SUMMARY OF EXAM TYPES

Several different examinations are performed; some exams occur on an as-needed basis while most exams are scheduled on a recurring basis. The NPS Dam Safety Program uses the following types of exams. Note that these exams are for only High- and Significant-hazard potential dams. Low-hazard dams receive an intermediate exam every five years.

TABLE 12. SUMMARY OF EXAMINATION TYPES FOR NPS HIGH AND SIGNIFICANT HAZARD POTENTIAL DAMS

Exam Type	Frequency	Examiner Qualification	Notes
Special	As needed	Experienced dam engineer technical specialist	This exam is prompted by the discovery of a situation at a dam which indicates high risks: examples: cracks, new/increasing/turbid seepage, slides sinkholes, sand boils, spillway erosion, post-earthquake, or post-flood.
Intermediate*	Every fourth year (alternating every two years with formal exams)	Professionally licensed dam engineer examiner	A checklist report with photos is included. O&M and safety of dams (SOD) recommendations are updated.
Formal*	Every fourth year (alternating every other year with intermediate exam) and following dam milestones	Professionally licensed dam engineer examiner	This exam is performed every four years and following construction of a new dam, acquisition of a new dam, or after a dam has been significantly modified. The report includes measurements of key structures and photos to provide a baseline for future dam safety evaluation activities.
Comprehensive Review*	Every 8 or 12 years	CR senior engineer and professionally licensed dam engineer examiner	The CR exam is used in the broad and in-depth CR evaluation including development of failure modes, assessment of consequences, estimation of dam risks and monitoring program.
Inaccessible Features	As needed and before the comprehensive review	Staff experienced in the operation of remote camera equipment	Outlet works, toe drains and other dam penetrations are inspected using remotely operated camera equipment (also called closed circuit television – CCTV). The video information is reviewed by an experienced waterways engineer. The report is used to evaluate an incident (see special exam) or more commonly, for use in the development of the comprehensive review.

*The NPS dams database information is reviewed and updated following these exams.

SPECIAL EXAMINATIONS

Special examinations are scheduled immediately after (or during if possible) dam incidents. For example, if a sand boil develops at the downstream toe of an embankment dam, a dam safety

technical specialist (usually a professional engineer) will be requested to promptly visit the dam and evaluate the situation. They will document the exam in a report with photos. Special examinations are performed for the following dam concerns:

- increasing or turbid seepage
- sand boils or sinkholes
- spillway erosion
- embankment cracking or slides
- following an earthquake or flood
- cracking or movement of critical concrete features

These exams include a field inspection of the areas of concern but may not include inspection of all dam features. Previous dam examination reports will be reviewed for historical performance of the problem area. The WASO dam safety officer will fund and coordinate special examinations with regional dam safety coordinators and park staff. Local park operation and maintenance personnel should participate in the inspection. Upon completion of the site visit, the technical specialist will brief the park on the problem and draft recommendations for monitoring, repair or further evaluation. The special examination report will include at a minimum

- brief description of the site visit
- sketch of the problem, including location
- description of the problem area and metrics about the problem
- recommendations for problem monitoring, repair or further evaluation
- photographs

INTERMEDIATE EXAMINATIONS

Intermediate examinations include a thorough field review of the dam and appurtenant structures, reviews of previous inspection records and the last formal inspection. The dam safety officer funds and coordinates intermediate examinations with the regional dam safety coordinator and parks. Intermediate examinations will be completed by professionally licensed engineers in dam maintenance and operations. Local park operation and maintenance personnel should participate in the examination to receive on-site training. Intermediate examinations are performed every two years except during years when formal or comprehensive reviews (CRs) are scheduled. Each dam examination will produce an individual checklist report. The report will to include at a minimum

- description of the site visit and location map
- review of downstream hazard classification noting any changed conditions from last evaluation
- overview of dam condition and operation and maintenance concerns
- review of previous recommendations for corrective action and if complete or incomplete
- new listing of prioritized recommendations for corrective action including incomplete previous recommendations and with initial cost estimates for repair
- photographs

FORMAL EXAMINATIONS

Formal examinations verify the safety and integrity of the dam and appurtenant structures. The formal examination reviews the structure for meeting current accepted design criteria and practices. The conditions of the mechanical, electrical, structural, seismic and hydrological features are thoroughly reviewed to include underwater structures of the dam if possible. Formal inspections will be completed by professionally licensed engineers in dam design, construction, maintenance, and operations. The engineers selected for the examination team should be specialized in site-specific features and the type of dam. Local park operation and maintenance personnel should participate in the inspection to provide information on operation and maintenance concerns and to receive on-site training.

Formal inspections will be performed every four years except during years where comprehensive reviews are scheduled. Each dam inspected during the formal inspection cycle will receive an individual written report. The report will include at a minimum

- description of the site visit and location map
- review of downstream hazard classification noting any changed conditions from last evaluation
- thorough review of dam condition to include structural, geological, hydraulic, mechanical, electrical, and underwater dam features
- operation and maintenance concerns
- review of emergency action plans
- review of previous inspections and recommendations for corrective action and if complete or incomplete
- new listing of prioritized recommendations for corrective action including incomplete previous recommendations and with initial cost estimates for repair
- photographs

COMPREHENSIVE REVIEWS

Comprehensive Reviews are performed for High- or Significant-hazard dams owned by the National Park Service. Comprehensive reviews include a comprehensive historical review of the dam design, construction, and operation/maintenance over the life of the dam. The comprehensive review evaluates the risks associated with all potential dam failure modes and provides recommendations for corrective action to bring the dam up to current design and safety standards (see “Chapter 13: Risk Estimation and Analysis for Other Functions of a Comprehensive Review”).

The dam safety officer will fund and coordinate the comprehensive review with the regional dam safety coordinators, and parks.

Comprehensive review examinations will be completed by professionally licensed engineers in dam design, construction, maintenance, and operations. The CR senior engineer also attends the examination. The engineers selected for the inspection team should be specialized in site-specific features and the type of dam. Local park operation and maintenance personnel should participate in the examination to provide information on operation and maintenance concerns and to receive on-site training.

The CR examination will be documented as a separate section in the overall CR report. This CR examination report section will follow FEMA 93 recommendations to include at a minimum

- analysis of the hazard classification
- description and condition of the dam features
- status of existing O&M recommendations and new O&M recommendations
- evaluation of emergency preparedness and operations
- photographs

The CR senior engineer uses the information obtained in his/her examination to develop dam failure modes, estimate failure probabilities and estimate consequences of dam failure. The CR report includes other report sections to describe the dam, evaluate design/construction, describe the consequences of failure, document the potential failure modes, develop a monitoring plan, and develop quantified dam risk estimates.

INACCESSIBLE FEATURES EXAMINATIONS

Most dams have penetrations that create potential pathways for failure. For example, most dams have outlet works pipes. Seepage can begin flowing through a crack in an outlet works pipe. If this situation goes undetected, the problem could worsen and ultimately lead to dam failure. To detect weaknesses in dam penetrations, inaccessible feature examinations are performed. Most often these inspections are performed by remotely operated and self-propelled closed-circuit television (CCTV) cameras. Equipment operators are trained to run these CCTV cameras throughout the lengths of outlet works, toe drains and other penetrations. The resulting video tape is reviewed by a waterways engineer and a report is produced.

Any obvious problems (dam safety-related) discovered are immediately brought to the attention of the park, the regional dam safety coordinator, and the dam safety officer.

These examinations are conducted as a result of an incident (e.g., turbid water flowing from an outlet works) or more commonly, in the months before a scheduled CR. The inaccessible features report gives the CR team valuable information about the inner workings of a dam that is not visible during a normal visual exam.

The dam safety officer will fund and coordinate inaccessible features examinations with the regional dam safety coordinators and the parks. Local park operation and maintenance personnel should participate in the inaccessible feature inspection to assist with dam access, equipment, and other logistics.

The report will include at a minimum

- background information
- description of the equipment used
- summary of observations
- conclusions

Drawings, figures (photos), and an inspection log are also included.

CHAPTER 10: EMERGENCY MANAGEMENT AND EMERGENCY ACTION PLANS

1. General
2. Emergency responsibilities
3. Incident response
4. Emergency action plan
5. Post-incident actions
6. Inundation mapping

TABLE 13. SUMMARY OF ROLES AND RESPONSIBILITIES FOR EMERGENCY MANAGEMENT AND EMERGENCY ACTION PLANS

Entity	Roles and Responsibilities
DSO	1. Reports EAP performance. 2. Procures dam experts to respond to a dam safety incident. 3. Sets up an after action meeting/conference call within 30 days following an incident/emergency.
RDSC	1. Assists parks with the planning and accomplishment of EAP development/exercising. 2. Coordinates annual EAP updates with the parks. 3. Coordinates with the park for an after action meeting/conference call, to develop an after-incident / emergency report, and to incorporate lessons learned. 4. Maintains updated copies of EAP documents. 5. Assists parks with EAP status reporting.
Park Staff	1. Manages the on-site incident or emergency, including: - increased monitoring - coordination with the regional dam safety coordinator and dam safety officer - accompanying dam safety technical specialists to the site - emergency dam repairs (normally at the direction of a qualified engineer) 2. Performs annual EAP updates/communication checks. 3. Participates in the development and exercises of the emergency action plan. 4. Operates the dam emergency action plan including declaring response levels and notifying downstream public safety officials. 5. Communicates incident/emergency updates promptly and on a frequent basis. 6. Participates in after action meetings and develops an after-action report.

GENERAL

Emergency management means (1) preparing to handle an emergency appropriately, (2) responding safely and responsibly to an emergency, repairing the damage, and (3) taking steps to prevent or lessen the harmful effects of future emergencies. This can be simplified to the preparedness, response, recovery, and mitigation phases.

Emergencies are managed using incident internal notification procedures and the dam emergency action plan. The emergency action plan allows the National Park Service to communicate with those responsible for warning and evacuating people downstream from the dams. In situations where the dam failure inundation area lies completely within the park, the National Park Service is responsible

for all of the warning and evacuation. In these cases, the dam failure warning and evacuation should be included in the park emergency operations plan.

In cases where the dam would cause threatening flows to people beyond the park boundaries, the National Park Service is required to notify public safety authorities and recommend that they warn and evacuate people at risk downstream.

EAP development and exercising are performed through active joint participation by the involved entities. Both the park facility management and the park law enforcement functions participate. Any downstream impacted communities also participate.

The emergency action plans are exercised on a periodic basis so all entities are prepared to act in an actual emergency.

Inundation maps are used to communicate the areas expected to be flooded should dam failure occur. These maps are included as part of the emergency action plan.

EMERGENCY RESPONSIBILITIES

TABLE 14. EMERGENCY RESPONSIBILITIES BY HAZARD CLASSIFICATION AND DAM OWNER

Dam hazard classification/type	Responsibility for taking actions to detect events, respond (to monitor and prevent failure), and to notify entities downstream	Responsibility to warning and evacuate people at risk downstream	Responsibility for developing an EAP and inundation map
High	NPS	NPS if people in park (or park resources) could be at risk. Entities downstream if dam failure flood flows out of park.	NPS
Significant	NPS	NPS if people in park (or park resources) could be at risk. Entities downstream if dam failure flood flows out of park.	NPS
Low	See note*	See note*	Not required*
Nonjurisdictional	See note*	See note*	Not required
Dams owned by others upstream from parks	Nonpark dam owner	NPS if people in park (or park resources) could be at risk.	Nonpark dam owner

* Failure of Low-hazard dams and nonjurisdictional dams should be avoided through routine dam inspection monitoring and repair. Although no loss of life is expected or probable, there is always a chance people could be in the floodplain downstream. Parks should monitor dam incidents and take actions to prevent failure. Failure of Low-hazard dams may damage park lands/resources. Emergency preparedness plans may be appropriate for Low-hazard dams.

INCIDENT RESPONSE

Parks are responsible for promptly communicating prompt emerging dam safety deficiencies to the regional dam safety coordinator and the dam safety officer. Communication and cooperation at all

levels in the National Park Service is required to address safety issues at dams as required by Director's Order 40.

Records show that dam safety-related incidents occur at the rate of about one per month at the DOI inventory of 616 High- and Significant-hazard dams. These incidents are discovered by dam monitoring personnel or by people visiting the dam and reporting the problem.

Incidents include sinkholes, cracks, slides, floods, sand boils, increasing seepage, muddy seepage, earthquakes, and spillway erosion.

Often, these incidents represent a dramatic increase in the risks of the dam failing. The incidents indicate a failure mode is in active development. Positive action is necessary to monitor the situation and lower the risk of failure. A dam engineering technical specialist will often promptly visit the dam, evaluate the problem and make recommendations. It is important to get the best technical expertise available to evaluate the situation. Actions to be taken in response to the discovery of a potentially unsafe condition will depend on the nature of the problem and the time estimated to be available for remedial or mitigating measures.

Because dam incidents can be true public safety emergencies, needed funding will be made immediately available under emergency acquisition authorities (FAR). Environmental permitting shall not delay the protection of human life. The park environmental compliance officer should be consulted at the onset of an emergency so the environment can be protected to the extent possible without delays that would put human life at risk.

During an incident the emergency action plan shall be reviewed and followed. Some incidents can be addressed internally without declaration of formal EAP response levels (see response levels below).

Incidents at dams need to be reported immediately to the park superintendent, the regional dam safety coordinator, and the dam safety officer. This includes nights, holidays, and weekends.

Following the incident, an after action incident/emergency report is developed by the park and transmitted to the regional dam safety coordinator and the dam safety officer. The length of the report should be commensurate with the risks and complexity of the incident.

EMERGENCY ACTION PLAN

General

An emergency action plan is a formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The emergency action plan specifies actions the dam owner should take to moderate or alleviate the problems at the dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities. It also contains inundation maps to show the emergency management authorities the critical areas for probable evacuation in case of an emergency.

Policy

All High- and Significant-hazard dams are required by Director's Order 40 and the DOI Departmental Manual, Part 753, and Director's Order 40, to have emergency action plans. Should the dam failure inundation area include off park lands, the plan shall be coordinated with the local government and other authorities involved in public safety. The emergency action plan must include notification procedures, which are discussed below.

The emergency action plans will be developed and exercised for all High- and Significant-hazard dams in accordance with *FEMA 64 - Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners*.

An inundation map, showing the areas flooded during dam failure, will be included in the emergency action plan.

The dam safety officer will fund and the regional dam safety coordinator will coordinate with the parks so that emergency action plans are developed and exercised for each High- and Significant-hazard dam in their region.

Emergency Action Plan Content

Emergency action plans generally contain six basic elements:

1. **Notification Flowchart.** A notification flowchart shows who is to be notified, by whom, and in what priority. The information on the notification flowchart is necessary for the timely notification of persons responsible for taking emergency actions.

2. **Emergency Detection, Evaluation, and Classification**. Early detection and evaluation of the situation(s) or triggering event(s) that initiate or require an emergency action are crucial. The establishment of procedures for reliable and **timely** classification of an emergency situation is imperative to ensure that the appropriate course of action is taken based on the urgency of the situation. It is better to activate the emergency action plan while confirming the extent of the emergency than to wait for the emergency to occur. Following detection, staff will monitor the situation and will work to prevent the dam from failing. Equipment, materials, and staff may be mobilized to prevent dam failure.

3. **Responsibilities**. Detection, decision making, and notification are the responsibility of the National Park Service. These procedures are specified in the emergency action plan. Warning and evacuation are the responsibility of the officials responsible for the safety of the public downstream from the dam. Therefore, when people at a park could be adversely impacted, the National Park Service is responsible for both the dam and the safety of the public downstream, including warning and evacuation. Warning and evacuation procedures are not included in the emergency action plan, but are in the park overall emergency operations plan, a warning and evacuation appendix, or in a separate warning or evacuation plan. When dam failure or large releases impact areas off a park, other county and city jurisdictions are responsible for warning and evacuation in those areas.

