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NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS.(U)
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US Army Corps
of Engineers

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National Program of Inspection of Non-Federal Dams

Final Report to Congress

The National Dam Inspection Act of 1972
Section 5, Public Law 92-367

May 1982

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REPORT OF THE CHIEF OF ENGINEERS

TO THE

SECRETARY OF THE ARMY

ON THE

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS

May 1982

Department of the Army

Office of the Chief of Engineers

Washington, D.C. 20314

[redacted]

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PART I

EXECUTIVE SUMMARY

A. PURPOSE

This report is a summary of the results of the National Program of Inspection of Non-Federal Dams, by the U.S. Army Corps of Engineers and completed on 30 September 1981. The recommendations provided in this report for improving the safety of non-Federal dams augment those offered in the report submitted to the Congress in 1976, prior to initiating the inspection of non-Federal dams, and reflect additional findings resulting from these inspections.

B. AUTHORITY

The National Program of Inspection of Non-Federal Dams was authorized by the National Dam Inspection Act of 1972 (P.L. 92-367), which directed the Secretary of the Army, acting through the Chief of Engineers, to carry out a national program of inspection of non-Federal dams for the purpose of protecting human life and property. P.L. 92-367 specifically required the Secretary of the Army to conduct the following activities and to report to the Congress by July 1, 1974, on these activities and

others performed under the act:

(1) Compile an inventory of all dams in the United States which are in excess of 6 feet in height and have a maximum water impounding capacity of at least 50 acre-feet, or which are at least 25 feet in height and have a maximum water impounding capacity in excess of 15 acre-feet.

(2) Inspect certain non-Federal dams in the inventory, and provide the inspection results and advice for remedial measures to state governors.

(3) Formulate recommendations for a comprehensive national dam safety program.

C. BACKGROUND

The National Dam Inspection Act of 1972 (P.L. 92-367) was enacted as a result of catastrophic dam failures. The Buffalo Creek, West Virginia coal refuse dam failed in February 1972, killing 125 people and causing extensive property damage. The Canyon Lake Dam at Rapid City, South Dakota, failed during a violent rainstorm and flooding in June 1972, contributing to the loss of life and destruction in Rapid City. Heavy rainfall, created by Hurricane Agnes, caused the overtopping and damaging of a number of dams in June 1972, adding to flooding and property damage, and further increasing public concern for the safety of dams.

D. SUMMARY

The Secretary of the Army initiated actions to implement the requirements of P.L. 92-367 immediately after it was signed into law. Plans were formulated to perform the following:

(1) Compile an inventory of dams in the United States, including its commonwealths and trust territories.

(2) Develop recommendations for a comprehensive national dam safety program.

(3) Develop guidelines and criteria for inspecting and evaluating dams.

(4) Provide advice to state* governors, upon request, relating to timely remedial measures necessary to mitigate or obviate any hazardous conditions found by states inspecting non-Federal dams within their boundaries.

Due to limited funding and the position of the Executive Branch that the inspection of non-Federal dams should be conducted by the states as part of their normal responsibilities, plans to implement P.L. 92-367 did not include Corps of Engineers inspection of non-Federal dams.

The Assistant Secretary of the Army (Civil Works) transmitted a report to Congress in November 1976, on the initial activities performed

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*Includes commonwealths and trust territories.

by the Corps of Engineers under P.L. 92-367.

The President, in December 1977, as a result of a tragic dam failure, directed the Secretary of the Army, acting through the Chief of Engineers, to conduct a program to inspect non-Federal dams that presented a high potential for loss of life and property damage should they fail. A four-year program, scheduled for completion on 30 September 1981, was developed to perform the following activities:

(1) Update and verify the national inventory of dams.

(2) Inspect about 9,000 non-Federal dams.

(3) Encourage and prepare the states to implement effective state dam safety programs.

(4) Provide data for the definition of a viable national dam safety program.

The updating and verifying of the inventory was essentially completed by 30 September 1980. The revised inventory contains 68,153 dams, of which 63,419 meet the size requirements of P.L. 92-367. Most of the 4,734 dams in the inventory which do not meet the size requirements were listed in the original inventory, and, therefore, retained.

Nearly nine thousand dams (8,818) were inspected under the inspection program. Of this number, nearly three thousand (2,925) were evaluated as unsafe due to various deficiencies, primarily for inadequate spillway

capacity. Reports on all inspections were provided to state governors. Recommendations for remedial measures were included in reports for all dams having deficiencies. In most states, these recommended measures have not been adequately implemented by dam owners, because state officials are not convinced that existing dams create a great enough hazard to require dam owners to spend large sums of money to improve conditions which, in most cases, have existed for many years.

Corps of Engineers efforts to prepare the states to implement effective state dam safety programs included encouraging the states to enact dam safety legislation and to supervise the Corps of Engineers inspection program activities within their boundaries, in order to gain experience, and conducting seminars and training courses for state personnel. The assessment of state dam safety programs after the Corps of Engineers inspection program was completed revealed that (a) forty(40) states had enacted effective dam safety legislation, but 6 states had no dam safety legislation, (b) 34 states had implemented effective regulatory practices, (c) 29 states had employed adequate technical staffing, and (d) 16 states had developed programs which were completely adequate. The 16 states with the completely adequate programs and two additional states indicated that they will provide adequate funding for their programs without Federal aid. Seventeen (17) states with deficient programs indicated that they plan to implement adequate programs in the near future.

E. FINDINGS AND CONCLUSIONS

From the results of the inspection program, certain findings were developed and conclusions drawn. These provide a basis for defining the needs of a viable national dam safety program for non-Federal dams, and for developing recommendations for improving the safety of non-Federal dams. These findings and conclusions are:

(1) The updated national inventory of dams is a reliable data base for state dam safety programs.

(2) On a national basis, 33% of the non-Federal dams inspected were found to be unsafe. However, the percentage of unsafe dams varied between states, ranging from a low of 3.3% in California to a high of 74.3% in Missouri. It is difficult to project whether these percentages would change materially for the non-inspected dams.

(3) Most states have not adequately required dam owners to implement measures recommended for unsafe dams; nor is there evidence that this is expected to change.

(4) The large percentage of unsafe dams and the lack of implementation of additional investigations and/or remedial measures indicate that most dam owners are not willing to modify, repair, or maintain their dams.

(5) Most states have shown an unwillingness to implement and maintain effective dam safety programs with state funds. Additional dam failures will likely occur before the states give adequate priority to their dam safety programs.

(6) Most states participated in the inspection program in a manner that provided training and experience for state personnel. Almost all states have developed at least a nucleus for a dam safety organization.

(7) Most states believe that the criteria contained in the "Recommended Guidelines for Safety Inspection of Dams," particularly spillway capacity criteria, are too stringent. Consequently, only a few corrections are expected to be made, at least on existing projects, thus allowing substantial hazards to remain until the occurrence of extreme rainfall verifies the concern for spillway capacity and creates public concerns and pressures to upgrade state priorities for dam safety.

F. RECOMMENDATIONS

The following actions are recommended for improving the safety of the nation's non-Federal dams:

(1) The Corps of Engineers should be authorized and funded to continuously maintain the national inventory of dams. Such proposed legislation has been submitted to the Congress.

(2) If Federal legislation is enacted providing Federal funds for implementing remedial measures for dams inspected under the non-Federal dam inspection program and determined to be unsafe, only those dams which are owned by state, county, or municipal governments, and whose major purpose is public water supply and flood protection should be considered. Such legislation should also establish minimum standards for

state dam safety programs, and only those states meeting these standards would be eligible to receive Federal funding.

(3) To utilize the existing Federal technical capability in dam safety, a Federal agency should be designated to furnish technical assistance to the states, upon request, concerning implementation of dam safety programs.

(4) The construction of non-Federal dams on Federal lands should not be allowed unless the dams are designed and constructed to meet minimum standards established by a designated Federal agency and the proposed dam owners agree legally to properly maintain these dams. Owners of existing non-Federal dams on Federal lands should be required to upgrade and maintain such dams to meet minimum standards.

(5) The Federal Emergency Management Agency (FEMA) should concentrate their dam safety efforts on those dams inspected by the Corps of Engineers and considered to be unsafe. FEMA should, using the Corps, publicize and promote design criteria impinging on dam safety, especially that pertaining to the Probable Maximum Flood (PMF), and maximize public awareness when dams fail because of spillway deficiencies.

(6) The National Oceanic and Atmospheric Agency (NOAA) should be informed of the location of all dams with unsafe spillways to enable special alerts when unsafe flows are likely to be approached.

(7) The Federal government should remove restrictions on block grants to states, where they exist, so funds can be used for dam safety. If there are no restrictions, it could be specified that dam safety will be considered as one of the uses.

PART II

INTRODUCTION

A. INITIAL PROGRAM ACTIVITIES

The report on the National Program of Inspection of Dams, transmitted to Congress in November 1976, included analyses of the primary activities conducted under the program by the Corps of Engineers prior to the initiation of the inspection of non-Federal dams in December 1977. These activities consisted of:

(1) Compiling a national inventory of 49,329 dams.

(2) Conducting a review of each state and Federal agency's capabilities, practices, and regulations regarding the design, construction, operation and maintenance of dams.

(3) Developing guidelines for the safety inspection and evaluation of dams.

(4) Formulating recommendations for a comprehensive national dam safety program, and proposed legislation to implement these recommendations.

The national inventory of dams was completed in 1974. Approproximately 20,000 of the dams inventoried were classified as having high or significant hazard potential, that is, so located that failure or misoperation could result in loss of life and property damage.

The review of each state and Federal agency's capabilities and practices for the regulation of dams under their jurisdictions indicated that dam safety programs in most states and some Federal agencies were either non-existent or inadequate to insure the safety of dams. Of the 50 states and 3 territories reviewed, 11 had no laws regulating dams and 24 had regulations which were inadequate. Five (5) of the Federal agencies reviewed indicated that the existing regulations for dam safety were not fully adequate.

The efforts to develop guidelines for the safety inspection and evaluation of dams produced the "Recommended Guidelines for Safety Inspection of Dams." These guidelines were developed with input from selected state agencies, Federal agencies, professional engineering societies, and private engineering consultants.

Recommendations for a comprehensive national dam safety program included establishing regulatory functions for state dam safety programs based upon the provisions of the "Model Law for State Supervision of Safety of Dams and Reservoirs," as prepared by the United States Committee on Large Dams (USCOLD). These recommendations also proposed the immediate initiation of the inspection of dams with high or significant hazard potential. The states were to be responsible for the inspection of non-Federal dams on private property, and the owning Federal agencies were to be responsible for Federal dams and non-Federal dams on Federal property. The Federal agencies possessing technical expertise and capabilities in the field of dam design and construction

would be authorized to furnish technical assistance and guidance to the states, upon request, concerning the implementation of state dam safety programs. The Chief of Engineers would be authorized to maintain the national inventory of dams.

The Presidential memorandum of April 23, 1977, in directing Federal agencies involved with the design and construction of dams to review their practices which could affect the safety of dams, served to separate efforts for insuring the safety of Federal dams from those for non-Federal dams. This memorandum directed the heads of Federal agencies responsible for Federal dams to review their practices which affect the safety and integrity of these structures. It directed the Chairman of the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) to (a) convene an ad hoc interagency committee to coordinate Federal dam safety programs, (b) provide recommendations for improving the effectiveness of the Federal dam safety effort, and (c) prepare proposed Federal guidelines for management procedures to ensure dam safety. It also required the Director of the Office of Science and Technology Policy to arrange for review of agency practices and the proposed Federal guidelines for dam safety by a panel of recognized experts. Each Federal agency responsible for dams completed a thorough review of its management procedures relating to dam safety and submitted a report to the FCCSET ad hoc committee. The FCCSET committee issued a comprehensive report on these studies which contained proposed Federal guidelines for dam safety and recommended future actions to improve the safety of Federal dams.

B. PROGRAM REVITALIZATION

Subsequent to the failure of the Teton Dam, near Newdale, Idaho, in June 1976, national interest concerning the safety of dams increased. Efforts to ensure the safety of non-Federal dams were revitalized when Congress appropriated 15 million dollars in the Fiscal Year 1978 budget to initiate the inspection of non-Federal dams. The failure of the Kelley Barnes Dam at Toccoa Falls, Georgia in November 1977, further increased national concern, and the President, in December 1977, directed the Secretary of the Army to commence, at once, a national program to inspect non-Federal dams.

The President directed the Secretaries of Interior and Agriculture to cooperate with the Secretary of the Army in developing technical criteria and guidelines for inspections and assisting the states. He emphasized in his directive that the inspection program could not be a substitute for effective dam safety programs at the state level, and the primary objective of the program was to stimulate the states to develop effective state dam safety programs.

The President asked the Secretary of the Army to report back to him within one year on the status of the inspection effort, development of state dam safety programs, and the need for additional Federal actions to assure national dam safety.

PART III

PROGRAM DEVELOPMENT

A. OBJECTIVES AND SCOPE

1. Objectives

With the separation of the efforts for insuring the safety of Federal and non-Federal dams, and the issuance of the Presidential directive in December 1977, requiring the inspection of non-Federal dams, a four-year national program of inspection of non-Federal dams was formulated. The objectives of the program, designated as the "National Program of Inspection of Non-Federal Dams," were defined as follows:

(1) Update the national inventory of dams by 30 September 1980.

(2) Provide technical inspection and evaluation of about 9,000 non-Federal dams by 30 September 1981, identifying deficiencies to permit timely correction by non-Federal interests.

(3) Provide data for a better definition of a viable national dam safety program, including the Federal role.

(4) Encourage and prepare the states to implement effective dam safety programs for non-Federal dams by 30 September 1981.

2. Scope of Inventory Updating

The initial scope of work established for updating the national inventory of dams provided for:

(1) Verifying existing inventory data.

(2) Adding missing data to the inventory.

(3) Adding new data items and corresponding data to the inventory.

(4) Adding complete data for all qualifying dams not previously listed in the inventory.

The scope of work for the inventory was expanded in October 1979, to provide for the documentation of inspection and remedial measures information for dams in the computerized inventory data base.

3. Scope of Inspections

The scope of work established for the dam inspection activity included the inspection of the following classes of dams as defined in the Recommended Guidelines for Safety Inspection of Dams:

(1) Dams presenting a high hazard potential because of their location relative to downstream development.

(2) Dams presenting a significant hazard potential because of their location relative to lesser developed downstream areas, and are located on Federal lands.

(3) Dams presenting a significant hazard potential and determined, in consultation with state officials, to be in a condition that presents an immediate threat to public safety.

B. ORGANIZATION AND RESPONSIBILITY

1. Corps of Engineers

A decentralized approach was used within the Corps of Engineers for executing the inspection program. The Office of the Chief of Engineers had the responsibility for overall program direction. Corps field offices were responsible for executing the program at the state level and for providing general support services.

2. Other Federal Agencies

The Departments of Interior and Agriculture were directed by the President to cooperate with the Corps of Engineers in the establishment of inspection criteria, providing assistance to the states and in the development of program follow-up recommendations.

3. State Agencies

Each state was asked by the Corps of Engineers to manage and execute the program within the state through an appropriate state agency, using qualified state personnel or private engineers to perform the work. States were to be paid for their efforts by the Corps on a cost reimbursable basis. Where states failed to accept this responsibility or were unable to develop the required capability, Corps field offices were to use available personnel or contract private engineers to perform inventory and inspection activities.

The states were also asked by the Corps to assure that they would undertake the following activities:

(1) Take actions necessary to implement effective programs for regulating dams within their boundaries, to include the immediate implementation of any existing state dam safety legislation and the enactment of new legislation, if needed.

(2) Participate in the inspection program in a manner that would provide training for state personnel.

(3) Use all available means to require remedial measures to be taken expeditiously in cases where dams were determined to be unsafe.

C. POLICIES AND REGULATIONS

1. Policies

Basic program policies were established to insure that the inspection program would be executed in accordance with the requirements of P.L. 92-367 and the Presidential directive; these were:

(1) States have the basic responsibility for the protection of the lives and property of their citizens.

(2) Owners of dams have the basic legal responsibility for hazards created by their dams.

(3) The inspection program does not modify the basic responsibility of states or dam owners.

(4) Remedial work recommended for inspected dams is the responsibility of non-Federal interests (states and dam owners), not the Federal government.

(5) Public Law 92-367 provides only for a one-time inspection of each dam; the Corps does not have any reinspection responsibility after recommended remedial work has been implemented.

(6) The Corps will immediately notify state governors of hazardous conditions found during inspections and, upon request, will provide advisory assistance to dam owners and governors in implementing emergency actions for mitigation of hazardous conditions.

2. Regulations

Engineer Circular No. 1110-2-188, specifying the procedures for conducting the inspection program, was issued in December 1977, immediately after the initiation of inspections. This circular was superseded in September 1979, by Engineer Regulation No. 1110-2-106 (See Appendix B).

PART IV

PROGRAM RESULTS

A. STATUS REPORTS

In the directive requiring the initiation of the inspection of non-Federal dams, the President asked the Secretary of the Army to report to him within one year on the status of the inspection, development of state dam safety programs, and the need for additional actions to assure national dam safety. This report was completed and submitted to the President in March 1979. It provided an in-depth analysis of the program and recommended its continuation to assure that program objectives would be met.

Internal status reports were also compiled at the end of FY 1979 and FY 1980, the second and third years of the inspection program. These reports provided complete summaries of the program activities, including the assessment of progress toward achieving program objectives.

B. INVENTORY OF DAMS

1. Performance of Inventory Updating

Data for updating the inventory of dams were compiled in the field by the following groups and provided to Corps field offices for

editing and recording in the computerized inventory data base:

(1) Corps field offices.

(2) Private engineers contracted by Corps field offices.

(3) State personnel.

(4) Private engineers contracted by state agencies.

Table 1 of Appendix D shows the number and percent of dams for which inventory data were compiled by each group.

Corps field offices compiled the data for 6,422 dams (9% of the total). Approximately one-third of these were Federal dams. Most of the remaining two-thirds were located in states which did not manage the inventory data compiling, or needed Corps assistance to complete the work in the scheduled time.

The 11,402 dams (17%) for which data were compiled by private engineers contracted by Corps field offices were primarily those dams inventoried during inspections and those located in states where Corps assistance was needed to complete the work.

States which managed the inventory data compiling used state personnel to collect data for 39,549 dams (58%) and contracted private engineers to collect data for 10,780 dams (16%).

2. *Procedures for Inventory Updating*

The criteria for updating the inventory of dams were published in ER 1110-2-106 (See Appendix B). These criteria specified the size of dams to be inventoried and the procedures to be used in compiling and recording inventory data. Procedures used for compiling inventory data included:

(1) Review of various records and documents.

(2) Examination of maps.

(3) Aerial photography and mapping.

(4) Detecting and mapping earth surface water from remotely sensed multispectral scanner data acquired by satellite.

(5) Site visits.

Records and documents reviewed were those obtained from Federal, state, county and municipal agencies, dam owners, designers and contractors. Included were design and construction drawings and specifications, construction permits, inspection reports, tax records, the Register of Dams in the United States, and existing inventories of Federally owned dams.

Maps examined were USGS quadrangle, topographic, and planimetric maps.

Aerial photography was used in some states for general detection, but primarily in remote areas for locating and mapping unrecorded bodies of water.

The remotely sensed data used to detect earth surface water was acquired by the National Aeronautics and Space Administration's (NASA) Land Satellite Multispectral Scanner (LANDSAT) system. Corps field offices used the Surface Water Detection and Mapping (DAM) software package, also developed by NASA, in conjunction with LANDSAT data, to develop computer-generated maps of surface water.

Site visits were used in most states to collect data not included in existing records and in several states to obtain and verify all data.

All inventory data was recorded in a computerized data base. A complete description of each data item of this data base is provided in Appendix C.

3. Problems Encountered in Inventory Updating

The inventory updating was hindered by insufficient state personnel to perform the work and the lack of uniformity in assigning the hazard potential classification to the dams. The employing of additional personnel by the states and the contracting of private engineers by Corps offices alleviated the personnel obstacle.

The "Recommended Guidelines for Safety Inspection of Dams" defines "high hazard potential dams," the primary class of dam inspected under the program, as dams located where failure may cause the loss of more

than a few lives and extensive property damage. Because this definition does not cite a specific number of lives that could be lost, Corps field offices experienced difficulty in determining if dams should be categorized as having "significant" or "high" hazard potential. The issue was clarified by emphasizing that the hazard potential classification should be based on the density of downstream developments containing habitable structures. For example, dams located upstream of isolated farm houses would be classified as having significant hazard potential; and those located upstream of several houses or residential developments would be classfied as having high hazard potential. This clarification did ease the difficulty, but did not result in the desired level of uniformity.

4. Results of Inventory Updating

The updating of the inventory was essentially completed in September 1980, as scheduled. The revised inventory contains 68,153 dams, of which 63,419 meet the size requirements of P.L. 92-367 (See Appendix D, Table 2). Most of the 4,734 dams listed in the inventory which do not meet P.L. 92-367 size requirements were listed in the original inventory, and therefore, retained. The total number of dams listed in the inventory represents the addition of over 18,000 dams to the original inventory.

Table 11 of Appdendix D shows the hazard potential classification of the dams which meet P.L. 92-367 requirements. The sum of "hazard 1 (high)" and "hazard 2 (significart)" dams indicates that over 20,000 of

the dams inventoried are so located that failure could cause the loss of life and property damage.

The updating process has resulted in tremendous inprovement in the original inventory. The scope of the recorded data was expanded to provide for the documentation of information on inspections and remedial measures. The computerized data base developed for the inventory provides for rapid retrieval of documented data. Tables 3 through 12 and Table 21 of Appendix D provide useful tabulated information on the dams listed in the inventory which meet P.L. 92-367 size requirements.

5. Cost of Inventory Updating

The total cost of updating the inventory was about $11.4 million. For the 68,153 dams listed in the inventory, this is an average cost of about $170 per dam. Table 24 of Appendix D shows the total and average costs of inventories for each state. The average costs range from a low of $18 in Wyoming to a high of $1,048 in Alaska. The states with the highest costs are those, in most cases, which used aerial photography and/or visited all sites to accomplish the updating.

C. INSPECTION OF DAMS

1. Performance of Inspections

The inspection and evaluation of dams were performed by the following groups:

(1) Corps field offices.

(2) Private engineers contracted by Corps field offices.

(3) State personnel.

(4) Private engineers contracted by state agencies.

Table 13 of Appendix D shows the number and percent of dams inspected by each group.

Corps field offices performed 738 inspections (9% of the total). Most of these were located in states which did not manage the inspections, or needed Corps assistance to complete the work in the scheduled time.

The 4,738 dams (55%) inspected by private engineers contracted by Corps field offices were also primarily located in the states which did not manage the inspections.

States which managed the dam inspections used state personnel to inspect 1,581 dams (18%) and contracted private engineers to inspect 1,582 dams (18%).

2. Procedures for Conducting Inspections

The procedures specified for conducting inspections are in accordance with the requirements of a "Phase I Investigation," as contained in the "Recommended Guidelines for the Safety Inspection of Dams." These procedures provide for the evaluation of the general

condition of the dam with respect to safety, and include the following broad areas:

(1) Review of pertinent, existing, and available engineering data on the design, construction, and operation of the dam and appurtenant structures.

(2) Systematic field inspection of the dam, appurtenant structures, reservoir area and downstream channel.

(3) Evaluation of hydraulic and hydrologic features to determine the capability of the dam's outlet works and spillway to safely pass floods (% probable maximum flood that can be passed).

(4) Evaluation of structural stability, including an assessment of seismic stability.

(5) Verification of the hazard potential of the dam.

The inspection procedures require the deficiencies found in dams to be described and assessed as to their severity. Dams assessed as having deficiencies of such nature that if not corrected could result in failure of the dam and subsequent loss of human life and property damage are required to be assessed as "unsafe." Unsafe dams are assessed as being in an "emergency" (probable failure is imminent) or "non-emergency" (probable failure is not imminent) condition.

The inspection procedures also require that state governors be notified immediately of all "unsafe" dams and that emergency procedures be recommended for "emergency-unsafe" dams.

Inspections were conducted generally in accordance with the specified criteria. However, interpretation of some of the criteria allowed the application of different techniques and the use of ranges of values that caused some inconsistencies.

3. Problems Encountered in Conducting Inspections

Several problems were encountered in conducting the inspections. These problems required considerable efforts for resolution, caused delays, and, in some cases, affected the overall outcome of the inspections. Major problems encountered pertained to the following areas:

(1) Technical staffing.

(2) State participation.

(3) Identifying and locating dam owners.

(4) Rights-of-entry.

(5) Private engineer services.

(6) Hazard potential classification.

(7) Available engineering data.

