The National Dam Safety Program

Model State Dam Safety Program

FEMA 316/July 2007

Federal Emergency Management Agency
www.fema.gov

Association of State Dam Safety Officials
www.damsafety.org

TABLE OF CONTENTS

CHAPTER III – INSPECTIONS AND SAFETY EVALUATIONS

Inspection activities provide the basis for dam* inventories, evaluation of downstream hazards and hazard potential classification, correlation of approved construction plans with actual construction, safety evaluation of existing dams, and emergency* response planning and execution. Adequate inspection of a dam and the documentation of such inspections are necessary before enforcement can be taken.

This chapter contains a discussion of issues related to implementing a program of periodic inspections and safety evaluations. It also makes suggestions for improving existing programs.

I. Considerations for Implementing an Inspection Program

A. Staff;

Specific aspects of personnel qualifications and staffing levels can be found in Chapter VI and Appendix I. Some of the considerations in determining these qualifications and staffing levels for an inspection program include:

1. The initial task of the inspection program must be to identify, classify and evaluate the existing dams in the state. The hazard potential classification for the dams located will need to be determined during the initial inspection of all the dams in the state. An adequate number of inspectors to accomplish this task will be necessary; and

2. Inspection frequency of existing dams must be decided. Geographical areas define whether a central inspection office or a regional office approach is desirable. If inspection frequency is not set by law, annual inspections of high hazard potential dams, biennial inspections of significant hazard potential dams* and inspection of low hazard potential dams every five years are recommended. An adequate number of qualified inspectors must be available for inspections and associated enforcement work after the initial inventory is completed. Average time for inspection of permitted/approved dams including travel time, on-site inspection time, and report writing may be as much as four (4) person days for high hazard potential dams, three (3) person days for significant hazard potential dams, and two (2) person days for low hazard potential dams. A detailed inspection, analysis and evaluation of a dam with production of a detailed report may take two person-months or more. This inspection time may vary on proximity

and types of dams, etc. It is recommended that at least one engineer and one inspector comprise each inspection team both initially and with subsequent inspections.

B. Equipment;

See Chapter VI for a list of basic inspection equipment.

C. Training;

See Chapter VII for required training.

D. Periodic Inspection Standards;

To help ensure quality and consistency among inspectors, the State should develop standards, and require the use of standard inspection checklists and report formats (Appendix C contains example inspection checklists). Additional inspection form examples may be found in the Compendium of State Dam Safety Inspection Forms compiled by ASDSO or on individual State's websites. Suggested inspection standards are as follows:

1. The engineer conducting the formal periodic inspection shall do all of the following.

   a. Review all documents, studies, plans, photos, etc. related to the dam and its appurtenances. This shall include a review of the Operation and Maintenance Plan, previous inspections, and the Emergency Action Plan (EAP).

   b. Provide an assessment of the need for hydrologic, hydraulic, stability and structural calculations and perform them as necessary to provide an accurate assessment of the condition of the dam.

   c. Evaluate the instrumentation data collected.

   d. Determine if additional development has occurred within the downstream reach that may change the hazard classification or require amendments or additions to the emergency action plan.

   e. Provide recommendations regarding the completion of an underwater inspection of relevant portions of the dam and its appurtenances. Underwater inspections are not generally required unless it is the best means to evaluate visual evidence of problems below the water level.

f. Visually inspect outlet works and conduits if they are of adequate size and can be accomplished in conformance with OSHA's confined space requirements. Video inspection of conduits is an alternative to the visual inspection. Video inspections of conduits are not generally required unless it is the best means to evaluate other evidence of problems in the conduit.

g. Prepare an inspection report detailing all visual observations of the embankment, spillway, outlet, appurtenant structures and reservoir conditions at the time of inspection. The report shall include findings, recommendations, and proposed actions.

h. Photographs of the dam, showing specific observations or problem areas must be included in the report with site name and date.

i. The engineer is expected to provide recommendations for all deficiencies identified, and to direct specific attention to conditions reported in previous reports and corrections required by the dam safety program.

2. The engineer conducting the periodic inspection shall use a standard inspection report form provided by the state, and shall inspect all of the following and other items as necessary:

a. Embankment, including stability, alignment, and seepage;

b. Abutments;

c. Concrete Dams and galleries;

d. Spillways and outlet works, including alignment, pipe joints, seepage, and the outlet channel (comply with OSHA confined space requirements);

e. Intakes;

f. Valves and Gates;

g. Instrumentation;

h. Concrete;

i. Mechanical equipment;

j, Trash racks;

k. Emergency spillways;

l. Reservoir rim;

m. Penstocks;

n. Other components and appurtenances.

o. Observe an exercise of valves, gates and other operating equipment as necessary to demonstrate proper functioning.

E. Documentation;

The inspection provides the basis for enforcement action. Adequate documentation of all inspections is necessary. Documentation will be critical in assessing legal liability;

1. Written documentation of visual inspections shall be filed and provided to dam owners. Inspection reports should detail all visual observations of embankment, spillway, and reservoir conditions at the time of inspection. Any recommendations to, or verbal agreements with, the owner/operator must be documented in the written report to the file. Follow-up letters to the owner/operator should be written without delay;

2. Photographs of the dam, specific observations or problem areas must be filed with site name and date of inspection clearly marked. All digital image files or negatives must be carefully labeled and preserved in anticipation of possible enforcement action;

3. Any conversation by telephone with the owner, owner's agent, consulting engineer, attorney, or concerned citizen must be documented in a telephone log and placed in the project file;

4. Any email correspondence with the owner, owner's agent, consulting engineer, attorney, or concerned citizen must be retained either digitally, or a paper copy placed in the project file;

5. Any conversation on site or in the office with the owner, owner's agent, consulting engineer, attorney, or concerned citizen shall be documented in writing and placed in the project file; and

6. Any legal notice or order must follow all legal requirements of the dam safety statute and legal administrative procedures for the state.

F. Inventory;

The results of the beginning inspection program should be maintained in a computerized inventory, which includes basic information necessary to set priorities and goals. The dam name, owner information, specific geographic location, height, storage, hazard potential classification, general condition, and inspection dates of the dam are suggested for the inventory. This data is also used for updating the National Inventory of Dams (NID). The Corps of Engineers provides the Dam Safety Program Management Tools (DSPMT) software, an inventory and data management tool, to state dam safety programs. States beginning a new inventory should consider using the DSPMT as their database software for its ease of transfer of NID and other program performance data. The locations of inventoried dams must be plotted on US Geological Survey (USGS) topographic maps for future inspections, planning and emergency response (see Appendix H for sample database fields). It is also recommended that the dams in the inventory be spatially located using a GIS application;

G. Construction Inspections;

State inspections during construction provide verification that dams are built in accordance with approved plans and specifications. It might be argued that such inspections are unnecessary when construction sites are overrun with contractor's inspectors, owner's inspectors, and consulting engineer's representatives. In many cases, however, the contractor is disposed to cutting cost and the other on-site inspectors may look to the state for ultimate justification in following the approved plans. Some obvious but often overlooked suggestions for construction inspections include:

1. Certification in writing by the design engineer that the construction or repair* of the dam was in accordance with the approved plans and specifications. This will assure the oversight responsibility for the project;

2. Often the most vulnerable phase in the life of a structure is the construction phase. Coffer dams, diversions, and the main embankment are usually incapable of safely passing floods until sufficient dam height is achieved. An emergency action plan specific to construction activities should be approved prior to starting the project. Inspection teams should ask on-site monitoring personnel to produce copies of the plan and explain emergency procedures;

3. Inspection teams should ensure that construction personnel have copies of the approved plans and specifications, and the state permit or application approval for construction;

4. The entire site must be examined to check conformity with the approved plans and specifications, and applicable safety standards. When site personnel dismiss the need to check particular areas of construction, the inspection teams should make it a point to see these areas;

5. Documentation of inspection including photographs and written inspection reports while on site is extremely important. Legal notices of violation must conform with statutory requirements; and

6. Monitoring of a new dam should be exhaustive during a restricted filling schedule.

H. Owner Responsibilities;

A state inspection program depends on dam owners and/or their consultants to provide complimentary and necessary inspections and surveillance. The dam owner and heirs, successors, or assigns is ultimately responsible for the safety of the dam. The owner is directly responsible for the ongoing operation, maintenance, surveillance, and periodic inspection. The owner shall do all of the following:

1. Provide for on-going surveillance of the dam. The level of surveillance will depend on the size, condition and hazard classification of the dam;

2. Train their personnel in the basics of visual inspection techniques. Any person* employed by the owner who regularly visits or works at the dam should be trained to inspect part or all of the dam and to report any observed problems;

3. Measure or read appropriate instrumentation and record and evaluate the data at specified time frames;

4. Promptly notify the state dam safety program of any unusual observations. Unusual observations may be indications of distress;

5. Inspect the dam and its appurtenances:

   a. On a regular periodic schedule based on size, condition and consequence of failure, and;

   b. During and after any unusual loading including, but not limited to, significant storm/runoff events or earthquakes, to determine if structural or operational problems exist;

6. Maintain records for the dam, including but not limited to construction plans and documents, engineering studies, inspection reports, monitoring records, photos, the emergency action plan, and the operation and maintenance manual;

7. Obtain the services of an engineer or have qualified in-house staff to inspect the dam as required by state regulations.

II. Considerations for Implementing an Owner-Responsible Inspection Program

As outlined in Section I, periodic inspections conducted by the state provide an independent and unbiased review of the dam and are the preferred model. Shrinking state budgets and the trend toward privatization of government services have led some states to depend more heavily on inspections conducted by private consulting engineers hired and paid for by the dam owner. These types of programs, referred to here as Owner-Responsible Inspections, have more emphasis on the owner and/or their consultants as the primary source of the review and inspection. The state plays a reduced role for the periodic inspection and review of the dam, but provides direction, enforcement, quality control and policy for consistency. The state shall continue with the responsibilities for construction inspections as outlined in Section I, G.

Either model requires compliment inspections by both owners and states . This section provides guidance on how to develop an owner-responsible inspection program. An owner-responsible inspection program must clearly define the owner's responsibilities for operation, maintenance and inspection of the dam.

A. Owner Responsibilities;

In an owner-responsible program, the owner is responsible for providing in-depth inspections by either an in-house engineer or an engineer hired by the owner. This in-depth inspection is outlined in Section I, parts D and E. The owner continues to retain the tasks outlined in Section I, part H. The engineer conducting the inspections would be required to have the proper equipment and training as referenced in this model. The owner shall use standard report formats and guidelines that are developed by the state to assure consistency among owners.

B. State Responsibilities;

The State should continue to be responsible for the following: Identification of jurisdiction, inventory, assigning hazard classification and developing required frequency of inspections. Recommendations for these issues are outlined in Section I above. The State should also

develop policy, standard forms, and other dam safety standards, and conduct quality assurance as outlined below:

Quality Assurance/Quality Control. As a result of an owner-responsible inspection program, a Quality Assurance/Quality Control (QA/QC) procedure conducted by the state is important to help ensure that formal inspections are being conducted in accordance with the standards. The state should implement the following measures. Recommended staffing needs for QA/QC are presented in Appendix I.