   The emergency action plan must be site-specific because conditions at the dam and downstream of all dams are different.

4. **Preparedness**. Preparedness actions are actions taken in advance of any emergency in order to have needed resources (procedures, stockpiled materials, spare parts, sandbags, stop logs, etc.) in an attempt to prevent dam failure. This section identifies actions to be taken before any emergency.

5. **Inundation Maps.** An inundation map should delineate the areas that would be flooded as a result of a dam failure. Inundation maps are used both by the dam owner and emergency management officials to facilitate timely notification and evacuation of areas affected by a dam failure or flood condition. These maps greatly facilitate notification by graphically displaying flooded areas and showing travel times for wave front and flood peaks at critical locations.

6. **Appendixes**. The appendixes contain information that supports and supplements the material used in the development and maintenance of the emergency action plan.

Decision Making

Once a threatening event is detected, decisions need to be made including:

- level of severity and urgency of the situation
- additional monitoring required at the dam
- plans and coordination to mitigate the threatening event (sandbags, stockpiling riprap, changes in reservoir operations such as additional releases, etc.)
- other entities to notify or with whom to coordinate
- other expected actions

The emergency action plan will assist dam operations personnel in making critical decisions in short time frames, identifying actions they need to perform, and identifying who is to make the decisions during an event. The emergency action plan also identifies backup personnel.

Notifications

Notification procedures must convey the appropriate sense of urgency, classify the severity of the situation, and be clear, concise, and up to date.

In a developing situation, notifications are usually made within the National Park Service, prior to alerting local downstream public safety officials. NPS contacts include the regional dam safety coordinator, park superintendent, the dam safety officer and NPS law enforcement.

If a situation worsens and there are potential adverse impacts to population, property, or environment that are located off park property, notifications must be expanded to the appropriate county, city, state, and federal authorities. These authorities must be identified in the planning process and included in the EAP notification charts or lists. The emergency action plan specifies who is to be contacted and provides telephone numbers and other contact information.

Warning and Evacuation

Warning and evacuation planning is the responsibility of those officials responsible for the safety of the public in the floodplain downstream from the dam. Many entities, including fire, police, medical, city, county, and the National Park Service, may be involved in preparing and implementing the warning and evacuation plan. It is recommended that warning and evacuation planning be included in the park's all hazard emergency operations plan.

In the preparation, review, approval, or execution of the plan. Before finalization, a copy of the plan should be furnished to the dam owner for information and comment.

Response Level System

Emergency management and response organizations enter different levels of readiness, depending on the severity of an emergency event and when it occurs. Therefore, the emergency action plan must define a system of "response levels" or "levels of severity" for classifying the severity of events. There are usually three or four levels, depending on the dam owner and response organization's preference.

There are various levels of severity currently in use. One example uses a Response Level 1, 2, and 3 (or corresponding "Get Ready," "Get Set," and "Go!") declaration. Since different agencies and jurisdictions may use other terminology, there is a need to describe what is happening at the dam and a recommended course of action. For example:

A Response Level 1 (Get Ready) declaration is for developing events that could, if they become more severe, threaten the dam, or cause dangerous spillway releases. In Level 1, the officials responsible for the safety of the public downstream are notified that threatening events could occur. The officials may perform internal communications to ensure that their people are notified and will be available should the emergency intensify. Equipment availability may be secured.

A Response Level 2 (Get Set) declaration is for threatening events that are occurring or are likely to occur. In level 2, the officials responsible for the safety of the public downstream are notified that the situation has worsened and that they should warn and evacuate the population at risk. The population at risk may then receive a warning that a situation is developing that could require their evacuation. Emergency people and equipment may be moved to the site. Examples include a rapidly rising reservoir with high inflows, a large rainfall event in the basin above the dam, a seep that is getting worse, or an extensive slough on the dam.

A Response Level 3 declaration is Go! In level 3, the officials downstream from the dam proceed immediately to evacuate the population at risk. Barricades are set up to restrict ingress to the potentially inundated areas. The areas to be evacuated are shown on the inundation map.

Expected Actions

Expected actions are usually developed in a table or checklist format for NPS personnel with dam operations responsibility. The table or checklist usually includes an incident commander, the dam tender, supervisory personnel, regional dam safety coordinator, and others with roles during an emergency event.

The expected actions for a response level system should be developed to incrementally stage the emergency response as an event worsens. However, emergency events may develop very suddenly that will not allow for this sequence to occur. Therefore, the expected actions must also be implementable at any level without passing through less severe levels first.

Incident Command System

The dam emergency should be managed in accordance with the incident command system. Training is available for the national incident management system; contact the regional dam safety coordinator for developing a training plan for this and other ICS training.

Emergency Action Plan Development

Superintendents should designate a park EAP coordinator, for the development and exercising of emergency action plans for the park High- and Significant-hazard dams. Parks need to coordinate with downstream public safety officials from potentially affected downstream jurisdictions. A list of state dam safety officials can be found at the Association of State Dam Safety Officials www.damsafety.org.

The dam safety officer initiates and funds EAP development projects in cooperation with the regional dam safety coordinator and the park.

The emergency action plans will be developed in accordance with *FEMA 64* - Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners.

Emergency action plans should be considered “living” documents. This means that they will never be complete and they should be reviewed and updated annually. An important EAP maintenance activity is to at least annually check and update contact phone numbers and names.

The effort to develop the emergency action plan and the EAP content shall be commensurate with the dam’s size and especially with the number of people/jurisdictions downstream.

Exercising

The purpose of an exercise program is to improve operational readiness and detect flaws in the existing plan so they may be corrected. An effective response to an actual emergency requires advance planning and regular exercising of the plans by the entities that would be involved in an actual emergency.

The benefits of getting representatives of the various entities in the same room to discuss emergency management for the dam should not be underestimated. The interaction and awareness gained at the exercises are critical in developing and refining the plans and ensuring that if an actual emergency happens, the people will follow the plans and know what to do. The exercises help break down barriers and develop trust between the participants.

It is best to use a crawl-walk-run approach to exercises. This means to conduct exercises with increasing levels of complexity. The types of exercises are described in the following section.

The following types of exercises are performed:

- Communications check (at least annually)
  - Park staff contact the people on the notification chart to ensure people and phone numbers are correct.
- Tabletop (not less than every five years)
  - A tabletop exercise is an activity in which management, dam operations personnel, and outside organizations are presented with simulated emergency situations without time constraints. It is usually informal, takes place in a conference room environment, and is designed to elicit constructive discussion by the participants as they attempt to examine and resolve problems based on the existing emergency action plan and other applicable emergency operations plans. The purpose is for participants to evaluate plans and procedures, resolve questions, and clarify roles and responsibilities in a nonthreatening format with minimum stress. An after-action report is prepared to document the exercise and improve the EAP.
- Functional (as needed)
  - Functional exercises use messages that can be either written or transmitted by telephone, radio, fax, computer, etc. The functional exercise creates stress by increasing the frequency of messages, playing messages from actual offices or EOCs, and due to the intensity of the activity. The functional exercise simulates operations in one or more functional areas as realistically as possible without actually mobilizing resources. An after-action report is prepared.

There may be situations where it is possible to combine several dams into one exercise. For example, when more than one dam exists on the same drainage, or if the response organizations are the same, it may be appropriate to combine dams into one exercise.

Responding to a recent actual emergency event may be accepted as an exercise by the NPS dam safety officer in lieu of conducting an emergency exercise, provided an after action report is prepared to document how the emergency action plan was activated and what EAP revisions or other recommendations may be needed.

POST-INCIDENT ACTIONS

Within 30 days following the incident, the dam safety officer will initiate a conference call with the regional dam safety coordinator and the park. The purpose of the call is to begin development of an after action report. The report includes:

- a time line of the incident and response
- pertinent environmental factors (flood, storm, earthquake)
- description of the problem including sketches, measurements, and photographs
- decision documents
- documentation of the repair
- description of EAP actions
- description of warning and evacuation actions
- lessons learned

The report should be reviewed in draft by the park, reviewed by the regional dam safety coordinator/ dam safety officer and formally transmitted via memorandum to the dam safety officer.

The report should have a positive tone including what lessons were learned. The report is shared with other parks so that the National Park Service can have a stronger Dam Safety Program. The report is also used by technical specialist for further dam risk evaluations and repair designs. Finally, lesions learned will be used at the next EAP update to further strengthen the plan. Should a serious flaw be discovered in the emergency action plan the dam safety officer will initiate and fund an immediate update to the document.

INUNDATION MAPPING

Inundation maps are required for each High- and Significant-hazard NPS dam. To evaluate the effects of dam failure, maps should be prepared delineating the area which would be inundated in the event of failure. Land uses and significant development or improvements within the area of inundation should be indicated.

The maps are usually based on the U.S. Geological Survey (USGS) Crystal Quadrangle, 7.5-minute series topographic maps. Aerial photographs are also being used for portions of the maps. They have been used to show populated areas and to better define the inundation area for local emergency management officials. Areas that would be flooded by a threshold flood, as well as the probable maximum flood (PMF), should be included on the maps. At critical sections, the depths, velocities, and flood wave travel time shall be shown on the maps. The maps are included with the emergency action plan. The maps should show the flood wave to the point of attenuation. If the flood wave crosses large barren territory, or if the exact location of flooding cannot be determined, a narrative description of the flooding can be used.

Since detailed inundation maps may not be readily available or easily used at a disaster area, a concise and clear word description should also be prepared for easy word-of-mouth communication. The word description should tell potential evacuees how High they should elevate themselves above the river or by horizontal distance to an area known to be safe from inundation.

Copies of the maps should be distributed to effected local public safety officials for use in the development of a warning and evacuation plan. The maps should be appropriately classified, usually as “For Official Use Only.”

CHAPTER 11: DAM OPERATIONS AND MAINTENANCE

1. Policy
2. General
3. Dam O&M manual
4. Dam operations
5. Large releases
6. Dam maintenance
7. Dam operating staff
8. Logbook
9. Operational and public safety

TABLE 15. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM OPERATIONS AND MAINTENANCE

Entity	Roles and Responsibilities
DSO	1. Assists regional dam safety coordinator with oversight of O&M issues. 2. Procures technical assistance to develop O&M Procedures document.
RDSC	1. Assists parks with O&M issues. 2. Tracks accomplishment of operation and maintenance 3. Assists the parks with accomplishment of O&M activities. 4. Assists park staff with meeting dam safety training requirements.
Park Superintendent	1. Identifies a park dam safety coordinator. 2. Assigns a dam tender and a backup dam tender. 3. Provides staff and funding for dam operation and maintenance. 4. Provides training of O&M staff. 5. Ensures a O&M manual is used for each High- and Significant-hazard potential dam. 6. Contacts the regional dam safety coordinator if problems are encountered or there are revisions needed for the O&M Procedures document.
Park Dam Safety Coordinator	1. Accomplishes ongoing operation and maintenance in accordance with O&M Procedures document. 2. Alerts superintendent, regional dam safety coordinator and dam safety officer of any dam safety incidents/emergencies.

POLICY

From Director's Order 40:

> *High and Significant hazard dams will have written standard operating procedures (SOPs)[now called O&M Procedures documents]. The SOPs [O&M Procedures documents] include at a minimum the annual maintenance requirements, such as grass cutting, tree removal, log removal, etc. Specific maintenance and inspection requirements may be identified during inspections and should be incorporated into the SOP [O&M Procedures documents]. Parks will maintain a dam operation logbook for documentation of maintenance and repairs, along with tracking changing conditions such as seepage. The logbooks may be in paper or electronic format (i.e., FMSS), so long as it is accessible to the dam operators and inspectors.*

GENERAL

The first line of defense for an effective SOD program is a regular and effective O&M program. Operations are the visiting of the dam, routine inspection, recording instrumentation readings (as required), controlling vegetation, and other activities related to operating/maintaining the dam.

One specific individual should be assigned to operate the dam—sometimes called a "dam tender." The dam tender is an important responsibility because it is they who will provide the consistent and long-term monitoring of the condition of the dam. A backup dam tender should be assigned to cover absences by the regular dam tender. It is important that the dam tender and their backup should attend dam-specific dam tender training. The training will ensure that the dam tenders can detect, evaluate, and appropriately respond to emergency and non-emergency O&M situations. The dam operator shall visit the dam on a regular basis in accordance with the visual inspection checklist (see "Chapter 12: Dam Monitoring") and immediately following events such as flooding or earthquakes. A backup dam tender is also assigned.

All features of NPS dams and appurtenant works should receive maintenance or operation as recommended from examination reports: intermediate, formal, or CDR. These reports are to be prepared by trained and experienced engineers familiar with potential failure modes, the maintenance and operation of dams.

Unless it is during an emergency, extensive maintenance or testing of dam equipment should only be performed because of recommendations in an inspection report, study or technical recommendation. These recommendations should be addressed by personnel familiar with the safety, maintenance, and operation of dams.

Serious maintenance, operational, or safety problems that are discovered should be reported immediately to park management, the park dam safety coordinator, the regional dam safety coordinator and the dam safety officer for the proper action to be taken. The emergency action plan may need to be activated. Dam safety experts may be requested to promptly visit the dam and evaluate the concern. **All actions at the dam should be in compliance with the O&M procedures (and with the emergency action plan in an emergency).**

Maintenance and operations should be scheduled far enough in advance to take advantage of good weather periods, terrain conditions, and manpower and equipment availability to assure safe and economic work. Cutting or burning of vegetation on the upstream and downstream faces of the dam should be completed no more than one month prior of the inspection. The vegetation should be no higher than 12 inches (6 inches is preferable) to ensure an adequate visibility for inspection.

DAM OPERATION AND MAINTENANCE MANUAL

A dam-specific O&M manual (formerly the SOP) document is required for each High- and Significant-hazard dam and its associated structures and equipment (a more general O&M manual is available for operations and maintenance of Low-hazard dams).

When properly used, the O&M manual will ensure adherence to approved operating and maintenance procedures over long periods of time and during changes in operating personnel.

The O&M manual is prepared for park staff who are assigned the responsibility for the operation and maintenance of the dam. The O&M manual is a custom document developed for a particular dam or several dams within a park. The O&M manual is the primary document containing instructions for operating and maintaining the dam, reservoir, and related structures such as outlet works systems and spillways.

If problems are encountered carrying out the procedures articulated in the manual park personnel shall contact the regional dam safety coordinator for technical consultation. Technical support needed for updates to the manual will be coordinated by dam safety officer.

The procedures will permit responsible persons (knowledgeable in reservoir operations, but unfamiliar with the conditions at a particular dam) to operate the dam and reservoir during emergency situations (such as floods) and at times when the dam tender cannot perform their normal duties. This O&M manual contains, as a minimum, all information and instructions necessary for the safe operation of the dam. Operating procedures shall not deviate from the O&M procedures document without appropriate authorization.

The O&M manual describes how often the dam should be visited. During periods of high reservoir water surface elevation or high precipitation, the dam may need to be visited more often. The O&M procedures document contains instructions and detailed procedures for operation of the mechanical and electrical gate operating equipment. Emergency operations during events that could cause dangerous releases or dam failure are not part of the O&M procedures document, but are part of the emergency action plan.

DAM OPERATIONS

Operations consist of the periodic testing of gates or any other type of equipment to assure reliable use, reading instrumentation as required, or reviewing any operating manuals or emergency action plans for completeness and accuracy.

If appropriate for more critical NPS dams, reservoir operating rule curves should be available for each normal mode of operation and for emergency conditions.

All spillway and outlet gates should be tested on a regular schedule and articulated in the O&M procedures document. The tests should include use of both the primary and the auxiliary power systems, if applicable.

Project security is a matter of concern at important dams and appurtenant works. This includes preventing structural damage by vandals or saboteurs and unauthorized operation of outlet or spillway gates. In some cases restricting public access is essential and security patrols may be necessary. Larger dams may have formal security requirements identified from security assessment reports. See chapter 22 for more information.