(8) Inspection criteria

a. Technical Staffing. The inspections required the diversion of Corps technical staff from other duties. Many state agencies were similarly strained and did not provide the desired level of staffing during the entire program. This inadequacy is reflected in the level of state performance, as previously discussed, and in the development

of state dam safety programs, as discussed later. The lack of adequate state staffing resulted in the use of Corps personnel and private engineers in excess of that planned. State officials indicated the unlikeliness of a continuing state inspection program as large as the Federally funded program prevented them from increasing their staffs.

b. State Participation. Most states participated in the program almost at the level agreed to at the outset of the program. However, several states did not sufficiently manage the inspection activities or adopt adequate regulatory practices. State officials indicated that they supported the development of state funded and managed dam safety programs for states, but that the lack of adequate state legislation and funds restricted the development of such programs. Again, the level of state participation was directly proportional to state capability at the beginning of the program and/or to the degree of improvement in state programs.

c. Identifying and Locating Owners. Inspection efforts were hindered by the inability to identify or locate several dam owners. In some cases, the ownership of dams was subject to court litigation. Several dam owners were identified in the records but could not be located. State officials had to invoke legal actions to provide for the inspection of dams of questionable ownership.

d. Rights-of-Entry. Since the Corps did not have specific authority under P.L. 92-367 for rights-of-entry to inspect dams, program

plans called for state officials to obtain these rights from dam owners. The rights-of-entry were not obtained by state officials in all states. Rights-of-entry were denied by 11 dam owners in Alabama, 6 in Missouri, and one in Arizona. Court actions were required to obtain rights-of-entry to inspect several dams in Virginia and one in Connecticut. Indiana did not obtain rights-of-entry for several dams until late in the last year of the program. These obstacles to rights-of-entry affected scheduling and obviously caused delays.

e. Private Engineer Services. Performance of private engineering firms engaged to perform inspections was, generally, satisfactory. However, some firms contracted in the first year of the program lacked engineers experienced in hydrology and hydraulics. Also, concern for the potential for being subjected to liability claims caused some private engineering firms not to accept contracts. These firms feared that claims could result from situations where (a) a dam failed due to some cause not detected by the inspection or (b) a dam was evaluated as unsafe and the owner disagreed with the evaluation. These concerns did reduce the number of firms willing to accept contracts; however, a sufficient number of qualified firms were available.

f. Hazard Potential Classification for Dams. Since the inventory data for dams were updated and verified during both the inventory and inspection activities, the problem of determining the hazard potential classification for dams, as previously presented in the discussion of problems associated with the inventory, also increased the efforts required to conduct inspections.

g. Available Engineering Data. The lack of available engineering design and construction data on many of the dams made the inspections more difficult. This was a recurring problem in many states, particularly those without standards for review and approval of designs and issuing permits for construction. Also, some dam owners were reluctant to cooperate and did not provide available data. In cases where there was not sufficient engineering data to make valid assessments of dams, it was recommended that dam owners secure the services of professional engineers to perform more extensive investigations of the dams.

h. Inspection Criteria. In a number of states, problems arose over the differences between the inspection criteria specified in the "Recommended Guidelines for Safety Inspection of Dams" and the criteria used by state agencies. The most serious difference related to the required spillway capacity. Also, differences in the application of criteria by Corps field offices were attributed as the primary cause for the large variances experienced between the states in the percentage of unsafe dams.

(1) Inadequate Spillway Capacity. The "Recommended Guidelines for Safety Inspection of Dams" establish the probable maximum flood (PMF) or some percentage thereof (based on the size of the dam and its hazard potential) as screening criteria for spillway capacity. That is, when the failure of a dam due to overtopping could result in the loss of life, it should be capable of passing the PMF.

The PMF is derived from the most extreme rainfall estimated by the National Weather Service (NWS) for a specific area. It is calculated by use of a watershed runoff model, designed to produce critical runoff for the area being examined by assuming a high level of antecedent rainfall and optimum peaking conditions (see Appendix B, page B-52). Although this runoff represents a rare flood condition, studies by NWS of major storms indicate that many of these storms have exceeded 50 percent of the precipitation expected to produce PMF's. In fact, some storms recorded were as high as 80-90 percent of the expected precipitation for PMF's.

Since most states do not have specific requirements regarding the capability of dams to pass floods, and because the design of dams to pass the PMF without overtopping greatly increases cost, very few existing non-Federal dams were found adequate to pass the PMF without overtopping. It became obvious that the continued application of the guidelines criteria, without change, would result in unsafe evaluations for most of the non-Federal dams.

The states could not be expected to require modification of the spillways of essentially all "high hazard potential" dams to provide for passing the PMF, particularly those which could pass a large percentage of the PMF. Therefore, it was necessary to establish criteria which would determine if the capacity of a dam's spillway was so "seriously inadequate" as to constitute an unsafe condition. The criteria established specified that a dam is considered to have a "seriously inadequate" spillway and is thereby "unsafe" if it meets all of the

following conditions:

(1) The dam presents a high hazard potential to downstream development.

(2) The dam cannot pass one-half the PMF without overtopping, and there is reasonable probability that overtopping would cause the dam to fail.

(3) Failure of the dam would significantly increase the potential for loss of life downstream from the dam. (See Appendix B, page B-30 for a more detailed discussion.)

(2) Criteria Application. An analysis conducted by the Corps to determine the reasons for the large variances between states in the percentage of dams evaluated as unsafe revealed that Corps field offices applied hydrological, hydraulic, and geotechnical assumptions more conservatively in some states than others. Reasons for these different levels of conservatism stemmed largely from the fact that widely varying amounts of necessary background data were available on important engineering design and construction parameters.

The conservative application of geotechnical assumptions stemmed from the fact that many structures had little or no instrumentation, design documentation, or as-built construction records. Therefore, subjective judgements had to be made on design parameters such as foundation strength properties, pore and uplift pressures, etc. Faced with these important unknowns, judgements were influenced by local experience, and were, in most cases, conservative.

Another area of judgement had to do with erosion resistance of embankment dams when overtopped. For the most part, earth or rockfill embankment dams are considered to be unable to safely sustain overtopping of any magnitude or duration. However, some Corps field offices concluded that some dams could safely withstand overtopping of small magnitude and short duration. But, in most cases where dams were calculated to experience overtopping, even when the properties of the embankment materials were known, conservative judgements were made as to the structures' resistance to erosion caused by overtopping.

It is recognized that the criteria given in the "Recommended Guidelines for Safety Inspection of Dams" for evaluating dams represent higher standards of dam design and construction than required by many states. However, these guidelines represent a consensus of experts in dam engineering, representing several Federal and state agencies, private consultants, and professional engineering societies, and it would be remiss not to apply such standards to non-Federal dams.

4. Results of Inspections

A total of 8,818 dams were inspected under the four-year program. Of this number, 8,639 met the size requirements of P.L. 92-367. Most of the 179 dams inspected which did not meet the size requirements were only slightly smaller than the required size. State officials scheduled these dams for inspection primarily because their sizes were marginal and they were located upstream of heavily populated areas.

a. Unsafe Dams. Of the total 8,818 dams inspected, 2,925 were evaluated as unsafe. On a national basis, the 2,925 unsafe dams represent 33% of all dams inspected. The percentage of unsafe dams varied between the states, ranging from a low of 3.3% in California to a high of 74.3% in Missouri. Of the 8,639 dams inspected which met the size requirements of P.L. 92-367, 2,884 (also about 33%) were evaluated as unsafe; for these dams, Table 14 of Appendix D shows for each state the number and percent of dams evaluated as unsafe and the number of unsafe dams in an emergency or non-emergency condition.

Tables 15, 16 and 17 of Appendix D provide summaries of deficiencies causing dams to be unsafe. The summary of primary deficiencies in shown in Table 15. This summary includes a variety of deficiencies distributed as follows:

(1) Inoperable water control components, such as gates, valves and drains (2%).

(2) Instability (5%).

(3) Seepage (8%).

(4) Inadequate spillway and/or outlet capacity (81%).

(5) Defective structural components, such as penstocks and gates (3%).

(6) Other (1%).

Table 16 provides a summary of unsafe dams with a single deficiency, and Table 17 provides a summary of unsafe dams with multiple deficiencies.

The enumeration of deficiencies found does not, alone, convey the seriousness of the problems found at many of the unsafe dams. Examples of extremely poor design, construction and maintenance were found at many dams.

Table 18 of Appendix D shows the number of unsafe dams owned by the Federal and local governments, organizations, and one or more individuals. Athough there is considerable variation in the range of the number of unsafe dams owned by the various groups, there is no established correlation between ownership and condition of dams.

The 11 unsafe Federal dams were inspected at the request of the owning agencies. These inspections were performed by Corps personnel on a cost-reimbursable basis.

b. Significant Hazard Potential Category non-Federal Dams on Federal Lands. The sampling inspection of significant hazard potential non-Federal dams was initiated in FY 1980. The purpose of the sampling inspection was to determine if the condition of these dams warranted the inspection of all dams in this category.

A numerical rating procedure, based on the descriptive characteristics, or categories, of age, height, and maximum water impounding capacity of dams, was developed to select the sample of dams to be inspected. Age was selected as a category because of the

possibility of being directly related to obsolete design parameters and a lack of maintenance. Size, as represented by height and impounding capacity, was selected because of being directly related to the hazard potential. The categories and corresponding rating factors are shown below:

CATEGORIES	RATING FACTORS
Age (years)	
0-5	(1)
5-50	(2)
over 50	(3)
Height (feet)	
6-40	(1)
40-100	(2)
over 100	(3)
Maximum Capacity (acre-feet)	
50-1,000	(1)
1,000-50,000	(2)
over 50,000	(3)

A numerical rating was computed for each dam by adding the corresponding rating factors for each of the three categories (A dam that is 20 years old, 150 feet in height and has a maximum capacity of 40,000 acre-feet would have a rating of: 2+3+2=7). Each dam could have received a rating of 3 to 9.

About 25% of the dams in each numerical rating were to be inspected in each state. If more than 25% of the inspected dams were evaluated as unsafe, all of the significant hazard potential category dams on Federal lands would have been recommended for inspection.

Table 19 shows the number of dams in each category and the ratings in each state. Table 20 shows the total number of significant hazard potential category dams on Federal lands in each state, the number of dams inspected, and the number of dams evaluated as unsafe. California had inventoried over 100 significant hazard potential non-Federal dams on Federal lands, but due to experiencing an overall low percentage of unsafe dams, chose not to participate in the sampling inspection.

Only 10% (9 of 98) of the inspected dams were evaluated as unsafe. This percent is significantly less than the 25% determined to warrant inspection of all significant hazard potential category dams located on Federal lands.

5. Remedial Measures for Dams

Corrective measures for remedying deficient or seemingly deficient conditions found in dams were recommended in all inspection reports provided to state governors and dam owners.

a. Emergency Measures. Emergency measures to eliminate the potential for imminent failure were recommended for the 132 dams evaluated as being in an "emergency-unsafe" condition. These measures included partial or complete draining of the reservoir, or breaching the dam. In some cases repairs were made immediately. Corps field offices assisted in the implementation of emergency measures for several dams, as authorized by P.L. 84-99.

b. Non-Emergency Measures. The non-emergency measures recommended for dams indicated the need to remedy deficiencies, and usually suggested, because the initial Phase I investigations were based upon limited data and visual inspections, the need to conduct more extensive investigations. Examples of recommendations made for dams are as follows:

(1) Develop, implement, and periodically test an emergency warning plan for use in the event of dam distress.

(2) Conduct more detailed hydrologic and hydraulic routing studies to better determine the downstream hazard and required spillway capacity, and modify the project as studies indicate.

(3) Make an assessment of the phreatic surface through the dam by installing piezometers. Perform and place on file a slope stability analysis of the embankment. This analysis should be conducted by a qualified geotechnical engineer and be based on actual phreatic surface and in situ material strength characteristics. Modify the project as studies indicate.

(4) Develop and implement a periodic inspection and maintenance plan.

The states were responsible for requiring dam owners to implement recommended remedial measures for unsafe dams and for providing the Corps the results of the remedial measures taken by dam owners. Table 22 of Appendix D shows the recorded data on unsafe dams on which remedial measures have been completed or initiated, the number of dams breached, and the number of dams on which no remedial measures have been recorded.

The 1,849 dams for which no remedial measures have been recorded represent 64% of the unsafe dams which meet the size requirements of P.L. 92-367. This large percentage indicates that dam owners are not adequately implementing remedial measures, and/or the states are not adequately monitoring remedial measures taken by dam owners. Some states offered the lack of adequate resources and authority as reasons for not requiring dam owners to implement remedial measures and have not provided evidence that this situation will change. Dam owners cited their inability to finance remedial measures and their non-acceptance of the assessment that dams evaluated as unsafe due to inadequate spillway capacity are subject to probable failure due to overtopping as reasons for not implementing remedial measures.

c. Cost of Remedial Measures. Table 23 of Appendix D shows the available recorded data on the cost of implementing remedial measures for dams. Most of the data shown are for constructing or enlarging spillways, repairing earth embankment and concrete gravity sections, and breaching dams. Significant cost data are also shown for engineering investigations, or studies, including dam-break and overtopping-stability analyses.

An average cost per dam for types, or combination of types, of remedial measures can be computed from the cost data shown in Table 22. However, since the data do not include information on the scope of remedial measures implemented for dams, projecting such data as general estimates of cost for remedial measures would be misleading. Detailed

design and construction data are needed to provide true estimates.

6. Cost of Inspections

The total cost of inspections was about $77.6 million. For the total 8,818 dams inspected, this is an average cost of about $8,800 per dam. Table 24 of Appendix D shows the total and average costs of inspections for each state. The average cost of inspections ranges from a low of $5,400 in North Carolina to a high of $17,900 in California.

Comparisons of the scopes of work of inspections generally show a correlation of lower cost to smaller scopes of work and higher cost to larger scopes of work. However, this is not true in all cases, and the low and high cost of inspections in some states as compared to others is attributed to other unidentified causes.

D. STATE DAM SAFETY PROGRAMS

Plans for implementing effective state dam safety programs called for the following state actions:

(1) Immediate implementation of any existing legislation, or the enactment of required new legislation and the corresponding implementation of regulatory procedures for effective dam safety programs.

(2) Participation in the inspection program in a manner that would provide training for state personnel.

1. State Legislation and Regulatory Practices

As previously indicated, the report transmitted to Congress in November 1976 included recommendations for a comprehensive national dam safety program based upon the provisions of the USCOLD "Model Law for State Supervision of Safety of Dams and Reservoirs." This model was also recommened as the basis for formulating state dam safety legislation and regulatory procedures. Briefly, it provides that the state regulatory agency for dams should perform the following functions to insure the adequacy of dams and reservoirs:

(1) Review and approve plans and specifications to construct, enlarge, modify, remove, or abandon dams.

(2) Perform periodic inspections during construction for the purpose of insuring compliance with approved plans and specifications.

(3) Upon completion of construction, issue certificates of approval permitting the impounding of water.

(4) Investigate dams and reservoirs at least every five years to determine their continued safety.

(5) Issue notices, when appopriate, to require owners of the dams and reservoirs to perform necessary maintenance or remedial work, revise operating procedures, or take other actions, including breaching dams when deemed necessary.

Appendix E provides final program evaluations of state dam safety programs based upon the attributes of dam safety legislation, regulatory functions (as indicated above), state funding, and technical staffing,

and shows the states which plan to maintain or implement adequate programs in the future. A summary of Appendix E shows:

(1) Forty (40) states have effective dam safety legislation.

(2) Alabama, Delaware, Hawaii, South Dakota, Puerto Rico and the U.S. Trust Territories have no dam safety legislation.

(3) Thirty-four (34) states have implemented effective regulatory practices.

(4) Twenty-nine (29) states have employed adequate technical staffing.

(5) Sixteen (16) states have developed programs which are completely adequate. These states are Arizona, California, Colorado, Georgia, Kentucky, Maryland, Nebraska, New Jersey, New Mexico, North Dakota, Pennsylvania, Rhode Island, South Carolina, Texas, Utah and Wyoming.

(6) The 16 states with adequate programs and two additional states have indicated that they will provide adequate funding for their programs without Federal aid.

(7) Seventeen (17) states with deficient programs have indicated that they plan to implement adequate programs in the near future.

2. <u>State Participation</u>

Participation in the inspection program by the states in a manner that would provide training for state personnel required state management of inventory and inspection activities and participation in all training provided by the Corps.

a. Inventory and Inspection Activities. As previously discussed, state personnel managed the data compiling for 73% of the inventory updating and managed 36% of the inspections. Comparison of state performance data in Tables 1 and 13 of Appendix D with the evaluations of state programs in Appendix E shows that the assessed adequacy of state programs is directly related to the level of state participation or performance in the program.

b. Training of State Personnel. Most states partcipated in the training provided for state personnel. During the first two years of the program (FY 78 and FY 79), the training of state personnel was limited to:

(1) Seminars on the procedures for investigating and evaluating the safety of dams.

(2) Exposure to the inspection process by participating in actual dam inspections.

(3) Instructions on the use of LANDSAT satellite data for detecting and locating water surfaces to verify and update the national inventory of dams.

During FY 80 and FY 81, the Corps conducted a total of 7 sessions of a one-week course designed to train state engineers to assess the general condition of dams with respect to safety, based upon available engineering data, visual inspection, and limited engineering analyses,

and to determine what emergency or remedial measures or additional engineering studies were necessary. These sessions were attended by 164 state engineers and technicians. Each state, except Illinois, Maine, North Dakota, Utah, Virgin Islands and Wisconsin, sent one or more representatives. Engineers from Corps field offices, Soil Conservation Service, Federal Emergency Management Agency, Forest Service, and Bureau of Reclamation also attended these sessions.

A consultant engineering firm, under contract to the Corps, developed the training course and presented the course sessions. The cost of the sessions were about $900 per student. Evaluations of the sessions indicated that they were very helpful in preparing the states to implement effective dam safety programs.

PART V

PROGRAM IMPACT

A. OWNERS OF DAMS

The impact of the inspection program on owners was varied. The owners of all dams inspected were provided technical information regarding their dams through inspection reports. These reports made them aware of the need for maintenance and proper design and construction of dams to insure safety.

The owners of unsafe dams were more severely affected. Not only were these owners faced with the need to provide funds for the repair of their dams, they were confronted with the threat of loss, or loss of the use of the water in the reservoirs of these dams, and the reduction in value of property surrounding the reservoirs. They were also confronted with the issue of liability for the hazards presented by their dams and subjected to various legal actions and adverse publicity regarding their dams.

Generally, the impact of the program was less severe on financially solvent owners than owners of dams who indicated the inability to fund recommended remedial measures. Some individual owners and organizations, such as water supply companies and state and municipal agencies, readily implemented remedial measures recommended for their dams. The owners who indicated the inability to provide funds for recommended remedial

measures have generally provided less maintenance for their dams, and offered the greatest resistance to complying with program requirements.

There were some areas of commonality among owners of dams inspected under the program. Many owners expressed the belief that the condition of their dam was not as severe as indicated in the inspection report, particularly if the dam had been in existence for many years without experiencing "problems." Flood criteria, particularly probable maximum flood (PMF), were also rejected by many owners.

It is expected that as a result of the inspection program, dam owners will provide better maintenance for their dams, and owners of future dams will seek to insure that these dams are better designed and constructed.

B. DOWNSTREAM INHABITANTS

Prior to the inspection program, many downstream inhabitants were unaware that a dam was located upstream of them, or of the potential hazards presented by the dam. Unless these downstream inhabitants were informed by the media or local officials, the inspection program had little impact. When downstream residents were made fully aware of the situation involving dams and warning/evacuation plans implemented, their response was generally positive. States generally responded to inquiries from downstream inhabitants. Some states are now in the process of trying to combine flood insurance programs with dam safety programs in

order to provide increased protection for downstream inhabitants. Obviously, where dam owners have taken corrective actions for deficient dams and/or provided emergency warning systems, downstream residents are better protected.

C. STATE, COUNTY, AND MUNICIPAL GOVERNMENTS

The impact of the inspection program on state governments was two-pronged. States were involved in the program as co-managers with the Corps and as dam owners. The impact on states resulting from their cooperation with the Corps in conducting the program is discussed throughout this report. The impact on states as dam owners, as well as county and municipal governments, was generally the same as for other private dam owners. However, these governments, as public service entities, had a greater need and organizational and financial capability to respond positively to the program than private owners. However, officials of these governments also indicated that the funds used for implementing remedial measures were difficult to obtain.

It is expected that since state, county, and municipal governments are responsible for the development of their communities and for providing safety and emergency sevices, the increased awareness generated by the program will aid them in the development and management of flood plain areas, and in the design, construction, maintenance, and operation of dams.

D. FEDERAL AGENCIES

When the President directed the initiation of inspections in December 1977, he directed the Secretaries of the Interior and Agriculture to cooperate with the Secretary of the Army in the development of technical criteria and guidelines for inspections and assistance to the states. This led to the direct involvement of Department of Agriculture agencies, including the Soil Conservation Service and Forest Service, and Department of the Interior agencies, including the Bureau of Reclamation, National Park Service, Bureau of Land Management, and Bureau of Indian Affairs. These agencies provided the Corps of Engineers available information on all dams for which they had some responsibility, including those located on lands under their jurisdiction.

Program activities were also coordinated with other Federal agencies which owned dams, had regulatory responsibilities for non-Federal dams, or had non-Federal dams located on lands under their jurisdiction.

The Soil Conservation Service (SCS) reviewed draft inspection reports and furnished technical assistance to owners effecting recommended remedial measures on dams for which they had provided financial, design, construction, and/or maintenance assistance.

Several SCS assisted dams were classified as unsafe. This was attributed to the use of criteria different than the "Recommended Guidelines for Safety Inspection of Dams" for assessing hazard potential

classifications of dams, and the use of different methods of establishing the probable maximum precipitation and unit hydrograph for runoff areas. Also, in many cases, the population density had increased significantly since the dams were designed and constructed. As a result of these situations, the SCS has reviewed their design procedures.

The Mine Safety and Health Administration of the Department of Labor was furnished copies of all inspection reports for dams associated with mining operations.

The Bureau of Indian Affairs requested the inspection of their dams and Indian-owned dams on trust lands under their jurisdiction. Some other Federal dams were also inspected on a cost-reimbursable basis at the request of the owning agencies.

The Federal Energy Regulatory Commission of the Department of Energy furnished the Corps with listings of projects licensed and those for which applications for licenses were pending to insure that dams regulated by them would not be inspected under the program.

The Federal Emergency Management Agency (FEMA) was assigned certain responsibilities for dam safety under Executive Order 12148, dated July 20, 1979. FEMA's principal responsibilities, as related to non-Federal dams, are to facilitate long-term dam safety programs within the states and private sector and assist the Administration in defining an

appropriate Federal role in non-Federal dam safety, including avenues for Federal-state cooperation.

To assist FEMA in accomplishing this task, program activities were continuously coordinated with FEMA, including furnishing monthly progress reports and inspection reports for dams evaluated as unsafe. FEMA also conducted dam safety seminars throughout the country. Corps personnel participated in these seminars. Other participants and audiences consisted of interested individuals from Federal, State, county and municipal government agencies, and the private sector.

The National Academy of Science has agreed to undertake a special study of FEMA's efforts in dam safety. The Assembly of Engineering of the National Academy of Science is using data from the program to consider what should be the role of the Federal government in non-Federal dam safety, and will assess the use of engineering guidelines in dam safety matters.

E. FEDERAL AND STATE LEGISLATORS

Actions taken by Federal and state legislators in response to the efforts and consequences of the inspection program are indications of the impact of the program on these legislators. Federal and state legislators made numerous inquiries to the Corps to obtain information for responding to their constituents. Legislators expressed extensive

interest concerning unsafe dams, particularly if there were several homes downstream of these dams or near the reservoir area.

Federal legislators have expressed a continuous interest in dam safety and the inspection program before and since the enactment of P.L. 92-367 in 1972. Legislation for amending P.L. 92-367 was proposed in the Congress each year of the four-year inspection program. However, none of these proposals, which have ranged in scope from provisions for continuous maintenance of the inventory by the Corps to comprehensive provisions for technical and financial support of state dam safety programs, were enacted.

Most state legislators responded positively to the efforts and consequences of the inspection program. As previously indicated, dam safety legislation has been enacted in several states. States have adopted provisions to resolve specific problems identified by the program. For example, Idaho enacted new regulations for mine tailings dams and devised a bonding scheme to aid in financing the rehabilitation of dams. Almost all of the states increased state funding for dam safety efforts. Federal and state legislators assisted local officials in obtaining Federal funds for remedial measures for publicly owned dams in Kansas and Missouri. In summary, overall response was positive, but the failure of legislators in Alabama, Delaware, Hawaii, South Dakota, Puerto Rico, and the U.S. Trust Territories to enact dam safety legislation reflects a lesser positive program impact.

PART VI

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This report represents the completion by the Chief of Engineers of all requirements mandated by the National Dam Inspection Act of 1972 (P.L. 92-367). In addition to complying with the specific requirements of P.L. 92-367 to (a) compile a national inventory of dams, (b) inspect non-Federal dams inventoried and provide the inspection results and advice for remedial measures to state governors and (c) formulate recommendations for a comprehensive national dam safety program, efforts have been made to encourage and assist the states to implement effective state dam safety programs for non-Federal dams.

A. NATIONAL INVENTORY OF DAMS

A national inventory of 68,153 dams has been compiled and recorded in a computerized data base. Of this number, 68,153 meet the size requirements of P.L. 92-367; most of the dams in the inventory which do not meet the size requirements were listed in the original inventory. The inventory of dams serves as a reliable data base for state and Federal dam safety programs. In order to remain reliable, the inventory must be continuously updated; however, the Corps of Engineers has not been authorized by Congress nor have funds been provided to maintain the inventory.

B. INSPECTION OF DAMS

P.L. 92-367 required the inspection of all dams inventoried, with few exceptions. In formulating objectives to comply with the requirements of the law, it was recognized that to inspect such a large number of dams would require enormous manpower and funds and probably was not necessary to define the national dam safety problem.