1. The dam owner should be required to sign an annual statement indicating that the dam is being maintained in accordance with the approved maintenance plan and that the emergency action plan, if required, has been exercised and updated as necessary.

2. The state shall have the authority to make inspections and inspect records and manuals.

3. The state program should promptly review all submitted reports and requirements.

4. The state should make independent periodic field inspections of jurisdictional dams to verify the findings of the owner's inspection.

5. The state should require more frequent or follow-up inspections by the owner's engineer if conditions indicate that more frequent inspections are necessary to assure adequate protection of life and property.

6. The state should document deficiencies by letter to the owner with specified time frames for abating the deficiencies consistent with recommendations of the inspection report.

In order to ensure the effectiveness of an owner-responsible inspection program, the state dam safety program should have enforceable regulations related to performance of owner inspections (See Chapter IV).

III. Considerations for Upgrading an Inspection Program

After an inspection program is established, or when the opportunity arises to add to an existing program, advanced inspections and in-depth reviews and evaluations should be conducted. The following areas should be considered for improvement:

A. Advanced Inventory;

An inventory verification of all dams within state jurisdiction every five years can be an effective tool for determining the overall program status and progress. Inventories should list all pertinent aspects of each dam such as height, storage, and hazard potential classification. Additionally, inventories can list permit or application approval status, inspection priority status, purpose of dam, owner information, enforcement status, and other useful information. Inspection teams must be trained to gather the information necessary from the field including use of global positioning stations to locate dams;

B. Advanced Inspections;

Inspection teams should conduct detailed inspections of dams to evaluate dam performance under normal or unusual site conditions. A detailed inspection of all outlet works should be performed a minimum of every five years. The inspection should include direct visual observation where practical and safe, or by remote cameras where necessary. Advanced inspections should take advantage of all available data such as agency and owners' records of construction, instrumentation records, and operation and maintenance records. Field inspections may include accurate measures of watershed and reservoir conditions, spillway configurations, embankment conditions, downstream hazard potential, or other specific problem areas. Wherever possible, gates and other operating equipment should be exercised to demonstrate proper functioning.

Additional unscheduled inspections should take advantage of unusual site conditions, such as a lowered or drained reservoir, or reservoir levels higher than normal. It may be useful to inspect concrete and masonry dams on a sunny day after heavy ice build-up in the reservoir. Inspections are useful also after record storms, snow melt, and earthquake events.

C. Design Reviews and Evaluations;

The agency should re-evaluate each high hazard dam every five years or when changes in the state of practice occur. This includes in-depth calculations and evaluations of hydrology, hydraulics, structural, stability, earthquake engineering and construction. Where necessary, a reanalysis employing advanced methods and modern design criteria and practices should be conducted in order to determine if the structure meets current design criteria. Specialized engineering software should be used to adequately evaluate each component of the dam for the various loading conditions expected.

D. Advanced Inspection Techniques and Equipment;

State programs may consider the use of advanced equipment either through direct purchase or cooperative agreement with other states.

APPENDIX C

INSPECTION CHECKLIST

CASE 1: ARIZONA

ARIZONA DEPARTMENT OF WATER RESOURCES
OFFICE OF WATER ENGINEERING – DAM SAFETY SECTION
DAM SAFETY INSPECTION REPORT

Each item of the checklist should be completed. Repair is required when obvious problems are observed. Monitoring is recommended if there is a potential for a problem to occur in the future. Investigation is necessary if the reason for the observed problem is not obvious.

SID: **(xx.xx)**	DAM NAME:	TYPE:	PURPOSE:							
CONTACT(S):		REPORT DATE:								
INSPECTED BY:		INSPECTION DATE:								
REVIEWED BY:		DATE:								
DESIGN DAM CREST ELEVATION:		DESIGN SPILLWAY CREST ELEVATION:								
DESIGN TOTAL FREEBOARD (FT):		*MEASURED TOTAL FREEBOARD (FT):*								
STATUTORY DAM HEIGHT (FT):		MAXIMUM EMBANKMENT HEIGHT (FT):								
DAM CREST LENGTH (FT):	UPSTREAM SLOPE:	DOWNSTREAM SLOPE:								
DAM CREST WIDTH (FT):	GPS	Lat.: **xx°xx′xx.x″** Long.: **xx°xx′xx.x″**	WATER RIGHTS:							
RSRVR. AREA (AC):	RSRVR. STORAGE (AC-FT):	MAX. STORAGE (AC-FT):								
INFLOW DESIGN FLOOD / SAFE FLOOD-PASSING CAPACITY:										
RESERVOIR LEVEL DURING INSPECTION:	PHOTOS:	**Page 1 of**								

COMPLIANCE CHECKLIST

1. CONDITION SUMMARY / LICENSE / EAP / NEXT INSPECTION	**NOT APPLICABLE**	**NO**	**YES**	**MONITOR**	**REPAIR**	**INVESTIGATE**
a. Recorded downstream hazard: _____ Should hazard be revised?						
b. If High Hazard, estimate downstream persons-at-risk (PAR): _____ Is there a significant increase since the last inspection?						
c. Recorded size: _____ Should size be revised?						
d. Any safety deficiencies? Describe:						
e. Any Statute or Rule violations? Describe and list required action:						
f. Safe storage level on License: _____ Should level be revised?						
g. Any License violations? Describe and list required action:						
h. Date of current License: _____ Should new License be issued?						
i. Date of last Emergency Action Plan revision: _____ Should EAP be revised?						
j. Normal inspection frequency: _____ Should inspection frequency be revised?						
k. Recommended date for next inspection:						

MONITORING CHECKLIST

2. INSTRUMENTATION AND MONITORING						
a. Describe:						
b. Any repair or replacement required? Describe:						
c. Date of last monitoring report: _____ Should new readings be taken and new report provided?						

DAM EMBANKMENT CHECKLIST

3. DAM CREST

a. Settlements, slides, depressions?						
b. Misalignment?						
c. Longitudinal/Transverse cracking?						
d. Animal burrows?						
e. Adverse Vegetation?						
f. Erosion?						
4. UPSTREAM SLOPE						
a. Erosion?						
b. Inadequate ground cover?						
c. Adverse vegetation?						
d. Longitudinal/Transverse cracking?						
e. Inadequate riprap?						
f. Stone deterioration?						
g. Settlements, slides, depressions, bulges?						
h. Animal burrows?						
5. DOWNSTREAM SLOPE						
a. Erosion?						
b. Inadequate ground cover?						
c. Adverse vegetation?						
d. Longitudinal/Transverse cracking?						
e. Inadequate riprap?						
f. Stone deterioration?						
g. Settlements, slides, depressions, bulges?						
h. Soft spots or boggy areas?						
i. Movement at or beyond toe?						
j. Animal burrows?						
6. ABUTMENT CONTACTS						
a. Erosion?						
b. Differential movement?						
c. Cracks?						
d. Settlements, slides, depressions, bulges?						
e. Seepage? Est. Left ___ gpm; Est. Right ___ gpm						
f. Animal burrows?						
7. SEEPAGE/PIPING CONTROL DESIGN FEATURE(S)						
a. Describe:						
b. Internal drains flowing? Est. Left ___ gpm; Est. Right ___ gpm						
c. Seepage at or beyond toe? Estimated ___ gpm						
e. If so, does seepage contain fines?						
d. Evidence of sand boils at or beyond toe?						

OUTLET WORKS CHECKLIST

8. APPROACH CHANNEL						
a. Describe:						
b. Eroding or backcutting?						
c. Sloughing?						
d. Restricted by vegetation?						
e. Obstructed with debris?						
f. Silted in?						
9. INLET STRUCTURE						
a. Describe:						
b. Seepage into structure?						
c. Debris or obstructions?						
d. *If concrete*, do surfaces show:						
1. Spalling or Scaling?						
2. Cracking?						
3. Erosion?						
4. Exposed reinforcement?						
e. *If metal*, do surfaces show:						
1. Corrosion?						
2. Protective coating deficient?						
3. Misalignment or split seams?						
f. Do the joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
g. Are the trash racks:						
1. Broken or bent?.						
2. Corroded or rusted?						
3. Obstructed?						
h. Operator, gates and valves:						
1. Describe:						
2. Date(s) last operated:						
3. Broken or bent?						
4. Corroded or rusted?						
5. Leaking?						
6. Not seated properly?						
7. Not operational?						
8. Not periodically maintained?						
10. CONDUIT						
a. Describe:						
b. Seepage into conduit?						

c. Debris present?						
d. *If concrete,* do surfaces show:						
1. Spalling or scaling?						
2. Cracking?						
3. Erosion?						
4. Exposed reinforcement?						
e. *If metal,* do surfaces show:						
1. Corrosion?						
2. Protective coating deficient?						
3. Misalignment or split seams?						
f. Do the joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
11. STILLING BASIN / ENERGY DISSIPATOR						
a. Describe:						
b. Do surfaces show:						
1. Spalling or Scaling?						
2. Cracking?						
3. Erosion?						
4. Exposed reinforcement?						
c. Do joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
d. Do energy dissipaters show:						
1. Signs of deterioration?						
2. Covered with debris?						
3. Signs of inadequacy?						
12. OUTLET CHANNEL						
a. Describe:						
b. Eroding or backcutting?						
c. Sloughing?						
d. Obstructions or restrictions?						
e. Poorly riprapped?						
f. Tailwater elevation and flow condition:						

EMERGENCY SPILLWAY CHECKLIST

13. ENTRANCE CHANNEL						
a. Describe						
b. Eroding or backcutting?						

c. Sloughing?						
d. Restricted by vegetation?						
e. Obstructed with debris?						
f. Silted in?						
14. CONTROL SECTION						
a. Describe:						
b. *If concrete,* do surfaces show:						
1. Spalling or Scaling?						
2. Cracking?						
3. Erosion?						
4. Exposed reinforcement?						
c. *If concrete,* do joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
f. If spillway is *unlined*:						
1. Are slopes eroding?						
2. Are slopes sloughing?						
3. Is crest eroding?						
g. Is the control structure (i.e. weir, sill, etc.) in poor condition?						
15. DISCHARGE CHANNEL						
a. Describe:						
b. Obstructions or restrictions?						
c. *If concrete,* do surfaces show:						
1. Spalling or Scaling?						
2. Cracking?						
3. Erosion?						
4. Exposed reinforcement?						
d. *If concrete,* do joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
e. If spillway is *unlined*:						
1. Are slopes eroding?						
2. Are slopes sloughing?						
3. Poorly protected w/ vegetation/riprap?						
16. STILLING BASIN / ENERGY DISSIPATOR						
a. Describe:						
b. Do surfaces show:						
1. Spalling or Scaling?						
2. Cracking?						