LARGE RELEASES

Some dams have outlet works that have significant flow capacities. Should these outlet works be opened, an operational flood would be passed into the channel below the dam. Fishermen, hikers, and others in and near the downstream channel could be at risk from drowning by such releases.

There also may be sensitive downstream habitat that could be damage by large releases. It is important that the outlet works/spillway operators be secure and locked to prevent unauthorized (public) operation. Consult the O&M procedures document on permitted outlet works releases.

DAM MAINTENANCE

Maintenance is normally the preserving of structures, appurtenant works and equipment in intended operating condition by the proper control of vegetation, removal of debris/trash, equipment repair, and minor structural repair. Maintenance does not include formal investigation of dam problems or dam repair design/construction, which are beyond normal maintenance.

Maintenance is the regular and special servicing of the dam to keep it in the intended operational condition. Normal maintenance is described in a O&M manual. Examination reports also include special maintenance recommendations. Normal maintenance may include the following:

- Removal of logs and trash from the spillway inlet channel, crest structure, downstream chute, impact basin, and outlet channel. If fish screens are present upstream of a spillway crest structure, sediments must be removed so flood flows are not prevented from entering the spillway.
- Grading the dam crest to be level (slope to the upstream).
- Replacement of riprap.
- Trees and bushes should never be allowed to grow on the dam or near the abutments.
- Vegetation on the dam crest, dam slopes, and within 25 feet of the abutments and at least 25 feet of the toe of the dam should be allowed to grow to no more than 6 to 12 inches in height. Mowing or burning may be required to keep vegetation at these heights.
- Restoring deteriorated coatings on metalwork.
- Testing of gates and greasing of gate operators.
- Removing debris from weirs and staff gauges.
- Minor structural repairs.
- Placement, maintenance and replacement of signs warning public to stay away from hazardous features and equipment, and of dangerous heights/depths, flows where applicable.

All maintenance work is to be performed in a safe manner. The use of personal protective and safety devices are required when so determined by the supervisor or the superintendent in consultation with the area safety officer or regional safety manager.

Any adverse dam performance noticed during dam maintenance activities should be reported immediately to the park dam safety coordinator, facility manager, and park superintendent. Other park staff may also need to be immediately notified, such as a park ranger. These park managers will use the dam's emergency action plan and will also notify the regional dam safety coordinator and the dam safety officer.

DAM OPERATING STAFF

Each park with a High- or Significant-hazard dam will assign a person as the park dam safety coordinator and/or dam tender. A backup person will also be assigned. See "Chapter 19: Training" for training requirements for this staff.

LOGBOOK

A dam logbook is an important record of the dam's performance history, maintenance activities, instrumentation, reservoir surface elevation, visitors to the dam, and dam incidents. A logbook of operations and maintenance will be kept and updated by the park dam safety coordinator and/or dam tender.

OCCUPATIONAL AND PUBLIC SAFETY

Occupational and public type safety is of paramount importance at dams and reservoirs. People can be injured or die at dam structures by falling, suffocating (confined spaces), drowning, slipping, or tripping.

Safety of people at dams is a concern at the following features:

- dam crest of concrete dams
- spillway chutes
- spillway walls
- other vertical concrete walls
- outlet works
- drop inlet structures
- impact basins
- confined spaces

Water borne recreation near run-of the-river dams are a particular concern because water craft can go over spillway crest structures and get caught in recirculating currents, or be killed while passing over vertical drops within the spillway. Warning signs and buoy systems are usually required to help prevent such accidents from happening.

Dam occupational and public safety issues should be evaluated by dam safety engineers or park/regional safety staff. They should evaluate the effectiveness of any proposed or existing signage and barriers/fences. Dam examination sometimes identify dam occupational and public safety issues and their resolution.

Operation and maintenance of safety features should be included in the dam's O&M procedures document.

Actual safety incidents should be evaluated by dam safety engineers as well as the NPS Injury Prevention Program to prevent similar incidents from recurring. If appropriate, this information should be shared within the other bureau dam safety programs within the Department of the Interior and other NPS dam operations personnel.

CHAPTER 12: DAM MONITORING

1. General
2. Visual inspections
3. Schedule for periodic monitoring
4. Data acquisition and review
5. Expected performance
6. Report of problems

TABLE 16. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM MONITORING

Entity	Roles and Responsibilities
DSO	1. Develops program policies and guidelines for dam monitoring.
RDSC	1. Tracks performance of dam monitoring. 2. Provides assistance to park staff.
Park Staff	1. Performs dam monitoring on the prescribed schedule and submits completed monitoring forms to the regional dam safety coordinator and dam safety officer. 2. Notifies park superintendent, regional dam safety coordinator, facility manager, and dam safety officer about incidents at dams. A park ranger may also need to be notified.

GENERAL

Dam monitoring is a separate and important activity beyond regular dam operations and maintenance. Dam monitoring is the deliberate and recurring effort by trained on-site personnel to look for dam performance problems that could lead to dam failure. Numerous dam problems have been discovered and addressed thus preventing dam failures. An undetected problem can accelerate and lead to dam failure.

An effective routine dam safety monitoring program involves regularly carrying out a well-designed program of visual inspections and instrument readings (as applicable) developed specifically for a particular dam. An effective dam monitoring program includes:

- The development and use of a dam-specific monitoring program based on failure modes. The monitoring program should be developed by a qualified engineer and include frequency of monitoring, visual inspection checklists, and instrument readings.
- Collection of data and information in accordance with the monitoring program and a quick review of the collected data and information at the time it is obtained, to determine if any obvious out of the ordinary or unexpected performance is indicated (which should be immediately acted upon).
- Prompt transmittal of the data and information to the RDSC and dam safety officer. The dam safety officer will ensure the data is reviewed by a qualified engineer. This engineer should

promptly review the data and information upon its receipt and report to dam safety officer any anomalies.

- Storage, for future reference, of collected and reviewed data and information.
- Proper maintenance of instrumentation installations.
- Prompt investigation concerning any out of the ordinary data or information to verify accuracy.
- Appropriate follow-up concerning confirmed out of the ordinary data or information, which may involve increasing monitoring frequencies, installing new instrumentation, performing analysis/evaluation work, restricting or drawing down the reservoir, or initiating emergency response activities in accordance with the EAP instructions.

VISUAL INSPECTIONS

In recent years, a greater appreciation has been gained for the importance of routinely performed visual inspections for dam safety. Such inspections should be carried out by people local to the dam (that typically are responsible for operations and maintenance efforts at the dam and reservoir). Many of the key monitoring parameters for failure modes relate to visual information (e.g., sediment deposits in front of a weir, new seepage areas, cracks in concrete, offsets at construction joints, etc.). Focused visual inspections that are routinely performed in accordance with the monitoring program greatly enhances the probability of detecting significant out of the ordinary dam performance at a time when actions can be taken to avert dam failure. Only performing focused visual dam safety monitoring inspections every year or couple of years in the course of formal examinations is clearly inferior to more frequent checks for key visual clues.

During the comprehensive review, a one- or two-page, ongoing visual inspection checklist is prepared to:

1. identify the features that need to be inspected
2. indicate what to look for at each of the features
3. provide guidance concerning expected and unexpected observations
4. provide a convenient means of documenting the inspection

If the people carrying out the routine visual inspections have a good general understanding of the failure modes for a dam and the associated key monitoring parameters, the effectiveness of these inspections is increased.

SCHEDULE FOR PERIODIC MONITORING

The schedule for dam monitoring is documented in a “Schedule for Periodic Monitoring” form. This form includes the frequency of monitoring. Some dams are required to be monitored less frequently at certain times of year such as during the winter or when the reservoir is seasonally low. Natural loading events such as floods or earthquakes also trigger monitoring. Monitoring frequency is increased during higher loads such as full flows through the spillway.

DATA ACQUISITION AND REVIEW

The dam monitoring program and the data to be collected by the dam tender should be listed on a short check list form, noting monitoring frequencies for both the instruments and the routine visual inspections. Special monitoring considerations (such as increased monitoring when the reservoir level is unusually high and obtaining seepage readings only when there has been no rainfall or snowmelt within 48 hours) should also be noted on the form.

A quick review of the collected data and information should occur at the time it is obtained to determine if any obvious out of the ordinary or unexpected performance is indicated (which should be immediately acted upon).

Upon collection, the data and information should be promptly transmitted for review to the RDSC and dam safety officer. The dam safety officer will arrange for an engineer who is (1) knowledgeable concerning the dam safety issues for the dam, and (2) experienced with instrumentation and dam safety monitoring to promptly review the data and information upon receipt and initiate an appropriate response if the data indicate out of the ordinary or unexpected performance.

EXPECTED PERFORMANCE

To assist in making the routine visual inspections and review of instrumentation data as straightforward as possible, it is valuable to define expected versus unexpected performance for both visual and instrumentation data. Regarding the visual data, the ongoing visual inspection checklist typically consist of a series of questions where the response associated with expected performance would be “NO.” A “YES” response to any question indicates unexpected performance that requires follow-up action.

REPORT OF PROBLEMS

Confirmed out of the ordinary performance information (instrumentation or visual inspection information) needs to be promptly reported to the following people:

- park dam safety coordinator and management
- regional dam safety coordinators
- dam safety officer

Emergency response activities should be initiated promptly, in accordance with the EAP instructions, as appropriate.

CHAPTER 13: RISK ESTIMATION AND ANALYSIS

1. Overview of managing the risks of dams
2. Nonloss of life consequences
3. Dam failure modes
4. Risk chart
5. Timeliness in response to elevated risks
6. Depth of risk analysis
7. Screening level risk assessment (SRLA)
8. Comprehensive review
9. Issue evaluation (IE)

TABLE 17. SUMMARY OF ROLES AND RESPONSIBILITIES FOR RISK ESTIMATION AND ANALYSIS

Entity	Roles and Responsibilities
DSO	1. Funds risk studies (screening, comprehensive reviews, and issue evaluations). 2. Reviews risk products. 3. Attends risk presentation.
RDSC	1. Attends CR meetings and the initial site visit (when possible). 2. Reviews risk products. 3. Advised parks on interpretation of risk products.
Park Staff	1. Provides knowledgeable staff to attend the CR initial meeting and the site visit. 2. Provides information to the CR team. 3. Attends a CR final presentation.

OVERVIEW OF MANAGING THE RISKS OF DAMS

Because dam failures release a tremendous amount of energy in the form of devastating floods, dams are high risk structures. In the past, the safety of dams was determined by assessing the ability of the dams to pass the largest possible earthquake or flood.

Recent advances in dam risk management have shown that these past standards-based approaches do not adequately reflect how dams actually fail or their vulnerability to failure. Over the past 10 to 15 years, dam safety is being assessed using risk management methodologies. Risk is the probability of a negative outcome. It is both the probability and the negative outcome. For dams, the probability is the likelihood of failure and the consequences is often simplified to an estimate of the number of lives lost should the dam fail.

Risk = Annual Probability of Failure x Loss of Life

Risk assessment of a particular dam is based on the unique set of failure modes for that dam and their consequences. Dam failure modes are specific to the unique geological setting, the dam type, composition, zoning (or lack thereof), operational vulnerabilities, and the presence of penetrations. The consequences of dam failure during a flood will be different than the consequences from failure due to internal seepage erosion.

The following procedure is used to estimate risks:

1. determine the dam-specific failure modes
2. assess their probability of occurrence (incorporating probability of load)
3. estimate loss of life for each failure mode
4. plot the results on a risk chart

For larger, more expensive, or high risk issues, more in depth risk analyses are performed.

With the risk information, the dam safety officer, park superintendent and region can make decisions that minimize risks while retaining the benefits of the dams.

NONLOSS OF LIFE CONSEQUENCES

The procedure described above considers only the loss of life aspect of dam failure consequences. The primary focus of dam safety programs should be on protecting people from dam failure floods. However, dam failures can also cause significant damage to park resources, lands, transportation systems, utility systems, buildings, the environment and the ability to carry out an agency's mission. Dam failures result in the loss of water behind the dam and the dam repair can be very expensive. These other potential consequences need to be described, quantified, and documented as information for decision makers to consider.

DAM FAILURE MODES

Failure modes are the particular ways a dam can fail. Some common and important failure modes are noted, and briefly discussed, below:

Subsurface Erosion or Piping Due to Seepage Flows at an Embankment Dam

This failure mode accounts for nearly half of the embankment dam failures that have historically occurred. Seepage flows can remove embankment or foundation materials, creating an ever-expanding flow path, through or under a dam that can eventually result in a breach of the dam. Removal of materials proceeds from downstream to upstream until the enlarged flow path reaches the reservoir, at which point catastrophic failure occurs. Key monitoring parameters are (1) evidence of embankment or foundation materials being transported by seepage or drain flows, (2) increasing seepage or drain flows, (3) changing water pressures in the dam or foundation, and (4) sinkholes, sloughs, or unusual depressions or deformations.

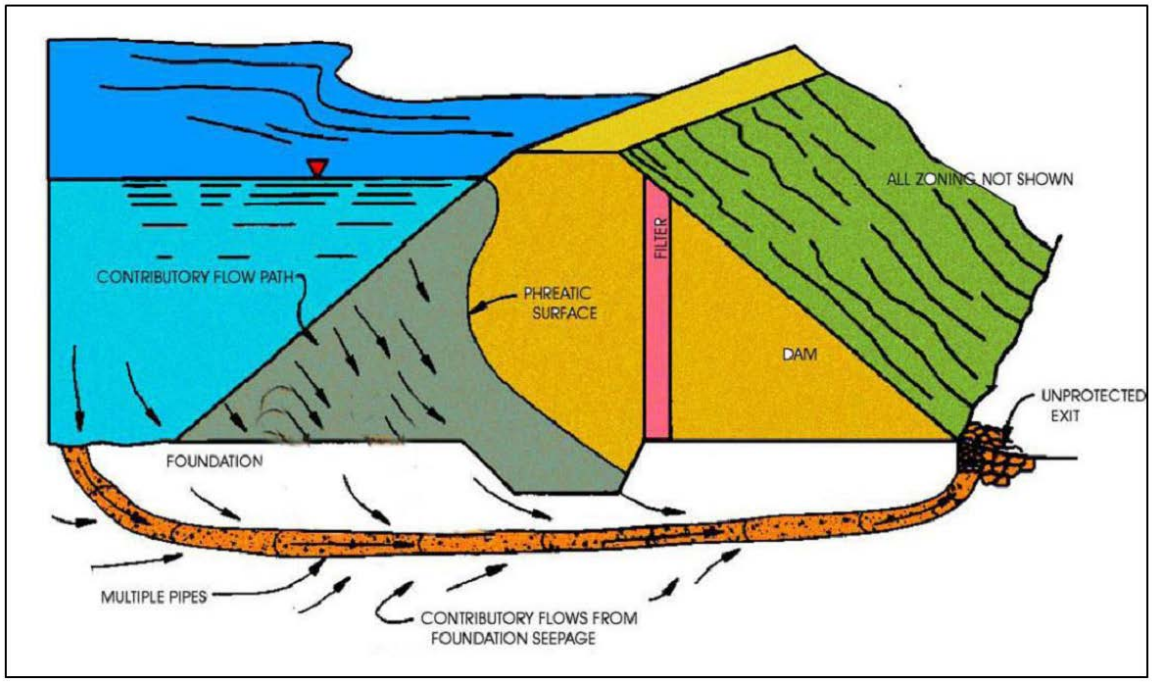


FIGURE 3. SEEPAGE LEADING TO PIPING (INTERNAL EROSION) THROUGH THE FOUNDATION ON AN EMBANKMENT DAM

Overtopping of an Embankment Dam

This failure mode accounts for nearly one-quarter of the embankment dam failures that have historically occurred. Overtopping during a flood event can result in erosion of the dam by the flow, which eventually can develop into a breach. Because of the nature of this failure mode, monitoring activities cannot prevent dam failures of this type, as recognition of a developing situation can do nothing to prevent occurrence of the failure mode (assuming the spillway and outlet works are already being appropriately operated). However, early recognition of a developing overtopping situation can allow timely downstream evacuations.