The decision was made that inspecting all dams which presented a high hazard potential and a sampling of those which presented a significant hazard potential would serve to identify immediate threats to human life and property, and would also fulfill the intent of P.L. 92-367 to define the national dam safety problem.

The inspection of 8,818 dams has identified 2,925 unsafe dams (33% of the dams inspected). Remedial measures have not been implemented for most of the unsafe dams. The unsafe condition of such a large percentage of non-Federal dams and the lack of implementation of recommended remedial measures by owners indicate that, for whatever the reasons might be, most owners are not willing to modify, repair or maintain their dams, and most states are not willing to require them to do so.

C. STATE DAM SAFETY PROGRAMS

The large scope of the proposed inspection program facilitated the decision to involve the states in a manner that would assist them in

implementing effective state dam safety programs. The results of this added objective were less than desired. Most states participated in the program in the manner prescribed to aid in developing effective programs. The assessment of state dam safety programs at the completion of the inspection program revealed that (a) almost all states had developed at least a nucleus for a dam safety program, (b) 40 states had enacted effective dam safety legislation, but 6 states had no dam safety legislation, (c) 34 states had implemented effective regulatory practices, (d) 29 states had employed adequate technical staffing, and (e) 16 states had developed programs which were completely adequate. The 16 states with adequate programs and two additional states indicated that they will provide adequate funding for their programs without Federal aid. Seventeen (17) states with deficient programs indicated that they plan to implement adequate programs in the near future.

D. RECOMMENDATIONS FOR IMPROVING DAM SAFETY

Based upon the results, findings, and conclusions of the National Program of Inspection of Non-Federal Dams, and the Federal position that the states are responsible for the safety of non-Federal dams within their boundaries, the following recommendations are offered for improving the safety of non-Federal dams throughout the nation:

(1) The Corps of Engineers should be authorized and funded to continuously maintain the national inventory of dams.

(2) If Federal legislation is enacted providing Federal funds for implementing remedial measures for dams inspected under the non-Federal dam inspection program and determined to be unsafe, only those dams which are owned by state, county, or municipal governments, and whose major purpose is public water supply and flood protection should be considered. Such legislation should also establish minimum standards for state dam safety programs, and only those states meeting these standards would be eligible to receive Federal funding.

(3) To utilize the existing Federal technical capability in dam safety, a Federal agency should be designated to furnish technical assistance to the states, upon request, concerning implementation of dam safety programs.

(4) The construction of non-Federal dams on Federal lands should not be allowed unless the dams are designed and constructed to meet minimum standards established by a designated Federal agency and the proposed dam owners agree legally to properly maintain these dams. Owners of existing non-Federal dams on Federal lands should be required to upgrade and maintain such dams to meet minimum standards.

(5) The Federal Emergency Management Agency (FEMA) should concentrate their dam safety efforts on those dams inspected by the Corps of Engineers and considered to be unsafe. FEMA should, using the Corps, publicize and promote design criteria impinging on dam safety, especially that pertaining to the Probable Maximum Flood (PMF), and maximize public awareness when dams fail because of spillway deficiencies.

(6) The National Oceanic and Atmospheric Agency (NOAA) should be informed of the location of all dams with unsafe spillways to enable special alerts when unsafe flows are likely to be approached.

(7) The Federal government should remove restrictions on block grants to states, where they exist, so funds can be used for dam safety. If there are no restrictions, it could be specified that dam safety will be considered as one of the uses.

These recommendations might not seem to provide for "a comprehensive national program" for the regulation of dams as mandated by P.L. 92-367. However, bearing in mind the respective responsibilities of the states, the owners and the Federal government, the scope of the recommendations stretches the Federal purview.

APPENDIX A

NATIONAL DAM INSPECTION ACT

Public Law 92-367
92nd Congress, H. R. 15951
August 8, 1972

An Act

To authorize the Secretary of the Army to undertake a national program of inspection of dams.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the term "dam" as used in this Act means any artificial barrier, including appurtenant works, which impounds or diverts water, and which (1) is twenty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier, or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of fifty acre-feet or more. This Act does not apply to any such barrier which is not in excess of six feet in height, regardless of storage capacity or which has a storage capacity at maximum water storage elevation not in excess of fifteen acre-feet, regardless of height.

National dam inspection program. "Dam."

SEC. 2. As soon as practicable, the Secretary of the Army, acting through the Chief of Engineers, shall carry out a national program of inspection of dams for the purpose of protecting human life and property. All dams in the United States shall be inspected by the Secretary except (1) dams under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, or the International Boundary and Water Commission, (2) dams which have been constructed pursuant to licenses issued under the authority of the Federal Power Act, (3) dams which have been inspected within the twelve-month period immediately prior to the enactment of this Act by a State agency and which the Governor of such State requests be excluded from inspection, and (4) dams which the Secretary of the Army determines do not pose any threat to human life or property. The Secretary may inspect dams which have been licensed under the Federal Power Act upon request of the Federal Power Commission and dams under the jurisdiction of the International Boundary and Water Commission upon request of such Commission.

Army, authorization.

Exceptions.

41 Stat. 1063; 49 Stat. 863. 16 USC 791a.

86 STAT. 506
86 STAT. 507

SEC. 3. As soon as practicable after inspection of a dam, the Secretary shall notify the Governor of the State in which such dam is located the results of such investigation. The Secretary shall immediately notify the Governor of any hazardous conditions found during an inspection. The Secretary shall provide advice to the Governor, upon request, relating to timely remedial measures necessary to mitigate or obviate any hazardous conditions found during an inspection.

Notice to Governors.

SEC. 4. For the purpose of determining whether a dam (including the waters impounded by such dam) constitutes a danger to human life or property, the Secretary shall take into consideration the possibility that the dam might be endangered by overtopping, seepage, settlement, erosion, sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboard, gates on conduits, or other conditions which exist or which might occur in any area in the vicinity of the dam.

SEC. 5. The Secretary shall report to the Congress on or before July 1, 1974, on his activities under the Act, which report shall include, but not be limited to—

Report to Congress.

(1) an inventory of all dams located in the United States;

(2) a review of each inspection made, the recommendations furnished to the Governor of the State in which such dam is located and information as to the implementation of such recommendation;

(3) recommendations for a comprehensive national program for the inspection, and regulation for safety purpose of dams of the Nation, and the respective responsibilities which should be assumed by Federal, State, and local governments and by public and private interests.

Liability.

SEC. 6. Nothing contained in this Act and no action or failure to act under this Act shall be construed (1) to create any liability in the United States or its officers or employees for the recovery of damages caused by such action or failure to act; or (2) to relieve an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam.

Approved August 8, 1972.

LEGISLATIVE HISTORY:

HOUSE REPORT No. 92-1232 (Comm. on Public Works).
CONGRESSIONAL RECORD, Vol. 118 (1972):
July 24, considered and passed House.
July 25, considered and passed Senate.
WEEKLY COMPILATION OF PRESIDENTIAL DOCUMENTS, Vol. 8, No. 33:
Aug. 9, Presidential statement.

GPO 996-112

APPENDIX B

Department of the Army
Office of the Chief of Engineers
Washington, D.C. 20314

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DAEN-CWE

Engineer Regulation
No. 1110-2-106

26 September 1979

Engineering and Design
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS

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Department of the Army
Office of the Chief of Engineers
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ER 1110-2-106
CFR 33

DAEN-CWE

Engineer Regulation
No. 1110-2-106

26 September 1979

Engineering and Design
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS

1. Purpose. This regulation states objectives, assigns responsibilities and prescribes procedures for implementation of a National Program for Inspection of Non-Federal Dams.

2. Applicability. This regulation is applicable to all Divisions and Districts having Civil Works functions.

3. References.

a. The National Dam Inspection Act, Public Law 92-367, 8 August 1972.

b. Freedom of Information Act, Public Law 87-487, 4 July 1967.

c. ER 500-1-1

4. Authority. The National Dam Inspection Act, Public Law 92-367, 8 August 1972 authorizes the Secretary of the Army, acting through the Chief of Engineers, to carry out a national program of inspection of non-Federal dams for the purpose of protecting human life and property.

5. Scope. The program provides for:

a. An update of the National Inventory of Dams.

b. Inspection of the following non-Federal dams (The indicated hazard potential categories are based upon the location of the dams relative to developed areas):

(1) Dams which are in the high hazard potential category (located on Federal and non-Federal lands).

(2) Dams in the significant hazard potential category believed by the State to represent an immediate danger to the public safety due to the actual condition of the dam.

This regulation supersedes ER 1110-2-104, dated 11 May 1973.

(3) Dams in the significant hazard potential category located on Federal lands.

(4) Specifically excluded from the national inspection program are (a) dams under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, the International Boundary and Water Commission and the Corps of Engineers and (b) dams which have been constructed pursuant to licenses issued under the authority of the Federal Power Act, and (c) dams which have been inspected within the 12-month period immediately prior to the enactment of this act by a State agency and which the Governor of such State requests be excluded from inspection.

6. Objectives. The objectives of the program are:

a. To update the National Inventory of Dams by 30 September 1980.

b. To perform the initial technical inspection and evaluation of the non-Federal dams described in paragraph 5 to identify conditions which constitute a danger to human life or property as a means of expediting the correction of hazardous conditions by non-Federal interests. The inspection and evaluation is to be completed by 30 September 1981.

c. To obtain additional information and experience that may be useful in determining if further Federal actions are necessary to assure national dam safety.

d. Encourage the States to establish effective dam safety programs for non-Federal dams by 30 September 1981 and assist the States in the development of the technical capability to carry out such a program.

7. Program Execution.

a. Responsibilities.

(1) The owner has the basic legal responsibility for potential hazards created by their dam(s). Phase II studies, as described in Chapter 4, Appendix D, and remedial actions are the owner's responsibility.

(2) The State has the basic responsibility for the protection of the life and property of its citizens. Once a dam has been determined to be unsafe, it is the State's responsibility to see that timely remedial actions are taken.

(3) The Corps of Engineers has the responsibility for executing the national program. The Federal program for inspection of dams does not modify the basic responsibilities of the States or dam owners. The Engineering Division of the Civil Works Directorate is responsible for overall program goals, guidance, technical criteria for inspections and inventory and headquarters level coordination with other agencies. The Water Resources Support Center (WRSC) located at Kingman Building, Fort Belvoir, Virginia 22060 is responsible for:

* (a) Program coordination of both the inventory and inspection programs.

(b) Developing and defining functional tasks to achieve program objectives.

(c) Determining resource requirements. (Budget)

(d) Compiling and disseminating progress reports.

(e) Monitoring and evaluating program progress and recommending corrective measures as needed.

(f) Collecting and evaluating data pertaining to inspection reports, dam owners' responses to inspection report recommendations, attitudes and capabilities of State officials, State dam safety legislation, Architect-Engineer performance, etc., for defining a comprehensive national dam safety program.

(g) Responding to Congressional, media, scientific and engineering organization and general public inquiries.

Division and District offices are responsible for executing the program at the State level. Assignment of Division responsibilities for States is shown in Appendix A.

b. State Participation. Where State capability exists, every effort should be made to encourage the State to execute the inspection program either with State personnel or with Architect-Engineer (A-E) contracts under State supervision. If the State does not have the capability to carry out the inspection program, the program will be managed by the Corps of Engineers utilizing Corps employees or contracts with A-E firms.

8. Update of National Inventory of Dams. (RCS-DAEN-CWE-17/OMB NO. 49-R0421)

a. The National Inventory of Dams should be updated and verified to include all Federal and non-Federal dams covered by the Act. Those

dams are defined as all artificial barriers together with appurtenant works which impound or divert water and which (1) are twenty-five feet or more in height or (2) have an impounding capacity of fifty acre-feet or more. Barriers which are six feet or less in height, regardless of storage capacity, or barriers which have a storage capacity at maximum water storage elevation of fifteen acre-feet or less, regardless of height, are not included.

b. Inventory data for all dams shall be provided in accordance with Appendix B.

c. The hazard potential classification shall be in accordance
* with paragraph 2.1.2 Hazard Potential of the Recommended Guideline for Safety Inspection of Dams (Appendix D to this ER).

*

d. As in the original development of the inventory, the States should be encouraged to participate in the work of completing, verifying and updating the inventory. Also, when available, personnel of other appropriate Federal agencies should be utilized for the inventory work on a reimbursable basis. Work in any State may be accomplished:

(1) Under State supervision utilizing State personnel or Architect-Engineers contracts.

(2) Under Corps supervision utilizing Corps employees, employees of other Federal agencies or Architect-Engineer contracts.

e. A minimum staff should be assigned in Districts and Divisions to administer and monitor the inventory activities. Generally, the work should be accomplished by architect-engineers or other Federal agency personnel under State or Corps supervision. Corps personnel should participate in the inventory only to the extent needed to assure that accurate data are collected.

f. The National Inventory of Dams computerized data base is stored on the Boeing Computer Services (BCS) EKS computer system in Seattle, Washington. The data base uses Data Base Management System 2000 and is accessible for query by all Corps offices.

g. Appendix B indicates details on accessing and updating inventory data.

h. Appendix I describes the procedure for using NASA Land Satellite (LANDSAT) Multispectral Scanner data along with NASA's Surface Water Detection and Mapping (DAM) computer program to assist in updating and verifying the National Inventory of Dams.

i. All inventory data for dams will be completed and verified utilizing all available sources of information (including LANDSAT overlay maps) and will include site visitation if required. It is the responsibility of the District Engineer to insure that the inventory of each State within his area of responsibility is accurate and contains the information required by the General Instructions for completing the forms for each Federal and non-Federal dam.

9. Inspection Program. (RCS-DAEN-CWE-17 AND OMB NO. 49-R0421)

a. Scheduling of Inspections. The Governor of each State or designee will continue to be involved in the selection and scheduling of the dams to be inspected. Priority will be given to inspection of those dams considered to offer the greatest potential threat to public safety.

(1) No inspection of a dam should be initiated until the hazard potential classification of the dam has been verified to the satisfaction of the Corps. Dams in the significant hazard category should be inspected only if requested by the State and only then if the State can provide information to show that the dam has deficiencies that pose an immediate danger to the public safety. Guidance for the selection of significant catagory non-Federal dams on Federal lands will be given in the near future.

(2) Selection for inspection of non-Federal dams located on Federal lands or non-Federal dams designed and constructed under the jurisdiction of some Federal agency, should be coordinated with the responsible Federal agency. The appropriate State or regional representative of the Federal agency also should be contacted to obtain all available data on the dam. Representatives of the agency may participate in the inspection if they desire and should be given the opportunity to review and comment on the findings and recommendations in the inspection report prior to submission to the Governor and the dam owner. Examples of such dams are: non-Federal dams built on lands managed by National Forest Service, Bureau of Land Management, Fish and Wildlife Service, etc.; non-Federal dams designed and constructed by the Soil Conservation Service of the U.S. Department of Agriculture; high hazard mine tailings and coal mine waste dams under the jurisdiction of the Mine Safety and Health Administration, Department of Labor.

(3) Indian-owned dams on trust lands are considered to be non-Federal dams. All dams in the high hazard potential category will be inspected. Privately-owned dams located on Indian lands are to be included in the program, however BIA-owned dams on Indian lands are Federal dams and are exempt.

b. Procedures. The Division Engineer is responsible for the quality of inspections and reports prepared by the District Engineer. Close liaison between the District Engineer and the State agency or A-E firm responsible for the inspections will be required in order to obtain a dependable result. To avoid undesirable delays in the evaluation of safety of individual dams, contracts with A-E's or agreements with States which are managing the program will provide that reports be completed and furnished to the District Engineer within a specified time after completion of the on-site inspection of the dam.

(1) Inspection Guidelines. The inspection should be conducted in accordance with the Recommended Guidelines for Safety Inspection of Dams (Appendix D to this ER). Expanded Guidance for Hydrologic and Hydraulic Assessment of Dams is provided in Appendix C. The criteria in the recommended guidelines are screening criteria to be used only for initial determinations of the adequacy of the dam. Conditions found during the investigation which do not meet the guideline recommendations should be assessed as to their importance from the standpoint of the degree of risk involved.

(2) Coordinators. Experience has shown that coordination and communications among technical disciplines, Public Affairs Office, emergency officials, training officers, operations personnel, State representatives and A-E firms has been best in those districts where

one person was delegated the responsibility for coordinating the actions of all involved elements. Each district should evaluate its overall coordination procedures to insure that all involved elements have the best possible access to necessary data.

(3) Field Investigations should be carried out in a systematic manner. A detailed checklist or inspection form should be developed and used for each dam inspection and appended to the inspection report. The size of the field inspection team should be as small as practicable, generally consisting of only one representative of each required discipline in order to control the costs of the inspection without sacrificing the quality of the inspection. The inspection team for the smaller less complex dams should be limited to two or three representatives from appropriate technical areas with additional specialists used only as special conditions warrant. The larger more complex projects may require inspection teams of three or four specialists. Performance of overly detailed and precise surveys and mapping should be avoided. Necessary measurement of spillway, dam slopes, etc. can generally be made with measuring tapes and hand levels.

(4) Additional Engineering Studies. Dam inspections should be limited to Phase I investigations as outlined in Chapter 3 of Appendix D. However, if recommended by the investigating engineer and approved by the District Engineer, some additional inexpensive investigations may be performed when a reasonable judgment on the safety of the dam cannot be made without additional investigation. Any further Phase II investigation needed to prove or disprove the findings of the District Engineer or to devise remedial measures to correct deficiencies are the responsibility of the owner and will not be undertaken by the Corps of Engineers.

(5) Assessment of the Investigation.

(a) The findings of the visual inspection and review of existing engineering data for a dam shall be assessed to determine its general condition. Dams assessed to be in generally good condition should be so described in the inspection report. Deficiencies found in a dam should be described and assessed as to the degree of risk they present. The degree of risk should consider only loss of life and/or property damage resulting from flooding due to dam failure. Loss of project benefits i.e., municipal water supply, etc., should not be considered. If deficiencies are assessed to be of such a nature that, if not corrected, they could result in the failure of the dam with subsequent loss of life and/or substantial property damage, the dam should be assessed as "Unsafe." If the probable failure of an "Unsafe" dam is judged to be imminent and immediate action is required

to reduce or eliminate the hazard, the "unsafe" condition of the dam should be considered an "emergency." If the probable failure is judged not to be imminent, the "unsafe" condition should be considered a "non-emergency."

(b) Adequacy of Spillway. The "Recommended guidelines for Safety Inspection of Dams," Appendix D, provide current, acceptable inspection standards for spillway capacity. Any spillway capacity that does not meet the criteria in the "Guidelines" is considered inadequate. When a spillway's capacity is so deficient that it is seriously inadequate, the project must be considered unsafe. If all of the following conditions prevail, the Governor of the State shall be informed that such project is unsafe:

1. There is high hazard to loss of life from large flows downstream of the dam.

2. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam over that which would exist just before overtopping failure.

3. The spillway is not capable of passing one-half of the probable maximum flood without overtopping the dam and causing failure.

Classification of dams with seriously inadequate spillways as "unsafe, non-emergency" is generally a proper designation of the urgency of the unsafe condition. However, there may be cases where the spillway capacity is unusually small and the consequences of dam overtopping and failure would be catastrophic. In such cases, the unsafe dam should be classified as an emergency situation.

(6) All inspection reports will receive one level of independent review by the Corps. If the reports are prepared by the Corps, the independent review may be performed internally within the district office. However, in cases which involve significant economic, social or political impacts and technical uncertainties in evaluating the dams, advice may be obtained from the staffs of the Division Engineer and the Office, Chief of Engineers.

c. Reports.

(1) Preparation. A written report on the condition of each dam should be prepared as soon as possible after the completion of the field inspection and assessment. A suggested report format is attached as Appendix E. It is important that the inspection report be completed in a timely manner. For inspections being done by Corps employees, it is suggested that once an inspection team has been assigned to a dam inspection it be allowed to complete the inspection and report without interruption by other work.

(2) Review and Approval. The coordinating engineer should determine which disciplines should review the report and establish a procedure to accomplish the review in a timely manner. A review panel, made up of the appropriate Division and Branch Chiefs has worked well in some districts. Use of a review panel should be seriously considered by all Districts. All inspection reports shall be approved by the District Engineer who will maintain a complete file of final approved reports. Any State or Federal agency having jurisdiction over the dam or the land on which the dam is built should be given the opportunity to review and comment on the report prior to submission to the Governor or dam owner. The District Engineer will transmit final approved reports to the Governor of the State and the dam owner (or the Governor only, when requested in writing by State officials). If the report is initially furnished to the Governor only, a period of up to ten days may be allowed before the report is furnished to the dam owner. If the Governor or the owner indicates additional technical information is available that might affect the assessment of the dam's condition, the District Engineer will furnish the proposed final report to the Governor and the owner and establish a definite time period for comments to be furnished to the District Engineer prior to report approval.

(3) In general the Governor will be responsible for public release of an inspection report and for initiating any public Statements. However, an approved report must be treated as any other document subject to release upon request under the Freedom of Information Act. The letters of transmittal to the Governor and owner should indicate that under the provisions of the Freedom of Information Act, the documents will be subject to release upon request after receipt by the Governor. Proposed final reports will be considered as internal working papers not subject to release under the Freedom of Information Act. Corps personnel, A-E contractor personnel and others working under supervision of the Corps will be cautioned to avoid public statements about the condition of the dam until after the District Engineer has approved the report. The Corps will respond fully to inquiries after the Governor has received the approved report or been notified of an unsafe dam. An information copy of the report should be sent to the District office normally having jurisdiction if other than the District responsible for the inspection.

(4) Follow-up Action. A Federal investment of the magnitude anticipated for this inspection program makes it desirable that a reporting system be established to keep the District Engineer abreast of the implementation of the recommendations in the inspection reports. The letters of transmittal to the Governor and owner will request that the District Engineer be informed of the actions taken on the recommendations in the inspection reports. However, the National

Dam Inspection Act only authorizes the initial inspection of certain dams; therefore, once a report is completed no reinspection will be undertaken.

d. Unsafe Dams. The investigating engineer will be required to immediately notify the District Engineer when a dam is assessed as being unsafe. He will also indicate if probable failure of the unsafe dam is judged to be imminent and immediate action is required to reduce or eliminate the threat. The District Engineer will evaluate the findings of the investigating team and will immediately notify the Governor and the owner if the findings are Unsafe Non-Emergency or Unsafe-Emergency. The appropriate State agency and the Corps of Engineers officials having emergency operation responsibility for the area in which the dam is located will also be notified. The information provided in the unsafe dam notice shall be as indicated in Appendix F. Any emergency procedures or remedial actions deemed necessary by the District Engineer will be recommended to the Governor who has the responsibility for any corrective actions. As provided in ER 500-1-1, Corps assistance under PL 84-99 "Advance Measures," may be made available to complement the owner's and Governor's action under certain conditions and subject to the approval of the Director of Civil Works. The District Engineer's Emergency Operation Officer will coordinate the advance measures request in accordance with existing procedures. Coordination will be maintained between the District responsible for emergency action under PL 84-90 and the District responsible for the inspection.

e. Emergency Action Plans. An emergency action plan should be available for every dam in the high and significant hazard category. Such plans should outline actions to be taken by the operator to minimize downstream effects of an emergency and should include an effective warning system. If an emergency action plan has not been developed, the inspection report should recommend that the owner develop such an action plan. However, the Corps has no authority to require an emergency action plan.

10. Progress Reports. Progress reports should be submitted monthly by the Division Engineer to WRSC. The reports shall include progress through the last Saturday of the month and should be mailed by the following Monday. The reports shall contain the information and be typewritten in the format shown in Appendix G. Copies of Unsafe Dam Data Sheets will be submitted with the progress report. Copies of the completed inspection report for Dams in the Unsafe-Emergency category will be submitted also. (RCS-DAEN-CWE-19)

11. Contracts.

a. Corps of Engineers Supervision. Contracts for performing inventory and inspection activities under supervision of the Corps of Engineers shall be Fixed-Price Architect Engineer Contracts for Services. A sample scope of work setting forth requirements is provided in Appendix H. Experience has shown that costs for
* individual dam inspections have been lower when multiple inspections are included in one contract. Therefore, each A-E contract should include multiple dam inspections where practicable. Corps participation in A-E inspections should be held to a minimum. Corps representatives should participate in only enough A-E inspections to assure the quality of the inspections.

b. State Supervision. Contracts with States for performing inventory and inspection activities under State supervision may be either a Cost-Reimbursement Type A-E Contract for Services or a Fixed-Price type contract. The selection of Architect-Engineers by the State should require approval of the Corps of Engineers Contracting Officer. The negotiated price for A-E services under cost-reimbursement type contracts with States will also require approval by the Contracting Officer. Contracts with States should require timely submission of the inspection reports to the District Engineer for review and approval. The contract provisions should also prevent public release of or public comment on the inspection report until the District Engineer has reviewed and approved the report. Corps of Engineers participation in State inspections should be limited to occasional selected inspections to assure the quality of the State program.

12. Training. As indicated in paragraph 6, one objective of the inspection program for non-Federal Dams is to prepare the States to provide effective dam safety programs. In many States this will require training of personnel of State agencies in the technical aspects of dam inspections. The Office, Chief of Engineers is studying the need for and content of a comprehensive Corps-sponsored training program in dam inspection technology. Pending the possible adoption of such a comprehensive plan, Division and District Engineers are encouraged to take advantage of suitable opportunities to provide needed training in dam safety activities to qualified employees of State agencies and, when appropriate, to employees of architect-engineer firms engaged in the program. The following general considerations should be observed in providing such training:

a. Priority must be placed on inspection of dams and updating the national dam inventory; hence, diversion of resources to training activities should not deter or delay these principle program functions.