3. Erosion?						
4. Exposed reinforcement?						
c. Do joints show:						
1. Displacement or offset?						
2. Loss of joint material?						
3. Leakage?						
d. Do energy dissipaters show:						
1. Signs of deterioration?						
2. Covered with debris?						
3. Signs of inadequacy?						
17. OUTLET CHANNEL						
a. Eroding or backcutting?						
b. Sloughing?						
c. Obstructions or restrictions?						

RESERVOIR CHECKLIST

18. RESERVOIR						
a. High water marks?						
b. Erosion/Slides into pool area?						
c. Sediment accumulation?						
d. Floating debris present?						
e. Depressions, sinkholes or vortices?						
f. Low ridges/saddles allowing overflow?						
g. Structures below dam crest elevation?						

ADDITIONAL COMMENTS AND RECOMMENDATIONS:

APPENDIX C

INSPECTION CHECKLIST

CASE 2: NEW JERSEY

Guidelines
for
Inspection of Existing Dams

New Jersey
Department of Environmental Protection
Dam Safety
Trenton, NJ 08625

March, 2004

Guide for the Inspection and Preparation of a Report on the Condition of a Dam

New Jersey Dam Safety Inspection Program

State law relating to the construction, repair, modification, and inspection of existing and proposed dams has been in existence since 1912. The law was amended in 1981 and cited as the Safe Dam Act, N.J.S.A. 58:4-1 et seq. The Dam Safety Standards N.J.A.C. 7:20-1 et seq. were promulgated in May 1985 **and *last readopted in May 2000.***

The New Jersey Dam Safety Program is implemented by the Department of Environmental Protection, Division of Engineering and Construction, Dam Safety Section. The objective of the program is to protect lives and property from the consequences of a dam failure or the improper release of impounded water. A primary means of achieving this goal is through the maintenance and periodic inspection of in-service dams.

The New Jersey Dam Safety inspection program is intended to identify conditions that may adversely affect the safety and functionality of a dam and its appurtenant structures; to note the extent of deterioration as a basis for long term planning, periodic maintenance or immediate repair; to evaluate conformity with current design and construction practices; and to determine the appropriateness of the existing hazard classification. The professional engineer performing the inspection should, where appropriate, recommend subsequent investigations required to resolve uncertain conditions and corrective measures to enable the dam to continue to perform its intended functions. ***For Class I and Class II dams, all addresses, e-mail, and phone numbers contained within the Emergency Action Plan must be verified and current. Inspection reports will be deemed incomplete without this information.***

Inspection Guidelines

The New Jersey Dam Safety inspection guidelines are designed to assist the dam owner to better understand the requirements, responsibilities, and duties inherent with dam ownership and to assist the professional engineer by providing a consistent approach to dam inspection and in-service evaluation.

Several different types of dam inspections can be performed. Dams and appurtenances should be inspected regularly to identify conditions that may adversely affect the safety of a dam and its ability to perform intended functions. An inspection may include the periodic evaluation of the as-built dam to insure conformity with current design and construction practices.

Dam Classifications

The State of New Jersey recognizes four (4) classes of dams. Class I dams are those structures which, should they fail, would likely cause loss of life. Class II dams are structures which, should they fail, would likely cause substantial downstream property damage but are not considered to be a threat to life. Class III dams are structures which would cause little or no downstream damage should they fail. Class IV dams are structures which are less than 15 feet in height, impound less than 15 acre feet of water to the top of dam, and drain less than 150 acres. No dam may be included in the Class IV category if failure of the dam could cause downstream property damage or loss of life.

When Should Dams be Inspected

Class I and Class II dam owners are required to have a regular inspection performed every two years and a formal inspection performed every six or ten years respectively. Class III and Class IV dam owners are required to have a regular inspection performed every four years but are not normally required to perform periodic formal inspections. On those years a formal inspection is performed, a regular inspection will not be required. All dams over 70 feet in height or which can potentially store more than 10,000 acre feet of water, regardless of hazard classification, are required to be inspected every year with a formal inspection conducted every third year. All dam inspections shall be performed from March through December.

Types of Inspections

Formal Inspection - The inspection and performance evaluation of Class I and Class II dams under the supervision of a qualified, New Jersey licensed professional engineer to review and determine the safety and integrity of the dam and appurtenant structures. Formal inspections require a detailed field examination and should include a thorough review of the records on project design, construction, and performance. Where appropriate, a reanalysis employing advanced methods and modern design criteria and practices should be conducted in order to determine if the structure meets current design criteria. In addition, formal inspections require that the long-term behavioral patterns revealed by instrumentation and spillway discharges be closely examined. Detailed underwater inspections should be included as needed. A Department approved Emergency Action Plan and Operation and Maintenance Manual should be confirmed and their adequacy determined. ***All addresses, e-mail, and phone numbers contained within the Emergency Action Plan must be verified and current. Inspection reports will be deemed incomplete without this information*** Technical experts and specialists may be required to evaluate individual features and conditions; however, a qualified New Jersey licensed professional engineer must make the final coordinated evaluation. A review of prior regular and formal inspection reports should be undertaken to evaluate trends in performance.

Regular Inspection - The visual inspection of a dam by a qualified, New Jersey licensed professional engineer to detect any signs of deterioration in material, developing weaknesses or unsafe hydraulic or structural behavior. For Class I and Class II dams, a Department approved Emergency Action Plan should be confirmed and its adequacy determined. ***All addresses, e-mail, and phone numbers contained within the Emergency Action Plan must be verified and current. Inspection reports will be deemed incomplete without this information*** For all dams a Department approved Operation and Maintenance Manual should be confirmed and its adequacy determined. All instrumentation data should be reviewed and evaluated.

Informal Inspection - The visual inspection of the dam by the dam owner or operator to detect apparent signs of deterioration or other deficiencies of the dam structure or function. Informal inspections require that personnel conducting the inspection be knowledgeable about the dam and its appurtenances.

Emergency Inspection - An emergency inspection is an unscheduled inspection of a dam and its appurtenances necessitated by a potentially adverse natural event such as a large flood, earthquake, landslide or when a condition develops that appears to immediately threaten the safety of the dam. An emergency inspection is applicable to any hazard classification and requires immediate attention. Any required emergency repairs resulting from the emergency inspection should be conducted in compliance with N.J.A.C. 7:20 - 1.4 (i).

Inspection Reports and Qualifications of Inspection Personnel

Formal and regular dam inspections must be performed by a qualified, professional engineer. The term "qualified engineer," as used in these standard guidelines is intended to mean an individual who:

1. Is a licensed New Jersey professional engineer.

2. Is competent in items related to dam investigation, design, construction, and operation for the type of dam being inspected.

3. Has at least 10 years of relevant experience in dam investigation, design, construction, operation, and evaluation.

4. Understands the effects of adverse dam incidents and failures and the potential cause of failures.

The text of the report on the condition of a dam should be concise and provide all relevant dam and dam related facts, findings, conclusions, analysis, recommendations, and data. ***For Class I and Class II dams, all addresses, e-mail, and phone numbers contained within the Emergency Action Plan must be verified and current. Inspection reports will be deemed incomplete without this information***. In addition, each report should contain clear, color photographs with each photograph indicating the date it was taken, the State dam reference number, and the photograph location. The visual inspection checklist, provided by the Department, should be completed and accompany all inspection reports. At the discretion of the Department, a completed visual inspection checklist, together with relevant color photographs and a completed NJ Dam Safety Compliance Schedule Form, will be considered the minimum information required for an acceptable inspection report.

Inspection reports for Class I, Class II and Class III dams should be submitted to the Department within 30 days of the completion of the inspection. Reports for Class IV dams are to be submitted to the county and/or municipality that has jurisdiction over the dam structure.

Informal inspections may be performed by the dam owner or operator and the resulting inspection report shall be part of the owner's or operator's permanent file. Unless specifically requested, informal inspection reports are not to be submitted to the Department. The Department may require the owner or operator of any dam to perform an inspection of any type at any time.

VISUAL INSPECTION CHECKLIST

This general checklist should be used as an aid when examining all dams. This checklist may not, however, include all features or conditions found at a specific dam that are relevant to the safety of that dam. All features integral to the safety of the dam being examined should be inspected and their condition reported.

NJ INSPECTION YEAR:

TYPE OF INSPECTION: (formal, regular, informal):

DAM NAME:

DAM FILE NO.:

LOCATION:

OWNER:

OPERATOR:

DATE OF INSPECTION:

RESERVOIR INFORMATION

Normal Reservoir Elevation (ft):

Reservoir Elevation at time of inspection (ft):

WEATHER CONDITIONS (including recent rainfall):

INSPECTION PERSONNEL

New Jersey Licensed Professional Engineer(s):

Name	Affiliation	Area of Expertise

Non-Licensed technical expert(s) and advisor(s):

Name	Affiliation	Area of Expertise

State Representative(s):

Name	Affiliation

Dam Owner Representative(s):

Name	Affiliation

Others:

Name	Affiliation

GENERAL INFORMATION

Name of Dam:

Fed. I.D. No. N.J. Dam No.:

River Basin:

Town: County:

Block: Lot:

Nearest Downstream City-Town:

Stream Name: Tributary of:

Latitude (N): Longitude (W):

Type of Dam:

Purpose of Dam:

Hazard Category: Drainage Area (sqr mls):

Height (ft): Length (ft):

Normal Surface (ac): Normal Capacity (af):

Maximum Capacity (af): Spillway Capacity (cfs):

HISTORY

Date Constructed: Dates(s) Reconstructed:

Designer: Constructed By:

Owner & Address:

Owner/Operator present during inspection (yes or no):

PREVIOUS INSPECTIONS (date of)

Last Inspection: Last Regular Inspection:

Phase I Inspection: Last Formal Inspection:

EMERGENCY ACTION PLAN (Required for all Class I and Class II dams)

Date of Approved Plan:

Date of Plan Revision:

Is the notification flowchart complete and current? ***(If the notification flow chart is not complete and current, all modifications, corrections, and additions must be made and replacement pages submitted with this report)***

Is inundation mapping or a description included?

Are emergency materials and equipment identified?

When was the plan last tested?

DOWNSTREAM HAZARD CLASSIFICATIONS

Present Hazard Classification:

Changes in Downstream Land Use and Habitation:

Is present classification appropriate?

OPERATION AND MAINTENANCE

Date of Operation and Maintenance Plan:

Are instructions adequate?

Do operating personnel follow instructions?

What are operating personnel capabilities?