Spillway Failure During a Flood Event

This failure mode accounts for nearly one-fifth of the embankment dam failures that have historically occurred. When subjected to high flows in a flood, the spillway may not be capable of safely passing them. The spillway could fail and, consequently, uncontrolled reservoir releases could occur. As with the previous failure mode, recognition of a developing problem cannot prevent occurrence of the failure mode, though it can allow timely downstream evacuations. However, appropriate monitoring of spillway performance during flood events can allow recognition of an unsatisfactory situation that could result in spillway failure during a subsequent larger flood event. Appropriate remedial actions can then be initiated to prevent a future failure.

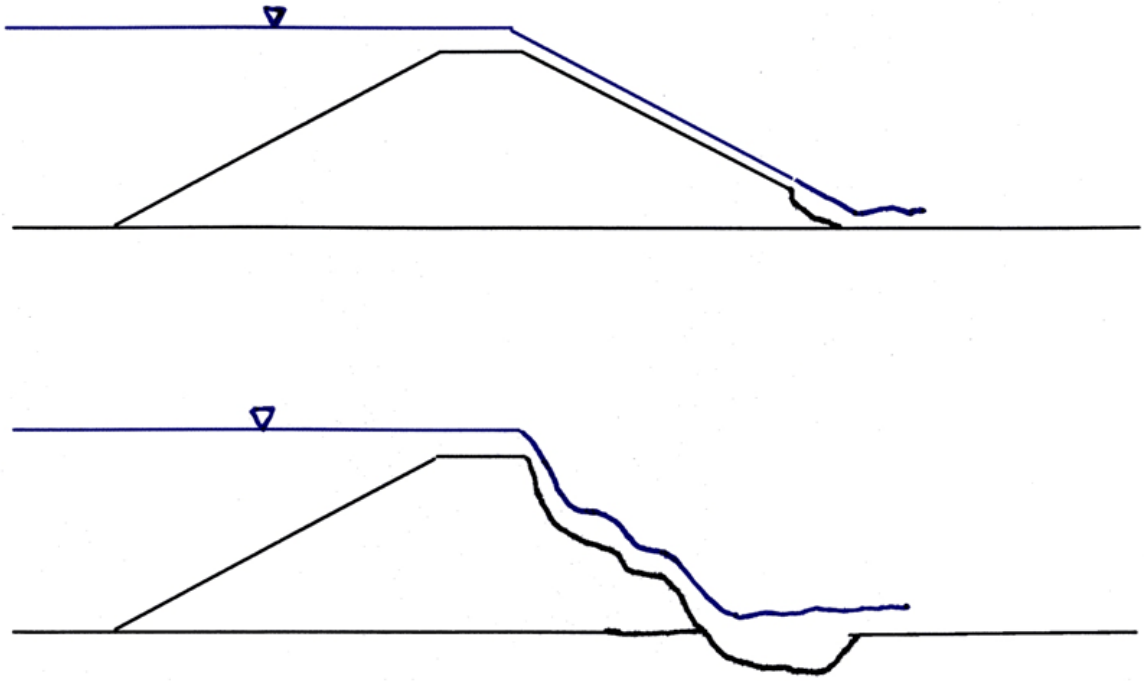


FIGURE 4. DAM OVERTOPPING AND FAILURE PROCESS VIA EROSION OF THE DOWNSTREAM SLOPE

Earthquake-related Failure of an Embankment Dam Due to Slope Instability

To date, this failure mode accounts for very few failures of embankment dams. Slope instability, and the resulting overtopping of the deformed dam, could be because seismic shaking has caused embankment or foundation materials to liquefy (lose strength). As with the previous two failure modes, prompt recognition of initiation of this failure mode cannot prevent its occurrence, though it may allow timely downstream evacuations. The only true way to prevent this failure mode at potentially susceptible sites is by exploration and analysis work to recognize the vulnerability, followed by dam modification to enhance seismic stability.

Earthquake-related Failure of an Embankment Dam Due to Seepage Erosion Failure

To date, this failure mode accounts for very few failures of embankment dams. Seismic shaking can result in transverse (upstream to downstream) cracks in a dam embankment. If appropriate filters were not included in the design of the dam, seepage through the transverse cracks could erode and remove embankment materials, creating an ever-expanding flow path that eventually could result in a breach of the dam. Key monitoring parameters (in the aftermath of an earthquake) are (1) evidence of new transverse cracks, (2) increased seepage or drain flows, and (3) evidence of embankment materials being transported by new crack-related seepage flows. Because this failure mode takes time to develop, prompt recognition of its initiation/development can allow timely downstream evacuations before catastrophic dam failure occurs and may even allow reservoir drawdown to avert dam failure.

Foundation-related Failure of a Concrete Dam

The vast majority of concrete dam failures have historically occurred because of foundation problems. The abutment or foundation support that the dam depends on could be compromised, the dam's concrete could consequently be subjected to stresses in excess of what it was designed for, the concrete could crack and fail, and failure of the dam could occur (which typically would be a "sudden" catastrophic failure). Foundation problems could be due to movement of a large mass of abutment rock (perhaps triggered by seismic shaking), erosion and removal of foundation or abutment rock due to overtopping flows in a flood, or other causes. Key monitoring parameters include: (1) new cracking of concrete that appears structural in nature (long, diagonal cracks, as opposed to pattern cracking), (2) offsets at contraction joints, and (3) unusual structural deformations. Evidence of changing water pressures in the abutments and foundations also could be important relative to this failure mode. This evidence could be water pressure data from piezometers, changes in drain flows, and visual evidence of new seepage areas at higher elevations on the abutments.

RISK ASSESSMENT: THE RISK CHART

Information developed from the failure mode analysis, the probability of failure estimation and consequence estimation is displayed on the risk chart. The risk chart displays the risks by each failure mode (see figure 3). The annual probability of failure is displayed on the Y-axis and the estimated number of lives lost from the failure is on the X-axis.

Using the chart, the dam safety program manager can also compare the failure modes at an individual dam (see figure D). They can also compare the failure mode risks for a whole portfolio of dams. This allows the program manager to allocate the available program funding and resources to the specific problems at dams that present the greatest risks.

When risks are found to present justification for taking risk reduction actions, the park superintendent in consultation with the region and the dam safety officer can choose to take one or more of the following actions to reduce the risks (long term or short term):

- breach the dam (temporarily or permanently)
- repair (temporarily or permanently)
- restrict the reservoir to a lower level (spillway notch)
- relocate the population at risk
- increased dam performance monitoring
- design and construct dam repairs

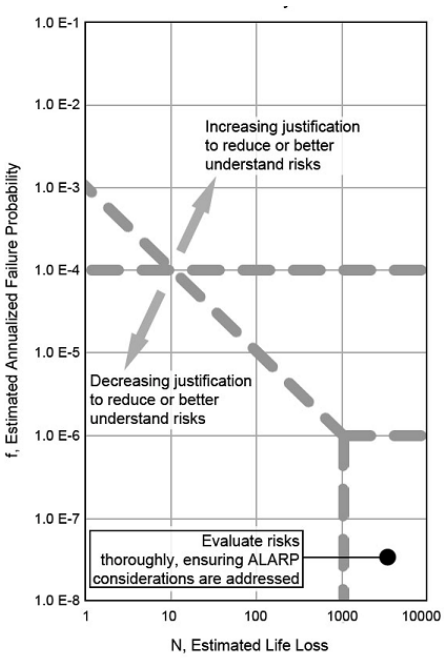


FIGURE 5. DAM FAILURE RISK CHART

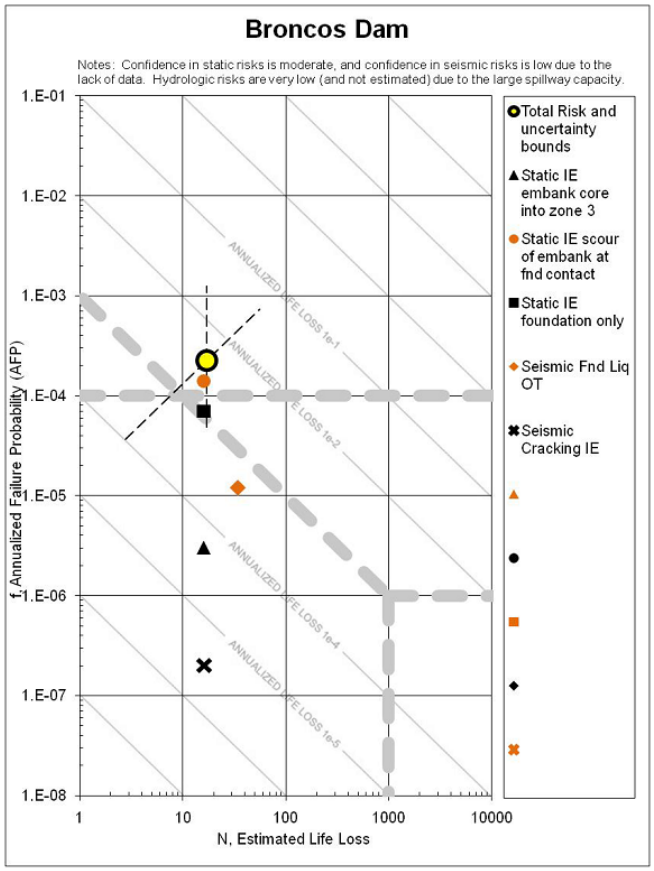


FIGURE 6. FAILURE MODES PLOTTED ON THE RISK CHART

TIMELINESS IN RESPONSE TO ELEVATED RISKS

Any dam with elevated risks (risks which present justification for taking risk reduction actions) must be addressed in a timely fashion. The speed or urgency needed corresponds to the rate of failure mode progression (how soon the dam could fail) and the consequences of failure. Dams that are experiencing serious dam safety incidents must be addressed immediately. Lesser risks can be addressed in a timely, but less urgent basis.

DEPTH OF RISK ANALYSIS

There are three levels of formal risk analysis (from least in-depth to most in-depth):

1. screening level
2. comprehensive dam evaluation
3. issue evaluation

SCREENING LEVEL RISK ASSESSMENT

Dams new to the dam safety program should initially have their risks estimated in a Screening Level Risk Analysis (SRLA). Likewise, during a dam incident a similar approach to the Screening Level Risk Analysis would be used to quickly assess the risks of a dam concern.

The Screening Level Risk Analysis is completed by a one or two person team. The team members are experienced dam engineer technical specialists. Often the members will include one geotechnical engineer and one concrete/waterways engineer. A site visit may or may not be performed depending upon the availability and accuracy provided to the SRLA team.

The purpose of the Screening Level Risk Analysis is to provide the dam safety program a relatively quick estimate of a dam's failure modes, consequences of failure and risks. These risks are displayed on a risk matrix that approximates the more detailed risk chart described above. With the SRLA risk information high risk can be reduced or further evaluated. The screening process should be conservative and not remove dams/issues from further consideration without confidence.

Usually an identified high risk issue would be further evaluated in a comprehensive facility review or an issue evaluation. Obvious high risk would warrant immediate risk reduction measures.

COMPREHENSIVE REVIEW

The recurring method of estimating risks in the NPS Dam Safety Program is via the CR. Every High- and Significant-hazard dam has a comprehensive review every 8 or 12 years depending on the dam's risks. As the name of the product indicates, it is a very thorough overall assessment of the safety and risks of a particular dam.

The comprehensive review is developed as follows:

[Note: if the dam has small diameter penetrations a remotely operated video camera survey (CCTV) will be performed in advance of the comprehensive review.]

1. A technical and NPS team is established. This team consists of a senior engineer, a geologist, a waterways/concrete engineer, an examination specialist, and a dam monitoring engineer. The National Park Service contributes a park contact and the regional dam safety coordinator to the team.
2. The existing dam data is collected and reviewed.
3. An initial meeting is held via conference call with the park and regional dam safety coordinator. During this meeting the data is discussed and an initial list of failure modes is created. The site visit logistics are determined.
4. The senior engineer and the dam examination specialist visit the park and the dam. The park staff accompanies the CR site reviewers. In some cases, key dam measurements or hand soil sampling is performed. The areas downstream from the dam susceptible to dam failure flooding are viewed.
5. Back at the office, the senior engineer performs failure mode probability assessment and a consequences assessment. The senior engineer writes CR report sections.
6. The draft report is internally reviewed by an expert panel.
7. A draft report is sent to the dam safety officer, the RDSO and the park for review.
8. A meeting or conference call is held to present the final draft CR report. Comments are incorporated and the report is finalized and transmitted.

Consistency of CR products from dam-to-dam is very important. comprehensive reviews should be completed by experienced teams of dam safety technical specialists and should be peer reviewed. One or more people should be included in the review of all CR products to ensure there is consistency across the whole portfolio of dams.

One of the most important products of the comprehensive review is a revised dam monitoring program based upon the identified failure modes and risks. The dam monitoring program is customized to assist local staff to monitor for precursors of failure mode development. In this way, problems at dams can be detected early, investigated, and dam failures can be avoided.

ISSUE EVALUATION

High risk dam issues are further evaluated in an issue evaluation. If it is a smaller dam and the risk reduction action is obvious, low cost, and no additional field data is required, the issue evaluation is a management decision document indicating that the issue was reviewed and a description of the decision made. For larger dams with higher risks (and higher repair costs) the issue evaluation will normally include additional data collection (field program) and analysis to more accurately estimate the risks. In some cases, previously identified high risks may be determined to be acceptably low.

The additional data collected for the issue evaluation is also used as design data during the subsequent dam repair conceptual and final design stages. The issue evaluation also develops pre-conceptual design and construction cost estimates. These cost estimates are used by the dam safety officer to develop the five year program budget.

CHAPTER 14: RISK ASSESSMENT AND MANAGEMENT

1. General
2. Dam Safety Priority Rating
3. Making the dam safety case
4. Use of the Dam Safety Priority Rating
5. Portfolio risk management
6. Decision making

TABLE 18. SUMMARY OF ROLES AND RESPONSIBILITIES FOR RISK ASSESSMENT AND MANAGEMENT

Entity	Roles and Responsibilities
DSO	1. Advises regional dam safety coordinator and parks on management of risks. 2. Manages the portfolio of risks for all of NPS dams and identifies program activities to reduce/manage the risks. 3. Endorses park risk management decision making.
RDSC	1. Advises parks on the management of dam risks. 2. Educates parks on dam risks and consequences of failure. 3. Promotes park timely and informed decision making. 4. Endorses park dam safety decision making.
Park Staff	1. Reviews risk information. 2. Considers alternatives to address high risks. 3. With endorsement of the regional dam safety coordinator and dam safety officer makes documented dam safety decisions.

GENERAL

This chapter is about reviewing dam risks, considering alternatives, and making decision to manage risk. The risk information displayed in figure 1 from chapter 9 provides the risk information needed to address not only risks at particular dams, but allows the program manager and senior managers to manage risks of the whole dam portfolio.

As written at the beginning of the last chapter, risk information is not the sole input for agency decision makers. Dam failures include an array of social, economic, biologic and cultural losses. The dam may provide benefits that would be lost in the event of a failure. For this reason it is important that managers be presented not only with the loss of life consequence estimates, but also a full description of the other consequences of failure.

The key references for risk assessment and management can be found here:
http://www.usbr.gov/ssle/damsafety/references.html

Dam Safety Priority Rating

Reclamation and other bureaus in the department are using a Five-level Dam Safety Priority Rating (DSPR) to evaluate estimated dam risks. See Reclamation's *Dam Safety Public Protection Guidelines* in the website above for full information. The levels are:

DSPR 1 – Immediate Priority. Very high risk, often an incident is occurring which could threaten or fail the dam. Such problems could include:

Such problems include:

- increasing/turbulent seepage
- erosion of the spillway during a flood
- significant cracking/slides
- dam deformations following an earthquake
- outlet works collapse
- rising floodwaters threatening to overtop an embankment dam
- major cracks/movement of concrete dam blocks

DSPR 2 – Urgent Priority. High risk, but no threatening incident.