* b. Salaries, per diem and travel expenses relating to training activities of State employees will be a State expense. There will be no tuition charge for State employees. *

c. Architect-Engineer firms will be required to pay expenses and
* tuition costs for their employees participating in Corps-sponsored training activities.

d. Corps-sponsored training will require that each trainee is a qualified engineer or geologist and will concentrate on engineering technology related directly to dam safety. (This may require screening of proposed candidates for training.)

e. Under this program, the Corps will not sponsor training that is intended primarily to satisfy requirements for a degree.

f. Training by participation in actual dam inspections and/or management of the inspection program should be encouraged.

FOR THE CHIEF OF ENGINEERS:

FORREST T. GAY, III
Colonel, Corps of Engineers
Executive Director, Engineer Staff

9 Appendixes
APP A - Division Assignments
APP B - Inventory of Dams
APP C - Hydro. and Hyd. Assessment of Dams
APP D - Recomm. Guidelines for Safety Inspection of Dams
APP E - Sugg. Outline of Insp. Rpt Natl. Dam Insp. Prog.
APP F - Instr. for Unsafe Dam Data Sheet
APP G - Monthly Progress Report
APP H - Sugg. Scope of Work
APP I - Proc. for Using NASA Scanner Data

Appendix A

Division Assignments

To facilitate better coordination with the States, the Division Engineers are responsible for the dam inspection program by States as follows:

New England Division: Maine, Rhode Island, Connecticut, Vermont, New Hampshire, Massachusetts

North Atlantic Division: New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, District of Columbia

Ohio River Division: West Virginia, Ohio, Kentucky, Tennessee, Indiana

South Atlantic Division: North Carolina, South Carolina, Georgia, Florida, Alabama, Puerto Rico, Virgin Islands

Lower Mississippi Valley Division: Mississippi, Louisiana, Missouri

North Central Division: Michigan, Wisconsin, Illinois, Minnesota, Iowa

Southwestern Division: Arkansas, Oklahoma, Texas, New Mexico

Missouri River Division: Kansas, Nebraska, South Dakota, North Dakota, Wyoming, Colorado

North Pacific Division: Oregon, Idaho, Montana, Washington, Alaska

South Pacific Division: Utah, California, Arizona, Nevada

Pacific Ocean Division: Hawaii, Trust Territories, American Samoa

APPENDIX B

INVENTORY OF DAMS
(RCS-DAEN-CWE-17 AND OMB NO. 49-R0421)

1. The updating of the inventory will include the completion of all items of data for all dams now included in the inventory, verification of the data now included in the inventory, and inclusion of complete data for all appropriate existing dams not previously listed. Data completion, verification and updating will be scheduled over a three year period.

2. The inventory data will be recorded on ENG Form 4474 and ENG Form 4474A (Exhibit 2). The general instructions for completing the forms are printed on the back of the forms. Parts I and II of the forms are to be fully completed. The instruction for completing Item 29, Line 5, Part II (ENG Form 4474A) is revised to conform identically with the hazard potential classification contained in the recommended guidelines for safety inspection of dams. Additional data has been added to designate Corps districts in which the dam is located, Federal agency owned dams, Corps owned dams, Federal agency regulated dams, dams constructed with technical or financial assistance of the U.S. Soil Conservation service, and privately owned dams located on Federal property. Forms available from "OCE Publications Depot".

3. All inventory data will be verified utilizing all available sources of information and will include site visitation if required.

4. The Inventory Data Base is stored on the Boeing Computer Services (BCS) EKS System in Seattle, Washington. The data is available to all Corps offices for queries using Data Base Management System 2000 (S2K)

a. To access the National Data Base log on BCS and type the following:

GET,DAMS/UN=CECELB

CALL,DAMS

b. For current information and changes to the National Inventory Data Base, type:

OLD,HOTDAM/UN=CEC1AT

LIST

5. The inventory update data will be furnished and the National Data Base will be updated on a monthly basis. The monthly submission will cover all dams whose inventory data were completed since the last report. The update data will be loaded directly onto the the Boeing Computer by the field office.

a. The procedure for loading the data on the Boeing Computer can be printed by accessing the Boeing Computer and listing the information file "HOTDAM." (See paragraph 4b. above)

b. It is the responsibility of the submitting office to edit the data prior to furnishing it for the update. Editing will be accomplished by processing the data using the Inventory Edit Computer program developed by the Kansas City District. This procedure is described in the "HOTDAM" file.

6. Federal agencies will be uniformly designated by major and minor abbreviations according to the following list whenever applicable to Items 46 through 53. Abbreviations are to be left justified within the field with one blank separating major and minor abbreviations.

	MAJOR	MINOR
a. International Boundary and Water Commission	IBWC	
b. U.S. Department of Agriculture:		
(1) Soil Conservation Service	USDA	SCS
(2) Forest Service	USDA	FS
c. U.S. Department of Energy Federal Energy Regulatory Commission	DOE	FERC
d. Tennessee Valley Authority	TVA	
e. U.S. Department of Interior:		
(1) Bureau of Sport Fisheries and Wildlife	DOI	BSFW
(2) Geological Survey	DOI	GS
(3) Bureau of Land Management	DOI	BLM
(4) Bureau of Reclamation	DOI	USBR
(5) Bureau of Indian Affairs	DOI	BIA
f. U.S. Department of Labor		
(1) Mine Safety and Health Administration	DOL	MSHA
g. Corps of Engineers:		
(1) Lower Mississippi Valley Division:		
(a) Memphis District	DAEN	LMM
(b) New Orleans District	DAEN	LMN
(c) St. Louis District	DAEN	LMS
(d) Vicksburg District	DAEN	LMK
(2) Missouri River Division:		
(a) Kansas City District	DAEN	MRK
(b) Omaha District	DAEN	MRO
(3) New England Division	DAEN	NED
(4) North Atlantic Division:		
(a) Baltimore District	DAEN	NAB
(b) New York District	DAEN	NAN
(c) Norfolk District	DAEN	NAO
(d) Philadelphia District	DAEN	NAP

	MAJOR	MINOR
(5) North Central Division:		
(a) Buffalo District	DAEN	NCB
(b) Chicago District	DAEN	NCC
(c) Detroit District	DAEN	NCE
(d) Rock Island District	DAEN	NCR
(e) St. Paul District	DAEN	NCS
(6) North Pacific Division:		
(a) Alaska District	DAEN	NPA
(b) Portland District	DAEN	NPP
(c) Seattle District	DAEN	NPS
(d) Walla Walla District	DAEN	NPW
(7) Ohio River Division:		
(a) Huntington District	DAEN	ORH
(b) Louisville District	DAEN	ORL
(c) Nashville District	DAEN	ORN
(d) Pittsburgh District	DAEN	ORP
(8) Pacific Ocean Division	DAEN	POD
(9) South Atlantic Division:		
(a) Charleston District	DAEN	SAC
(b) Jacksonville District	DAEN	SAJ
(c) Mobile District	DAEN	SAM
(d) Savannah District	DAEN	SAS
(e) Wilmington District	DAEN	SAW
(10) South Pacific Division:		
(a) Los Angeles District	DAEN	SPL
(b) Sacramento District	DAEN	SPK
(c) San Francisco District	DAEN	SPN
(11) Southwestern Division:		
(a) Albuquerque District	DAEN	SWA
(b) Fort Worth District	DAEN	SWF
(c) Galveston District	DAEN	SWG
(d) Little Rock District	DAEN	SWL
(e) Tulsa District	DAEN	SWT

7. Procedures for Revising and Updating the Inventory of Dams Master File.

a. To Change Correct or Add an Item. Submit a change card that contains the identification assigned to the dams (Columns 1 thru 7), the proper card code (Column 80) and only the item or items changed, corrected or added. Data on the master file is added or replaced on an item for item basis.

b. To Delete an Item. Submit a change card that contains the identification assigned to the dam, (Columns 1 thru 7), the proper card code (Columns 80), and an asterisk (*) in the left most column of the item or items to be deleted. More than one item can be changed, corrected, added on or deleted from the same card.

c. To Delete the Entire Data for a Dam from the Master File.

Submit a zero (0) card punched as follows:

Columns 1 thru 7 - Item 1 identification assigned to the dam
Columns 8 thru 10 - Item 2, Division Code
Columns 11 thru 16 - The word DELETE
Columns 17 thru 79 - Blank Spaces
Column 80 - A zero

8. Keypunch Instructions and Punched Card Formats.

a. Table 1 describes the character set to be used for keypunch cards of ENG Forms 4474 and 4474A.

b. Exhibit 1 is the EDPC keypunch instructions and punch card formats defining the data fields (Items) and card columns to be used in preparing punched cards in compliance with the requirements of this regulation.

c. Exhibit 2 are prints of ENG Forms 4474 and 4474A which are laid out in punch card format to facilitate punching cards directly from the completed forms.

Table 1

STANDARD CHARACTER SET AND CARD CODES

A	12-1		0	0
B	12-2		1	1
C	12-3		2	2
D	12-4		3	3
E	12-5		4	4
F	12-6		5	5
G	12-7		6	6
H	12-8		7	7
I	12-9		8	8
J	11-1		9	9
K	11-2	space	blank	
L	11-3		,	0-3-8
M	11-4		.	12-3-8
N	11-5		-	11
O	11-6		*	11-4-8
P	11-7		/	0-1
Q	11-8		$	11-3-8
R	11-9			
S	0-2			
T	0-3			
U	0-4			
V	0-5			
W	0-6			
X	0-7			
Y	0-8			
Z	0-9			

NON-STANDARD CHARACTER SET

(	12-5-8	0-8-4
)	11-5-8	12-8-4
"	8-4	
'	11-8-5	
+	12	
%	8-6	
;	12-8-7	11-8-6
:	8-2	
#	0-8-6	
@	8-5	
=	8-3	8-6

EDPC KEYPUNCH INSTRUCTIONS (Continued)

JOB TITLE: INVENTORY OF UNITED STATES DAMS

JOB NO.:

CARD IDENTIFICATION: CARDS 0&1

SOURCE: ENG FORM 4474

SOURCE BLOCK	NAME OF FIELD	COLUMNS FROM	COLUMNS TO	NO. COLS.	TYPE DATA *	JUSTIFY **	REMARKS-INSTRUCTIONS
1	Card Number 0 Identity (State)	1	2	2	A	L	
1	Identity (Number)	3	7	5	N	R	
2	Div	8	10	3	A	L	
3	State	11	12	2	A	L	
4	County	13	15	3	N	R	
5	Congr Dist	16	17	2	N	R	
6	State	18	19	2	A	L	
7	County	20	22	3	N	R	
8	Congr. Dist	23	24	2	N	R	
9	Name	25	61	39	A	L	
10	Latitude	62	66	5	N	R	No decimal point is punched.
11	Longitude	67	72	6	N	R	No decimal point is punched.
12	Report Data (Day)	73	74	2	N	R	
12	Report Data (Mo)	75	77	3	A	L	
12	Report Data (Yr)	78	79	2	N	R	
	Card Number	80	80	1	N		Punch a 0
1	CARD NUMBER 1 Identity	1	7				Repeat Item 1 card 0
13	Popular Name	8	43	36	A	L	
14	Name of Impoundment	44	79	36	A	L	
	Card Number	80	80	1	N		Punch a 1

* A = ALPHA, N = NUMERIC ** L = LEFT, R = RIGHT

ENG FORM 1 OCT 66 0-1817B

SHEET OF SHEETS

Exhibit 1

EDPC KEYPUNCH INSTRUCTIONS (Continued)

JOB TITLE: INVENTORY OF UNITED STATES DAMS

JOB NO.:

CARD IDENTIFICATION: CARD 2

SOURCE: ENG FORM 4474

SOURCE BLOCK	NAME OF FIELD	COLUMNS FROM	COLUMNS TO	NO. COLS.	TYPE DATA *	JUSTIFY **	REMARKS-INSTRUCTIONS
1	CARD NUMBER 2 Identity	1	7				Repeat Item 1 card 0
15	Region	8	9	2	N	R	
16	Basin	10	11	2	N	R	
17	River or Stream	12	40	29	A	L	
18	City-Town-Village	41	68	28	A	L	
19	Distance from Dam	69	71	3	N	R	
20	Population	72	79	8	N	R	
	Card Number	80	80	1	N		Punch a 2

* A = ALPHA, N = NUMERIC ** L = LEFT, R = RIGHT

ENG FORM 1 OCT 66 0-1817B

SHEET OF SHEETS
Exhibit 1

EDPC KEYPUNCH INSTRUCTIONS (Continued)

JOB TITLE: INVENTORY OF UNITED STATES DAMS

JOB NO.:

CARD IDENTIFICATION: CARD 3 & 4

SOURCE: ENG FORM 4474A

SOURCE BLOCK	NAME OF FIELD	COLUMNS FROM	COLUMNS TO	NO. COLS.	TYPE DATA *	JUSTIFY **	REMARKS-INSTRUCTIONS
	CARD NUMBER 3						
1	Identity	1	7				Repeat Item 1 card 0
21	Type of Dam	8	19	14	A	L	
22	Year Completed	20	23	4	N	R	
23	Purposes	24	33	10	A	L	
24	Structural Height	34	37	4	N	R	
25	Hydraulic Height	38	41	4	N	R	
26	Impounding Maximum	42	49	8	N	R	
27	Impounding Normal	50	57	8	N	R	
27A	C. E. District	58	60	3	A	L	
27B	Ownership	61	61	1	A		
27C	Fed. Regulated	62	62	1	A		
27D	Prv't Dams/Fed Land	63	63	1	A		
27E	Soil Con. Ser. Ass't.	64	64	1	A		
27F	Verif. Date (Day)	65	66	2	N	R	
27F	Verif. Date (Mo)	67	69	3	A	L	
27F	Verif Date (Yr)	70	71	2	N	R	
	Card Number	80	80	1	N		Punch a 3
	CARD NUMBER 4						
1	Identity	1	7				Repeat Item 1 card 0
28	Remarks	8	79	72	A	L	
	Card Number	80	80	1	N		Punch a 4

* A = ALPHA, N = NUMERIC ** L = LEFT, R = RIGHT

ENG FORM 1 OCT 66 0-1817B

SHEET OF SHEETS

Exhibit 1

EDPC KEYPUNCH INSTRUCTIONS (Continued)

JOB TITLE: INVENTORY OF UNITED STATES DAMS

JOB NO.:

CARD IDENTIFICATION: CARD 5

SOURCE: ENG FORM 4474A

SOURCE BLOCK	NAME OF FIELD	COLUMNS FROM	COLUMNS TO	NO COLS.	TYPE DATA *	JUSTIFY **	REMARKS-INSTRUCTIONS
1	CARD NUMBER 5 Identity	1	7				Punch from Part II Item 1
29	D/S Has	8	8	1	N		
30	Crest Length	9	13	5	N	R	
31	Spillway Type	14	14	1	A		
32	Spillway Width	15	18	4	N	R	
33	Maximum Discharge	19	25	7	N	R	
34	Volume of Dam	26	34	9	N	R	
35	Power-Installed	35	40	6	N	R	
36	Power-Proposed	41	46	6	N	R	
37	N.L. Number	47	47	1	N		
38	N.L. Length	48	51	4	N	R	
39	N.L. Width	52	54	3	N	R	
40	N.L. Length	55	58	4	N	R	
41	N.L. Width	59	61	3	N	R	
42	N.L. Length	62	65	4	N	R	
43	N.L. Width	66	68	3	N	R	
44	N.L. Length	69	72	4	N	R	
45	N.L. Width	73	75	3	N	R	
	Card Number	80	80	1	N		Punch a 5

* A = ALPHA, N = NUMERIC ** L = LEFT, R = RIGHT

ENG FORM 1 OCT 66 0-1817B

SHEET Exhibit 1 OF SHEETS

EDPC KEYPUNCH INSTRUCTIONS (Continued)

JOB TITLE: INVENTORY OF UNITED STATES DAMS

JOB NO.:

CARD IDENTIFICATION: CARD 6,7,8, & 9

SOURCE: ENG FORM 4474A

SOURCE BLOCK	NAME OF FIELD	COLUMNS FROM	COLUMNS TO	NO. COLS.	TYPE DATA *	JUSTIFY **	REMARKS-INSTRUCTIONS
	CARD NUMBER 6						
1	Identity	1	7				Repeat Item 1 card 5
46	Owner	8	31	24	A	L	
47	Engineering By	32	55	24	A	L	
48	Construction By	56	79	24	A	L	
	Card Number	80	80	1	N		Punch a 6
	CARD NUMBER 7						
1	Identity	1	7				Repeat Item 1 card 5
49	Design	8	25	18	A	L	
50	Construction	26	43	18	A	L	
51	Operation	44	61	18	A	L	
52	Maintenance	62	79	18	A	L	
	Card Number	80	80	1	N		Punch a 7
	CARD NUMBER 8						
1	Identity	1	7				Repeat Item 1 card 5
53	Inspection By	8	40	33	A	L	
54	Inspection (Day)	41	42	2	N	R	
54	Inspection (Mo)	43	45	3	N	R	
54	Inspection (Yr)	46	47	2	N	R	
55	Authority	48	79	32	A	L	
	Card Number	80	80	1	N		Punch a 8
	CARD NUMBER 9						
1	Identity	1	7				Repeat Item 1 card 5
56	Remarks	8	79	72	A	L	
	CARD NUMBER	80	80	1	N		Punch a 9

* A = ALPHA, N = NUMERIC ** L = LEFT, R = RIGHT

ENG FORM 1 OCT 66 0-1817B

PART I - INVENTORY OF DAMS IN THE UNITED STATES

(PURSUANT TO PUBLIC LAW 92-367)

See reverse side for instructions

FORM APPROVED
OMB NO. 49-R0421

REQUIREMENTS CONTROL SYMBOL
DAEN-CWE-17

STATE | IDENTITY NUMBER

[1]

IDENTIFICATION	[2] DIVISION	[3] STATE	[4] COUNTY	[5] CONGR DIST	[6] STATE	[7] COUNTY	[8] CONGR DIST	[9] NAME	[10] LATITUDE (North) ° '	[11] LONGITUDE (West) ° '	[12] REPORT DATE DAY MO YR	80
												0

IDENTIFICATION (Continued)	[13] POPULAR NAME	[14] NAME OF IMPOUNDMENT	80
			1

FOR ILLUSTRATION PURPOSES ONLY

LOCATION	[15] REGION	[16] BASIN	[17] RIVER OR STREAM	[18] NEAREST DOWNSTREAM CITY - TOWN - VILLAGE	[19] DIST. FROM DAM (mi)	[20] POPULATION	80
							2

STATISTICS	[21] TYPE OF DAM	[22] YEAR COMPLETED	[23] PURPOSES	[24] STRUCTURAL HEIGHT (ft)	[25] HYDRAULIC HEIGHT (ft)	[26] IMPOUNDING CAPACITIES MAXIMUM (acre - ft)	[27] IMPOUNDING CAPACITIES NORMAL (acre - ft)	[27A] CORPS ENGR. DIST	[27B] OWN.	[27C] FED. R.	[27D] PRV FED.	[27E] SCS A.	[27F] VERIFICATION DATE DA MO YR	BLANK	80
															3

REMARKS	[28] REMARKS	80
		4

ENG FORM 1 DEC 77 4474

B-13

Exhibit 2

GENERAL INSTRUCTIONS

This form is for use in preparing the inventory of dams in the United States under the requirements of the National Program for the Inspection of Dams, P.L. 92-367. All items of Part I and Part II (Lines 0-9) must be completed as instructed below. Print neatly in ink or pencil. Use letters a, z, and x, omit Ø, Z, and I.

Write only one letter or numeral in each space, do not use more letters than blocks allowed for an item. Do not abbreviate on Part I. Leave one space between words and no space between code letters.

For all letter codes or word entries place first letter in left block of field. In word fields any alphabetic, numeric or special character may be entered. For all numerical entries, use only numerals placing the last digit of number in the right block of field, including leading zeros. Do not include a decimal point! In fields where decimals are required values are to be placed around the decimal point printed on the form.

Leave blank those spaces where item does not apply, e.g., do not write "N/A", "-", "None", etc., unless instructed to do so by specific instructions. Use the remarks line when additional space is needed for an item, or to clarify an entry. Preface each remark with the item number. (See form [28] or [56] instructions)

PART I

Item [1-3] IDENTITY. The Corps of Engineers will assign and control the identity for dams in the states for which he is responsible. The first two character of the identity will be the two-letter state abbreviation in accordance with Federal Information Processing Standards Publications, June 15, 1970 (FIPS PUB 6-1). In cases where a dam is physically located in two or more states, one state will be designated as the principal state for the identity. The last five (5) characters of the identity will be a sequential number assigned to identify dams within a state.

LINE 0

Item 0-23 DIVISION. Enter the three (3) letter office symbol for the division making the report in accordance with ABBR Report Code, Appendix B, ER 18-2-1, Civil Works Information Systems, e.g., NAD, ORD, SWD, etc.

Location:

Item [4-6] STATE. Enter two (2) letter principal state abbreviation in accordance with FIPS PUB 6-1.
Item [7-9] COUNTY. Enter three (3) digit county identification in accordance with FIPS PUB 6-2.
Item [10-11] CONG DIST. Enter one (1) or two (2) digit number for congressional district in which dam is located.
Item [12-13], and [14-15] (Use second location for structures situated in more than one state.)

Item [16-45] DAM NAME. Enter official name of dam. Do not abbreviate unless the abbreviation is a part of the official name. For dams that do not have a name, create a name by combining the two (2) letter state abbreviation plus "NO NAME" plus a sequential number. Example: If two dams in the State of Alabama do not have names, they would be named as ALNONAME1 and ALNONAME2.
Item [46-51] & [52-57] LATITUDE AND LONGITUDE. Enter the latitude and longitude in degrees, minutes and tenths of a minute. All geographical location items pertain to dam or its maximum section.
Item [58-63] REPORT DATE. Enter the one (1) or two (2) digits for day, the first three (3) letters of the month and a two (2) digit year (e.g., 12JAN76) in which the data has been revised, updated or otherwise changed.

LINE 1

Item [64-79] POPULAR NAME OF DAM. If (other than the official name of the dam) in common use, enter the name in this space. Leave blank if not applicable.
Item [80-95] NAME OF IMPOUNDMENT. Enter official name of lake or reservoir. Leave blank if reservoir does not have a name.

LINE 2

Item [96-97] & [98-99] REGION AND BASIN. Enter two (2) digit numbers for Region and Basin in accordance with Appendix C, ER 18-2-1, Civil Works Information System.
Item [100-119] RIVER OR STREAM. Enter official name of river or stream on which the dam is built. If stream is without name, indicate as tributary to river named, e.g., TRACO CREEK. If off stream, enter name of river plus "OFFSTREAM".
Item [120-139] NEAREST DOWNSTREAM CITY-TOWN-VILLAGE. Enter the nearest downstream city-town-village of such size which can be located on a general map.
Item [140-143] DISTANCE FROM DAM. Enter distance from dam to nearest downstream city-town-village to the nearest mile.
Item [144] POPULATION. Enter population of city-town-village given at Item [138].

LINE 3

Item [145] TYPE OF DAM. Enter two (2) letter codes, in any order, to describe type of dam.

EARTH	- EI	BUTTRESS	- CB	OTHER	- OT
ROCKFILL	- RF	ARCH	- VA	(Describe "other" in remarks)	
GRAVITY	- PG	MULTI-ARCH	- MV		

Item [146] YEAR COMPLETED. Enter year when the main dam structure was completed and ready for use. If only approximate year can be determined, note this in remarks.
Item [147] PURPOSES. Enter one (1) letter codes that describe the purposes for which the reservoir is used. The order entered should indicate the relative decreasing importance of the project purposes.

IRRIGATION	- I	WATER SUPPLY	- S	DEBRIS CONTROL	- D
HYDROELECTRIC	- H	RECREATION	- R	OTHER	- O
FLOOD CONTROL	- C	STOCK OR SMALL		(Describe "other" in remarks)	
NAVIGATION	- N	FARM POND	- P		

Item [148] STRUCTURAL HEIGHT. Enter, to the nearest foot, the structural height of the dam which is defined as: the overall vertical distance from the lowest point of foundation surface to the top of the dam.
Item [149] HYDRAULIC HEIGHT. Enter, to the nearest foot, the hydraulic height of the dam which is defined as: the effective height of the dam with respect to the maximum storage capacity, measured from the natural bed of the stream or watercourse at the downstream toe of the barrier, or if it is not across a stream or watercourse, the height from the lowest elevation of the outside limit of the barrier to the maximum storage elevation.

Impounding Capabilities

Item [150] MAXIMUM. Enter the acre feet for maximum storage which is defined as: the total storage space in a reservoir below the maximum attainable water surface elevation, including any surcharge storage.
Item [151] NORMAL. Enter the acre feet for normal storage 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.