EXAMINATION OF EMBANKMENT DAMS AND DIKES

DESCRIPTION OF STRUCTURE

Embankment Material:

Cutoff Type:

Impervious Core:

Internal Drainage System:

Movement (Horizontal and Vertical Alignment):

Junctions with Abutments or Embankments:

Miscellaneous:

CREST

Vertical Alignment:

Horizontal Alignment:

Surface Cracks:

Settlement:

Unusual Conditions:

UPSTREAM SLOPE

Slope (Estimate) (H:V):

Trees, Undesirable Growth or Debris, Animal Burrows:

Sloughing, Subsidence or Depressions:

Slope Protection:

Surface Cracks or Movement at Toe:

Unusual Conditions:

DOWNSTREAM SLOPE

Slope (Estimate) (H:V):

Trees, Undesirable Growth or Debris, Animal Burrows:

Sloughing, Subsidence or Depressions:

Surface Cracks or Movement at Toe:

Seepage:

External Drainage System (Ditches, Trenches, Blanket):

Condition Around Outlet Structure:

Unusual Conditions:

ABUTMENTS AND TOE AREA

Erosion at Contract:

Seepage or Wet Area Along Contract:

Signs of Movement:

Depressions, Sinkholes:

Unusual Conditions:

SEEPAGE AND TOE DRAIN / RELIEF WELL FLOW SUMMATION

Location	Estimated Flow	Color (Turbidity)

(Attach additional sheets for facilities with more than one embankment dam or dike)

EXAMINATION OF CONCRETE AND MASONRY DAMS

DESCRIPTION OF STRUCTURE

Type of Dam (Gravity, Arch, etc.):

Internal Drainage System:

Movement (Horizontal and Vertical Alignment):

Miscellaneous:

UPSTREAM FACE

Condition of Concrete or Masonry:

Cracking:

Location	Orientation	Length	Width	Type

DOWNSTREAM FACE

Condition of Concrete or Masonry:

Cracking:

Location	Orientation	Length	Width	Type

Leakage Through Dam (Location and Estimated Flow):

CREST

Condition of Concrete or Masonry:

Cracking

Location	Orientation	Length	Width	Type

Signs of Movement:

Differential Movement (Joint or Crack Separation or Offset):

GALLERIES

Cracking

Location	Orientation	Length	Width	Type

Differential Movement (Joint or Crack Separation):

Leakage into Galleries (Location and Estimated Flow):

Condition of Gallery Drains:

FOUNDATION

Condition of Rock or Concrete Lining:

Cracking:

Signs of Movement:

Seepage (Location and Estimated Flow):

ABUTMENTS AND TOE AREA

Seepage or Wet Areas:

Signs of Movement:

Cracking:

Erosion:

Unusual Conditions:

(Attach additional sheets for facilities with more than one concrete or masonry dam or dike)

EXAMINATION OF SPILLWAYS AND OUTLET WORKS

TYPE(S) AND DESCRIPTION OF SPILLWAY(S)

Primary:

Secondary (auxiliary):

Emergency:

Other:

FOR EACH SPILLWAY THE FOLLOWING ASPECTS MUST BE EXAMINED WHERE APPROPRIATE

ENTRANCE CHANNEL

Description:

Vegetation (Trees, Bushes):

Debris:

Channel Side-Slope Stability:

Slope Protection/Erosion:

Unusual Conditions:

SPILLWAY CREST

Description:

Condition of Material:

Signs of Movement:

Joints:

Unusual Conditions:

DROP BOX

Description:

Condition of Material:

Signs of Movement:

Joints:

Floor:

Unusual Conditions:

SPILLWAY WING WALLS

Description:

Condition of Material:

Signs of Movement:

Joints:

Drains:

Unusual Conditions:

DOWNSTREAM APRON

Description:

Condition of Material:

Signs of Movement:

Unusual Conditions:

CULVERTS

Description:

Condition of Material:

Joints:

Signs of Movement:

Seepage:

Location	Estimated Flow	Turbidity

Unusual Conditions:

TRASH RACKS

Description:

Condition of Material:

Unusual Conditions:

CHUTES

Description:

Condition of Material:

Signs of Movement:

Unusual Conditions:

STILLING BASIN

Description:

Condition of Material:

Signs of Movement:

Erosion:

Unusual Conditions:

EXIT CHANNEL

Vegetation (Trees, Bushes):

Debris:

Channel Side-Slope Stability:

Erosion:

Unusual Conditions:

LOW LEVEL OUTLET

Description:

Condition:

Trash Rack:

Leakage:

Location	Estimated Flow

Unusual Conditions:

Was the low level outlet operated during the inspection?

Were there difficulties operating the low level outlet?

When was the low level outlet last operated and did this conform with the Operation and Maintenance procedures?

Miscellaneous:

STILLING BASIN FOR LOW LEVEL OUTLET

Description:

Condition of Material:

Signs of Movement:

Erosion:

Unusual Conditions:

EXIT CHANNEL FOR LOW LEVEL OUTLET

Description (Trees, Bushes):

Debris:

Channel Side-Slope Stability:

Slope Protection Erosion:

Unusual Conditions:

EXAMINATION OF OTHER FEATURES

INSTRUMENTATION (Monumentation/Surveys, Observation Wells, Weirs, Piezometers, Etc.) location, condition:

(A separate report including instrument readings, condition of instruments, observations, and conclusions based upon the collected data should be attached.)

RESERVOIR

Slopes:

Sedimentation:

Unusual Conditions Which Affect Dam:

Unusual Conditions:

APPURTENANT STRUCTURES (Power House, Gatehouse, Penstocks, Water Supply, Other)

Description and Condition of each:

CONCLUSION

I certify that the above dam was personally inspected by me and was found to be in:

☐ **Safe** ☐ **Unsafe** condition (check one).

The following studies should be undertaken:	☐ Hydrologic and Hydraulic analysis ☐ Stability analysis ☐ Failure/Inundation analysis ☐ Other _____ ☐ None

I recommend the following repairs be made immediately:

The following long term improvements should also be undertaken:

Have the recommendations above included those from the Phase I Inspection Report or previous Regular or Formal Inspection Reports? If not, indicate why.

Does the Emergency Action Plan require revisions?

Do the Operation and Maintenance Procedures require revisions?

Has the NJ Dam Safety Compliance Schedule Form (attached) been completed? (This form must be completed or the Inspection Report will be deemed incomplete.)

Name of Professional Engineering Company/Consultant Representing the Owner:

Company/Consultant Address:

Company/Consultant Telephone Number:

New Jersey Licensed Professional Engineer representing the dam owner in responsible charge of the inspection:

Sign _____ Date _____

New Jersey Professional Engineer License Number_____

SEAL

New Jersey Dam Safety Compliance Schedule Form

Dam Name: _____ **File No:** _____	**Owner:** _____ **Address:** _____ **Address:** _____ **Address:** _____ **Phone:** _____ **Email:** _____	**Owners Engineering Firm:** **Name:** _____ **Address:** _____ **Address:** _____ **Address:** _____ **Phone:** _____

The purpose of this form is to allow the dam owner, through consultation with their engineer, to establish a time line for addressing the deficiencies identified in the inspection report for the dam and bringing the dam into compliance with the New Jersey Dam Safety Standards, N.J.A.C. 7:20-1.1 et seq.

Proposed time frame for submission of required information and implementation of recommended repairs:

(Engineer should check required sections and propose appropriate time frames. However, the Dam Safety Section reserves the right to require additional dates and/or information as needed.)

❑ **Performance of maintenance and repairs not requiring approval from the Dam Safety Section** (Such work includes grass mowing, brush removal, debris removal, filling of animal burrows, minor concrete repairs, minor gate repairs, filling of areas of minor surface erosion, etc. The Dam Safety Section must be notified upon completion of these activities.)

Work to be completed no later than: _____

❑ **Engineering Report / Studies** (This work includes any required hydrologic and hydraulic analysis, structural analysis, alternative analysis, geotechnical investigations or dam breach analysis that may be recommended by your engineer and/or required by the Dam Safety Section.)

Studies to be submitted for review no later than: _____

❑ **Permit Application:** (A permit application must be submitted for any construction activity at the dam. The permit application must address all deficiencies as identified in the inspection report and the subsequent engineering report / studies.)

Permit application to be submitted no later than _____ months after the date of the Dam Safety Section's approval of any required studies. (Please provide date if no studies are required.)

❑ **Construction to start no later than _____ months after the date of issuance of the permit by the Dam Safety Section.**

❑ **Operation and Maintenance Plan (O&M):** (An O&M is required for all dams. O&M's should be submitted with the permit application or sooner if possible. Existing O&M's may need to be updated if a dam is being rehabilitated. Please indicate if an O&M has already been submitted and approved.)

O&M to be submitted no later than: _____

❑ **Emergency Action Plan (EAP):** (EAPs are required for all high and significant hazard dams and should be submitted as soon as possible. Existing EAPs should be reviewed on a yearly basis and revised as necessary. Please indicate if an EAP has already been submitted and approved.)

EAP to be submitted no later than: _____

The dates provided above will be reviewed by the Dam Safety Section to determine if the schedule is acceptable to achieve compliance with the Dam Safety Standards. Requests for extensions to the accepted time frames outlined above must be submitted to this office in writing along with appropriate justification and will be considered on its merits on a case by case basis.

_____ _____ _____ _____

Signed: Dam Owner **Date** **Signed: Owner's Engineer** **Date**

Additional information including Dam Safety Section forms, standards and inspection guidelines as well and EAP guidelines and a sample O&M is available at http://www.state.nj.us/dep/damsafety or contact this office via e-mail at Damsafety@dep.state.nj.us or telephone at (609)984-0859. Please submit the completed form to: NJDEP, Dam Safety Section, P.O. Box 419, Trenton, NJ 08625

APPENDIX C

INSPECTION CHECKLIST

CASE 3: COLORADO

ENGINEERS INSPECTION REPORT

OFFICE OF THE STATE ENGINEER-DIVISION OF WATER RESOURCES - DAM SAFETY BRANCH
1313 Sherman Street, Room 818, Denver, CO 80203, (303) 866-3581

DAM NAME _____ W. DIV. _____ W. DIST. _____ DATE OF INSPECTION ___/___/___

DAM ID _____ FILE NO. C- _____ FOREST I.D. _____ DATE OF LAST INSPECTION ___/___/___

OWNER NAME _____ OWNER PHONE _____

ADDRESS _____ ZIP CODE _____

CONTACT NAME _____ CONTACT PHONE _____

CLASS _____ CAPACITY _____ AF SURFACE AREA _____ AC. HEIGHT _____ FT. CREST LENGTH _____ FT CREST WIDTH _____ FT.

CURRENT RESTRICTION ☐ (NO) ☐ (YES) LEVEL _____ EPP ON FILE ☐ (NO) ☐ (YES) SPWY WIDTH _____ FT. FBD. _____ FT. Z _____

INSPECTION PARTY REPRESENTING _____ _____ _____

DIRECTIONS: MARK AN **X** FOR CONDITIONS FOUND **AND** UNDERLINE WORDS THAT APPLY. GIVE LOCATION AND EXTENT WITH NUMBER REFERENCE I.E. (25) ALL ALONG SLOPE, OR SHOW IT ON SKETCH.