DSPR 3 – Moderate to High Priority. Existing conditions potentially represent high risks. Often, additional studies need to be performed.

DSPR 4 – Risks are estimated to be low.

DSPR 5 – Risks are estimated to be low with high confidence.

MAKING THE DAM SAFETY CASE

Dam safety risk estimation and evaluation documents arrive at a DSPR category by "making the case." Making the case means consideration of and documenting the following factors: the risk estimate (on the risk chart), uncertainty in analysis, and confidence in analysis, cost efficiency, and construction risk.

USE OF THE DAM SAFETY RELIABILITY RATING

The DSPR ratings allow the Dam Safety Program to rate dams and dam issues and compare and prioritize dam safety activities to properly manage risks. For example, a DSPR 1 sets up a NPS expectation that the risk issue will be addressed immediately – usually on an emergency basis. A DSPR 2 rating would mean that risks need to be reduced promptly (weeks/months not years).

In general, the NPS Dam Safety Program will fund higher DSPR rating projects before lower rated projects.

DSPR 1 and 2 ratings may require dams be breached or restricted until more permanent repairs can be performed. These ratings would result in additional dam monitoring and/or examinations to manage the higher risks.

DSPR 3 ratings may indicate that additional technical studies should be performed. Some low-cost issues may be repaired without further study.

DSPR 4 and DSPR 5 ratings indicate less risk, however the dam should continue to be monitored.

PORTFOLIO RISK MANAGEMENT

Using the portfolio of dam risks, the dam safety officer annually develops a dam safety program of activities to address risks. Usually, DSPR 2 and 3 ratings will form a pool of potential project for long-term dam safety projects. With the dam risks temporarily mitigated, the lower risks allow the program to proceed in an organized manner.

The scale of the dam and the potential cost of repairs can be considered in efficient decision making. For instance at a large dam, an Issue Evaluation with a field drilling program may be justified while at a small dam the design could be initiated with a limited data collection program using test pits.

The dam safety officer uses a rolling several year schedule to track and budget the issue evaluation, design and construction projects.

DECISION MAKING

Once risk information is presented, NPS managers need to make decisions about the continued operation or repair of dams. A decision to operate the dam normally with an identified risk is still a decision.

According to Director's Order 40, the park superintendent has decision making authority for dam safety issues. However, WASO and the region are stakeholders and also have responsibility for dam safety. The National Park Service will document in writing its dam safety decisions. These decisions will briefly list courses of actions considered, the action to accomplish and timeframes. The risk reduction to be achieved will be described. The dam safety officer and the regional dam safety officer are available to the park superintendent to provide review and advice on dam safety decisions. Approved dam safety decision documents are distributed to the dam safety officer and regional dam safety coordinator.

CHAPTER 15: OVERSEEING RISK REDUCTION

1. General
2. Dam scale and complexity
3. Implementing reservoir restrictions
4. Implementing breaches
5. Relocating people downstream
6. Increasing dam monitoring
7. Overview of repair design
8. Conceptual design
9. Environmental compliance
10. Final design

TABLE 19. SUMMARY OF ROLES AND RESPONSIBILITIES FOR OVERSEEING RISK REDUCTION

Entity	Roles and Responsibilities
DSO	1. Leads the decision making process with the region and the park to develop and review alternatives and make documented decisions. 2. Supports construction line item funding requests by the National Park Service.
Design Team Leader (A/E)	1. Prepares the interagency agreement that will include the scope of work, budget, and schedule for the entire project. Modifies the interagency agreement as required. 2. Monitors the budget, and may provide monthly status reports to the Park and other NPS staff. 3. Provides timely communication with the park and other NPS staff. 4. Provides investigations, design and construction management for dam modifications. 5. Provides support regarding environmental compliance. 6. May provide contract administration. 7. Provides technical documents. 8. Prepares AutoCAD as-built drawings and places all design and as-built drawings in a drawing archive system.
Park Superintendent	1. In collaboration with the dam safety officer and the regional dam safety coordinator and with technical advice from the dam safety engineer, selects the final dam modification alternative.
Park Staff	1. Provides information to the design team regarding issues that are important to the park, such as coating colors, preferred construction time frame, location of staging areas and access roads. 2. Provide lead regarding environmental compliance, and are responsible for determining what permits and what federal and state surveys are required. 3. May provide NPS staff, or hire private companies to assist with environmental compliance. 4. Assists technical specialists with onsite field data collection programs. 5. Reviews conceptual alternatives and provides input toward the preferred alternative. 6. Provides staff to participate in value engineering studies. 7. Reviews specification paragraphs and design drawings. 8. Provides a principal contact for the entire duration of project. 9. Inputs project information in the PEPC system.
RDSC and Region	1. Provides the contracting officer for the interagency agreement for design/construction services. 2. Facilitates the Development Advisory Board (DAB) approval process for the selected dam modification alternative. 3. Performs other services as requested by the park.

GENERAL

The risk reduction actions taken at dams include temporary and permanent actions. The most common risk reduction action is the design and construction of repairs to the dams. Most of this chapter addresses proper design and repair of dams. However, actions such as dam breaching and reservoir restrictions can also be effective risk reduction actions.

The decision document authorizing risk reduction will provide the risk reduction to be achieved as well as a timeframe. The risk reduction action needs to be within this scope and timeframe.

DAM SCALE AND COMPLEXITY

The scale of the dam is important when considering risk reduction activities. Small dams can be repaired using fewer or shorter process steps than for a large dam. See the *Small Embankment Dam Safety Guide, 2006* (Reclamation) for efficient, but effective strategies for small dam projects. Specific strategies for small embankment dams include:

- performing soils data collection via test pits rather than drilling
- assuming worst case conditions for the design and confirming conditions during construction
- having the designer be an active partner in the construction project
- using force account labor or partner construction entities to work closely with the designer for the construction of the project
- using abbreviated procurement procedures, such as an 8(a) contractor, rather than full and open competition

For permanent breaching and decommissioning, see “Chapter 6: Dam Removal and Restoration.”

IMPLEMENTING RESERVOIR RESTRICTIONS

Reservoir restrictions are instituted to lower the water behind the dam. This is done to decrease the effective head on the dam and to reduce/control seepage from the dam.

It can be difficult or impossible to effectively implement a reservoir restriction at some dams. Most NPS dams are not manned on a permanent basis so frequent operation of the outlet works is not feasible. A more reliable approach is to lower the spillway crest by excavating a notch in the existing spillway. If the dam has a free flow drop inlet spillway, the crest of this structure can be lowered to accomplish a reservoir restriction. Siphons can be effective for one time draining of a reservoir, but they do not operate well unattended on a long term basis.

Reservoir restrictions for small reservoirs on larger drainages are usually not effective for reducing the risk associated with overtopping because the volume of the reservoir and the capacity of the outlet works (or spillway notch) are very small compared with the flood flow/volume.

IMPLEMENTING BREACHES

The risk reduction decision may be to construct a temporary or permanent breach through the dam. The following issues should be considered in the breach design and construction process:

- Decide what flood frequency the breached dam will pass without overtopping failure. The breached dam and the spillway(s) should pass large floods so there are low failure risks following breach construction.
- Complete any required environmental permits. Transportation of reservoir sediments is often a concern. The reservoir sediments must be tested for environmental toxins if the sediments are to be hauled outside the park.
- Drain the reservoir with the outlet works (if there are no failure modes of concern with the outlet works) or with siphons or pumps. Do not cut a notch in the crest of the dam or spillway with a full reservoir—the dam can breach uncontrollably.
- Line the lower areas of the breach to limit erosion. Grouted riprap has worked well on temporary breach projects.
- The breach should be designed by a qualified dam engineer.

RELOCATING PEOPLE DOWNSTREAM

If the area downstream is a campground or other high-use facility, the park may choose to discontinue operation in response to high dam safety risks. This may be a good strategy, especially as a short term action until the dam can be permanently repaired.

If there are homes downstream, the people living in the homes can be moved. Relocation of people in homes downstream may be feasible if there are only one or two homes. However, there are social barriers to the dislocation of residents.

INCREASED DAM MONITORING

As a response to high risk issues, the decision may include increased monitoring to reduce risks. Increased monitoring can be initiated as soon as a high risk issue is discovered. To be effective, a problem dam needs to be monitored frequently so that an accelerating failure mode does not occur undetected between monitoring visits. Frequent dam monitoring often requires a lot of personnel time (e.g., daily). Some dam problems are so severe that they need to be monitoring several times per day to be effective.

Recent advances in technology have allowed for the development and application of dam instruments that are remotely monitored. The Bureau of Indian Affairs monitors most of their dams remotely at a 24-7 monitoring center in Ronan, Montana. Remote camera monitoring of dams is being developed.

OVERVIEW OF REPAIR DESIGN

Often, the decision is made to repair the dam to lower its risks. These repairs can be temporary or permanent. Repair involves a myriad of technical and logistic challenges. See chapter 16 for contracting and construction issues.

Initial Meeting

At the onset of the project, it is highly recommended that the park, the RDSR, the dam safety officer, the designer, and the construction representative meet. This should occur at park offices with a site visit to the dam site. This meeting can be crucial at the outset to establish roles, determine what should be fixed, to identify technical design criteria, outline environmental/cultural/historical challenges, and identify construction methods. Most importantly, the dam scale and complexity can be considered to have an efficient repair project. Some projects use a Project Alternatives Solution Study, which is a multiday facilitated session to identify the above project needs.

One common element of almost all NPS dam modification projects to date is the cohesive makeup of a project management team (PMT). The project management team typically consists of the parks' assigned principal contact (more often than not this person is not an engineer), the dam safety officer, and a technical lead from the Reclamation design and construction groups or another well qualified technical organization.

Effective and frequent communication between the technical lead and the park is perhaps the greatest factor in the success of a dam safety project. At the beginning of the project, the project management team determines their communication methods, decision making process, and meeting frequency. Strong communication results in addressing problems early and uses the combined strength of the team to efficiently work through these problems. Periodic PMT meetings can be used to identify and address issues without being burdensome. Many important issues can be resolved with timely phone calls and conference calls.

The project usually proceeds in stages

- Identify dam safety deficiencies that are to be addressed in the dam modifications.
- Identify all environmental compliance issues and initiate all compliance processes at the earliest possible time.
- Identify hydrology requirements and have required hydrologic data and hydrographs developed.
- Identify and quantify design loads.
- Determination of the need for and collection of additional field data evaluation of data.
- Develop and select modification alternatives.
- Conduct a value analysis (called a value engineering study by Reclamation) if construction field cost are such that a value analysis is required.
- Modification design (includes specification paragraphs, drawings, and cost estimates).
- Procurement.
- Construction.

- Prepare a "close-out package" that includes, among other things, a final construction report and as-built drawings.
- First filling (assuming reservoir was significantly lowered or emptied).

It is essential for the team leader and construction liaison to visit the dam early in the project. This site visit should be completed with at least one park person who is very familiar with the dam. It is advisable to have other team members and other stakeholders to visit the dam site early in the project.

Designer Qualifications

Dam repair designs need to be performed by experienced dam engineers and organizations with long experience with dam design and construction. Dams are complex civil engineering structures involving the disciplines of hydrology, hydraulics, geology, geotechnical, and structures.

Designer Role

Design team leader should be involved throughout the design and construction. The design team leader leads a team of qualified engineers, technical specialists, and technicians to prepare design drawings, specifications, and cost estimates that are appropriate for a given dam modification. The designer (or the design team) completes a design summary, technical report of construction, first filling criteria, as-built drawings, and transmits these documents to the National Park Service. During construction, a qualified and experienced construction inspector in the field of dams is on site during at least the majority of the construction work. The design engineer visits the construction site to verify the conditions in the field are consistent with the design intent, and to facilitate smooth progress of work. If warranted, a designer will perform an on-site foundation inspection, and prepare a foundation inspection report to ensure foundation conditions are adequate for placement of materials. First filling criteria must be developed by an appropriate design team member, and the criteria must be provided to someone at the park who will actually monitor the first filling. The design team leader will participate in the construction close out inspection

Efficient Design and Construction for Small Dams

As stated above, there are strategies for completing efficient and effective dam safety projects for small dams. For the design of small dam projects, the following should be considered:

- Conduct an initial project alternatives solution study.
- Compare the cost of acquiring additional design data versus designing for worst case materials. Verify conditions during construction.
- Combine conceptual and final design.
- Carefully plan for the independent reviews.
- Perform an initial value planning study to confirm project requirements at the project initiation rather than well into the design.
- Forgo the value engineering study if the construction cost is below NPS requirements.

- Look into other construction arrangements rather than traditional contractors. Some projects may be small enough that local forces (National Park Service or other USDI bureaus) can accomplish the work. Hub zone or minority contractors have often been able to perform the work most satisfactorily.
- Have the construction liaison play a very active role in overseeing the construction project.

Federal/Independent Technical Review

Independent technical reviews are required for every modification or construction project for High- or Significant-hazard dams. The depth and frequency of the reviews will be commensurate with the particular dam's size, risks, and complexities. Qualified engineers and other experts not involved in the project conduct this review. The depth and scope of reviews are based upon the degree of the downstream hazard and the size and complexity of the project.

CONCEPTUAL DESIGN

The design team leader will prepare a project plan for the development of the conceptual design. Some or all of the following steps may be performed during conceptual design:

1. Determination of the design loadings: flood and earthquake selection. The designer will usually request the National Park Service to approve flood loading selection.
2. Development of alternatives for reducing the risks. Designs, sketches, and cost estimates are prepared for each alternative. The preferred alternative is selected and a cost estimate is prepared. The alternatives may include no-action and breach alternatives.
3. Completion of a multi-day value engineering study (see the Departmental Manual, Part 369, Value Engineering).
4. Any needed independent review is completed.
5. Completion of a draft and final conceptual design report.
6. The park (in consultation with the dam safety officer and the regional dam safety officer selects the alternative to be implemented. This may be done with a memo from the park to the design team leader.

ENVIRONMENTAL COMPLIANCE

The NEPA process determines the environmental, wetlands, fish and wildlife, cultural, and sociological effects of the proposed dam modification alternatives. In some cases, a categorical exclusion checklist is all that is required to document the NEPA compliance activities. In other cases, an environmental assessment is necessary, which results in either a finding of no significant impact (FONSI) or an environmental impact statement being prepared.

The following environmental compliance activities are required for an environmental assessment:

- NEPA compliance shall be in accordance with NEPA policies; 40 *Code of Federal Regulations* (CFR), Parts 1500–1508

- National Historic Protection Act (NHPA) shall be in accordance with 36 CFR 60; 36 CFR 80; contact the appropriate state historical preservation office.
- 401 permit: water quality certification.
- USACE 404 permit: regulates the discharge of dredged and fill material into waters of the United States.

In most cases, compliance with NEPA and the NHPA takes place in tandem.

Environmental compliance will require timely coordination between the park, team leader, and other state and federal agencies to obtain permits in a timely manner. An environmental assessment, archeology surveys, and a Historical American Engineering Record (HAER) may all be required before a construction contract can be awarded.

FINAL DESIGN

Final designs; including design assumptions, design calculations, drawings, and specifications; shall be completed for the selected alternative. Additional field data may be collected. State-of-the-art design methods and procedures shall be incorporated into the final designs of dam modifications. During the final designs process, designers and construction personnel shall maintain adequate communications to ensure that the final designs are reasonably constructible.

A design summary report will be prepared which includes complete written documentation of all data, computations, and the decision-making process, including the rationale supporting the design decisions. All geological/geotechnical features and hazards, whether specifically identified during investigations or inferred from the data, shall be fully documented.

Construction specifications, including all bidding, award, and contract documents, shall be in accordance with current Federal Acquisition Regulations (FAR), and other applicable laws and regulations.