Item [152] CORPS OF ENGINEERS DISTRICT. Enter the three character Corps of Engineers ABBR report code in which the dam is geographically located, in accordance with Appendix B, ER 18-2-1, Civil Works Information Systems, e.g., NAN, ORN, SWF, etc.
Item [153] OWNERSHIP. Enter N, for Non-Federal, G, for Federal Gov't Agencies other than the Corps of Engineers; C for Corps of Engineers.
Item [154] FEDERALLY REGULATED. Enter N for No, Enter Y for Yes.
Item [155] PRIVATE DAMS ON FEDERAL LAND. Enter N for No, Enter Y for Yes.
Item [156] ASSISTANCE BY SOIL CONSERVATION SERVICE. Enter N for None, T for Technical Assistance, F for Financial Assistance, B for Both Technical and Financial Assistance.
Item [157] VERIFICATION. Date the data was verified as being complete and correct. Enter date as described in Item [61].

LINE 4

Item [158] REMARKS. Preface remarks with the item number to which it pertains, e.g., 32-ORIGINALLY CONSTRUCTED IN 1970, 27-SETTLING BASIN. Only one remark line should be used for PART I remarks.

FOR ILLUSTRATION PURPOSES ONLY

ER U10-2-106
26 Sept 79

PART II - INVENTORY OF DAMS IN THE UNITED STATES
(PURSUANT TO PUBLIC LAW 92-367)

See reverse side for instructions

FORM APPROVED
OMB NO. 49-R0421

REQUIREMENTS CONTROL SYMBOL
DASN-CWE-17

STATE	IDENTITY NUMBER					
1	2	3	4	5	6	7

STATISTICS

[29]	[30]	[31]	[32]	[33]	[34]	[35]	[36]	[37]	[38]	[39]	[40]	[41]	[42]	[43]	[44]	[45]
D S HAZ	CREST LENGTH (ft)	SPILLWAY TYPE	SPILLWAY WIDTH (ft)	SPILLWAY MAXIMUM DISCHARGE (cfs)	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	OWN	NAVIGATION LOCKS LENGTH (ft)	NAVIGATION LOCKS WIDTH (ft)	NAVIGATION LOCKS LENGTH (ft)	NAVIGATION LOCKS WIDTH (ft)	NAVIGATION LOCKS LENGTH (ft)	NAVIGATION LOCKS WIDTH (ft)	NAVIGATION LOCKS LENGTH (ft)	NAVIGATION LOCKS WIDTH (ft)

BLANK

5

MISC DATA

[46]	[47]	[48]
OWNER	ENGINEERING BY	CONSTRUCTION BY

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6

MISC DATA (Continued)

[49]	[50]	[51]	[52]
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE

REGULATORY AGENCY

7

MISC. DATA (Continued)

[53]	[54]	[55]
INSPECTION BY	INSPECTION DATE (DAY, MO, YR)	AUTHORITY FOR INSPECTION

8

REMARKS

[56] REMARKS

9

DNO FORM 1 DEC 77 4474A

Exhibit 2

PART II

Item 1 IDENTITY Enter identity per GENERAL INSTRUCTIONS on PART I

LINE 5

Item [29] D/S HAZ Enter the digit that most closely represents the hazard potential that could occur to the downstream (D/S) area resulting from failure or mal-operation of the dam or facilities.

HAZARD POTENTIAL

CATEGORY	LOSS OF LIFE (Extent of Development)	ECONOMIC LOSS (Extent of Development)
3 = Low	None expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
2 = Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
1 = High	More than few	Excessive (Extensive community, industry or agriculture)

Item [30] CREST LENGTH Enter, to the nearest foot, the crest length of the dam which is defined as, the total horizontal distance measured along the axis at the elevation of the top of dam between abutments or ends of dam. Note that this includes spillway width, powerhouse sections, and navigation locks where they form a continuous part of the dam water retaining structure. Detached spillways, locks, and powerhouses shall not be included.

Spillway

Item [31] TYPE Enter the one letter code that applies.

CONTROLLED = C UNCONTROLLED = U NONE = N

Item [32] WIDTH Enter to the nearest foot, the width of the spillway available for discharge when the reservoir is at its maximum designed water surface elevation.
Item [33] MAXIMUM DISCHARGE Enter the number of cubic feet per second which the spillway is capable of discharging when the reservoir is at its maximum designed water surface elevation.

Volume of Dam

Item [34] VOLUME OF DAM Enter the total number of cubic yards occupied by the materials used in the dam structure. If volume of separate materials is known, enter in remarks. Include portions of powerhouses, locks and spillways only if integral with the dam and required for structural stability.

Power Capacity

Item [35] INSTALLED Enter installed capacity to one tenth (1/10) Megawatt as of the report date.
Item [36] PROPOSED Enter the future additional capacity proposed to one tenth (1/10) Megawatt.

Navigation Locks

Item [37] NUMBER Enter the number of existing navigation locks for the project.

Item [38] LENGTH: Enter to the nearest foot the length of the navigation lock.

Item [39] WIDTH: Enter to the nearest foot the width of the navigation lock.

Item [40] thru [45] Enter the lengths and widths of additional locks.

LINE 6

Item [46] OWNER: Enter name of owner. Abbreviate as necessary.
Item [47] ENGINEERING BY: Enter name of organization that engineered the main dam structure. Abbreviate as required.
Item [48] CONSTRUCTION BY: Enter name of construction agency responsible for construction of main structure. Abbreviate as required.

LINE 7

Regulatory Agency

Item [49] DESIGN: Enter the name of the organization other than the owner having regulatory or approval authority over the design of the dam. If no organization other than the owner has regulatory or approval authority over the design of the dam indicate NONE.
Item [50] CONSTRUCTION: Enter the name of the organization other than the owner having regulatory authority or inspection responsibilities over the construction of the dam. If no organization other than the owner has regulatory authority or inspection responsibilities over the construction of the dam indicate NONE.
Item [51] OPERATION: Enter the name of the organization other than the owner having regulatory authority, operational control, or surveillance responsibilities over the operation of the dam. If no organization other than the owner has regulatory authority, operational control or surveillance responsibilities over the operation of the dam indicate NONE.
Item [52] MAINTENANCE: Enter the name of the organization other than the owner having regulatory authority or inspection or surveillance responsibilities over the maintenance of the dam. If no organization other than the owner has regulatory authority or inspection or surveillance responsibilities over the maintenance of the dam indicate NONE.

LINE 8

Inspection

Item [53] BY: Enter the name of the organization that performed the last safety inspection. Abbreviate as required. If no inspection has been performed enter NONE.
Item [54] DATE: Enter the one (1) or two (2) digits for day, the first three (3) letters of the month and a two (2) digit year when the inspection was performed. If not applicable, leave blank.
Item [55] AUTHORITY FOR INSPECTION: Enter the legislative or regulatory authority for performing the inspection indicated in item 53, e.g., P.L. 92-367, Div 3, Water Code, State of Calif., ER 1110-2-100, etc.

LINE 9

Item [56] REMARKS: Preface remarks with the item number to which it pertains e.g., 34.2, 500,000 c.y. conc. 475,000 c.y. earthfill. Only one Remarks line should be used for PART II remarks.

FOR ILLUSTRATION PURPOSES ONLY

Appendix C

HYDROLOGIC AND HYDRAULIC ASSESSMENT OF DAMS

1. Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses of dam and reservoir capabilities. However, when such analyses are available, they should be evaluated for reliability and completeness. If a project's ability to pass the appropriate flood (see Table 3, page D-12 of Recommended Guidelines) can be determined from available information or a brief study, such an assessment should be made. It should be noted that hydrologic and hydraulic analyses connected with the Phase I inspections should be based on approximate methods or systematized computer programs that take minimal effort. The Hydrologic Engineering Center (HEC) has developed a special computer program for hydrologic and hydraulic analyses to be used with the Phase I inspection program. Other Field Operating Agencies have developed similar computer programs or generalized procedures which are acceptable for use. All such efforts should be completed with minimum resources.

2. A finding that a dam will not safely pass the flood indicated in the Recommended Guidelines does not necessarily indicate that the dam should be classified as unsafe. The degree of inadequacy of the spillway to pass the appropriate flood and the probable adverse impacts of dam failure because of overtopping must be considered in making such classification. The following criteria have been selected which indicate when spillway capacity is so seriously inadequate that a project must be classified as unsafe. All of the following conditions must prevail before designating a dam unsafe:

a. There is high hazard to loss of life from large flows downstream of the dam.

b. Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

c. The spillway is not capable of passing one-half of the probable maximum flood without overtopping the dam and causing failure.

3. The above criteria are generally adequate for evaluating most non-Federal dams. However, in a few cases the increased hazard potential from overtopping and failure is so great as to result in catastrophic consequences. In such cases, the evaluation of condition 2c should utilize a flood more closely approximating the full probable maximum flood rather than one-half the flood. An example of such a situation would be a large dam immediately above a highly populated flood plain, with little likelihood of time for evacuation in the event of an emergency.

4. Conditions 2a and 2b require an approximation of housing location in relation to flooded areas. Resources available in Phase I inspections do not permit detailed surveys or time-consuming studies to develop such relationships. Therefore, rough estimates will generally be made from data obtained during the inspection and from readily available maps and drawings. Brief computer routings such as the HEC-1 dam break analysis, using available data, are recommended in marginal cases. The HEC-1, dam break version, is available on the Boeing Computer Services or may be obtained from the Hydrologic Engineering Center, Davis, California. Available resources do not permit detailed studies or investigations to establish the amount of overtopping that would cause a dam to fail, as designated in condition 2c. Professional judgment and available information will have to be used in these determinations. When detailed investigations and studies are required to make a reasonable judgment of the conditions which designate an unsafe dam, the inspection report should recommend that such studies be the responsibility of the dam owner.

5. During the inspection of a dam, consideration should be given to impacts on other dams located downstream from the project being inspected. When failure of a dam would be likely to cause failure of another dam(s) downstream, its designation as an unsafe dam could result in multiple impacts. Therefore, the information should be explicitly described in the inspection report. Such information may be vital to the priorities established by State Governors for dam improvements. Similarly, when the failure of an upstream dam (classified as unsafe) could cause failure of the dam being inspected, this information should be prominently displayed in the inspection report.

6. The criteria established in paragraph 2 for designating unsafe dams because of seriously inadequate spillways are considered reasonable and prudent. They provide a consistent bases for declaring unsafe dams and also serve as an effective compromise between the Recommended Guidelines and unduly low standards suggested by special interests and individuals unfamiliar with flood hazard potential.

7. The Hydrometeorological Branch (HMB) of the National Weather Service has reviewed some 500 experienced large storms in the United States. The purpose of the review was to ascertain the relative magnitude of experienced large storms to probable maximum precipitation (PMP) and their distribution throughout the country.

Their review reveals that about 25 percent of the major storms have exceeded 50 percent of the probable maximum precipitation for one or more combinations of area and duration. In fact some storms have very closely approximated the PMP values. Exhibits C-1 thru C-5 indicate locations where experienced storms have exceeded 50 percent of the PMP. Table 1 provides specific information on each storm.

8. There are several options to consider when selecting mitigation measures to avoid severe consequences of a dam failure from overtopping. The following measures may be required by a Governor when sufficient legal authority is available under State laws and a dam presents a serious threat to loss of life.

a. Remove the dam.

b. Increase the height of dam and/or spillway size to pass the probable maximum flood without overtopping the dam.

c. Purchase downstream land that would be adversely impacted by dam failure and restrict human occupancy.

d. Enhance the stability of the dam to permit overtopping by the probable maximum flood without failure.

e. Provide a highly reliable flood warning system (generally does not prevent damage but avoids loss of life).

Table 1.--Storms with rainfall ≥ 50% of PMP, U.S. east of the 105th meridian, (for 10 mi², 6 hrs; 200 mi², 24 hrs and/or 1000 mi², 48 hrs).

Storm date	Index No.	Corps Assignment No. (if available)	Storm center Town	State	Lat.	Long.
7/26/1819	1	--	Catskill	NY	42°12'	73°53'
8/5/1843	2	--	Concordville	PA	39°53'	75°32'
9/10-13/ 1878	3	OR 9-19	Jefferson	OH	41°45'	80°46'
9/20-24/ 1882	4	NA 1-3	Paterson	NJ	40°55'	74°10'
6/13-17 / 1886	5	LMV 4-27	Alexandria	LA	31°19'	92°33'
6/27-7/11/ 1899	6	GM 3-4	Turnersville	TX	30°52'	96°32'
8/24-28/ 1903	7	MR 1-10	Woodburn	IA	40°57'	93°35'
10/7-11/ 1903	8	GL 4-9	Paterson	NJ	40°55'	74°10'
7/18-23/ 1909	9	UMV 1-11B	Ironwood	MI	46°27'	90°11'
7/18-23/ 1909	10	UMV 1-11A	Beaulieu	MN	47°21'	95°48'
7/22-23/ 1911	11	-	Swede Home	NB	40°22'	96°54'
7/19-24/ 1912	12	GL 2-29	Merrill	WI	45°11'	89°41'
7/13-17/ 1916	13	SA 2-9	Altapass	NC	35°33'	82°01'
9/8-10/ 1921	14	GM 4-12	Taylor	TX	30°35'	97°18'
10/4-11/ 1924	15	SA 4-20	New Smyrna	FL	29°07'	80°55'
9/17-19/ 1926	16	MR 4-24	Boyden	IA	43°12'	96°00'
3/11-16/ 1929	17	UMV 2-20	Elba	AL	31°25'	86°04'
6/30-7/2/ 1932	18	GM 5-1	State Fish Hatchery	TX	30°01'	99°07'
9/16-17/ 1932	19	-	Ripogenus Dam	ME	45°53'	69°09'
7/22-27/ 1933	20	LMV 2-26	Logansport	LA	31°58'	94°00'

Table 1.--Storms with rainfall ≥ 50% of PMP. U.S. east of the 105th meridian, (for 10 mi², 6 hrs; 200 mi², 24 hrs and/or 1000 mi², 48 hrs) - continued.

Storm date	Index No.	Corps Assignment No. (if available)	Storm center Town	State	Lat.	Long.
4/3-4/ 1934	21	SW 2-11	Cheyenne	OK	35°37'	99°40'
5/30-31/ 1935	22	MR 3-28A	Cherry Creek	CO	39°13'	104°32'
5/31/1935	23	GM 5-20	Woodward	TX	29°20	99°28'
7/6-10/ 1935	24	NA 1-27	Hector	NY	42°30'	76°53'
9/2-6/ 1935	25	SA 1-26	Easton	MD	38°46'	76°01'
9/14-18/ 1936	26	GM 5-7	Broome	TX	31°47'	100°50'
6/19-20/ 1939	27	-	Snyder	TX	32°44'	100°55'
7/4-5/ 1939	28	-	Simpson	KY	38°13'	83°22'
8/19/1939	29	NA 2-3	Manahawkin	NJ	39°42'	74°16'
6/3-4/1940	30	MR 4-5	Grant Township	NB	42°01'	96°53'
8/6-9/1940	31	LMV 4-24	Miller Isl.	LA	29°45'	92°10'
8/10-17/1940	32	SA 5-19A	Kensville	VA	37°03'	78°30'
9/ 1/1940	33	NA 2-4	[illegible]	NJ	39°42'	75°12'
9/2-6/1940	34	SW 2-18	[illegible]illet	OK	36°15'	96°36'
8/28-31/1941	35	UMV 1-22	Haywood	WI	46°00'	91°28'
10/17-22/1941	36	SA 5-6	Trenton	FL	29°48'	82°57'
7/17-18/1942	37	OR 9-23	Smethport	PA	41°50'	78°25'
10/11-17/1942	38	SA 1-28A	Big Meadows	VA	38°31'	78°26'
5/6-12/1943	39	SW 2-20	Warner	OK	35°29'	95°18'
5/12-20/1943	40	SW 2-21	Nr. Mounds	OK	35°52'	96°04'
7/27-29/1943	41	GM 5-21	Devers	TX	30°02'	94°35'
8/ 4-5/1943	42	OR 3-30	Nr. Glenville	WV	38°56'	80°50'
6/10-13/1944	43	MR 6-15	Nr. Stanton	NB	41°52'	97°03'
8/12-15/1946	44	MR 7-2A	Cole Camp	MO	38°40'	93°13'
8/12-16/1946	45	MR 7-2B	Nr. Collinsville	IL	38°40'	89°59'

Table 1.--Storms with rainfall ≥ 50% of PMP. U.S. east of the 105th meridian, (for 10 mi², 6 hrs; 200 mi², 24 hrs and/or 1000 mi², 48 hrs) - continued.

Storm date	Index No.	Corps Assignment No. (if available)	Storm center Town	State	Lat.	Long.
9/26-27/1946	46	GM 5-24	Nr. San Antonio	TX	29°20'	98°29'
6/23-24/1948	47	--	Nr. Del Rio	TX	29°22'	100°37'
9/3-7/1950	48	SA 5-8	Yankeetown	FL	29°03'	82°42'
6/23-28/1954	49	SW 3-22	Vic Pierce	TX	30°22'	101°23'
8/17-20/1955	50	NA 2-22A	Westfield	MA	42°07'	72°45'
5/15-16/1957	51	--	Hennessey	OK	36°02'	97°56'
6/14-15/1957	52	--	Nr. E. St. Louis	IL	38°37'	90°24'
6/23-24/1963	53	--	David City	NB	41°14'	97°05'
6/13-20/1965	54	--	Holly	CO	37°43'	102°23'
6/24/1966	55	--	Glenullin	ND	47°21'	101°19'
8/12-13/1966	56	--	Nr. Greely	NB	41°33'	98°32'
9/19-24/1967	57	SW 3-24	Falfurrias	TX	27°16'	98°12'
7/16-17/1968	58	--	Waterloo	IA	42°30'	92°19'
7/4-5/1969	59	--	Nr. Wooster	OH	40°50'	82°00'
8/19-20/1969	60	NA 2-3	Nr. Tyro	VA	37°49'	79°00'
6/ 9/1972	61	--	Rapid City	SD	44°12'	103°31'
6/19-23/1972	62	--	Zerbe	PA	40°37'	76°31'
7/21-22/1972	63	--	Nr. Cushing	MN	46°10'	94°30'
9/10-12/1972	64	--	Harlan	IA	41°43'	95°15'
10/10-11/1973	65	--	Enid	OK	36°25'	97°52'

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Table 2.--Storms with rainfall ≥ 50% of PMP, U.S. west of Continental Divide

(for 10 mi^2 6 hours or 1000 mi^2 for one duration between 6 and 72 hours)

Storm date	Index No.	Storm Center Town	State	Lat.	Long.	Duration for 1000 mi^2
8/11/1890	1	Palmetto,	NV	37°27	117°42	
8/12/1891	2	Campo	CA	32°36	116°28	
8/28/1898	3	Ft. Mohave	AZ	35°03	114°36	
10/4-6/1911	4	Gladstone	CO	37°53	107°39	
12/29/1913-1/3/1914	5	-	CA	39°55	121°25	
2/17-22/1914	6	Colby Ranch	CA	34°18	118°07	
2/20-25/1917	7	-	CA	37°35	119°36	
9/13/1918	8	Red Bluff	CA	40°10	122°14	
2/26-3/4/1938	9		CA	34°14	117°11	
3/30-4/2/1931	10	-	ID	46°30	114°50	24
2/26/1932	11	Big Four	WA	48°05	121°30	
11/21/1933	12	Tatoosh Is.	WA	48°23	124°44	
1/20-25/1935	13	-	WA	47°30	123°30	6
1/20-25/1935	14	-	WA	47°00	122°00	72
2/4-8/1937	15	Cyamaca Dam	CA	33°00	116°35	
12/9-12/1937	16	-	CA	38°51	122°43	
2/27-3/4/1938	17	-	AZ	34°57	111°44	12
1/19-24/1943	18	-	CA	37°35	119°25	18
1/19-24/1943	19	Hoagee's Camp	CA	34°13	118°02	
1/30-2/3/1945	20	-	CA	37°35	119°30	
12/27/1945	21	Mt. Tamalpias	CA	37°54	122°34	
11/13-21/1950	22	-	CA	36°30	118°30	24
8/25-30/1951	23	-	AZ	34°07	112°21	72
7/19/1955	24	Chiatovich Flat	CA	37°44	118°15	
8/16/1958	25	Morgan	UT	41°03	111°38	
9/18/1959	26	Newton	CA	40°22	122°12	
6/7-8/1964	27	Nyack Ck.	MT	48°30	113°38	12
9/3-7/1970	28	-	UT	37°38	109°04	6
9/3-7/1970	29	-	AZ	33°49	110°56	6
6/7/1972	30	Bakersfield	CA	35°25	119°03	
12/9-12/1937	31	-	CA	39°45	121°30	48

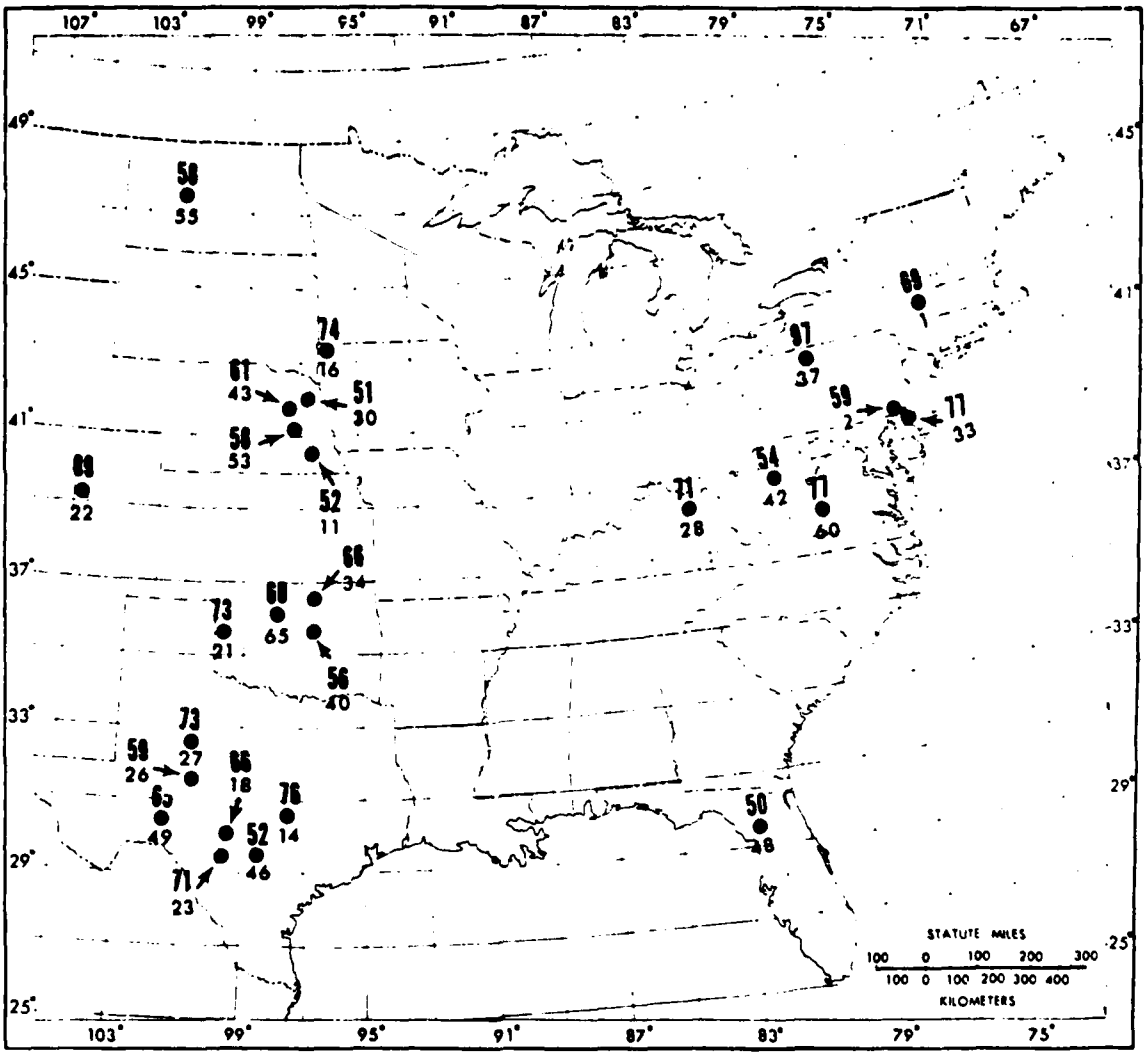

Plate 1: Observed point rainfalls ≥ 50% of all-season PMP, U.S. east of 105th meridian for 10 mi^2 6 hours. (Large number is % of PMP, small number is storm index, see table 1.)