FIELD CONDITIONS OBSERVED

WATER LEVEL - BELOW DAM CREST _____ FT., BELOW SPILLWAY _____ FT., GAGE ROD _____

GROUND MOISTURE CONDITION: DRY _____ WET _____ SNOWCOVER _____ OTHER _____

UPSTREAM SLOPE

PROBLEMS NOTED: ☐ (0) NONE ☐ (1) RIPRAP - MISSING, SPARSE, DISPLACED, WEATHERED ☐ (2) WAVE EROSION-WITH SCARPS
☐ (3) CRACKS-WITH DISPLACEMENT ☐ (4) SINKHOLE ☐ (5) APPEARS TOO STEEP ☐ (6) DEPRESSIONS OR BULGES ☐ (7) SLIDES
☐ (8) CONCRETE FACING-HOLES, CRACKS, DISPLACED, UNDERMINED ☐ (9) OTHER _____
Comments: _____

CREST

PROBLEMS NOTED: ☐ (10) NONE ☐ (11) RUTS OR PUDDLES ☐ (12) EROSION ☐ (13) CRACKS - WITH DISPLACEMENT ☐ (14) SINKHOLES
☐ (15) NOT WIDE ENOUGH ☐ (16) LOW AREA ☐ (17) MISALIGNMENT ☐ (18) INADEQUATE SURFACE DRAINAGE
☐ (19) OTHER _____
Comments: _____

DOWNSTREAM SLOPE

PROBLEMS NOTED: ☐ (20) NONE ☐ (21) LIVESTOCK DAMAGE ☐ (22) EROSION OR GULLIES ☐ (23) CRACKS - WITH DISPLACEMENT ☐ (24) SINKHOLE
☐ (25) APPEARS TOO STEEP ☐ (26) DEPRESSION OR BULGES ☐ (27) SLIDE ☐ (28) SOFT AREAS ☐ (29) OTHER _____
Comments: _____

SEEPAGE

PROBLEMS NOTED: ☐ (30) NONE ☐ (31) SATURATED EMBANKMENT AREA ☐ (32) SEEPAGE EXITS ON EMBANKMENT
☐ (33) SEEPAGE EXITS AT POINT SOURCE ☐ (34) SEEPAGE AREA AT TOE ☐ (35) FLOW ADJACENT TO OUTLET ☐ (36) SEEPAGE INCREASED/MUDDY
DRAIN OUTFALLS SEEN ___No ___Yes ☐ (37) FLOW INCREASED/MUDDY ☐ (38) DRAIN DRY/OBSTRUCTED
☐ (39) OTHER _____ Show location of drains on sketch and indicate amount and quality of discharge.
Comments: _____

OUTLET

PROBLEMS NOTED: ☐ (40) NONE ☐ (41) NO OUTLET FOUND ☐ (42) POOR OPERATING ACCESS ☐ (43) INOPERABLE
☐ (44) UPSTREAM OR DOWNSTREAM STRUCTURE DETERIORATED ☐ (45) OUTLET NOT OPERATED DURING INSPECTION
INTERIOR INSPECTED ☐ (120) NO ☐ (121) YES ☐ (46) CONDUIT DETERIORATED OR COLLAPSED ☐ (47) JOINTS DISPLACED ☐ (48) VALVE LEAKAGE
☐ (49) OTHER _____
Comments: _____

SPILLWAY

PROBLEMS NOTED: ☐ (50) NONE ☐ (51) NO EMERGENCY SPILLWAY FOUND ☐ (52) EROSION-WITH BACKCUTTING ☐ (53) CRACK - WITH DISPLACEMENT
☐ (54) APPEARS TO BE STRUCTURALLY INADEQUATE ☐ (55) APPEARS TOO SMALL ☐ (56) INADEQUATE FREEBOARD ☐ (57) FLOW OBSTRUCTED
☐ (58) CONCRETE DETERIORATED/UNDERMINED ☐ (59) OTHER _____
Comments: _____

Conditions Observed

	GOOD	ACCEPTABLE	POOR
UPSTREAM SLOPE			
CREST			
DOWNSTREAM SLOPE			
SEEPAGE			
OUTLET			
SPILLWAY			

See Guidelines on Back of this Sheet

DC185a-85

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, OUTLET, SPILLWAY

GOOD	ACCEPTABLE	POOR
In general, this part of the structure has a near new appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD	ACCEPTABLE	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in seepage. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Seepage conditions observed appear to threaten the safety of the dam. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment, i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MONITORING

GOOD	ACCEPTABLE	POOR
Monitoring includes movement surveys and leakage measurements for all dams, and piezometer readings for Class I dams. Instrumentation is in reliable, working condition. A plan for monitoring the instrumentation and analyzing results by the owner's **engineer** is in effect. Periodic inspections by owner's engineer.	Monitoring includes movement surveys and leakage measurements for Class I & II dams; leakage measurements for Class III dams. Instrumentation is in serviceable condition. A plan for monitoring instrumentation is in effect by **owner**. Periodic inspections by owner or representative. OR, NO MONITORING REQUIRED.	All instrumentation and monitoring described under "ACCEPTABLE" here for each class of dam, are not provided, or required periodic readings are not being made, or unexplained changes in readings are not reacted to by the owner.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Dam does not appear to receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam.

OVERALL CONDITIONS

SATISFACTORY	CONDITIONALLY SATISFACTORY	UNSATISFACTORY
The safety inspection indicates no conditions that appear to threaten the safety of the dam, and the dam is expected to perform satisfactorily under all design loading conditions. Most of the required monitoring is being performed.	The safety inspection indicates symptoms of *possible* structural distress (seepage, evidence of minor displacements, etc.), which, if conditions worsen, *could* lead to the failure of the dam. Essential monitoring, inspection, and maintenance must be performed as a requirement for continued full or reduced storage in the reservoir.	The safety inspection indicates *definite* signs of structural distress (excessive seepage, cracks, slides, sinkholes, severe deterioration, etc.), which *could* lead to the failure of the dam if the reservoir is used to full capacity. The dam is judged unsafe for full storage of water.

SAFE STORAGE LEVEL

FULL STORAGE	CONDITIONAL FULL STORAGE	RESTRICTION
Dam may be used to full capacity with no conditions attached.	Dam may be used to full storage if certain monitoring, maintenance, or operational conditions are met.	Dam may not be used to full capacity, but must be operated at some reduced level in the interest of public safety.

CLASSIFICATION OF DAMS

CLASS I	CLASS II	CLASS III
Class I - Loss of human life is expected in the event of failure of the dam, while the reservoir is at the high water line.	Class II - Significant damage to improved property is expected in the event of failure of the dam while the reservoir is at the high water line, but no loss of human life is expected.	Class III - Loss of human life is not expected, and damage to improved property is expected to be small, in the event of failure of the dam while the reservoir is at high water line.

DAM NAME: _____ DAM I.D.: _____ DATE ___/___/___

MONITORING

EXISTING INSTRUMENTATION FOUND ☐ (110) NONE ☐ (111) GAGE ROD ☐ (112) PIEZOMETERS ☐ (113) SEEPAGE WEIRS/FLUMES

☐ (114) SURVEY MONUMENTS ☐ (115) OTHER _____

MONITORING OF INSTRUMENTATION: ☐ (116) NO ☐ (117) YES PERIODIC INSPECTIONS BY: ☐ (118) OWNER ☐ (119) ENGINEER

Comments: _____

GOOD ☐ ACCEPTABLE ☐ POOR ☐ **MONITORING**

MAINTENANCE AND REPAIR

PROBLEMS NOTED: ☐ (60) NONE ☐ (61) ACCESS ROAD NEEDS MAINTENANCE ☐ (62) CATTLE DAMAGE

☐ (63) BRUSH ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (64) TREES ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE

☐ (65) RODENT ACTIVITY ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (66) DETERIORATED CONCRETE-FACING, OUTLET, SPILLWAY

☐ (67) GATE AND OPERATING MECHANISM NEED MAINTENANCE ☐ (68) OTHER _____

Comments: _____

GOOD ☐ ACCEPTABLE ☐ POOR ☐ **MAINTENANCE AND REPAIRS**

OVERALL CONDITIONS

REMARKS: _____

Based on this Safety Inspection and recent file review, the overall condition is determined to be:

☐ 71 SATISFACTORY ☐ 72 CONDITIONALLY SATISFACTORY ☐ 73 UNSATISFACTORY

OVERALL CONDITIONS

ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE - MINOR REPAIR - MONITORING

☐ (80) PROVIDE ADDITIONAL RIPRAP: _____

☐ (81) LUBRICATE AND OPERATE OUTLET GATES THROUGH FULL CYCLE: _____

☐ (82) CLEAR TREES AND/OR BRUSH FROM: _____

☐ (83) INITIATE RODENT CONTROL PROGRAM AND PROPERLY BACKFILL EXISTING HOLES: _____

☐ (84) GRADE CREST TO A UNIFORM ELEVATION WITH DRAINAGE TO THE UPSTREAM SLOPE: _____

☐ (85) PROVIDE SURFACE DRAINAGE FOR: _____

☐ (86) MONITOR: _____

☐ (87) DEVELOP AND SUBMIT AN EMERGENCY PREPAREDNESS PLAN. _____

☐ (88) OTHER: _____

☐ (89) OTHER: _____

ENGINEERING - EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO: (Plans & Specification must be approved by State Engineer prior to construction.)

☐ (90) PREPARE PLANS AND SPECIFICATIONS FOR THE REHABILITATION OF THE DAM: _____

☐ (91) PREPARE AS-BUILT DRAWINGS OF: _____

☐ (92) PERFORM A GEOTECHNICAL INVESTIGATION TO EVALUATE THE STABILITY OF THE DAM: _____

☐ (93) PERFORM A HYDROLOGIC STUDY TO DETERMINE REQUIRED SPILLWAY SIZE: _____

☐ (94) PREPARE PLANS AND SPECIFICATIONS FOR AN ADEQUATE SPILLWAY: _____

☐ (95) SET UP A MONITORING SYSTEM INCLUDING WORK SHEETS, REDUCED DATA AND GRAPHED RESULTS: _____

☐ (96) PERFORM AN INTERNAL INSPECTION OF THE OUTLET: _____

☐ (97) OTHER: _____

☐ (98) OTHER: _____

☐ (99) OTHER: _____

The State Engineer, by providing this dam safety inspection report, does not assume responsibility for any unsafe condition of the subject dam. The sole responsibility for the safety of this dam rests with the reservoir owner or operator, who should take every step necessary to prevent damages caused by leakage or overflow of waters from the reservoir or floods resulting from a failure of the dam.