Personnel familiar with dam construction should be involved in the design process to ensure the constructability of the design. During the construction phase, continued close coordination between design and construction management personnel is essential to assure that the project design intent is carried out and that new field information is incorporated into the design. Designers should make periodic field inspections for approval of changes at predetermined phases, and at other times when significant varying conditions are encountered.

If appropriate, the designer shall incorporate instrumentation in the design of the modification. The instrumentation will allow the designer to monitor the structure during first filling to assure the structure is performing as anticipated. Following first filling, the instrumentation should be monitored to evaluate the long-term performance of the dam.

CHAPTER 16: OVERSEEING RISK REDUCTION: CONSTRUCTION

1. Introduction
2. Roles
3. Acquisition
4. Post-award activities
5. Construction safety
6. Construction management
7. Construction quality control/quality assurance
8. First filling and post-construction activities

TABLE 20. ROLES AND RESPONSIBILITIES FOR OVERSEEING RISK REDUCTION: CONSTRUCTION

Entity	Roles and Responsibilities
DSO	1. Supports line item dam modification project funding.
RDSC	1. Advises park on the dam construction project. 2. Attends pre-award meetings (when available). 3. Travels with the designer to the construction site (time permitting). 4. Communicates with the dam safety officer on the status of the project.
Park Staff	1. May provide the contracting officer. 2. Participates in pre-bid conferences and site visits. 3. Coordinates project in field.
Denver Service Center	1. Participates in project team meetings. 2. Solicits contractors. 3. Awards contract. 4. Issues modifications to contract.
Other Federal Agency/Bureau	1. Provides construction inspector. 2. Conducts pre-bid conferences and site visits.
Design Team Leader/ AE Project Manager	1. Advises the park on the dam construction project. 2. Technical point of contact regarding design. 3. Reviews/comments on submittals.
Construction Liaison	1. Usually serves as the contracting officer's technical representative. 2. Responsible for construction management activities.

INTRODUCTION

Construction, as used in this document, is the physical modification of a dam and appurtenances for the reduction of risks. Construction of dam modifications can include demolition and removal of an existing spillway, widening or a new spillway, modification or replacement of the outlet works, rehabilitation of gates and valves, construction of stability berms, filters and toe drain systems, raising the dam, and installation of geotechnical membranes.

ROLES

The roles of each of the following individuals/teams are separate but must operate in concert with each other during all phases of the project. Successful completion of the project is a team effort.

Contracting Officer (DSC)

The contracting officer will normally be from the Denver Service Center. Contracting officer means a person with the authority to enter into, administer, modify, and/or terminate contracts and make related determinations and findings. The contracting officer is the only person authorized to commit funds to or make changes to the contract. The contracting officer issues the solicitation, receives bids/proposal, evaluates bids (in sealed bidding) or oversees the technical evaluation of proposals in negotiated procurements.

Contracting Officer's Technical Representative (DSC)

The contracting officer's technical representative (COTR) is delegated in writing by and represents the contracting officer in technical matters and day-to-day oversight of the contract, including review and approval of progress payments. *(The term contracting officer's representative is synonymous with COTR.)* The contracting officer's technical representative is not authorized to

1. award, agree to, or execute any contract, contract modification, or notice of intent
2. obligate, in any way, the payment of money by the government
3. make a final decision on any contract matter which is subject to the clause at FAR 52.233-1, Disputes
4. terminate, for any cause, the contractor's right to proceed

Designer/Design Team

The designer/design team, made up of staff from a federal agency/bureau, or an A/E firm, must work closely with the construction liaison, inspector and contractor to ensure the original design intent is met during construction. The designer/design team reviews submittals and site changes, provides foundation approvals, performs periodic inspections, and provides design changes to meet unanticipated site conditions. The designer/design team is responsible for assuring that the project was constructed in accordance with current dam safety guidelines and to industry standards.

Construction Liaison

The construction liaison has overall responsibility for the technical oversight of construction activities and contracts, understanding the design and contract intent, maintaining technical coordination between design, contracting, and construction, to ensure compliance with specifications. Generally, contracting officer's representative (COR) authority is delegated to the construction liaison.

Inspector

The inspector is from the same organization as the designer and construction liaison. The inspector plays an important role to ensure the dam is repaired in conformance with the design and specifications.

Contractor

The contractor, selected by the contracting officer either through competitive or noncompetitive procedures in accordance with all Federal Acquisition Regulations, performs the construction necessary to complete the safety of dam modifications.

ACQUISITION

"Acquisition" means the acquiring by contract with appropriated funds of supplies or services (including construction) by and for the use of the federal government through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, and evaluated. Acquisition begins at the point when agency needs are established and includes the description of requirements to satisfy agency needs, solicitation and selection of sources, award of contracts, contract financing, contract performance, contract administration, and those technical and management functions directly related to the process of fulfilling agency needs by contract. The term "procurement" is synonymous with "acquisition."

The objective of the acquisition process is to ensure that goods and services are acquired from a contractor with adequate skills at a reasonable cost, and that work is completed in strict compliance with the contract specifications.

Acquisition Milestones

The following steps are generally applied in the acquisition process for SOD modifications:

1. Toward the end of the final designs process, the contract specifications and drawings are reviewed by the park and region in detail to ensure that the specifications clearly describe the contemplated work.

2. A camera-ready copy of the specifications and drawings is prepared.

3. An independent government cost estimate is prepared.

4. The contracting officer prepares the remaining contract sections (consisting of contract clauses and solicitation provisions (exclusive of the specifications). The contract clauses, specifications, and solicitation provisions make up the final solicitation document.

5. If required by FAR, a presolicitation notice is posted on the Federal Business Opportunities website <http://www.fedbizopps.gov/ advising all potential bidders of the solicitation,

6. A site visit to the dam may be conducted by the government and attended by prospective bidders or the selected 8(a) contractor. Government attendees may include the construction liaison, contracting officer technical representative, park official(s), and contracting officer.

7. Bids/proposals are received and opened. In sealed bidding, the bid documents are reviewed for responsiveness and the award decision is based on the lowest, responsive bid received; in negotiation, the proposals are evaluated (this may include technical evaluation in competitive negotiation, but always includes cost/price analysis. For noncompetitive (8(a) actions, only cost/price analysis is conducted.
8. A contractor is selected, in all competitive procurements, or negotiations are concluded in an 8(a) noncompetitive procurement and the selected firm is notified, in writing, of the contract award.

POST AWARD ACTIVITIES

Notice to Proceed

After a contract award has been made, the contractor has provided Performance and Payment Bonds, and the contracting officer has approved the bonds, the contractor is given a notice to proceed (NTP) letter that defines the exact date the contractor may begin site work. The contract contains the clause "Commencement, Prosecution, and Completion of Work" which specifies the number of calendar days after receipt of the notice to proceed that the work must be completed. The date the contractor receives the NTP letter is the date used to calculate the calendar date that work must be completed. Stating the performance period as 'number of days after receipt of notice to proceed is the preferred method, since the actual dates that all prior activities are concluded can never be determined with specificity.

Contract Administration

Contract administration begins when a contract is awarded and ends when the contract is formally closed-out. It includes the following activities:

- monitoring contractor performance to ensure compliance with the contract requirements
- reviewing and approving/rejecting contractor invoices
- making payments to the contractor
- reviewing/approving/rejecting submittals
- negotiation and execution of contract modifications
- contract closeout

Contract administration duties are the responsibility of the contracting officer. However, contracting officers may delegate contracting administration duties to another government office.

CONSTRUCTION SAFETY

Providing workers a safe work environment is required by the safety clause contained in the contract (see 52.236-13, Accident Prevention). All contractors are required to comply with Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910 and CFR 29 CFR 1926). The Bureau of Reclamation's Safety and Health Standards (RSHS), require compliance with OSHA regulations, but impose additional safety requirements. The RSHS can be downloaded in either .pdf or Word format at: http://www.usbr.gov/ssle/safety/RSHS/rshs.html

If the National Park Service is conducting the acquisition, the RSHS clause can be used in the solicitation and contract. The clause can downloaded at
http://www.usbr.gov/mso/aamd/resources.html

At this website, select the Word file "Reclamation Acquisition Regulation" (RAR). The RAR will be downloaded to the user's computer, who can then select the clause ***WBR 1452.223-81 Safety and Health.***

CONSTRUCTION MANAGEMENT

General

Construction management team field inspector(s) must not only oversee the day-to-day operations and provide documentation of construction activities (i.e., daily construction reports), but they must also be available to interpret the specifications and coordinate with the design team regarding design intent questions.

After award and before construction starts, a pre-construction meeting is strongly recommended, not only for the benefit of the contractor, but to allow park staff to hear first-hand what to expect during construction so they can make sure that (1) other park activities do not interfere with the construction, (2) park visitors are kept away from all construction areas, and (3) the contractor clearly understands NPS restrictions stated in the specifications (i.e., hours of operation, environmental restrictions).

Scheduling

The construction management team normally starts with a complete review of the specifications for constructability and attends the prebid tour with the design team to answer questions by prospective contractors. The team then reviews the contractors work schedule and throughout the duration of the contract, assures that the schedule stays within the allocated time frame. Time extensions can be authorized only by the contracting officer, and only (a) if the government has delayed the contract performance or (b) if the delay is the fault of the Contractor, the government receives some consideration (something of value) for a time extension.

CONSTRUCTION QUALITY ASSURANCE/QUALITY CONTROL

Inspection

Dam modifications are different than other types of construction, e.g., buildings. Although dams are usually constructed of soil or concrete, each dam has a unique construction, unique potential failure modes, and a unique geologic setting. The scope and complexity of the project and how many concurrent activities are scheduled at the same time normally dictate the number of inspectors needed. For smaller NPS dam modifications, normally only one full-time inspector is used. Continuous construction inspection by qualified and independent personnel is essential in ensuring that contract requirements are met. The inspector must be familiar with all the specification paragraphs, the contract's safety requirements, and the contractor's safety program. Proper inspection assures that the work is performed in compliance with the specifications, provides information on quantities necessary for the review and approval of progress payments, and is valuable in documenting daily activities when evaluating and negotiating contractor claims.

The designers must be kept abreast of all construction activities and be provided with test results per submittal requirements. The inspection team uses the test results from laboratory(s) and daily visual inspection of the work being performed to ensure that the materials and end results stated in the specifications are being met.

Testing

Quality control testing should be performed by qualified materials engineering technicians (independent from the contractor).

If concrete is to be used during construction, the inspector will confirm that the concrete placed meets the specifications requirements. During concrete placement, the inspector will test for slump and air entrainment.

Foundation Approval

Personnel responsible for the investigation and design should perform an on-site evaluation of the actual foundation conditions to confirm the conditions encountered conform to those assumed in the design and to review documentation of site conditions. If the on-site inspector has sufficient experience, then the foundation approval can be provided without a site visit by a member of the design team.

If necessary, a qualified project geologist should examine and map geologic details of the foundation exposed during construction. Even if extensive exploration and testing have been conducted before construction, foundation examinations can be expected to reveal unanticipated conditions, which may require redesign or modifications to the type or extent of foundation treatment required. Investigations, photography, mapping, and testing of foundation materials during construction can provide detailed information concerning the competency of the foundation, identify deficiencies, and outline any additional treatment requirements.

Approval should be obtained from the geotechnical and design staff, in conjunction with qualified and experienced on-site inspector, before placement of dam materials on the foundation. This approval should be documented and furnish proof that all unanticipated conditions encountered

were dealt with and that the foundation and its preparation and treatment satisfy the design requirements.

Support from Design Team During Construction

During the construction phase, continued close coordination between the design team, the contracting officer's technical representative, and the contractor is essential for assuring contract compliance; and addressing differing site conditions through contract modification. Designers may conduct periodic site visits to address potential specification changes. These site visits may be made at predetermined phases and during other times when differing site conditions are encountered.

Daily Reports

Written daily reports containing photographs of the construction shall be prepared by the inspector. The daily report includes the "who, what, where, and why" of construction activities, safety compliance, weather data, equipment used, contractor's labor force, quantities of materials used, as-built information, and any communications between the inspector and the contractor or his supervisor. Copies of daily reports are provided to the contracting officer's technical representative.

As-built Drawings

As-built drawings are critical to developing and verifying final quantities and may prove very valuable for future reference. Depending on how the specification paragraphs are written, pencil notes, data, and sketches for inclusion in the as-built drawings are prepared by either the contractor or the on-site inspector as the work progresses and should include any deviations to the original drawings. Upon completion of the contract work, the contractor transfers the as-built information to a set of specifications drawings that are marked "As-Built." These marked drawings are returned to the design team, who then prepares as-built AutoCAD drawings.

If Reclamation prepares the AutoCAD drawings, they will be saved in the Reclamation Electronic Document System (REDS). The team leader should confirm that all AutoCAD as-built drawings appear in the "Official Record AutoCAD Drawing" state, and that a tiff file for each as-built drawing eventually appears in the "Official Records Signed TIFF" state.

A complete set of as-built drawings must be provided for inclusion in O&M manuals, emergency action plans, the final construction report, and for NPS project files.

As-built drawings are essential for reference by the parties involved in the operation of the project.

Contract Modifications

Modifications can result from a contractor's request to use alternate materials or processes, differing site conditions, funding situations, VE proposals submitted by the contractor, or to reconcile estimated and actual quantities.

The proposed changes are sent to the contractor, with a request for a price proposal. When received, the government conducts an analysis of the price proposal, the contracting officer prepares the

required prenegotiation documentation; negotiations are conducted with the contractor, and the contracting officer prepares a contract modification, which is signed by the contracting parties.

FIRST FILLING AND POST-CONSTRUCTION ACTIVITIES

First Filling

The first filling of a dam following completion of dam modifications can be of critical importance because a significant percentage of dam failures have occurred during the first filling process. First filling activities are accomplished by the government. The plan for the first filling of the dam following construction completion shall be developed by the designer-of-record, or the geotechnical engineer on the design team. The plan shall include the frequency and type of monitoring, a visitation schedule, and expected instrumentation readings. The field data should be transmitted by electronic means to appropriate design team members, usually on a daily basis. The performance during this process must be monitored and evaluated from visual observation and instrumentation data, as appropriate.

If dam modifications include placement of new embankment material, a first filling report is required. The first filling report, if required, will document all pertinent activities that take place during the first filling.

Final Construction Report

Upon completion of construction, a final construction report shall prepared that documents the history of the dam modification project, solicitation and contract award information, details of construction, and contract administration activities.

CHAPTER 17: PROGRAM MANAGEMENT

1. General
2. Management of program authorities and guidelines
3. Management of risks
4. Financial administration
5. Program performance measurement and reporting
6. Projects oversight
7. Participating on Departmental and other working groups
8. Participation in program reviews
9. Records and information management
10. Maintenance of staff capability

TABLE 21. SUMMARY OF ROLES AND RESPONSIBILITIES FOR PROGRAM MANAGEMENT

Entity	Roles and Responsibilities
DSO	1. Maintains program policies, guidelines, and procedures. Forms teams to develop/revise these documents. 2. Manages the portfolio of servicewide dam safety risks. 3. Administers the servicewide dam safety budget. 4. Develops annual program performance report. 5. Develops annual program report. 6. Identifies program weaknesses and resolves them in collaboration with the regional dam safety coordinator and the parks. 7. Works with others to develop and accomplish dam safety-related training. 8. Participates with other federal agencies, the states, and other dam safety organizations to stay technically current and ensure the National Park Service has a state-of-the-art dam safety program. 9. Maintains system of records.
RDSC	1. Participates on teams to develop or revise program policies, guidelines or procedures documents. 2. Works with the parks to manage risks in a timely manner and in a technically adequate manner. 3. Supports parks in the collection of annual program performance information. 4. Helps parks respond to other information requests. 5. Helps parks establish and train dam tenders and backups.
Park Staff	1. Annually collects program performance information. 2. Participates on teams with the dam safety officer and regional dam safety coordinator for development/revision of program policies, guidelines or procedures.