Exhibit C-1

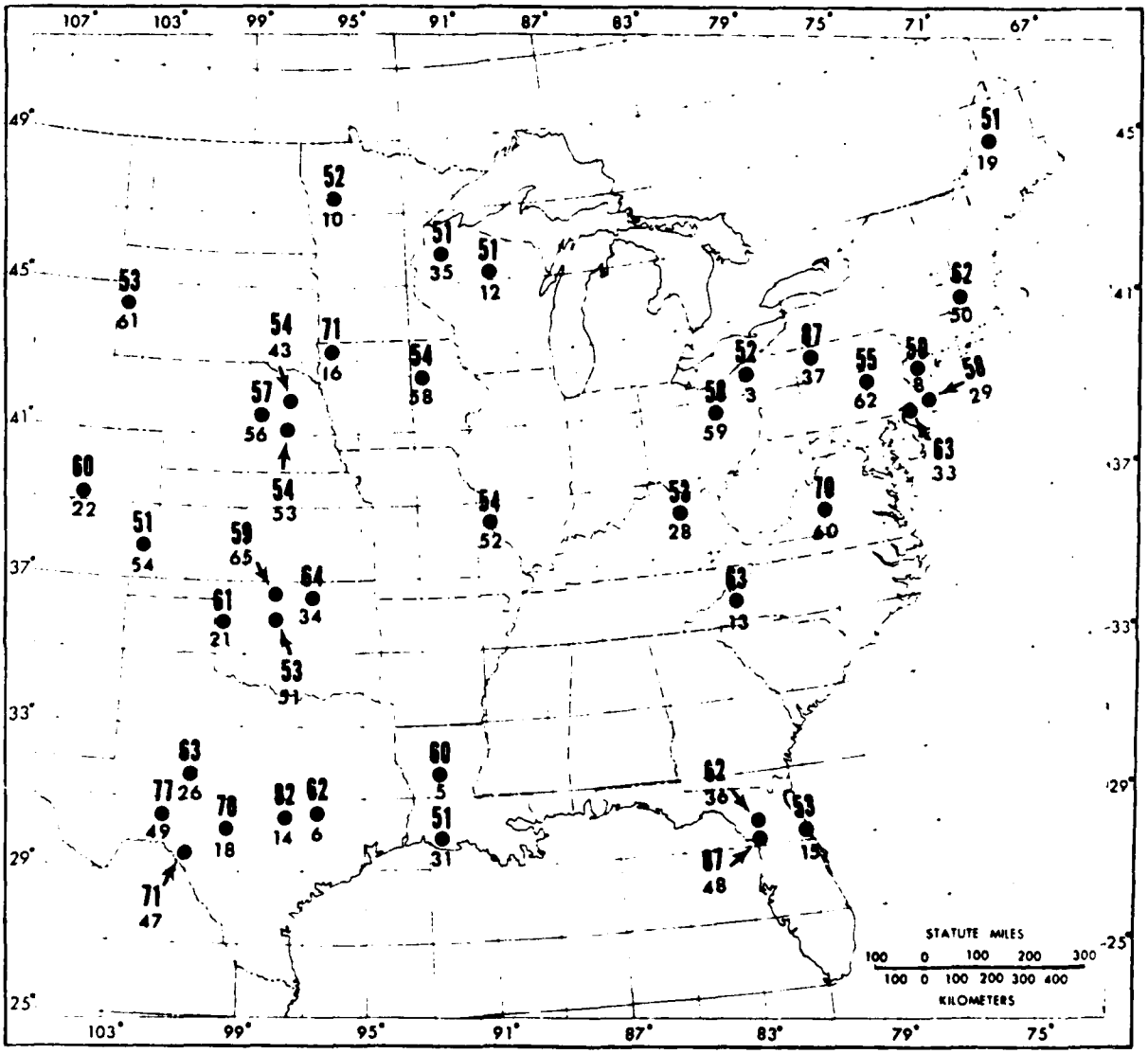

Plate 2: Observed rainfalls ≥ 50% of all-season PMP, U.S. east of 105th meridian for 200 mi^2 24 hours. (Large number is % of PMP, small number is storm index, see table 1.)

Exhibit C-2

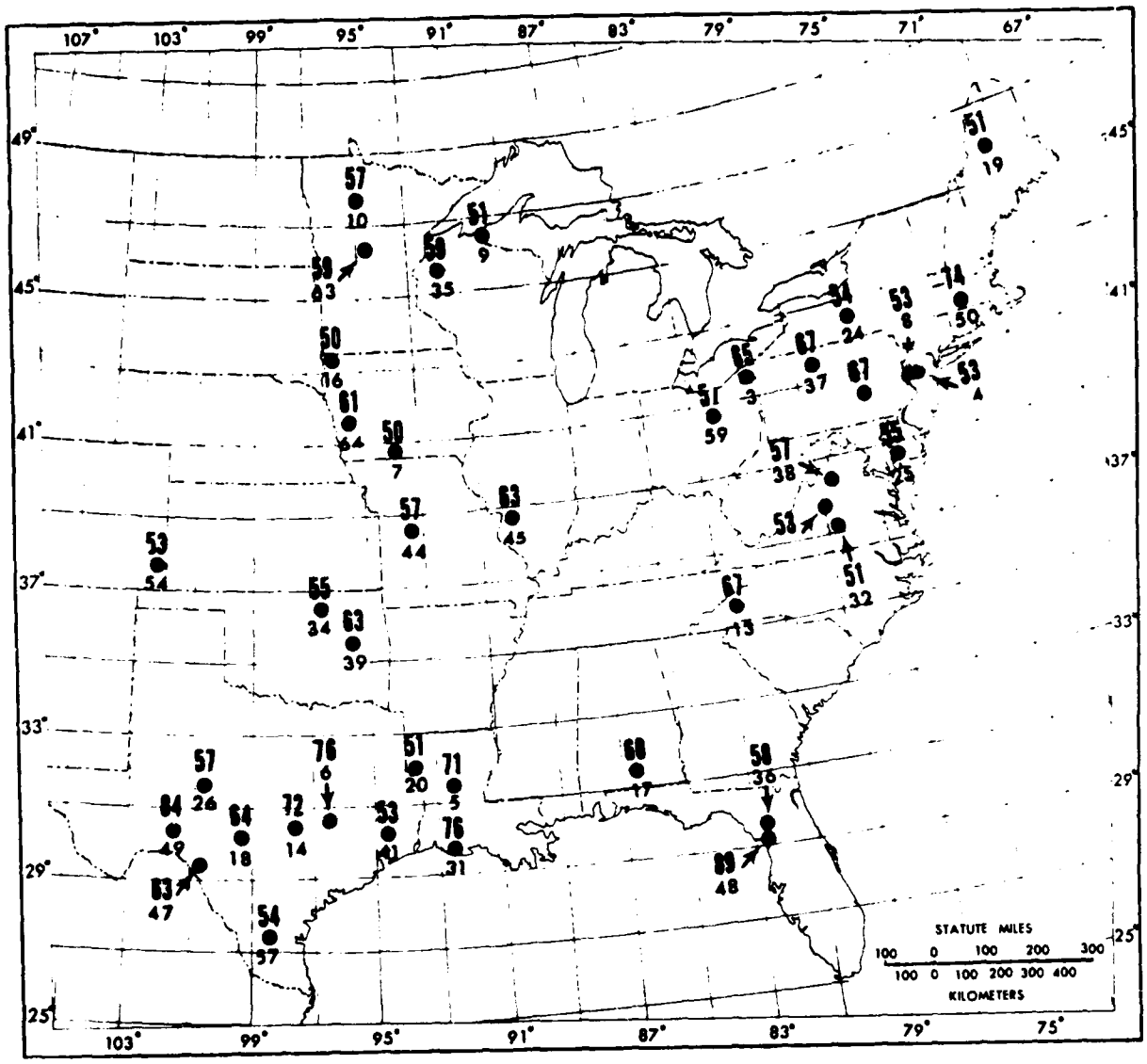

Plate 3: Observed rainfalls ≥ 50% of all-season PMP, U.S. east of the 105th meridian for 1000 mi^2 48 hours. (Large number is % of PMP, small number is storm index, see table 1.)

Exhibit C-3

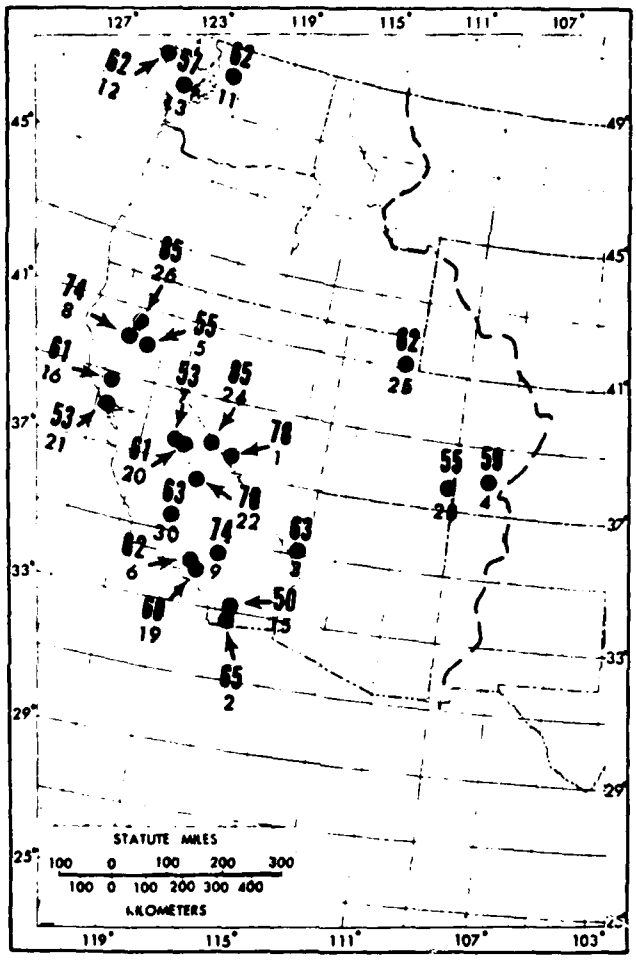

Plate 4: Observed point rainfalls ≥ 50% of all-season PMP, U.S. west of the Continental Divide for 10 mi^2 for 6 hours. (Large number is % of PMP. Small number is storm index, see table 2.)

Exhibit C-4

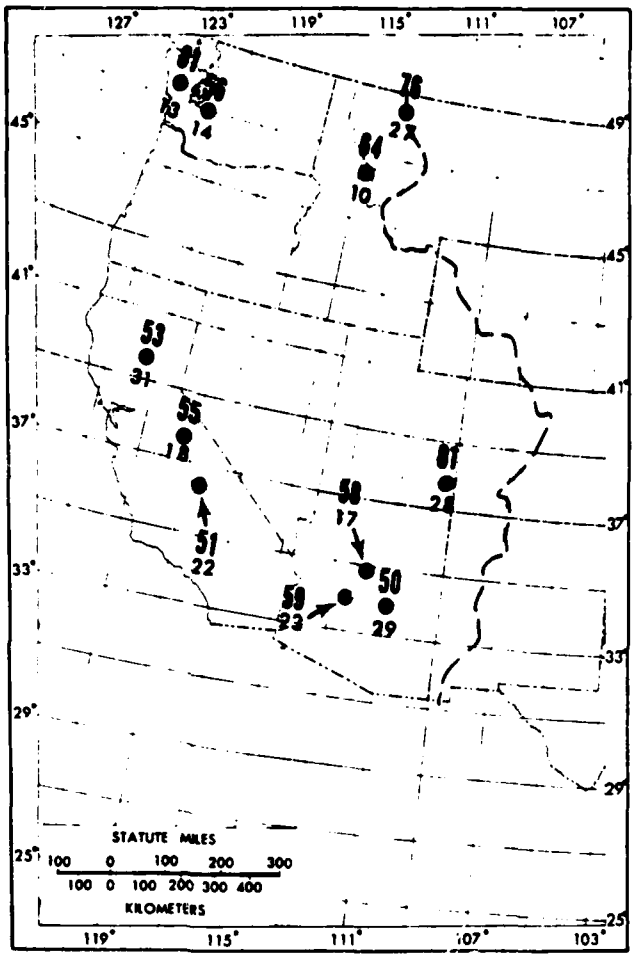

Plate 5: Observed rainfalls ≥ 50% of all-season PMP, U.S. west of the Continental Divide for 1000 mi^2 for one duration between 6 and 72 hours. (Large number is % of PMP. Small number is storm index, see table 2.)

Exhibit C-5

recommended guidelines for safety inspection of DAMS

DEPARTMENT OF THE ARMY • OFFICE OF THE CHIEF OF ENGINEERS

WASHINGTON D C 20314

PREFACE

The recommended guidelines for the safety inspection of dams were prepared to outline principal factors to be weighed in the determination of existing or potential hazards and to define the scope of activities to be undertaken in the safety inspection of dams. The establishment of rigid criteria or standards is not intended. Safety must be evaluated in the light of peculiarities and local conditions at a particular dam and in recognition of the many factors involved, some of which may not be precisely known. This can only be done by competent, experienced engineering judgement, which the guidelines are intended to supplement and not supplant. The guidelines are intended to be flexible, and the proper flexibility must be achieved through the employment of experienced engineering personnel.

Conditions found during the investigation which do not meet guideline recommendations should be assessed by the investigator as to their import from the standpoint of the involved degree of risk. Many deviations will not compromise project safety and the investigator is expected to identify them in this manner if that is the case. Others will involve various degrees of risk, the proper evaluation of which will afford a basis for priority of subsequent attention and possible remedial action.

The guidelines present procedures for investigating and evaluating existing conditions for the purpose of identifying deficiencies and hazardous conditions. The two phases of investigation outlined in the guidelines are expected to accomplish only this and do not encompass in scope the engineering which will be required to perform the design studies for corrective modification work.

It is recognized that some States may have established or will adopt inspection criteria incongruous in some respects with these guidelines. In such instances assessments of project safety should recognize the State's requirements as well as guideline recommendations.

The guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers. In reviewing two drafts of the guidelines they have contributed many helpful suggestions. Their contributions are deeply appreciated and have made it possible to evolve a document representing a consensus of the engineering fraternity. As experience is gained with use of the guidelines, suggestions for future revisions will be generated. All such suggestions should be directed to the Chief of Engineers, U.S. Army, DAEN-CWE-D, Washington, D.C. 20314.

RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS

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RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS

CHAPTER 1 - INTRODUCTION

1.1. Purpose. This document provides recommended guidelines for the inspection and evaluation of dams to determine if they constitute hazards to human life or property.

1.2. Applicability. The procedures and guidelines outlined in this document apply to the inspection and evaluation of all dams as defined in the National Dam Inspection Act, Public Law 92-367. Included in this program are all artificial barriers together with appurtenant works which impound or divert water and which (1) are twenty-five feet or more in height or (2) have an impounding capacity of fifty acre-feet or more. Not included are barriers which are six feet or less in height, regardless of storage capacity, or barriers which have a storage capacity at maximum water storage elevation of fifteen acre-feet or less regardless of height.

1.3. Authority. The Dam Inspection Act, Public Law 92-367 (Appendix III), authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. The Chief of Engineers issues these guidelines pursuant to that authority.

CHAPTER 2 - GENERAL REQUIREMENTS

2.1. Classification of Dams. Dams should be classified in accordance with size and hazard potential in order to formulate a priority basis for selecting dams to be included in the inspection program and also to provide compatibility between guideline requirements and involved risks. When possible the initial classifications should be based upon information listed in the National Inventory of Dams with respect to size, impoundment capacity and hazard potential. It may be necessary to reclassify dams when additional information becomes available.

2.1.1. Size. The classification for size based on the height of the dam and storage capacity should be in accordance with Table 1. The height of the dam is established with respect to the maximum storage potential measured from the natural bed of the stream or watercourse at the downstream toe of the barrier, or if it is not across a stream or watercourse, the height from the lowest elevation of the outside limit of the barrier, to the maximum water storage elevation. For the purpose of determining project size, the maximum storage elevation may be considered equal to the top of dam elevation. Size classification may be determined by either storage or height, whichever gives the larger size category.

TABLE 1

SIZE CLASSIFICATION

Category	Impoundment Storage (Ac-Ft)	Impoundment Height (Ft)
Small	$<$ 1000 and $\geq$ 50	$<$ 40 and $\geq$ 25
Intermediate	$\geq$ 1000 and $<$ 50,000	$\geq$ 40 and $<$ 100
Large	$\geq$ 50,000	$\geq$ 100

2.1.2. Hazard Potential. The classification for potential hazards should be in accordance with Table 2. The hazards pertain to potential loss of human life or property damage in the area downstream of the dam in event of failure or misoperation of the dam or appurtenant facilities. Dams conforming to criteria for the low hazard potential category generally will be located in rural or agricultural areas where failure may damage farm buildings, limited agricultural land, or township and country roads. Significant hazard potential category structures will be those located in predominantly rural or agricultural areas where failure may damage isolated homes, secondary highways or minor railroads

or cause interruption of use or service of relatively important public utilities. Dams in the high hazard potential category will be those located where failure may cause serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads.

TABLE 2

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (No permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

2.2. Selection of Dams to be Investigated. The selection of dams to be investigated should be based upon an assessment of existing developments in flood hazard areas. Those dams possessing a hazard potential classified high or significant as indicated in Table 2 should be given first and second priorities, respectively, in the inspection program. Inspection priorities within each category may be developed from a consideration of factors such as size classification and age of the dam, the population size in the downstream flood area, and potential developments anticipated in flood hazard areas.

2.3. Technical Investigations. A detailed, systematic, technical inspection and evaluation should be made of each dam selected for investigation in which the hydraulic and hydrologic capabilities, structural stability and operational adequacy of project features are analyzed and evaluated to determine if the dam constitutes a danger to human life or property. The investigation should vary in scope and completeness depending upon the availability and suitability of engineering data, the validity of design assumptions and analyses and the condition of the dam. The minimum investigation will be designated Phase I, and an in-depth investigation designated Phase II should be

made where deemed necessary. Phase I investigations should consist of a visual inspection of the dam, abutments and critical appurtenant structures, and a review of readily available engineering data. It is not intended to perform costly explorations or analyses during Phase I. Phase II investigations should consist of all additional engineering investigations and analyses found necessary by results of the Phase I investigation.

2.4. Qualifications of Investigators. The technical investigations should be conducted under the direction of licensed professional engineers experienced in the investigation, design, construction and operation of dams, applying the disciplines of hydrologic, hydraulic, soils and structural engineering and engineering geology. All field inspections should be conducted by qualified engineers, engineering geologists and other specialists, including experts on mechanical and electrical operation of gates and controls, knowledgeable in the investigation, design, construction and operation of dams.

CHAPTER 3 - PHASE I INVESTIGATION

3.1. Purpose. The primary purpose of the Phase I investigation program is to identify expeditiously those dams which may pose hazards to human life or property.

3.2. Scope. The Phase I investigation will develop an assessment of the general condition with respect to safety of the project based upon available data and a visual inspection, determine any need for emergency measures and conclude if additional studies, investigation and analyses are necessary and warranted. A review will be made of pertinent existing and available engineering data relative to the design, construction and operation of the dam and appurtenant structures, including electrical and mechanical operating equipment and measurements from inspection and performance instruments and devices; and a detailed systematic visual inspection will be performed of those features relating to the stability and operational adequacy of the project. Based upon findings of the review of engineering data and the visual inspection, an evaluation will be made of the general condition of the dam, including where possible the assessment of the hydraulic and hydrologic capabilities and the structural stability.

3.3. Engineering Data. To the extent feasible the engineering data listed in Appendix I relating to the design, construction and operation of the dam and appurtenant structures, should be collected from existing records and reviewed to aid in evaluating the adequacy of hydraulic and hydrologic capabilities and stability of the dam. Where the necessary engineering data are unavailable, inadequate or invalid, a listing should be made of those specific additional data deemed necessary by the engineer in charge of the investigation and included in the Phase I report.

3.4. Field Inspections. The field inspection of the dam, appurtenant structures, reservoir area, and downstream channel in the vicinity of the dam should be conducted in a systematic manner to minimize the possibility of any significant feature being overlooked. A detailed checklist should be developed and followed for each dam inspected to document the examination of each significant structural and hydraulic feature including electrical and mechanical equipment for operation of the control facilities that affect the safety of the dam.

3.4.1. Particular attention should be given to detecting evidence of leakage, erosion, seepage, slope instability, undue settlement, displacement, tilting, cracking, deterioration, and improper functioning of drains and relief wells. The adequacy and quality of maintenance and

operating procedures as they pertain to the safety of the dam and operation of the control facilities should also be assessed.

3.4.2. Photographs and drawings should be used freely to record conditions in order to minimize descriptions.

3.4.3. The field inspection should include appropriate features and items, including but not limited to those listed in Appendix II, which may influence the safety of the dam or indicate potential hazards to human life or property.

3.5. Evaluation of Hydraulic and Hydrologic Features.

3.5.1. Design Data. Original hydraulic and hydrologic design assumptions obtained from the project records should be assessed to determine their acceptability in evaluating the safety of the dam. All constraints on water control such as blocked entrances, restrictions on operation of spillway and outlet gates, inadequate energy dissipators or restrictive channel conditions, significant reduction in reservoir capacity by sediment deposits and other factors should be considered in evaluating the validity of discharge ratings, storage capacity, hydrographs, routings and regulation plan. The discharge capacity and/or storage capacity should be capable of safely handling the recommended spillway design flood for the size and hazard potential classification of the dam as indicated in Table 3. The hydraulic and hydrologic determinations for design as obtained from project records will be acceptable if conventional techniques similar to the procedures outlined in paragraph 4.3. were used in obtaining the data. When the project design flood actually used exceeds the recommended spillway design flood, from Table 3, the project design flood will be acceptable in evaluating the safety of the dam.

TABLE 3

HYDROLOGIC EVALUATION GUIDELINES

RECOMMENDED SPILLWAY DESIGN FLOODS

Hazard	Size	*Spillway Design Flood (SDF)
	Small	50 to 100-yr freq
Low	Intermediate	100-yr to 1/2 PMF
	Large	1/2 PMF to PMF
	Small	100-yr to 1/2 PMF
Significant	Intermediate	1/2 PMF to PMF
	Large	PMF

(TABLE 3 Continued on next page)

(TABLE 3 Continued)

Hazard	Size	*Spillway Design Flood (SDF)
	Small	1/2 PMF to PMF
High	Intermediate	PMF
	Large	PMF

*The recommended design floods in this column represent the magnitude of the spillway design flood (SDF), which is intended to represent the largest flood that need be considered in the evaluation of a given project, regardless of whether a spillway is provided; i.e., a given project should be capable of safely passing the appropriate SDF. Where a range of SDF is indicated, the magnitude that most closely relates to the involved risk should be selected.

100-yr = 100-Year Exceedence Interval. The flood magnitude expected to be exceeded, on the average, of once in 100 years. It may also be expressed as an exceedence frequency with a one-percent chance of being exceeded in any given year.

PMF = Probable Maximum Flood. The flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is derived from probable maximum precipitation (PMP), which information is generally available from the National Weather Service, NOAA. Most Federal agencies apply reduction factors to the PMP when appropriate. Reductions may be applied because rainfall isohyetals are unlikely to conform to the exact shape of the drainage basin and/or the storm is not likely to center exactly over the drainage basin. In some cases local topography will cause changes from the generalized PMP values, therefore, it may be advisable to contact Federal construction agencies to obtain the prevailing practice in specific areas.

3.5.2. Experience Data. In some cases where design data are lacking, an evaluation of overtopping potential may be based on watershed characteristics and rainfall and reservoir records. An estimate of the probable maximum flood may also be developed from a conservative, generalized comparison of the drainage area size and the magnitude of recently adopted probable maximum floods for damsites in comparable hydrologic regions. Where the review of such experience data indicates that the recommended spillway design flood would not cause overtopping additional hydraulic and hydrologic determinations will be unnecessary.

3.6. Evaluation of Structural Stability. The Phase I evaluations of structural adequacy of project features are expected to be based principally on existing conditions as revealed by the visual inspection, together with available design and construction information and records of performance. The objectives are to determine the existence of conditions which are hazardous, or which with time might develop into safety hazards, and to formulate recommendations pertaining to the need for any additional studies, investigations, or analyses. The results of this phase of the inspection must rely very substantially upon the experience and judgment of the inspecting engineer.

3.6.1. Design and Construction Data. The principal design assumptions and analyses obtained from the project records should be assessed. Original design and construction records should be used judiciously, recognizing the restricted applicability of such data as material strengths and permeabilities, geological factors and construction descriptions. Original stability studies and analyses should be acceptable if conventional techniques and procedures similar to those outlined in paragraph 4.4 were employed, provided that review of operational and performance data confirm that the original design assumptions were adequately conservative. The need for such analyses where either none exist or the originals are incomplete or unsatisfactory will be determined by the inspecting engineer based upon other factors such as condition of structures, prior maximum loadings and the hazard degree of the project. Design assumptions and analyses should include all applicable loads including earthquake and indicate the structure's capability to resist overturning, sliding and overstressing with adequate factors of safety. In general seepage and stability analyses comparable to the requirements of paragraph 4.4 should be on record for all dams in the high hazard category and large dams in the significant hazard category. This requirement for other dams will be subject to the opinion of the inspecting engineer.

3.6.2. Operating Records. The performance of structures under prior maximum loading conditions should in some instances provide partial basis for stability evaluation. Satisfactory experience under loading conditions not expected to be exceeded in the future should generally be indicative of satisfactory stability, provided adverse changes in physical conditions have not occurred. Instrumentation observations of forces, pressures, loads, stresses, strains, displacements, deflections or other related conditions should also be utilized in the safety evaluation. Where such data indicate abnormal behavior, unsafe movement or deflections, or loadings which adversely affect the stability or functioning of the structure, prompt reporting of such circumstances is required without the delay for preparation of the official inspection report.

3.6.3. Post Construction Changes. Data should be collected on changes which have occurred since project construction that might influence the safety of the dam such as road cuts, quarries, mining and groundwater changes.