SAFE STORAGE LEVEL RECOMMENDED AS A RESULT OF THIS INSPECTION

☐ (101) FULL STORAGE

☐ (102) CONDITIONAL FULL STORAGE

☐ (103) RECOMMENDED RESTRICTION → RESTRICTED LEVEL OFFICIAL ORDER TO FOLLOW

- _____ FT. BELOW DAMS CREST
- _____ FT. BELOW SPILLWAY CREST
- _____ FT. GAGE HEIGHT
- _____ NO STORAGE-MAINTAIN OUTLET FULLY OPEN
- _____ _____

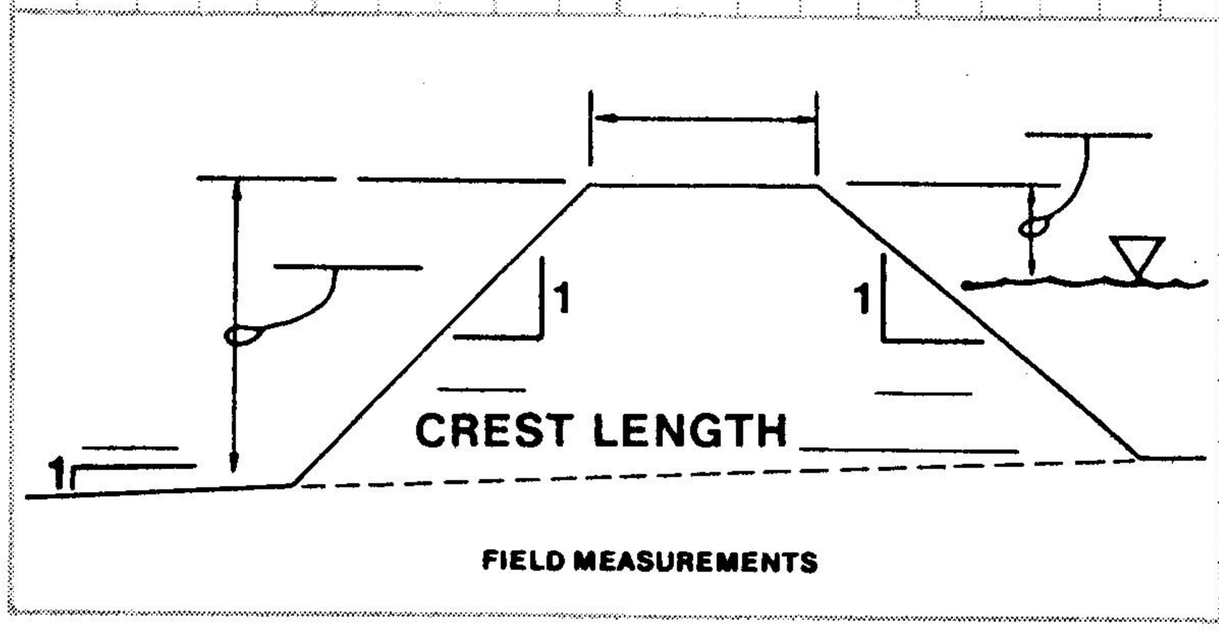
REASON FOR RESTRICTION: _____

ACTIONS REQUIRED FOR CONDITIONAL FULL STORAGE OR CONTINUED STORAGE AT THE RESTRICTED LEVEL: _____

Engineer's Signature _____ INSPECTED BY

Owner's Signature _____ OWNER/OWNER'S REPRESENTATIVE DATE: ___/___/___

DAM NAME _____ DAM ID _____ DATE ___/___/___



FIELD MEASUREMENTS

APPENDIX C

INSPECTION CHECKLIST

CASE 4: PENNSYLVANIA

Fact Sheet

Commonwealth of Pennsylvania • Department of Environmental Protection

DAM INSPECTIONS BY OWNERS

Although all Hazard Potential Category 1 or 2 (i.e., "High Hazard") dams must be inspected annually by a registered professional engineer, dam owners in Pennsylvania are required to inspect their dam(s) at least once every three months. A manual entitled *The Inspection, Maintenance and Operation of Dams in Pennsylvania* is available upon request from the Division of Dam Safety.

The Inspection

It is helpful to prepare an inspection route in advance to assure that every part of the dam will be observed. The following is a recommended sequence to assist you in your inspection:

CREST - Walk across the crest from abutment to abutment.

UPSTREAM/DOWNSTREAM SLOPE - Walk across the slope in an up and down or zigzag pattern from abutment to abutment.

EMBANKMENT-ABUTMENT CONTACTS - Walk the entire length of the embankment-abutment contacts (groin).

OUTLET CONDUIT - Observe all accessible features of the outlet conduit.

SPILLWAY - Walk along the entire length of the spillway in a back and forth manner.

ABUTMENTS - Traverse abutments in a practical manner so as to gain a general feel for the conditions which exist along the valley sidewalls.

DOWNSTREAM CHANNEL - Travel the route of the stream below the dam to maintain familiarity with locations of residences and property which can be affected by dam failure.

DOWNSTREAM TOE - Walk the entire length of the downstream toe.

RESERVOIR SLOPES - Scout the reservoir perimeter in an effort to develop an overall familiarity with its conditions.

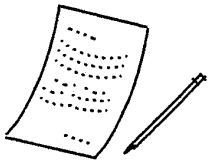
What To Look For

The following is a partial list of some of the conditions a dam owner may discover. This list does not cover all of the problems which may be encountered.

SETTLEMENT	STRUCTURAL CRACKING	EROSION
SINKHOLES	ANIMAL BURROWS	DEPRESSIONS
SEEPS	EXCESSIVE VEGETATION	BOILS
TURBID DISCHARGE	FOUNDATION MOVEMENT	VANDALISM

Keeping Records

It is important for the dam owner/operator to keep records throughout the existence of the dam. Accurate records can better illustrate the dynamic nature of the structure.



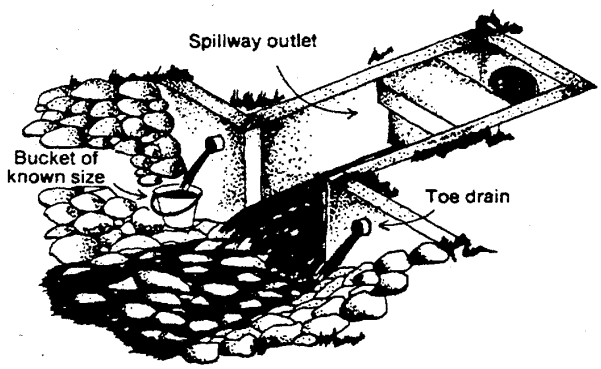
DEP requires the dam owner to establish a permanent file to retain inspection records including records of actions taken to correct conditions found in such inspections. The following items will aid the dam owner/operator in keeping good records.

Inspection Checklist - A convenient way of compiling inspection observations is by recording them directly onto an inspection checklist. The checklist should be attached to a clipboard and carried by the dam inspector as he/she traverses the entire structure. Copies of the checklist can be obtained by contacting DEP.

A good practice to follow along with filling out the inspection checklist is to draw a field sketch of observed conditions. The field sketch is intended to supplement the information recorded on the inspection checklist, however, it should never be used as a substitute for clear and concise inspection checklists.

Photographs - Inspection photographs can be vitally important. Over time, photographs serve to provide a pictorial history of the evolving characteristics of a dam. The dam owner/operator often finds them to be great money savers because they can illustrate that some observed conditions (seepage, foundation movement, etc.) have existed for many years and may have reached a state of equilibrium. With this knowledge, quick and economical remedial actions can be developed and implemented. Photographs should be dated on the back and provided with brief descriptions of the locations shown in the pictures.

Monitoring Data - As previously indicated, it may become necessary to make measurements of various items during the course of a dam inspection. This may include measurements of seepage rates, spillway discharge rates, settlement, and for some dam owners, readings from instruments such as piezometers. It is important that this data also be compiled in a systematic manner and placed in a permanent file.



Accompany Your Engineer During Annual Inspections

Many engineers encourage dam owners or operators to accompany them, or even assist them, on annual dam inspections. Also, many owners accompany department engineers during our periodic inspections. Owners can learn many things from experienced inspectors such as:

- What to look for;
- How to photograph certain features of a dam;
- What records to keep; and
- How to read different types of instrumentation.

For more information contact:

Department of Environmental Protection
Bureau of Waterways Engineering
Division of Dam Safety
P.O. Box 8554
Harrisburg, PA 17105-8554
(717) 787-8568

For more information, visit DEP's Web site at www.depweb.state.pa.us, Keyword: "Dam Safety."

APPENDIX H

SAMPLE DATABASE FIELDS

DESCRIPTIONS & DEFINITIONS
of Fieldnames

From National Inventory of Dams Field Definitions

Record
Assigned by TEC.

Dam Name
Official name of the dam. No abbreviations used unless a part of the official name. For dams that do not have an official name, the popular name is used.

Other Dam Names
Reservoir name or names in common use other than the official name of the dam. Names are separated with semi-colons. Leave blank if not applicable.

Dam Former Name
Any previous reservoir or dam name(s), if changed. Names are separated with semi-colons.

State or Federal Agency ID
Official State or Agency identification number for the dam.

NID ID
The official NID identification number for the dam, known formerly as the National ID. This is a required field, and must have an entry for each dam included in the NID. This field is used as the unique identifier for each dam record. The first two characters of the identity are the state two-letter abbreviation, based on the location of the dam. The last five characters of the identity are a unique number (AB######).

The NID ID is the Corps Identification Number assigned to each dam in the 1995-96 NID update, under the National Dam Inspection Program (P.L. 92-367). Once assigned, this number should be not changed. However, the following guidelines are provided for assignment of ID numbers for new dams. Each new dam will be assigned an NID ID number by the state or federal coordinator. *NID ID numbers will not be reused.* If a dam is retired or is otherwise not longer in existence, that ID number is retired. The state coordinator is responsible for assigning ID numbers for all dams, regardless of ownership. The numbers may not necessarily be continuous, because of a previously established scheme which assigned certain number ranges to federal agencies. Continued use of this numbering scheme for new dams is at the discretion of the state coordinator. Please contact ASDSO or USACE Dam Safety Team for further information

on the process of assigning NID ID numbers or if an alternative number sequence is necessary to meet the needs of the state.

Longitude
Longitude at dam centerline as a single value in decimal degrees.

Latitude
Latitude at dam centerline as a single value in decimal degrees.

Section, Township, Range Location
Dam location in terms of Section, Township, and Range. Meridian location is included if it is needed to locate the dam. (Optional field)

County
Name of the county in which the dam is located.

River or Stream
Official name of the river or stream on which the dam is built. If the stream is unnamed, it is identified as a tributary ("TR") to the named river. If the dam is located offstream, the name of the river or stream is entered plus "-OS" or "OFFSTREAM".

Nearest City/Town
Name of the nearest city, town, or village that is most likely to be affected by floods resulting from the failure of the dam.

Distance to Nearest City/Town
Distance from the dam to the nearest affected City/Town/Village, to the nearest mile (and tenth if appropriate).

Owner Name
Name of the owner of the dam.

Owner Type
Code indicating owner type:
F for Federal;
S for State;
L for Local Government;
U for Public Utility;
P for Private.

Dam Designer-----New field
Name of the principal firm(s) or agency accomplishing design of dam and major

appurtenant operating features, and major modifications. The original designer is listed first then modification designers (if applicable). The names are separated with semi-colons.

Private Dam On Federal Property
Code indicating whether the dam is a private dam located on federal property:
Y for Yes;
N for No.