GENERAL

Dam safety programs consist of many facets and parts in order to understand and address the risks of the dams. Program management is the active integration of these parts in order to have a fully functional, comprehensive and efficient long term program. Most of the program management duties fall to the dam safety officer.

Probably the most important role of the dam safety officer is to provide assurance to the NPS director that dams are not presenting unacceptable risks. Each dam is unique, in a unique park setting and it falls to the dam safety officer that no high risk issue is going unaddressed.

He/she collects information from the park and region levels and produces an annual report to the director.

The dam safety officer uses program performance measurement to track program accomplishment and proactively develops strategies for program area improvement.

The dam safety officer must stay current with state-of-the-art dam safety technical guidelines. They need to coordinate with other dam safety professionals within other bureaus within the department.

Finally, the dam safety officer maintains records and information needed to document program activities.

MANAGEMENT OF PROGRAM AUTHORITIES AND GUIDELINES

With the participation of the regional dam safety coordinator and the parks, the dam safety officer identifies new program authorities/guidelines needed or revisions to existing documents. The dam safety officer forms teams to revise and improve policies and guidelines. Significant program changes require briefings to senior management or established working groups with the National Park Service. In many cases, program improvements involve the use of new information technologies including databases, Sharepoint, websites, and email.

MANAGEMENT OF RISKS

The dam safety officer ensures that both individual dam risks and the portfolio of risks are identified and addressed. The dam safety officer participates in individual dam risk presentations and works with the regions and parks to resolve high risk issues. He/she helps the regions/parks to allocate limited program funding to the highest risks in the portfolio.

When incidents occur, the dam safety officer lends support for timely and effective response. The dam safety officer ensures that after-action incident reports are developed and distributed so that the NPS program learns from actual dam events.

FINANCIAL ADMINISTRATION

The dam safety officer manages a Dam Safety Program servicewide budget which funds the following program activities (also see “Chapter 18: Funding”).

- downstream hazard classifications
- dam examinations
- comprehensive reviews
- issue evaluations
- program staff cost
- line item dam modification construction projects
- training

- emergency action planning and exercising
- funding for Reclamation to input instrumentation data received from various parks into a tracking system, and for a qualified engineer to periodically review the data

The dam safety officer maintains interagency agreements with Reclamation and other federal agencies for dam safety technical assistance.

PROGRAM PERFORMANCE MEASUREMENT AND REPORTING

Not only must program requirements be established, their accomplishment needs to be measured. By setting goals and measuring performance, the program can be successful and make long-term improvement.

Performance is measured at the parks via the NPS Dam Safety Database. Performance data is reviewed by the regional dam safety coordinator and the dam safety officer. The performance information is used by the dam safety officer to develop an annual DSP report. The report identifies program areas for improvement.

The dam safety officer submits the NPS contribution to the FEMA Biennial Dam Safety Progress Report.

Reports and briefings are also developed on an as-needed basis.

The dam safety officer provides performance feedback to the supervisors of the regional dam safety coordinators.

PROJECTS OVERSIGHT

Dam safety projects at the parks are challenging. The dam safety officer provides:

- Assistance to the regional dam safety coordinators and parks in the acquisition of technical dam safety services, project review/documentation requirements, and acquisition of funding
- Assurance that all dam safety projects are of adequate technical quality so safe dam projects are constructed
- Assurance that processes are in place for first filling monitoring and project documentation

PARTICIPATING ON DEPARTMENTAL AND OTHER WORKING GROUPS

The NPS dam safety officer is a member of the USDI Working Group on Dam Safety and Security. This group meets on a quarterly basis to discuss national/federal dam safety issues, Departmental issues, conferences/training, and policy/guideline development.

The NPS dam safety officer is a member of the Interagency Committee on Dam Safety.

The dam safety officer also manages NPS contribution to the multi-bureau Reduce Dam Safety Risk project. This five-year implementation project has the objectives to improve the safety of dams and improve program efficiency of dam safety programs within the department. This project is helping the bureaus to adopt common approaches to dam safety including: policy, guidelines, and dam examination.

- development of a department dam safety guideline
- common terms and glossary
- a common dam examination practices
- common technical standards
- common program performance measures
- adoption of risk management
- information technology and document management

PARTICIPATION IN PROGRAM REVIEWS

The NPS Dam Safety Program is formally reviewed every five years by the Reclamation as part of their dam safety oversight and advice role in the department. The dam safety officer prepares for the review, participates in the review, and arranges for senior management briefings. The dam safety officer develops responses to review recommendations including the adoption of new program improvements.

RECORDS AND INFORMATION MANAGEMENT

For the program to operate efficiently and to meet federal and NPS records requirements, the dam safety officer manages NPS dam safety records. A central file is maintained. The regional dam safety coordinators maintain a set of dam safety records for the dams within their region. See “Chapter 21: Records Management.”

MAINTENANCE OF STAFF CAPACITY

The dam safety officer supports WASO, regions and park management in the staffing of qualified staff to operate the Dam Safety Program. The dam safety officer provides recommended position description requirements and provides feedback on staff performance. The dam safety officer also assists the regions and parks with succession planning and training.

CHAPTER 18: FUNDING

1. General
2. Non-authorized projects
3. Program activities and sources of funding
4. Methods
5. Cost accounting

TABLE 22. SUMMARY OF ROLES AND RESPONSIBILITIES FOR FUNDING

Entity	Roles and Responsibilities
DSO	1. Manages the servicewide dam safety budget. 2. Accounts for funds. 3. Prioritizes line item construction projects that may be funded with Dam Safety Program funds. 4. Executes and administers interagency agreements with Reclamation and others for dam safety technical services (but not dam repair projects). 5. Allocates funds to the regions for regional dam safety coordinator duties.
RDSC	1. Supports parks in budgeting for dam operation, maintenance, and emergency action plan activities from the park maintenance budget. 2. Assists parks with funding processes and interagency agreements for dam repairs. 3. Coordinates with regional line-item construction personnel to ensure dam repair projects are meeting line-item construction project management requirements. 4. Coordinates with other regional funding sources.
Park Staff	1. Requests line-item construction funds in cooperation with the regional dam safety coordinator and dam safety officer. 2. Enters projects into PMIS and FMSS.

GENERAL

Funding is provided in each applicable region, park, and DSC to assure that all dam safety program activities are programmed, staffed, and accomplished. The funding is targeted to those offices with responsibilities for High and Significant hazard dams.

The National Park Service funds inventory maintenance, examinations, dam evaluations, construction projects to reduce risks at NPS dams, emergency maintenance, dam removal projects and evaluation of dams considered for acquisition. The National Park Service will utilize a risk-based process for prioritizing dam safety and security projects to obtain maximum risk reduction benefits. Risk encompasses natural and manmade (accidental or intentional) events, the response of the dam to those events, and the consequences of an adverse response to the event(s).

DAM SAFETY FUNDING SOURCES

Although servicewide funding for the Dam Safety Program has been made available out of the Washington Support Office Park Facility Management Division, it is the responsibility of regional directors and the Superintendents to assure adequate funding and personnel to meet DSP objectives.

There are several other funded programs which are interrelated to the maintenance, operation and safety of dams. The following list is provided to alert NPS managers as to the need for well-coordinated and funded programs to prevent overlap and duplication of funding and personnel

- Cultural resources cyclic maintenance
- Preservation, design, and construction
- Risk Management Division (occupational and public type safety)
- Law enforcement and ranger activities (evacuation during imminent disasters)
- Land acquisition (acquire existing dams during land purchases)

NONAUTHORIZED PROJECTS

The following activities will not be funded from the Dam Safety Program and will require funding from other programs

- repair of nonjurisdictional dams
- examination and repair of dams owned by others
- removal of accumulated reservoir sediments behind dams

PROGRAM ACTIVITIES AND SOURCES OF FUNDING

TABLE 23. PROGRAM ACTIVITIES AND SOURCES OF FUNDING FOR HIGH AND SIGNIFICANT HAZARD POTENTIAL

Program Area	Program Activity	Funding Source
Downstream Hazard Classifications	Hiring a dam safety technical expert to evaluate a dam as to whether the dam failure would endanger people or cause major damage.	DSP servicewide
Examinations	Special, annual, intermediate, formal, inaccessible features, comprehensive review.	DSP servicewide
Risk Assessment	Risk screening, comprehensive dam reviews, issue evaluations.	DSP servicewide
Operations and Maintenance	Making releases, clearing debris, controlling vegetation, greasing gate mechanisms, painting, concrete patching, and minor repairs.	Park base
Repair	Major gate repairs/replacement, significant concrete repairs, erosion repair (e.g., new riprap).	DSP servicewide
Risk Reduction Projects	Designing and constructing of dam breaches, implementation of reservoir restrictions, design/ construction of dam reduction projects.	DSP line-item construction
Inspection Monitoring	Periodically visiting the dam and completes monitoring checklists.	Park maintenance budget
Remote Monitoring	Remotely monitored electronic early warning systems.	DSP servicewide
Emergency Management	Development and exercising of Emergency action plans. Development and updating of inundation maps.	DSP servicewide

TABLE 23. PROGRAM ACTIVITIES AND SOURCES OF FUNDING FOR HIGH AND SIGNIFICANT HAZARD POTENTIAL

Program Area	Program Activity	Funding Source
Security	Access barriers, locks on operating equipment.	Park base
	Formal security assessments on high security-risk dams.	DSP servicewide
Dam Removal	Permanently breaching dam, removing the dam embankment, sediment control and revegetation.	DSP servicewide or other sources

TABLE 24. PROGRAM ACTIVITIES AND SOURCES OF FUNDING FOR LOW-HAZARD POTENTIAL DAMS

Program Area	Program Activity	Funding Source
Inventory	Review of areas downstream from Low-hazard dams to determine if hazard classification studies should be performed for upgrading the dam to High- or Significant-hazard.	Dam safety servicewide
	Downstream hazard classifications.	Dam safety servicewide
Inspections/condition assessments*	Checklist inspections and condition assessments for asset management and entry into FMSS.	Park base
Monitoring*	Periodically reviewing the dams to ensure no major problems are developing.	Park base
Operation and Maintenance*	Operation and maintenance.	Park base
Emergency Management*	An emergency action plan is not normally required. An inundation map is not required.	N/A
Repair	Minor and major repairs.	DSP Servicewide or Park Base

* These activities are not performed under the authority of the Dam Safety Program. However, the failure of Low-hazard dams has the potential to cause damage to park resources and there is a small chance someone could be harmed by the flood failure wave. Repair of Low-hazard dams can be expensive. Parks should monitor, operate, and maintain Low-hazard dams so as to prevent their failure consistent with the management of other park assets and risks.

METHODS

There are several methods of requesting funding and personnel to assure the maintenance and safety of NPS dams.

In response to the annual servicewide call, parks request funding for construction and dam repair projects in the FMSS (project management information system) PMIS. The dam safety officer uses risk and other factors to prioritize submitted projects.

The regular budget formulation and execution process is used to program funds for routine but yet necessary activities. For high risk projects, the parks, regional dam safety coordinators and the dam safety officer work on an expedited basis to reduce risks in a timely manner.

The dam safety officer develops and maintains a five-year funding plan for DSP activities.

Cost Accounting

Cost accounting should be used to assure cost effective management of funds and manpower utilized in the maintenance, operation, and safety of dams.

CHAPTER 19: TRAINING

1. General
2. Conferences and meetings

TABLE 25. SUMMARY OF ROLES AND RESPONSIBILITIES FOR TRAINING

Entity	Roles and Responsibilities
DSO	1. Develops and funds training programs. 2. In collaboration with the regional dam safety coordinator and the parks, establishes program training requirements. 3. Attends training.
RDSC	1. Attends training. 2. Supports parks in the accomplishment of training.
Park Staff	1. Attends training. 2. Reports on training accomplishment. 3. Maintains training history.

GENERAL

Training is an important part of an effective dam safety program. Staff must be aware of and competent in the execution of their responsibilities.

To supplement technical staffing, NPS managers should provide internal personnel training. Provisions should be made for technical personnel to observe and participate in decision-making meetings and to make site visits with more experienced staff. Staff members should be encouraged to attend consultant meetings in order to gain valuable experience.

Operations and maintenance personnel should be trained in problem detection and evaluation, and application of appropriate remedial (emergency and nonemergency) measures.

Personnel involved in monitoring inspections should be trained for the requirements of these duties. The training should cover the types of information needed to prepare for the inspections, critical features that should be observed, failure modes, inspection techniques, and preparation of inspection reports.

The regional dam safety coordinators, maintenance personnel, and park emergency action plan coordinators should complete training to assure they stay abreast of developments in the maintenance, operation and safety of dams. Training for the inspection of dams is normally provided by Reclamation on an annual basis. These courses are geared to persons not familiar with engineering or geology but who are responsible for the safety and maintenance of small dams.

Designated park staff should attend training in the preparation, exercising, or use of emergency action plan's and ensure their integration into the park’s overall emergency operations plan.

Appropriate park dam personnel shall be trained to detect, evaluate, and appropriately respond to emergency and nonemergency situations. A sufficient number of personnel should be trained to assure adequate coverage at all times. The regional dam safety coordinators and park superintendents should identify training needs and request such training from appropriate sources. The dam operator and their backup should attend dam tender training.

CHAPTER 20: PROTECTION FROM NONOWNED DAMS

1. General
2. Policy
3. Inventory of nonowned dams
4. Dam ownership and regulation
5. Strategies for managing risks from nonowned dams

TABLE 26. SUMMARY OF ROLES AND RESPONSIBILITIES FOR PROTECTION FROM NONOWNED DAMS

Entity	Roles and Responsibilities
DSO	1. Maintains an inventory of nonowned dams. 2. Coordinates with other agencies for a consistent approach to the management of risks from nonowned dams. 3. Tracks management of risks from these dams.
RDSC	1. Educates parks about risks from nonowned dams. 2. Assists with technical assistance needs from the parks. 3. Provides advice to parks on how to work with the owners of nonowned dams and the state dam safety programs.
Park Staff	1. Requests technical assistance from the regional dam safety coordinator for extent/severity of flooding from potential failure of nonowned dams. 2. Works collaboratively (as a good neighbor) with the owner of nonowned dams to ensure the dams are: monitored, examined, evaluated, and repaired. 3. Works with the nonowned dam owners to have emergency action plans so the parks are notified if there is a problem with the dam. Participates in EAP exercises. 4. Develops park-specific warning and evacuation plans to effectively respond to failures of nonowned dams and incorporates into park emergency operations plan.

GENERAL

The NPS *Management Policies 2006* require NPS staff to protect park resources unimpaired for the enjoyment of future generations and to protect staff and visitors in the parks. Dams are civil structures that have the potential that, if they fail, could cause loss of life or major damage (impairment) to park resources. Most of the chapters of this reference manual are about the proper management of the risks of dams owned by the National Park Service. However, there are many dams owned by others upstream of (or within) parks that, if they were to fail, would significantly damage or impair park resources.

Unfortunately, Rocky Mountain National Park, has experienced the following two failures of hydraulic structures owned by others resulting in major damage and loss of life:

- **Lawn Lake Dam Failure 1982.** Lawn Lake Dam and Reservoir are owned by an irrigation company. The parcel is an in-holding within the park. The dam failure eroded a steep ravine down a mountainside and deposited a several acre boulder field. The flood went on to kill three people and flood the town of Estes Park. The federal government was found liable for

poor warnings to evacuate and the government had to pay $30 million (over $100 million today).

- **Grand Ditch Failure 2003.** An irrigation company owns the land under the canal surrounded by park lands. During spring runoff, the elevated canal embankment overtopped and failed releasing canal waters down a steep mountainside. A 167-foot-wide by 60-foot-deep mountain side gully/erosion scar was created. The National Park Service sued the canal owner for damaging park resources and was awarded $10 million.

The owners of dams and other structures may be unaware that they may be held liable for damage of park resources.