3.6.4. Seismic Stability. An assessment should be made of the potential vulnerability of the dam to seismic events and a recommendation developed with regard to the need for additional seismic investigation. In general, projects located in Seismic Zones 0, 1 and 2 may be assumed to present no hazard from earthquake provided static stability conditions are satisfactory and conventional safety margins exist. Dams in Zones 3 and 4 should, as a minimum, have on record suitable analyses made by conventional equivalent static load methods. The seismic zones together with appropriate coefficients for use in such analyses are shown in Figures 1 through 4. Boundary lines are approximate and in the event of doubt about the proper zone, the higher zone should be used. All high hazard category dams in Zone 4 and high hazard dams of the hydraulic fill type in Zone 3 should have a stability assessment based upon knowledge of regional and local geology, engineering seismology, in situ properties of materials and appropriate dynamic analytical and testing procedures. The assessment should include the possibility of physical displacement of the structures due to movements along active faults. Departure from this general guidance should be made whenever in the judgment of the investigating engineer different seismic stability requirements are warranted because of local geological conditions or other reasons.

CHAPTER 4 - PHASE II INVESTIGATION

4.1. Purpose. The Phase II investigation will be supplementary to Phase I and should be conducted when the results of the Phase I investigation indicate the need for additional in-depth studies, investigations or analyses.

4.2. Scope. The Phase II investigation should include all additional studies, investigations and analyses necessary to evaluate the safety of the dam. Included, as required, will be additional visual inspections, measurements, foundation exploration and testing, materials testing, hydraulic and hydrologic analysis and structural stability analyses.

4.3. Hydraulic and Hydrologic Analysis. Hydraulic and hydrologic capabilities should be determined using the following criteria and procedures. Depending on the project characteristics, either the spillway design flood peak inflow or the spillway design flood hydrograph should be the basis for determining the maximum water surface elevation and maximum outflow. If the operation or failure of upstream water control projects would have significant impact on peak flow or hydrograph analyses, the impact should be assessed.

4.3.1. Maximum Water Surface Based on SDF Peak Inflow. When the total project discharge capability at maximum pool exceeds the peak inflow of the recommended SDF, and operational constraints would not prevent such a release at controlled projects, a reservoir routing is not required. The maximum discharge should be assumed equal to the peak inflow of the spillway design flood. Flood volume is not controlling in this situation and surcharge storage is either absent or is significant only to the extent that it provides the head necessary to develop the release capability required.

4.3.1.1. Peak for 100-Year Flood. When the 100-year flood is applicable under the provisions of Table 3 and data are available, the spillway design flood peak inflow may be determined by use of "A Uniform Technique for Determining Flood Frequencies," Water Resources Council (WRC), Hydrology Committee, Bulletin 15, December 1967. Flow frequency information from regional analysis is generally preferred over single station results when available and appropriate. Rainfall-runoff techniques may be necessary when there are inadequate runoff data available to make a reasonable estimate of flow frequency.

4.3.1.2. Peak for PMF or Fraction Thereof. When either the Probable Maximum Flood peak or a fraction thereof is applicable under the provisions of Table 3, the unit hydrograph - infiltration loss technique is generally the most expeditious method of computing the spillway design flood peak for most projects. This technique is discussed in the following paragraph.

4.3.2. Maximum Water Surface Based on SDF Hydrograph. Both peak and volume are required in this analysis. Where surcharge storage is significant, or where there is insufficient discharge capability at maximum pool to pass the peak inflow of the SDF, considering all possible operational constraints, a flood hydrograph is required. When there are upstream hazard areas that would be imperiled by fast rising reservoirs levels, SDF hydrographs should be routed to ascertain available time for warning and escape. Determination of probable maximum precipitation or 100-year precipitation, whichever is applicable, and unit hydrographs or runoff models will be required, followed by the determination of the PMF or 100-year flood. Conservative loss rates (significantly reduced by antecedent rainfall conditions where appropriate) should be estimated for computing the rainfall excess to be utilized with unit hydrographs. Rainfall values are usually arranged with gradually ascending and descending rates with the maximum rate late in the storm. When applicable, conservatively high snowmelt runoff rates and appropriate releases from upstream projects should be assumed. The PMP may be obtained from National Weather Service (NWS) publications such as Hydrometeorological Report (HMR) 33. Special NWS publications for particular areas should be used when available. Rainfall for the 100-year frequency flood can be obtained from the NWS publication "Rainfall Frequency Atlas of the United States," Technical Paper No. 40; Atlas 2, "Precipitation Frequency Atlas of Western United States;" or other NWS publications. The maximum water surface elevation and spillway design flood outflow are then determined by routing the inflow hydrograph through the reservoir surcharge storage, assuming a starting water surface at the bottom of surcharge storage, or lower when appropriate. For projects where the bottom of surcharge space is not distinct, or the flood control storage space (exclusive of surcharge) is appreciable, it may be appropriate to select starting water surface elevations below the top of the flood control storage for routings. Conservatively high starting levels should be estimated on the basis of hydrometeorological conditions reasonably characteristic for the region and flood release capability of the project. Necessary adjustment of reservoir storage capacity due to existing or future sediment or other encroachment may be approximated when accurate determination of deposition is not practicable.

4.3.3. Acceptable Procedures. Techniques for performing hydraulic and hydrologic analyses are generally available from publications prepared by Federal agencies involved in water resources development or textbooks written by the academic community. Some of these procedures are rather sophisticated and require expensive computational equipment and large data banks. While results of such procedures are generally more reliable than simplified methods, their use is generally not warranted in studies connected with this program unless they can be performed quickly and inexpensively. There may be situations where the more complex techniques have to be employed to obtain reliable results; however, these cases will be exceptions rather than the rule. Whenever the acceptability of procedures is in question, the advice of competent experts should be sought. Such expertise is generally available in the Corps of Engineers, Bureau of

Reclamation and Soil Conservation Service. Many other agencies, educational facilities and private consultants can also provide expert advice. Regardless of where such expertise is based, the qualification of those individuals offering to provide it should be carefully examined and evaluated.

4.3.4. Freeboard Allowances. Guidelines on specific minimum freeboard allowances are not considered appropriate because of the many factors involved in such determinations. The investigator will have to assess the critical parameters for each project and develop its minimum requirement. Many projects are reasonably safe without freeboard allowance because they are designed for overtopping, or other factors minimize possible overtopping. Conversely, freeboard allowances of several feet may be necessary to provide a safe condition. Parameters that should be considered include the duration of high water levels in the reservoir during the design flood; the effective wind fetch and reservoir depth available to support wave generation; the probability of high wind speed occurring from a critical direction; the potential wave runup on the dam based on roughness and slope; and the ability of the dam to resist erosion from overtopping waves.

4.4. Stability Investigations. The Phase II stability investigations should be compatible with the guidelines of this paragraph.

4.4.1. Foundation and Material Investigations. The scope of the foundation and materials investigation should be limited to obtaining the information required to analyze the structural stability and to investigate any suspected condition which would adversely affect the safety of the dam. Such investigations may include borings to obtain concrete, embankment, soil foundation, and bedrock samples; testing specimens from these samples to determine the strength and elastic parameters of the materials, including the soft seams, joints, fault gouge and expansive clays or other critical materials in the foundation; determining the character of the bedrock including joints, bedding planes, fractures, faults, voids and caverns, and other geological irregularities; and installing instruments for determining movements, strains, suspected excessive internal seepage pressures, seepage gradients and uplift forces. Special investigations may be necessary where suspect rock types such as limestone, gypsum, salt, basalt, claystone, shales or others are involved in foundations or abutments in order to determine the extent of cavities, piping or other deficiencies in the rock foundation. A concrete core drilling program should be undertaken only when the existence of significant structural cracks is suspected or the general qualitative condition of the concrete is in doubt. The tests of materials will be necessary only where such data are lacking or are outdated.

4.4.2. Stability Assessment. Stability assessments should utilize in situ properties of the structure and its foundation and pertinent geologic

information. Geologic information that should be considered includes groundwater and seepage conditions; lithology, stratigraphy, and geologic details disclosed by borings, "as-built" records, and geologic interpretation; maximum past overburden at site as deduced from geologic evidence; bedding, folding and faulting; joints and joint systems; weathering; slickensides, and field evidence relating to slides, faults, movements and earthquake activity. Foundations may present problems where they contain adversely oriented joints, slickensides or fissured material, faults, seams of soft materials, or weak layers. Such defects and excess pore water pressures may contribute to instability. Special tests may be necessary to determine physical properties of particular materials. The results of stability analyses afford a means of evaluating the structure's existing resistance to failure and also the effects of any proposed modifications. Results of stability analyses should be reviewed for compatibility with performance experience when possible.

4.4.2.1. Seismic Stability. The inertial forces for use in the conventional equivalent static force method of analysis should be obtained by multiplying the weight by the seismic coefficient and should be applied as a horizontal force at the center of gravity of the section or element. The seismic coefficients suggested for use with such analyses are listed in Figures 1 through 4. Seismic stability investigations for all high hazard category dams located in Seismic Zone 4 and high hazard dams of the hydraulic fill type in Zone 3 should include suitable dynamic procedures and analyses. Dynamic analyses for other dams and higher seismic coefficients are appropriate if in the judgment of the investigating engineer they are warranted because of proximity to active faults or other reasons. Seismic stability investigations should utilize "state-of-the-art" procedures involving seismological and geological studies to establish earthquake parameters for use in dynamic stability analyses and, where appropriate, the dynamic testing of materials. Stability analyses may be based upon either time-history or response spectra techniques. The results of dynamic analyses should be assessed on the basis of whether or not the dam would have sufficient residual integrity to retain the reservoir during and after the greatest or most adverse earthquake which might occur near the project location.

4.4.2.2. Clay Shale Foundation. Clay shale is a highly overconsolidated sedimentary rock comprised predominantly of clay minerals, with little or no cementation. Foundations of clay shales require special measures in stability investigations. Clay shales, particularly those containing montmorillonite, may be highly susceptible to expansion and consequent loss of strength upon unloading. The shear strength and the resistance to deformation of clay shales may be quite low and high pore water pressures may develop under increase in load. The presence of slickensides in clay shales is usually an indication of low shear stength. Prediction

of field behavior of clay shales should not be based solely on results of conventional laboratory tests since they may be misleading. The use of peak shear strengths for clay shales in stability analyses may be unconservative because of nonuniform stress distribution and possible progressive failures. Thus the available shear resistance may be less than if the peak shear strength were mobilized simultaneously along the entire failure surface. In such cases, either greater safety factors or residual shear strength should be used.

4.4.3. Embankment Dams.

4.4.3.1. Liquefaction. The phenomenon of liquefaction of loose, saturated sands and silts may occur when such materials are subjected to shear deformation or earthquake shocks. The possibility of liquefaction must presently be evaluated on the basis of empirical knowledge supplemented by special laboratory tests and engineering judgment. The possibility of liquefaction in sands diminishes as the relative density increases above approximately 70 percent. Hydraulic fill dams in Seismic Zones 3 and 4 should receive particular attention since such dams are susceptible to liquefaction under earthquake shocks.

4.4.3.2. Shear Failure. Shear failure is one in which a portion of an embankment or of an embankment and foundation moves by sliding or rotating relative to the remainder of the mass. It is conventionally represented as occurring along a surface and is so assumed in stability analyses, although shearing may occur in a zone of substantial thickness. The circular arc or the sliding wedge method of analyzing stability, as pertinent, should be used. The circular arc method is generally applicable to essentially homogeneous embankments and to soil foundations consisting of thick deposits of fine-grained soil containing no layers significantly weaker than other strata in the foundation. The wedge method is generally applicable to rockfill dams and to earth dams on foundations containing weak layers. Other methods of analysis such as those employing complex shear surfaces may be appropriate depending on the soil and rock in the dam and foundation. Such methods should be in reputable usage in the engineering profession.

4.4.3.3. Loading Conditions. The loading conditions for which the embankment structures should be investigated are (I) Sudden drawdown from spillway crest elevation or top of gates, (II) Partial pool, (III) Steady state seepage from spillway crest elevation or top of gate elevation, and (IV) Earthquake. Cases I and II apply to upstream slopes only; Case III applies to downstream slopes; and Case IV applies to both upstream and downstream slopes. A summary of suggested strengths and safety factors are shown in Table 4.

TABLE 4

FACTORS OF SAFETY /

Case	Loading Condition	Factor of Safety	Shear // Strength	Remarks
I	Sudden drawdown from spillway crest or top of gates to minimum drawdown elevation.	1.2*	Minimum composite of R and S shear strengths See Figure 5.	Within the drawdown zone submerged unit weights of materials are used for computing forces resisting sliding and saturated unit weights are used for computing forces contributing to sliding.
II	Partial pool with assumed horizontal steady seepage saturation.	1.5	$\frac{R+S}{2}$ for $R < S$ S for $R > S$	Composite intermediate envelope of R and S shear strengths. See Figure 6.
III	Steady seepage from spillway crest or top of gates with $K_h/K_v = 9$ assumed**	1.5	Same as Case II	
IV	Earthquake (Cases II and III with seismic loading)	1.0	***	See Figures 1 through 4 for Seismic Coefficients.

/ Not applicable to embankments on clay shale foundation. Experience has indicated special problems in determination of design shear strengths for clay shale foundations and acceptable safety factors should be compatible with the confidence level in shear strength assumptions.

// Other strength assumptions may be used if in common usage in the engineering profession.

* The safety factor should not be less than 1.5 when drawdown rate and pore water pressure developed from flow nets are used in stability analyses.

** K_h/K_v is the ratio of horizontal to vertical permeability. A minimum of 9 is suggested for use in compacted embankments and alluvial sediments.

*** Use shear strength for case analyzed without earthquake. It is not necessary to analyze sudden drawdown for earthquake loading. Shear strength tests are classified according to the controlled drainage conditions maintained during the test. R tests are those in which specimen drainage is allowed during consolidation (or swelling) under initial stress conditions, but specimen drainage is not allowed during application of shearing stresses. S tests allow full drainage during initial stress application and shearing is at a slow rate so that complete specimen drainage is permitted during the complete test.

4.4.3.4. Safety Factors. Safety factors for embankment dam stability studies should be based on the ratio of available shear strength to developed shear strength, S_D:

$$S_D = \frac{C}{F.S.} + \sigma \frac{\tan \phi}{F.S.} \qquad (1)$$

C = cohesion

ϕ = angle of internal friction

σ = normal stress

The factors of safety listed in Table 4 are recommended as minimum acceptable. Final accepted factors of safety should depend upon the degree of confidence the investigating engineer has in the engineering data available to him. The consequences of a failure with respect to human life and property damage are important considerations in establishing factors of safety for specific investigations.

4.4.3.5. Seepage Failure. A critical uncontrolled underseepage or through seepage condition that develops during a rising pool can quickly reduce a structure which was stable under previous conditions, to a total structural failure. The visually confirmed seepage conditions to be avoided are (1) the exit of the phreatic surface on the downstream slope of the dam and (2) development of hydrostatic heads sufficient to create in the area downstream of the dam sand boils that erode materials by the phenomenon known as "piping" and (3) localized concentrations of seepage along conduits or through pervious zones. The dams most susceptible to seepage problems are those built of or on pervious materials of uniform fine particle size, with no provisions for an internal drainage zone and/or no underseepage controls.

4.4.3.6. Seepage Analyses. Review and modifications to original seepage design analyses should consider conditions observed in the field inspection and piezometer instrumentation. A seepage analysis should consider the permeability ratios resulting from natural deposition and from compaction placement of materials with appropriate variation between horizontal and vertical permeability. An underseepage analysis of the embankment should provide a critical gradient factor of safety for the maximum head condition of not less than 1.5 in the area downstream of the embankment.

$$F.S = i_c/i = \frac{H_c/D_b}{H/D_b} = D_b \frac{(\gamma_m - \gamma_w)}{H \gamma_w} \qquad (2)$$

i_c = Critical gradient

i = Design gradient

H = Uplift head at downstream toe of dam measured above tailwater

H_c = The critical uplift

D_b = The thickness of the top impervious blanket at the downstream toe of the dam

γ_m = The estimated saturated unit weight of the material in the top impervious blanket

γ_w = The unit weight of water

Where a factor of safety less than 1.5 is obtained the provision of an underseepage control system is indicated. The factor of safety of 1.5 is a recommended minimum and may be adjusted by the responsible engineer based on the competence of the engineering data.

4.4.4. Concrete Dams and Appurtenant Structures.

4.4.4.1. Requirements for Stability. Concrete dams and structures appurtenant to embankment dams should be capable of resisting overturning, sliding and overstressing with adequate factors of safety for normal and maximum loading conditions.

4.4.4.2. Loads. Loadings to be considered in stability analyses include the water load on the upstream face of the dam; the weight of the structure; internal hydrostatic pressures (uplift) within the body of the dam, at the base of the dam and within the foundation; earth and silt loads; ice pressure, seismic and thermal loads, and other loads as applicable. Where tailwater or backwater exists on the downstream side of the structure it should be considered, and assumed uplift pressures should be compatible with drainage provisions and uplift measurements if available. Where applicable, ice pressure should be applied to the contact surface of the structure at normal pool elevation. A unit pressure of not more than 5,000 pounds per square foot should be used. Normally, ice thickness should not be assumed greater than two feet. Earthquake forces should consist of the inertial forces due to the horizontal acceleration of the dam itself and hydrodynamic forces resulting from the reaction of the reservoir water against the structure. Dynamic water pressures for use in conventional methods of analysis may be computed by means of the "Westergaard Formula" using the parabolic approximation (H.M. Westergaard, "Water Pressures on Dams During Earthquakes," Trans., ASCE, Vol 98, 1933, pages 418-433), or similar method.

4.4.4.3. Stresses. The analysis of concrete stresses should be based on in situ properties of the concrete and foundation. Computed maximum compressive stresses for normal operating conditions in the order of 1/3 or less of in situ strengths should be satisfactory. Tensile stresses in unreinforced concrete should be acceptable only in locations where cracks will not adversely affect the overall performance and stability of the structure. Foundation stresses should be such as to provide adequate safety against failure of the foundation material under all loading conditions.

4.4.4.4. Overturning. A gravity structure should be capable of resisting all overturning forces. It can be considered safe against overturning if the resultant of all combinations of horizontal and vertical forces, excluding earthquake forces, acting above any horizontal plane through the structure or at its base is located within the middle third of the section. When earthquake is included the resultant should fall within the limits of the plane or base, and foundation pressures must be acceptable. When these requirements for location of the resultant are not satisfied the investigating engineer should assess the importance to stability of the deviations.

4.4.4.5. Sliding. Sliding of concrete gravity structures and of abutment and foundation rock masses for all types of concrete dams should be evaluated. by the shear-friction resistance concept. The available sliding resistance is compared with the driving force which tends to induce sliding to arrive at a sliding stability safety factor. The investigation should be made along all potential sliding paths. The critical path is that plane or combination of planes which offers the least resistance.

4.4.4.5.1. Sliding Resistance. Sliding resistance is a function of the unit shearing strength at no normal load (cohesion) and the angle of friction on a potential failure surface. It is determined by computing the maximum horizontal driving force which could be resisted along the sliding path under investigation. The following general formula is obtained from the principles of statics and may be derived by resolving forces parallel and perpendicular to the sliding plane:

$$R_R = V \tan(\phi + \alpha) + \frac{cA}{\cos\alpha(1 - \tan\phi \tan\alpha)} \qquad (3)$$

where

R_R = Sliding Resistance (maximum horizontal driving force which can be resisted by the critical path)

ϕ = Angle of internal friction of foundation material or, where applicable, angle of sliding friction

V = Summation of vertical forces (including uplift)

c = Unit shearing strength at zero normal loading along potential failure plane

A = Area of potential failure plane developing unit shear strength "c"

α = Angle between inclined plane and horizontal (positive for uphill sliding)

For sliding downhill the angle α is negative and Equation (1) becomes:

$$R_R = V \tan(\phi - \alpha) + \frac{cA}{\cos\alpha(1 + \tan\phi \tan\alpha)} \qquad (4)$$

When the plane of investigation is horizontal, and the angle α is zero and Equation (1) reduced to the following:

$$R_R = V \tan\phi + cA \qquad (5)$$

4.4.4.5.2. Downstream Resistance. When the base of a concrete structure is embedded in rock or the potential failure plane lies below the base, the passive resistance of the downstream layer of rock may sometimes be utilized for sliding resistance. Rock that may be subjected to high velocity water scouring should not be used. The magnitude of the downstream resistance is the lesser of (a) the shearing resistance along the continuation of the potential sliding plane until it daylights or (b) the resistance available from the downstream rock wedge along an inclined plane. The theoretical resistance offered by the passive wedge can be computed by a formula equivalent to formula (3):

$$P_p = W \tan(\phi + \alpha) + \frac{cA}{\cos\alpha\,(1 - \tan\phi \tan\alpha)} \qquad (6)$$

P_p = passive resistance of rock wedge

W = weight (buoyant weight if applicable) of downstream rock wedge above inclined plane of resistance, plus any superimposed loads

ϕ = angle of internal friction or, if applicable, angle of sliding friction

α = angle between inclined failure plane and horizontal

c = unit shearing strength at zero normal load along failure plane

A = area of inclined plane of resistance

When considering cross-bed shear through a relatively shallow, competent rock strut, without adverse jointing or faulting, W and α may be taken at zero and 45°, respectively, and an estimate of passive wedge resistance per unit width obtained by the following equation:

$$P_p = 2\,cD \qquad (7)$$

where

D = Thickness of the rock strut

4.4.4.5.3. Safety Factor. The shear-friction safety factor is obtained by dividing the resistance R_R by H, the summation of horizontal service

loads to be applied to the structure:

$$S_{s-f} = \frac{R_R}{H} \tag{8}$$

When the downstream passive wedge contributes to the sliding resistance, the shear fruction safety factor formula becomes:

$$S_{s-f} = \frac{R_R + P_p}{H} \tag{9}$$

The above direct superimposition of passive wedge resistance is valid only if shearing rigidities of the foundation components are similar. Also, the compressive strength and buckling resistance of the downstream rock layer must be sufficient to develop the wedge resistance. For example, a foundation with closely spaced, near horizontal, relatively weak seams might not contain sufficient buckling strength to develop the magnitude of wedge resistance computed from the cross-bed shear strength. In this case wedge resistance should not be assumed without resorting to special treatment (such as installing foundation anchors). Computed sliding safety factors approximating 3 or more for all loading conditions without earthquake, and 1.5 including earthquake, should indicate satisfactory stability, depending upon the reliability of the strength parameters used in the analyses. In some cases when the results of comprehensive foundation studies are available, smaller safety factors may be acceptable. The selection of shear strength parameters should be fully substantiated. The bases for any assumptions; the results of applicable testing, studies and investigations; and all pre-existing, pertinent data should be reported and evaluated.

CHAPTER 5 - REPORTS

5.1. General. This chapter outlines the procedures for reporting the results of the technical investigations. Hazardous conditions should be reported immediately upon detection to the owner of the dam, the Governor of the State in which the dam is located and the appropriate regulatory agency without delay for preparation of the formal report.

5.2. Preparation of Report. A formal report should be prepared for each dam investigated for submission to the regulatory agency and the owner of the dam. Each report should contain the information indicated in the following paragraphs. The signature and registration identification of the professional engineer who directed the investigation and who was responsible for evaluation of the dam should be included in the report.

5.2.1. Phase I Reports. Phase I reports should contain the following information:

5.2.1.1. Description of dam including regional vicinity map showing location and plans, elevations and sections showing the essential project features and the size and hazard potential classifications.

5.2.1.2. Summary of existing engineering data, including geologic maps and information.

5.2.1.3. Results of the visual inspection of each project feature including photographs and drawings to minimize descriptions.

5.2.1.4. Evaluation of operational adequacy of the reservoir regulation plan and maintenance of the dam and operating facilities and features that pertain to the safety of the dam.

5.2.1.5. Description of any warning system in effect.

5.2.1.6. Evaluation of the hydraulic and hydrologic assumptions and structural stability.

5.2.1.7. An assessment of the general condition of the dam with respect to safety based upon the findings of the visual inspection and review of engineering data. Where data on the original design indicate significant departure from or non-conformance with guidelines contained herein, the engineer-in-charge of the investigation will give his opinion of the significance, with regard to safety, of such factors. Any additional studies, investigations and analyses considered essential to assessment of the safety of the dam should be listed, together with an opinion about the urgency of such additional work.

5.2.1.8. Indicate alternative possible remedial measures or revisions in operating and maintenance procedures which may (subject to further evaluation) correct deficiencies and hazardous conditions found during the investigation.