Dam Type
Code indicating the type of dam (in order of importance): RE for Earth;
ER for Rockfill;
PG for Gravity;
CB for Buttress;
VA for Arch;
MV for Multi-Arch;
CN for Concrete;
MS for Masonry;
ST for Stone;
TC for Timber Crib;
OT for Other.

Codes are concatenated if the dam is a combination of several types. For example, the entry *CNCB* would indicate a concrete buttress dam type.

Core-----New field
Code indicating the position, type of watertight member and certainty.
Position:
F for upstream facing;
H for homogeneous dam;
I for core;
X for unlisted/unknown;

Type: A for bituminous concrete;
C for concrete;
E for earth;
M for metal;
P for plastic;
X for unlisted/unknown;

Certainty:
K for known;
Z for estimated;

Foundation-----New field
Code for the material upon which dam is founded, and certainty.
Foundation:

R for rock;
RS for rock and soil;
S for soil;
U for unlisted/unknown.

Certainty:
K for known;
Z for estimated.

Purposes
Codes indicating the purposes for which the reservoir is used:
I for Irrigation;
H for Hydroelectric;
C for Flood Control and Storm Water Management;
N for Navigation;
S for Water Supply;
R for Recreation;
P for Fire Protection, Stock, Or Small Farm Pond;
F for Fish and Wildlife Pond;
D for Debris Control;
T for Tailings;
O for Other.

The order indicates the relative decreasing importance of the purpose. Codes are concatenated if the dam has multiple purposes. For example, *SCR* would indicate the primary purposes, *Water Supply* and *Flood Control and Storm Water Management,* followed by *Recreation.*

Year Completed
Year when the original main dam structure was completed, optionally followed by code ("E") to indicate an estimated date. If unknown, and reasonable estimate is unavailable, "0000" will be used.

Year Modified-----New field
Year (four digit) when major modifications or rehabilitation of dam or major control structures were completed. Major modifications are defined as a structural, foundation, or mechanical construction activity which significantly restores the project to original condition; changes the project's operation; capacity or structural characteristics (e.g. spillway or seismic modification); or increases the longevity, stability, or safety of the dam and appurtenant structures. Entries should be followed by *one of more of the following codes* indicating type of modification:
S for structural;
F for foundation;
M for mechanical;
E for seismic;
H for hydraulic;
O for other.

Up to ten modifications can be entered, separated by semicolons.

Dam Length
Length of the dam, in feet, which is defined as the length along the top of the dam. This length also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam, these structures should not be included.

**** Because the "height of dam" definition used by each of the participating State and Federal agencies varies, three different height fields are provided in the NID database. Each agency is requested to enter values for the height field item(s) that most closely correspond to the height of the dam definition(s) used by the agency. Height field items #24-26 that do not correspond to agency data maybe left blank****

Dam Height
Height of the dam, in feet to the nearest foot, which is defined as the vertical distance between the lowest point on the crest of the dam and the lowest point in the original streambed.

Structural Height
Structural height of the dam, in feet to the nearest foot, which is defined as the vertical distance from the lowest point of the excavated foundation to the top of the dam.

Hydraulic Height
Hydraulic height of the dam, in feet to the nearest foot, which is defined as the vertical difference between the maximum design water level and the lowest point in the original streambed.

NID Height
A calculated field based on the maximum value of field items #25 Dam Height, #26 Structural Height, and #27 Hydraulic Height, providing a single height value to facilitate database queries.

Maximum Discharge
Number of cubic feet per second (cu ft/sec) which the spillway is capable of discharging when the reservoir is at its maximum designed water surface elevation.

Maximum Storage
Maximum storage, in acre-feet, which is defined as the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.

Normal Storage
Normal storage, in acre-feet, which is defined as the total storage space in a reservoir below the normal retention level, including dead and inactive storage and excluding any flood control or surcharge storage.

NID Storage
A calculated field based on the maximum value of field items #30 Maximum Storage and #31 Normal storage, providing a single storage value to facilitate database queries.

Surface Area
Surface area, in acres, of the impoundment at its normal retention level.

Drainage Area
Drainage area of the dam, in square miles, which is defined as the area that drains to a particular point (in this case, the dam) on a river or stream.

Downstream Hazard Potential
Code indicating the potential hazard to the downstream area resulting from failure or misoperation of the dam or facilities:
L for Low;
S for Significant;
H for High.

Definitions, as accepted by the Interagency Committee on Dam Safety, are as follows:

1. LOW HAZARD POTENTIAL
Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.

2. SIGNIFICANT HAZARD POTENTIAL
Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environment damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.

3. HIGH HAZARD POTENTIAL
Dams assigned the high hazard potential classification are those where failure or misoperation will probably cause loss of human life.

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner

Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)

Emergency Action Plan
Code, indicating whether the dam has an Emergency Action Plan (EAP) developed by the dam owner. An EAP is defined as a plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood.

Y for Yes;
N for No;
NR for Not Required by submitting agency.

Inspection Date
Date of the most recent inspection of the dam prior to the transmittal of the data by the submitting agency. Date fields require day, month and year information, and various alphanumeric or numeric combinations are used.

Inspection Frequency---New Field
Scheduled frequency interval for periodic inspections, in years. NOTE: Replacement for "Phase I Inspection" field.

State Regulated Dam---New Field
Code indicating whether the dam is "State Regulated" under the National Dam Safety Program Act:
Y for Yes;
N for No.

A "State Regulated Dam" is defined as a dam meeting the NID criteria for which the State executes one or more of the following general responsibilities: (a) Inspection; (b) Enforcement; or (c) Permitting.

State Regulatory Agency
Name of the primary state agency with regulatory or approval authority over the dam.

****NOTE: Following four fields are optional submissions for states****

Spillway Types
Code that describes the type of spillway:
C for Controlled;
U for Uncontrolled;
N for None.

Spillway Width
Width of the spillway, to the nearest foot, available for discharge when the reservoir is at its maximum designed water surface elevation.

Outlet Gates---New Field
Code(s) that describe the type of spillway and controlled outlet gates, if any:
X for None;
U for Uncontrolled;
T for Tainter (radial);
L for Vertical Lift;
R for Roller;
B for Bascule;
D for Drum;
N for Needle;
F for Flap;
S for Slide (sluice gate);
V for Valve;
O for Other controlled.

Enter up to five types in decreasing size order, separated by semicolons, followed by number of gates.

Volume of Dam
Total number of cubic yards occupied by the materials used in the dam structure. Portions of powerhouse, locks, and spillways are included only if they are an integral part of the dam and required for structural stability.

****** NOTE: The remaining fields are federal submissions only ******

Number of Locks
Number of existing navigation locks for the project.

Length of Locks
Length of the primary navigation lock to the nearest foot.

Lock Width
Width of the primary navigation lock to the nearest foot.

****** NOTE: See Table below for required codes for the following fields******

Federal Agency Involvement in Funding
Code identifying which federal agency was involved in funding of the dam. Codes are concatenated if several agencies were involved.

Federal Agency Involvement in Design
Code identifying which federal agency was involved in the design of the dam. Codes are concatenated if several agencies were involved.

Federal Agency Involvement in Construction
Code identifying which federal agency was involved in the construction of the dam. Codes are concatenated if several agencies were involved.

Federal Agency Involvement in Regulatory
Code identifying which federal agency is involved in the regulation of the dam. Codes are concatenated if several agencies are involved.

Federal Agency Involvement in Inspection
Code identifying which federal agency is involved in the inspection of the dam. Codes are concatenated if several agencies are involved.

Federal Agency Involvement in Operation
Code identifying which federal agency is involved in the operation of the dam. Codes are concatenated if several agencies are involved.

Federal Agency Owner
Code identifying which federal agency partly or wholly owns the dam. Codes are concatenated if several owners are involved.

Federal Agency Involvement in Other
Code identifying which federal agency is involved in other aspects of the dam. Codes are concatenated if several owners are involved.

Source Agency
Code identifying the federal or state source agency that has provided the field data on the dam. The code used for a state source agency is the two letter abbreviation for the state; the code used for a federal source agency is the Federal Agency Code defined in the table below.

State
The two letter abbreviation for the state in which the dam is located. A calculated field based on the field item #6 NIDID.

Congressional Person
The congressional person representing the district where the dam is located. A calculated field based on the latitude/longitude coordinate of the dam.

Political Party
The political party of the congressional person. A calculated field based on the congressional person and district fields.

Congressional District
The congressional district where the dam is located. A calculated field based on the latitude/longitude coordinate of the dam.

FEDERAL AGENCY CODE TABLE	
Federal Agency Name	**Federal Agency Code**
Department of Agriculture:	
Natural Resources Conservation Serv *Formerly Soil Conservation Serv (SCS)*	USDA NRCS
Forest Service	USDA FS
Rural Housing Service *Formerly Farmers Home Loan*	USDA RHS
Department of Defense:	
US Army Corps of Engineers	CE
US Army	DOD USA
US Navy	DOD USN
US Air Force	DOD USAF
Department of Interior:	
Bureau of Reclamation	DOI BR
Bureau of Indian Affairs	DOI BIA
Bureau of Land Management	DOI BLM
Fish and Wildlife Service	DOI FWS
Geological Survey	DOI GS
National Park Service	DOI NPS

Department of Labor:	
Mine Safety and Health Administration	DOL MSHA
Department of State:	
International Boundary and Water Commission	IBWC
Department of Energy:	
Federal Energy Regulatory Commission	DOE FERC
Nuclear Regulatory Commission	US NRC
Tennessee Valley Authority	TVA

Examples of Other Fieldnames not included in National Inventory of Dams

Owners Address

Owner's Agent or Responsible Person
Primarily used for mailing purposes. The name of the person responsible for correspondence inspection contacts, etc.

Emergency Phone Number
The phone number to be called in case of an emergency.

Dam Crest Elevation
Approximate USGS datum (to the nearest 0.1 foot). Top of parapet wall when applicable.

Parapet
Parapet code number as defined below:

1. Dam has a parapet wall and the wall is adequate to impound water and/or for flood routing.
2. Dam has a parapet wall, however, it is not adequate for flood routing.
3. Dam does not have a parapet wall.

Note: If parapet code is 1, the dam crest elevation is taken to be the top of the parapet wall.

Crest Width
Normal to the dam axis at the narrowest point (in feet). Parapet widths are never used.

Spillway Crest
Elevation of the lowest point of the spillway in the control section excluding any flashboard, gate, etc. (to the nearest 0.1 foot).

Spillway Type

1. Earth or soil
2. Concrete
3. Rock channels
4. Masonry or placed stone
5. Corrugated metal pipe
6. Reinforced concrete pipe
7. Steel pipe
8. Tile

Total Freeboard
Vertical distance from dam crest to spillway crest (to the nearest 0.1 foot).

Operating Freeboard
Vertical distance from the dam crest to the certified water storage elevation; i.e. top of flashboards, restricted elevation, etc. (to the nearest 0.1 foot).