Policy

Parks will incorporate response plans for non-NPS-owned dams within, or upstream from, park boundaries that would impact park visitors, employees, resources and assets in their emergency operation plan for the park in accordance with NPS *Management Policies 2006,* section 8.2.5.2, *Emergency Preparedness and Emergency Operations*. The need to communicate with the owners of nonowned dams is consistent with section 1.6, *Cooperative Conservation Beyond Park Boundaries*.

Inventory of Nonowned Dams

The dam safety officer and individual parks are responsible for maintaining an inventory of all dam structures whose failure would damage or impair park resources. This inventory should be maintained in the NPS Dam Safety Database.

The data fields include: dam name, location, owner, latitude, longitude, dam height, *National Inventory of Dams*, hazard classification, contact name, EAP comments.

Both the regional dam safety coordinator and the dam safety officer are available to provide technical assistance to the parks in the creation and maintenance of this inventory. The regional dam safety coordinator and dam safety officer can also assist if there is a question whether a dam's failure would impact park resources.

Dam Ownership and Regulation

Other dam owners include: irrigation companies, towns/cities, other federal agencies, and states. Except for federal dams and Federal Energy Regulatory Commission regulated hydropower dams, the safety of dams is regulated by the individual states. All states (except Alabama) have legislated dam safety programs. The authorities of the dams vary state by state, but generally the state dam safety programs are empowered to inspect dams, require emergency action plans, compel actions to reduce risks, and to review/approve dam repair designs. Some states are very thorough in their accomplishment of their dam safety programs, other states are challenged in dam safety program accomplishment.

The contacts for the dam safety programs of the states can be found at the Association of State Dam Safety Officials website: http://www.damsafety.org

Strategies for Protecting Parks from Failure of Nonowned Dams

Establish and Maintain an Inventory. Inventory all lands (in-holdings or outside and upstream of park lands) for dams of concern.

Collaborate. Consistent with the management policies, the park should develop a good neighbor relationship with the dam owner. It is also important to develop a collaborative relationship with the state dam safety program (or the federal dam safety officer if a federal dam).

Execute a Memorandum of Understanding with the Dam Owner and/or the State. This document would describe the procedures, communications, responsibilities and interests of the dam stakeholders.

Provide emergency contact information to the dam owner. This helps the dam owner know who to contact at the park.

Tactfully Inform the Dam Owner of Liability. Explain the mission of the park and the need to protect park resources. The dam owner may be unaware that if their dam fails and damages park resources, they may be held liable for damages.

Participate in the Dam Owners EAP Exercise. High-hazard potential dams are normally required to have emergency action plans. Request a copy of the emergency action plan from the dam owner or the state. Ensure that the park will be notified if there is a problem with the dam. Request to participate in an EAP exercise. Offer to assist in the development/exercise of the emergency action plan.

Develop a Warning and Evacuation Plan. The park should be fully prepared to respond if the dam or hydraulic structure fails in order to protect the lives of staff and visitors. Planning in advance can also limit flood damage to critical park resources.

Review the Inundation Map. The emergency action plan typically includes an inundation map. Request a copy of the map and review it for impacted park lands. If no inundation map exists, request assistance from the regional dam safety coordinator or the dam safety officer.

Review the Examination Report. Get copies of dam examination reports. Check to see if important dam safety concerns are outstanding. If there is no recent examination report, collaborate with the dam owner and the state (or federal) dam safety office to get the examination accomplished.

Participate in the Examination. Park staff could participate in the dam examination with the dam owner and the state.

Influence Others to get Outstanding Dam Safety Issues Addressed. If there are dam safety concerns, there is increased risk to the park. The park should collaborate with the dam owner and the state to address these issues. The dam safety officer can assist with this communication.

CHAPTER 21: RECORDS MANAGEMENT

1. General
2. Records stations
3. Records retention schedule
4. Records security

TABLE 27. SUMMARY OF ROLES AND RESPONSIBILITIES FOR RECORDS MANAGEMENT

Entity	Roles and Responsibilities
DSO	1. Maintains the system of DSP records. 2. Files copies of all program and dam records in WASO. 3. Negotiates with Reclamation to maintain technical records in Denver. 4. Maintains a database of dam information.
RDSC	1. Maintains records for all dams within the region.
Park Staff	1. Maintains records for all dams within the park.

GENERAL

Parks, regions and WASO are responsible for documentation of all dam safety records. These include, but are not limited to: examination reports, risk assessments, monitoring data, decision documents, dam performance, incident after action reports, dam repair designs, and construction records. Dam safety records which will be appropriately preserved per Director's Order 19: *Records Management*.

Dam data is valuable. Dams have very long periods of operation and records of past performance are often critical to a current evaluation of a dam. Therefore, dam technical information is retained permanently.

RECORDS STATIONS

The following records repositories will be maintained:

Dam Safety Officer

- Program authorities, guidelines, program management documentation, correspondence, dam decision memos, dam designs, and dam-related records, and emergency action plans and all other information pertinent to the dam

Regional Dam Safety Coordinator

- Program authorities, guidelines, program management documentation, correspondence, and for dams within their region: dam decision memos, dam designs, other dam-related records, emergency action plans, and dam performance data

Park

- Dam decision memos, dam designs, other dam-related records, emergency action plans, dam performance data, logbook, historical documents, incident reports

RECORDS RETENTION SCHEDULE

The dam safety records should be retained in accordance with the NPS records management policies and guidelines.

TABLE 28. DAM SAFETY PROGRAM RECORDS RETENTION SCHEDULE

Record Type	DSO	RDSC	Park
Downstream hazard classification	Permanent	Permanent	Permanent
Examination reports	Permanent	Permanent	Permanent
Monitoring data/reports	Permanent	Permanent	Permanent
Dam engineering evaluation	Permanent	Permanent	Permanent
Decision memos	Permanent	Permanent	Permanent
Emergency action plans	Permanent	Permanent	Permanent
Dam repair designs	Permanent	Permanent	Permanent
Dam repair construction reports	Permanent	Permanent	Permanent
Logbook	Permanent	Permanent	Permanent
Dam historical files	Permanent	Permanent	Permanent
Draft documents	Do not retain	Do not retain	Do not retain

Records Security

Dam information must be properly classified and secured.

CHAPTER 22: DAM SECURITY

1. General
2. Dam security screening and plans
3. Dam security measures
4. Document and information security

TABLE 29. SUMMARY OF ROLES AND RESPONSIBILITIES FOR DAM SECURITY

Entity	Roles and Responsibilities
DSO	1. Performs security screening of all NPS dams. 2. Procures formal security assessments for large/high security risk dams. 3. Maintains guidelines and procedures for security at small and medium dams.
RDSC	1. Supports parks in security of dams.
Park Staff	1. Maintains security at dams. 2. Completes security recommendations from formal security assessment reports. 3. Develops FSP for High- and Significant-hazard dams.

GENERAL

NPS dams shall be screened for security risks using current USDI dam security screening criteria. High risk dams (per current USDI dam security policy DM-753, chapter 2) shall have formal security assessments performed to evaluate threats, vulnerabilities and protective measures. Most of the NPS dams are small, present low security risks, and do not require formal security assessments.

DAM SECURITY SCREENING AND PLANS

According to NPS Director's Order 40, park programs responsible for dam safety at High- and Significant-hazard dams will cooperate with NPS law enforcement personnel in developing the facility security plans (FSPs). Each FSP will be developed in consultation and cooperation with appropriate bureau or office security officials, and with federal, state, tribal, and local agencies responsible for security and law enforcement for High- and Significant-hazard dams only. The FSP will be reviewed and updated annually per DM 753.2.13.C. For NPS roles and responsibilities, see NPS *Management Policies 2006* 8.3 Law Enforcement.

DAM SECURITY MEASURES

Security measures that should be implemented at all NPS dams to limit vandalism and mis-operation are described in table 1. Formal security plans for high risk NPS dams have additional security requirements.

TABLE 30. SECURITY ISSUES AND SOLUTIONS FOR NPS DAMS

Security Issue	Solution Examples
Unauthorized operation of outlet works	Strong box enclosure, handwheel chain and locks
Driving vehicles on embankment slopes	Vehicle gates, fencing, barriers, boulders
Unauthorized entry into large conduits	Locked grates (must not interfere with flow release requirements)
Vandalism/graffiti	Signage, crime reporting program sign

Locks and keys should be documented in the logbook and the park should have a key control program

DOCUMENT AND INFORMATION SECURITY

Dam information must be properly classified and secured. According to NPS Director's Order 40, "Documentation for the Critical Infrastructure Protection program, and related information will ensure that data and information on mission essential infrastructure and vulnerabilities are protected from harmful and/or unauthorized disclosure. Information not associated with critical infrastructure will be evaluated to determine the appropriate protective measures to avert unauthorized disclosure."

Security critical documents such as a dam inundation may be classified as For Official Use Only and protected from distribution. A court has ruled that a dam inundation map does not need to be provided to the public under the Freedom of Information Act.

CHAPTER 23: PROGRAM PERFORMANCE AND REPORTING

1. Introduction
2. Program performance measurement
3. Program reporting
4. Goal setting

TABLE 31. SUMMARY OF ROLES AND RESPONSIBILITIES FOR PROGRAM PERFORMANCE AND REPORTING

Entity	Roles and Responsibilities
DSO	1. Program performance ratings (PPRs). 2. Addresses areas of program underperformance. 3. Develops annual DSP report.
RDSC	1. Supports reporting from parks. 2. Contributes to annual DSP report.
Park Staff	1. Reports accomplishments for PPR.

INTRODUCTION

A main objective of the Dam Safety Program is to have a well-functioning program so that the dam risks are managed and failures are avoided. The program is national in scope with many regions and parks participating. The program has many components including hazard classification, examination, monitoring, risk analysis/evaluation, emergency management, and risk reduction projects. Because of the broad scope and complexity of the program, tools need to be used to periodically measure program performance.

With program performance measurement, the dam safety officer can work with the regional dam safety coordinator and the parks to identify and resolve program weakness. Annual program performance goals can be established and quantified. The program can improve over time.

The program performance measurement process also supports both formal and informal reporting. The NPS Dam Safety Program annually documents program performance, program activities, and other important program accomplishments in an annual report to NPS management.

PROGRAM PERFORMANCE RATINGS

The Dam Reliability Rating: A primary objective of the Dam Safety Program is to have a well-functioning Dam Safety Program so that the dam risks are managed and failures are avoided. The program is national in scope with many regions and parks participating. The NPS dam safety program and other bureaus in the Department of the Interior use a common PPR system. The system consists of several program elements and point assignments.

- Introduction (importance of doing this)
- The Dam Reliability Rating (instead of Facility Reliability Rating)
  - examinations
  - emergency management
  - operation and maintenance
  - security
  - documentation
  - personnel
  - dam monitoring

ANNUAL REPORT

The Dam Safety Officer shall develop an annual report each year. The report will be reviewed by program staff and transmitted to all staff with responsibility for dam safety. The report will include:

- incidents or failures
- staffing/resources
- dams with high risks
- ongoing and upcoming risk reduction projects (repair construction)
- objectives for the following year
- finances and budget issues
- a summary of the results from the PPR

APPENDIX A: ACRONYMS

CD	Conceptual Design
CEC	Categorical Exclusion Checklist
CO	Contracting Officer
COR	Contracting Officer's Representative
CR	Comprehensive Review
DHC	Downstream Hazard Classification
DM	Department Manual
DOI	Department of the Interior
DSD	Dam Safety Database
DSO	Dam Safety Officer
DSPR	Dam Safety Priority Rating
DSP	Dam Safety Program
EAP	Emergency Action Plan
EOP	Emergency Operations Plan
FEMA	Federal Emergency Management Agency
FD	Final Design
FMSS	Facility Management Software System
FONSI	Finding of No Significant Impact
FSP	Facility Security Plans
HAER	Historical American Engineering Record
IC	Incident Commander
IE	Issue Evaluation
NEPA	National Environmental Protection Act
NHPA	National Historical Preservation Act
NID	National Inventory of Dams
NPS	National Park Service
NTP	Notice to Proceed
O&M	Operation and Maintenance
PASS	Project Alternatives Solutions Study
PDSC	Park Dam Safety Coordinator
PEPC	Planning, Environment and Public Comment
PMF	Probable Maximum Flood
PMIS	Project Management Information System
PMT	Project Management Team
PPR	Program Performance Rating
QA/QC	Quality Assurance/Quality Control
RDSC	Regional Dam Safety Coordinator
RM	Reference Manual

SEED	Safety Evaluation of Existing Dams
SOD	Safety of Dams
SOP	Standard Operating Procedures (replaced by O&M Procedures)
SRLA	Screening Level Risk Assessment
SHPO	State Historical Preservation Office
SLRA	Screening Level Risk Assessment
SOP	Standard Operating Procedures
USACE	U.S. Army Corps of Engineers
USDI	U.S. Department of the Interior
USGS	U.S. Geological Survey
WASO	Washington Office (Department of the Interior, National Park Service)

APPENDIX B: GLOSSARY

See also FEMA 148 Federal Guidelines for Dam Safety: Glossary of Terms, access on the Web at: http://www.fema.gov/library/viewRecord.do?id=1829

Dam

Any artificial barrier, including appurtenant works, that impounds or diverts water, and that

1. is 25 feet or more in height from the natural bed 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.

These guidelines do not apply to any such barrier that is not in excess of 6 feet in height regardless of storage capacity, or that has a storage capacity at maximum water storage elevation not in excess of 15 acre-feet regardless of height. However, this lower size limitation should be waived if there is a potentially significant downstream hazard. For further information, refer to the FEMA *Federal Guidelines for Dam Safety*, Glossary of Terms (143) and DM 753.

Dam Failure

Means the catastrophic breakdown characterized by the sudden, rapid, and uncontrolled release of impounded water. Dam failures can include smaller volume releases that could lead up to a potential catastrophic failure if not address in time.

Deactivation

Means modification of a dam to prevent impoundment of water.

Emergency Action Plan

Means a formal written document specific to a given dam that identifies emergency conditions at a high or Significant hazard dam with preplanned actions to follow to minimize loss of life and damage to property and is developed, coordinated and communicated with community stakeholders.

Emergency Operations Plan

Is a formal written document produced by the park unit that utilizes the all hazards concept under the National Incident Management System to articulate how the park will deal with emergency situations. The plan addresses those hazards that can be reasonably expected utilizing the incident command system of the national incident management system and covers such topics as the concept of operations, assignment of responsibilities, administration, logistics, plans and authorities.

Facility Security Plan (FSP)

Means a written plan of procedures developed to address the physical, technical and procedural systems for reducing security risks and protecting NPS employees, the public, buildings and physical infrastructure.

Hazard Potential Classification

Refers to a system that categorizes dams as either "high," "Significant," or "low," according to the degree of adverse incremental consequences of a failure or mis-operation of a dam. The hazard potential classification does not reflect in any way the current condition of the dam (e.g., risk of failure, flood routing capacity, structural integrity, safety, etc.).

- High Hazard – probable loss of one or more lives.
- Significant Hazard – no probable loss of life, but expected economic, environmental, or lifeline losses. Impairment of park resources or visitation.
- Low-hazard – no probable loss of life, and minimal economic, environmental, or lifeline losses generally limited to the owner's property.

(Reference FEMA 333: Hazard Potential Classification System for Dams for additional information.)

Nonjurisdictional

Means a structure which does not meet federal guidelines for classification of a dam structure or for classification of a hazard potential. Existing dam structures which may be determined to be non-jurisdictional during a scheduled Hazard Classification evaluation, will remain listed in the database inventory as "nonjurisdictional" for documentation purposes. It will not be considered for dam safety program activities such as: inspections, Emergency Action Plans, or operation and maintenance requirements.

Removal

Means the water retaining structure and all appurtenances are removed, restoring the area to natural conditions prior to dam installation.

Stream flow Control Structure

Refers to a structure that regulates the flow of water associated with a river or stream, including locks, gates, and canal plugs.

National Park Service
U.S. Department of the Interior

NPS Dam Safety Program
Washington Support Office (WASO)
Park Facility Management Division