Certified Storage Level
Maximum certified water surface elevation.

Gating Code
Gating code for spillway. Gates are any movable structure used to control the reservoir level including but not limited to radial gates, sluice gates and flashboards.

1. Ungated, Unrestricted
2. Gated, Unrestricted.
3. Seasonally Restricted Gates. Storage is permitted above the spillway crest during a specified season.
4. Restricted Gates. Gates must be opened or removed only prior to impending flood flows.
5. Restricted. Storage is restricted to a specified elevation which is different from the top of gates or spillway crest. Normally the restriction is a specified elevation below the spillway crest.
6. Seasonally Restricted. Storage is reduced seasonally to a specified level which is different from the spillway crest. The operating freeboard entered is that to the restricted level.

Note: Dams that are certified 1 foot or less below the spillway crest to control wave splash should have operating freeboard which includes the 1 foot, but the 1 foot should not be considered in determining gating code.

Maximum Surcharge Storage
Storage between spillway crest and dam crest (or between top of gates or flashboards if applicable).

Basin Impairment
Impairment exists only if either of the following conditions exist:

a. Water is diverted out of drainage basin.
b. Upstream control impairs runoff.

Impaired Yes (1) or No (2)

Basin Location

a. Latitude Mean latitude of the drainage basin (to the nearest minute).

b. Longitude Mean longitude of the drainage basin (to the nearest minute).

Mean Annual Precipitation
Mean annual precipitation on the drainage basin (to the nearest 0.1 inch).

National Forest
If a dam is located within a National Forest.

Application Status
The most current status of an application.

Type of Flood Estimate
Probability of flood estimate or probable maximum flood.

Date of Flood Estimate
Date the flood estimate was completed.

Storm Precipitation
Total design storm precipitation (to the nearest 0.1 inch).

Precipitation Duration
Duration of design storm precipitation (in hours).

Time of Concentration
Time of concentration used in hydrology study (to the nearest hundredth of an hour).

Storm Runoff
Total design storm runoff volume from the drainage basin (to the nearest acre-foot).

Peak Flood Inflow
Peak design storm inflow to the reservoir (to the nearest cfs).

Peak Flood Inflow
Peak design storm inflow to the reservoir (in cubic feet per square mile).

Routed
Was the storm routed?

Yes (1)
No (2)

Peak Flood Discharge
Peak design storm outflow from the reservoir (to the nearest cfs).

Residual Freeboard
Residual freeboard measured from the maximum reservoir flood stage to the dam crest (to the nearest 0.1 foot).

Maximum Flood Stage
Maximum reservoir flood stage elevation (to the nearest 0.1 foot).

Outlet Description
The description could include diameter or size of the outlet as well as type of outlet (CMP, clay tile, etc.).

Outlet Capacity
The full head flow capacity of the outlet works at the normal reservoir water surface elevation, in cfs.

Outlet Inspection
Date of last internal outlet inspection.

Inspection Date
Date when last safety inspection was conducted.

Instrumentation
Only used when instruments including piezometers, crest monuments, seepage weirs, slope indicators, accelerograms present.

1. Piezometers
2. Crest monuments
3. Seepage wiers
4. Slope indicators
5. Accelerograms
6. Other

APPENDIX I

BUDGET PREPARATION

STAFFING LEVEL REQUIREMENTS: EXAMPLE STATE DAM SAFETY PROGRAM

Chapter VI discusses program staffing and funding. This appendix is intended as a supplement to Chapter VI.

For any state dam safety program to be effective and accountable, personnel levels must be sufficient to satisfy the statutory mandates. Each state must assess its particular needs based on its legislative, organizational, geographic, topographic and political constraints, some of which are described above under Chapter VI, section I. Due to the wide range of these constraints from state to state, it is difficult to provide precise guidelines for the number of inspections one engineer should be expected to perform in a year. This is equally true of each of the other functions of a state dam safety program. With these limitations in mind, an attempt has been made to provide guidelines that should provide assistance in the preparation of a budget for a state dam safety program.

INSPECTION OF EXISTING DAMS:

If inspection frequency is not set by law, annual inspections of high hazard potential dams, biennial inspections of significant hazard potential dams and inspections every five years for low hazard potential dams are recommended. Each dam should be inspected at least once every five years. Some states require the owner to hire a qualified engineer to conduct the inspections. When this is the case, a staff of one engineer per 250 - 400 inspections would be required to review the inspection reports and to attend 20 percent of the inspections for quality control purposes. Most state programs conduct safety inspections utilizing state employed engineers. For budget preparation, the recommended time for a detailed visual inspection of one existing high hazard potential dam including file review, preparation, travel time, on-site inspection time, engineering analysis and report writing is four (4) person-days. For significant and low hazard potential dams the recommended time to budget for inspections are three (3) and two (2) days respectively. It is desirable to include more than one person on the inspection team. There are many reasons for including more than one person on the inspection including training, personal safety, and special needs at the dam. Special needs include surveying and the complexities of the particular dam being inspected that may require staff members with different areas of expertise.

APPLICATION APPROVAL:

Chapter II describes the tasks included in the processing of an application. Statutory and internal policy controls may define the time allocated to review and approve or deny an application. The complexity of the application under review, the completeness of the data provided, the experience of the staff assigned to the review, etc., are factors in determining the length of a particular review. The

length of the permitting process can vary greatly; however, a recommended engineering review time for a complete application is 20 person days, with an additional 5 days for clerical/administrative tasks. The engineering review should include a site inspection as part of the application review. Reviews should also include the major aspects of the engineering design for the dam being proposed. Among these aspects are hydrologic, hydraulic, geotechnical, seismic, and stability considerations. Review and approval of the Emergency Action Plan (EAP), if required, is also part of the application approval.

CONSTRUCTION ASSURANCE:

Although it is the owner's responsibility (through the owner's engineer) in most states to assure that any construction is completed according to the approved application and that all unforeseen conditions are properly handled, review of construction activity by the state is recommended. Inspection and approval of all foundation preparation is essential and is a part of most programs. Inspection of the outlet, the main structure, and the spillway should also be conducted. In addition, many projects include prefinal and final inspections. A recommended inspection length is two (2) person days including preparation, travel and report preparation. The recommended time could double in those states where travel distances are significant. The recommended number of construction assurance inspections per new dam is fifteen (15). Ten (10) construction assurance inspections are recommended for repair of existing dams. The above inspection frequencies include review of quality assurance records of the owner's engineer. Changes to the approved application during construction require additional review. The time required for such additional review is not included in this section but is included in the application approval section above.

FOLLOW-UP ON DEFICIENCIES:

Inspections of operational dams frequently reveal deficiencies that require correction. The inspection report shall identify deficiencies and include an appropriate schedule to complete corrective actions. A program to follow up and assure that these actions are taken should be part of all state programs. The amount of time required to conduct a follow-up inspection can vary, however, for operating dams it can take an average of three (3) persons-days per deficiency. For budget preparation purposes, it should be anticipated that deficiencies will occur at 20 percent of the dams inspected.

Contacts with owners of unsafe dams to bring about the remediation of unsafe conditions is also an essential part of follow-up activities. The actual amount of time required can vary. It is recommended that 15 person-days per unsafe dam be used in budget preparation. The 15 person-days recommended does not include application review time for repair, reconstruction, breach or removal of the dam. In most cases a state will have to prioritize follow-up activity since the time required can easily exceed the available staff.

ENFORCEMENT:

In the event that progress toward correction of deficiencies is not satisfactory, enforcement actions must be pursued. Enforcement can be very time consuming. For budget estimates a recommended time for each enforcement action is 50 person-days for the dam safety engineering staff. The estimated time includes the time of the legal staff as well as that of the engineering staff for preparation, etc. The above estimates assume that actions taken by the technical staff have been properly documented to support the enforcement actions.

TRAINING:

Education and training of staff is an important part of an effective program. It is recommended that a minimum of 5 percent of staff time be devoted to specific training provided by short courses, etc. as described in Chapter VII.

ADMINISTRATION/OVERHEAD:

Depending on the agency within which the dam safety program is placed and the overall state government organizational structure, the administration of the dam safety program can require significant amounts of time. The administrator may be responsible for overseeing other programs as well. The recommended administrative staffing time is 30 percent of the technical staff time described above. The above estimates include supervision and support of the program.

Example Program
Staffing Level Requirements

Example program: 200 Dams:

70 High hazard potential,
60 Significant hazard potential,
70 Low hazard potential

with inspection frequency as follows:

High hazard potential, annual;
Significant hazard potential, every two years; and
Low hazard potential, every five years

TASK	No. of Tasks (Dams)	Person-Days Per Task	Total Person Days
Average annual inspections[2]			
High hazard potential	70/yr	4	280
Significant hazard	60/2 = 30/yr	3	90
Low hazard potential	70/5 = 14/yr	2	28
Special Conditions, Requests	30	2	60
Training new staff	1	15	15

Sub-Total: Annual Inspection Days = 473 days

	Person Tasks per Task	Person-Day per Task	Total Person-Days
Application approval:			
New Dams	10	20	200
Repair Existing Dams	10	10	100
Emergency Action Plans (EAP)	25	5	125

Sub-Total: Application Approval Days = 425

	Person Tasks Per year	Person-Day per Task	Total Person-Days
Construction Assurance:			
New Dams	10	30[3]	300
Repair Existing Dams	10	20[4]	200
Sub-Total: Construction Assurance Days = 500			
Follow-up on deficiencies:			
114 dams/yr. X 20% =	23	3	69
Unsafe dams	2	15	30
Enforcement:	4	50	200

Summary of Tasks:

Inspections:	473 days
Applications:	425 days
Construction:	500 days
Follow-ups:	69 days
Unsafe Dams:	30 days
Enforcement:	200 days
TOTAL:	1,697 days

Professional Development/
Continuing Education: 1697 X 5% = 85 days

Total Engineering/
Technical Staff: 1697 + 85 = 1782 days/(225 days/FTE/yr .) = 7.9 FTE

Administrative/
Clerical: 1782 X 30% = 535 days/(225 days/FTE/yr .) = 2 .4 FTE

TOTAL STAFFING REQUIRED: 10.3 FTE
(For Inventory of 200 dams)

[3]2 person-days per inspection X 15 inspections per year = 30
[4]2 person-days per inspection X 10 inspections per year = 20

Note:

1) In geographically large states without regional dam safety offices, a "distance multiplier" of 1.5 may be used to estimate the number of person-days required for field inspections.

2) "Construction Assurance" would include site inspections during:
   A. Foundation Preparation
   B. Embankment Construction
   C. Low Level Outlet Structure Construction/Placement
   D. Spillway Construction
   E. Final Review

3) In states with seismic risk, a "seismic multiplier" of 1.5 may be used to estimate the number of person-days required for application approval.

4) Initial inspection of an existing dam and production of a Phase I inspection report will likely take up to between 10 to 15 man-days.

5) Other administrative activities must be considered

Chapter VI lists other costs which must be considered in the budgeting process.