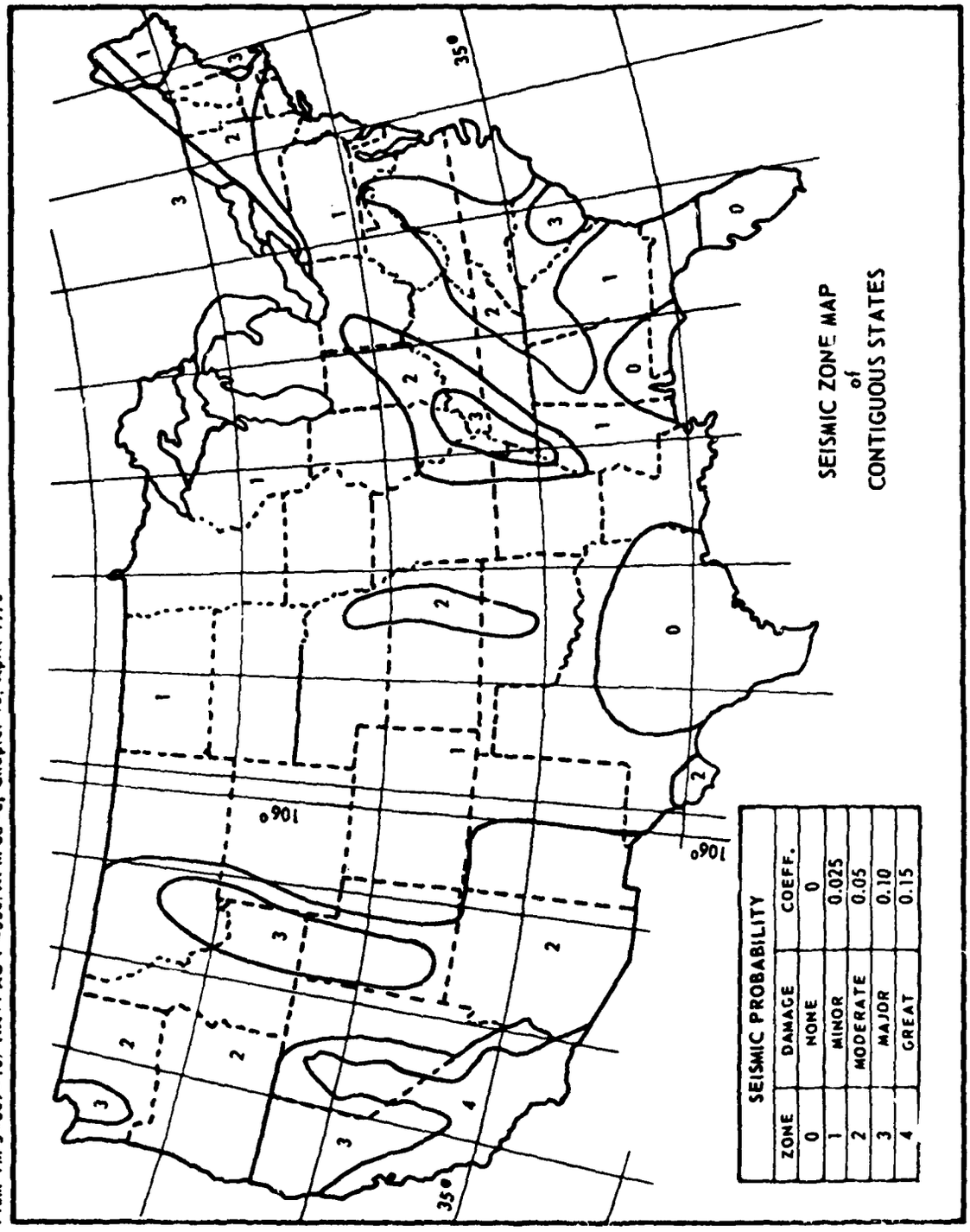
5.2.2. Phase II Reports. Phase II reports should describe the detailed investigations and should supplement Phase I reports. They should contain the following information:.

5.2.2.1. Summary of additional engineering data obtained to determine the hydraulic and hydrologic capabilities and/or structural stability.

5.2.2.2. Results of all additional studies, investigations, and analyses performed.

5.2.2.3. Technical assessment of dam safety including deficiencies and hazardous conditions found to exist.

5.2.2.4. Indicate alternative possible remedial measures or revision in maintenance and operating procedures which may (subject to further evaluation) correct deficiencies and hazardous conditions found during the investigation.



From TM 5-809-10/NAVFAC P-355/AFM 88-3, Chapter 13, April 1973

Figure 1

From TM 5-809-10/ NAVFAC P-355/AFM 88-3, Chapter 13; April 1973

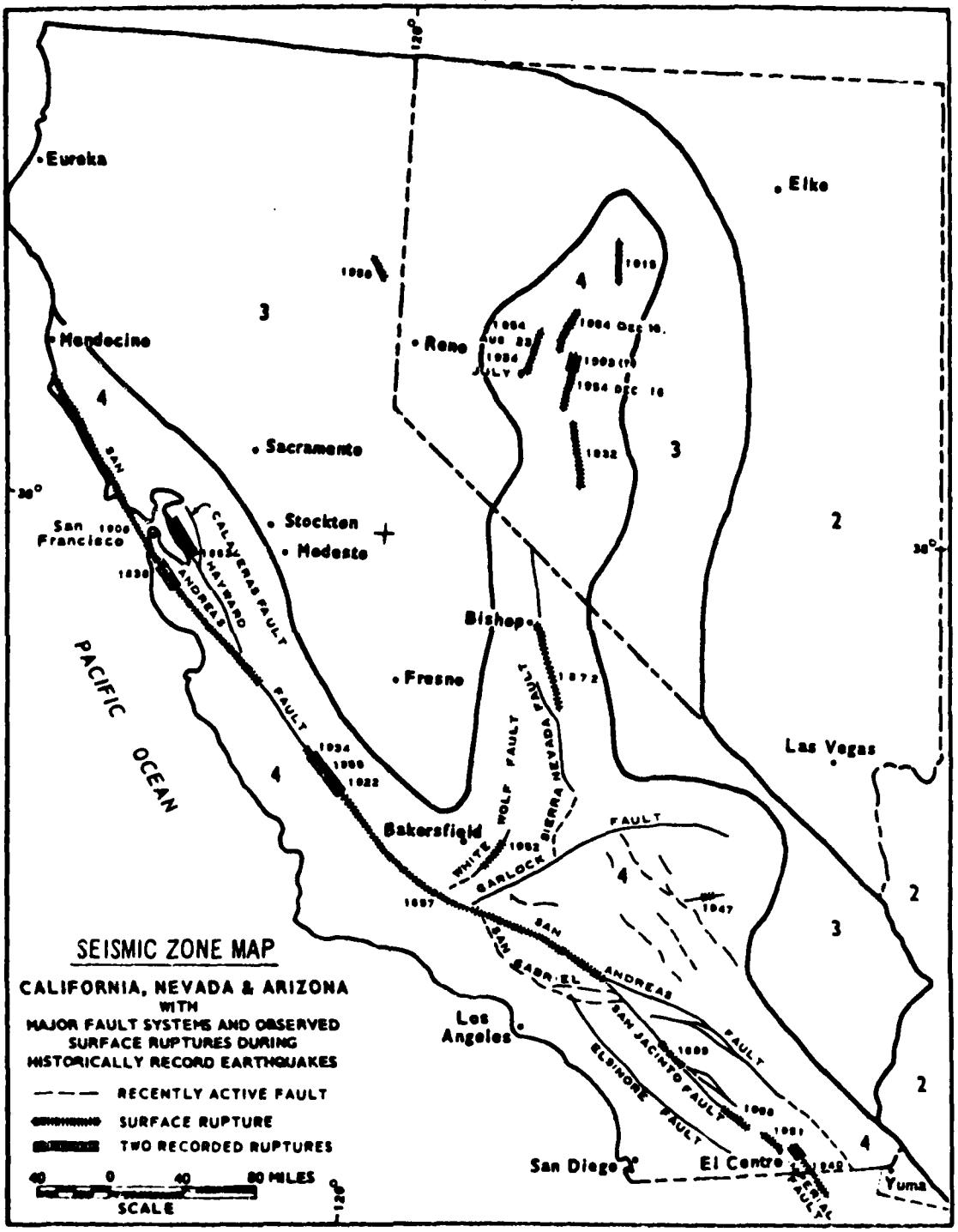
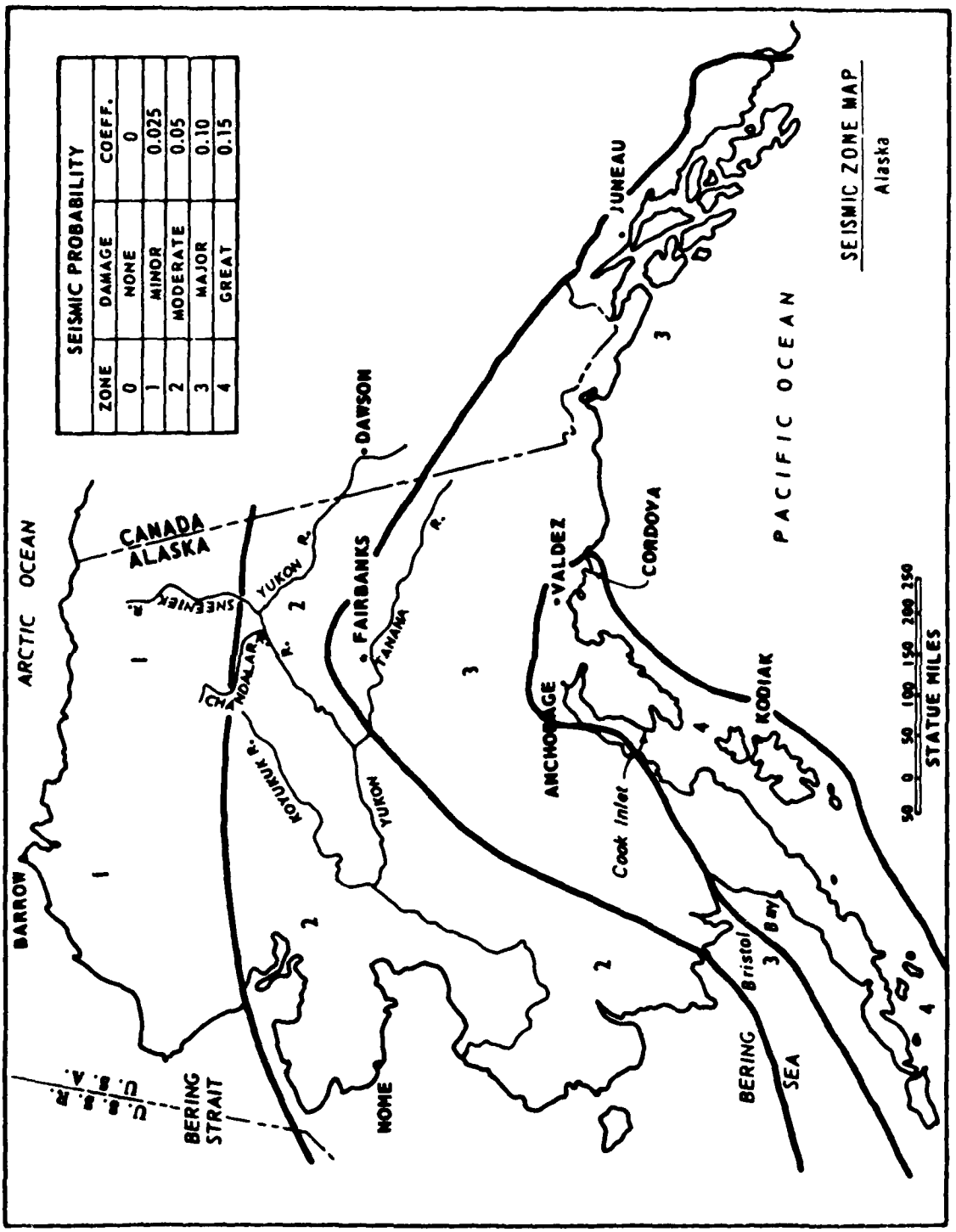
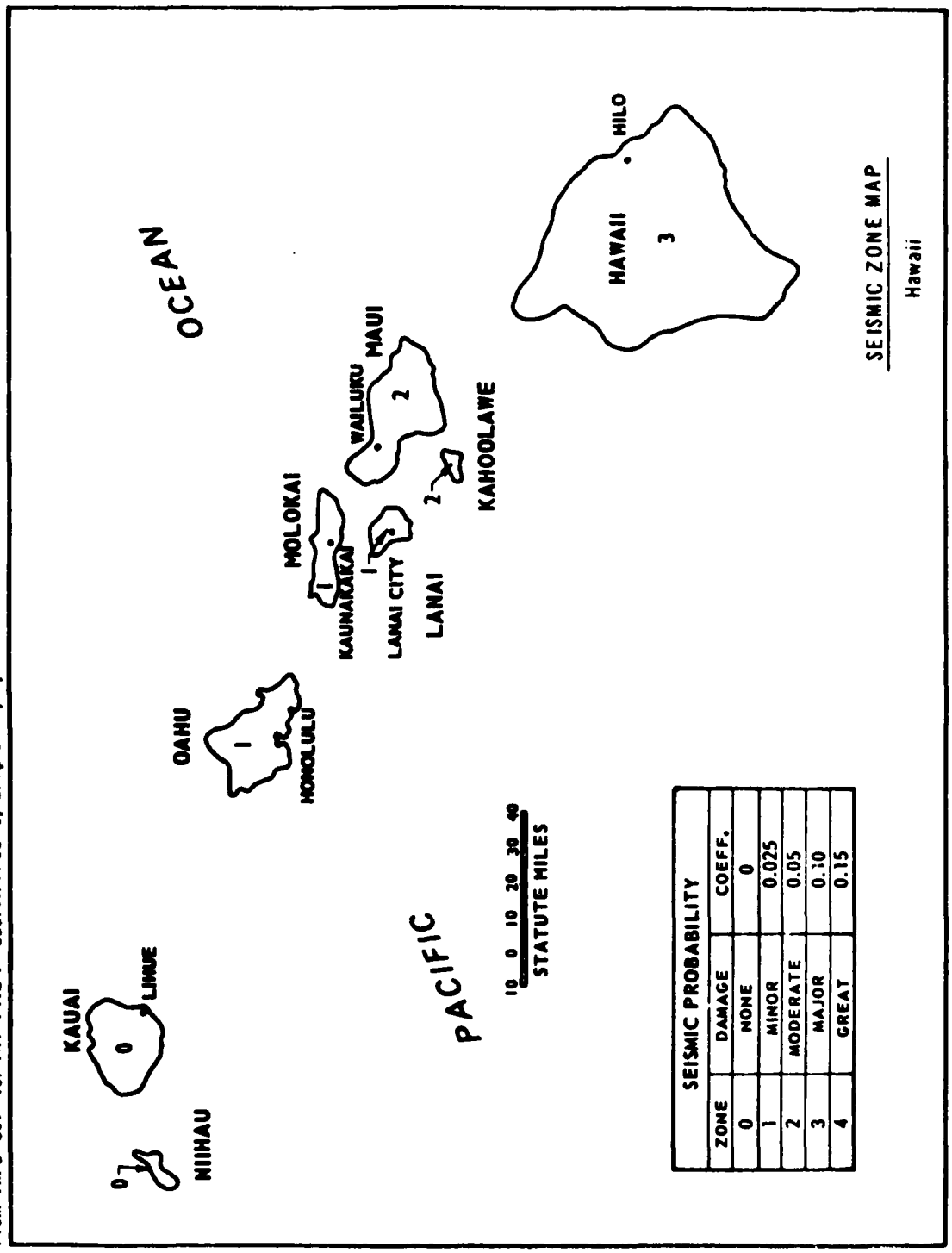


Figure 2



From TM 5-809-10/ NAVFAC P-355/AFM 88-3, Chapter 13; April 1973

Figure 3



SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

From TM 5-809-10/ NAVFAC P-355/AFM 88-3, Chapter 13; April 1973

Figure 4

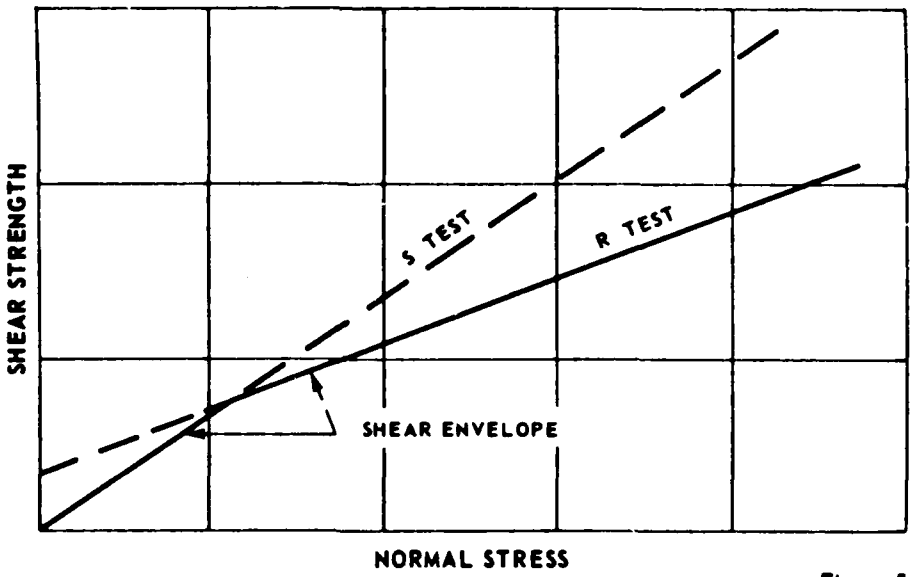


Figure 5

SHEAR ENVELOPE FOR CASE I

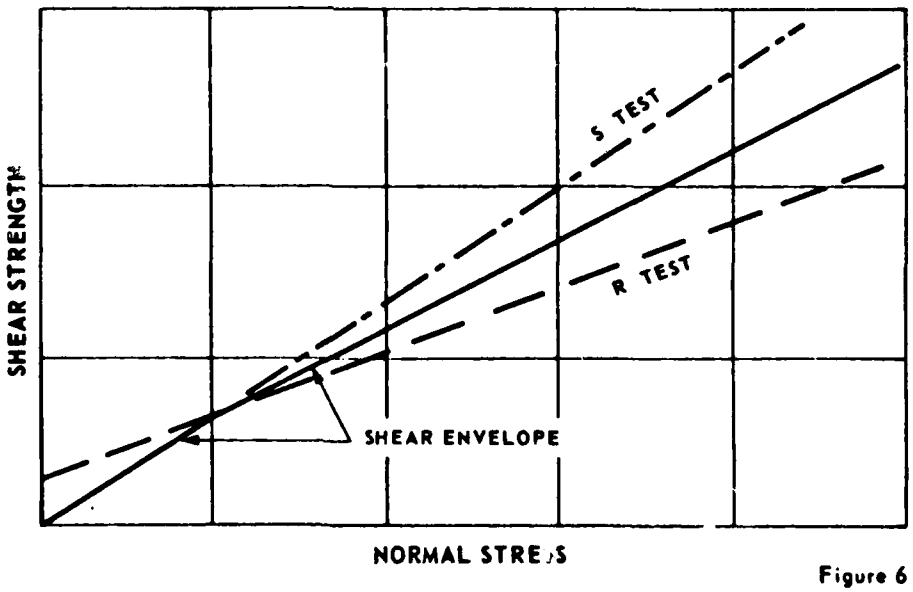


Figure 6

SHEAR ENVELOPE FOR CASES II AND III

APPENDIX I

ENGINEERING DATA

This appendix lists engineering data which should be collected from project records and, to the extent available, included in the Phase I investigation report. The list is intended to serve as a checklist and not to establish rigid data requirements. Such a compilation should also facilitate future inspections and investigations. Only data readily available will be included in Phase I reports, but data lacking and deemed necessary for an adequate safety evaluation should be identified.

1. General Project Data

a. Regional Vicinity Map showing the location of the dam, the upstream drainage area and the downstream area subject to potential damage due to failure of the dam and misoperation or failure of the operating equipment.

b. As-Built Drawings indicating plans, elevations and sections of the dam and appurtenant structures including the details of the discharge facilities such as outlet works, limited service and emergency spillways, flashboards, fuse plugs and operating equipment.

2. Hydrologic and Hydraulic Data including the following:

a. Drainage area and basin runoff characteristics (indicating pending changes).

b. Elevation of top of conservation pool or normal upper retention water surface elevation, as applicable (base level of any flood impoundment).

c. Storage capacity including dead or inactive storage, corresponding to top of conservation or normal upper retention level (cumulative, excluding flood control and surcharge storage).

d. Elevation of the top of flood control pool.

e. Storage capacity of flood control zone (incremental).

f. Elevation of maximum design pool (corresponding to top of surcharge storage or spillway design flood).

g. Storage capacity of surcharge zone (incremental, above top of flood control pool or, above normal upper retention level if flood control space not provided).

h. Height of freeboard (distance between maximum design flood water surface and top of dam).

i. Elevation of top of dam (lowest point of embankment or non-overflow structure).

j. Elevation of crest, type, width, crest length and location of spillways (number, size and type of gates if controlled).

k. Type, location, entrance and exit inverts of outlet works and emergency drawdown facilities (number, size and shape of conduits and gates, including penstocks and sluices).

l. Location, crest elevation, description of invert and abutments (concrete, rock, grass, earth) and length of limited service and emergency spillways.

m. Location and description of flashboards and fuse plugs, including hydraulic head (pool elevation) and other conditions required for breaching, along with the assumed results of breaching.

n. Location and top elevation of dikes and floodwalls (overflow and non-overflow) affected by reservoir. Include information on low reaches of reservoir rim.

o. Type, location, observations and records of hydrometeorological gages appurtenant to the project.

p. Maximum non-damaging discharge, or negligible damage rate, at potential damage locations downstream.

3. Foundation Data and Geological Features including logs of borings, geological maps, profiles and cross sections, and reports of foundation treatment.

4. Properties of Embankments and Foundation Materials including results of laboratory tests, field permeability tests, construction control tests, and assumed design properties for materials.

5. Concrete Properties including the source and type of aggregate, cement used, mix design data and the results of testing during construction.

6. Electrical and Mechanical Equipment type and rating of normal and emergency power supplies, hoists, cranes, valves and valve operator, control and alarm systems and other electrical and mechanical equipment and systems that could affect the safe operation of the dam.

7. Construction History including diversion scheme, construction sequence, pertinent construction problems, alterations, modifications and maintenance repairs.

8. Water Control Plan including regulation plan under normal conditions and during flood events or other emergency conditions. The availability of dam tenders, means of communication between dam tenders and authority supervising water control, and method of gate operation (manual, automatic, or remote control) should be included. Flood warning systems should be described in sufficient detail to enable assessment of their reduction in the flood hazard potential.

9. Operation Record.

a. Summary of past major flood events including any experiences that presented a serious threat to the safety of the project or to human life or property. The critical project feature, date and duration of event, causative factor, peak inflow and outflow, maximum elevation of water surface, wind and wave factors if significant, issuance of alert or evacuation warnings and adequacy of project feature involved should be included in the summary of past experience of serious threat to the safety of the project.

b. Records of performance observations including instrumentation records.

c. List of any known deficiencies that pose a threat to the safety of the dam or to human life or property.

d. History of previous failures or deficiencies and pending remedial measures for correcting known deficiencies and the schedule for accomplishing remedial measures should be indicated.

10. Earthquake History including a summary of the seismic data of significant recorded earthquakes in the vicinity of the dam and information on major damage in the vicinity of the dam from both recorded and unrecorded earthquakes. Regional geologic maps and other documents showing fault locations should be collected.

11. Inspection History including the results of the last safety inspection, the organization that performed the inspection, the date inspection performed and the authority for conducting the inspection.

12. Principal Design Assumptions and Analyses.

a. Hydrologic and Hydraulic Determinations.

(1) Quantity, time and area distribution, and reference source of depth-area-duration data of spillway design storm precipitation (point precipitation if applicable).

(2) Maximum design flood inflow hydrograph including loss rates (initial and average for design flood conditions) and time of runoff concentration of reservoir watershed (peak inflow only when applicable).

(3) Maximum design flood outflow hydrograph (maximum outflow only when applicable).

(4) Discharge-frequency relationship, preferably at damsite, including estimated frequency of spillway design flood for small dams, when appropriate.

(5) Reservoir area and storage capacity versus water surface elevation (table or curves).

(6) Rating curves (free flow and partial gate openings) for all discharge facilities contributing to the maximum design flood outflow hydrograph. Also a composite-rating of all contributing facilities, if appropriate.

(7) Tailwater rating curve immediately below damsite including elevation corresponding to maximum design flood discharge and approximate nondamaging channel capacity.

(8) Hydrologic map of watershed above damsite including reservoir area, watercourse, elevation contours, and principal stream-flow and precipitation gaging stations.

b. Stability and Stress Analysis of the dam, spillway and appurtenant structures and features including the assumed properties of materials and all pertinent applied loads.

c. Seepage and Settlement Analyses. The determination of distribution, direction and magnitude of seepage forces and the design and construction measures for their control. Settlement estimates and steps adopted to compensate for total settlement and to minimize differential settlements.

APPENDIX II

INSPECTION ITEMS

This appendix provides guidance for performing field inspections and may serve as the basis for developing a detailed checklist for each dam.

1. Concrete Structures in General.

a. Concrete Surfaces. The condition of the concrete surfaces should be examined to evaluate the deterioration and continuing serviceability of the concrete. Descriptions of concrete conditions should conform with the appendix to "Guide for Making a Condition Survey of Concrete in Service," American Concrete Institute (ACI) Journal, Proceedings Vol. 65, No. 11, November 1968, page 905-918.

b. Structural Cracking. Concrete structures should be examined for structural cracking resulting from overstress due to applied loads, shrinkage and temperature effects or differential movements.

c. Movement - Horizontal and Vertical Alignment. Concrete structures should be examined for evidence of any abnormal settlements, heaving, deflections, or lateral movements.

d. Junctions. The conditions at the junctions of the structure with abutments or embankments should be determined.

e. Drains - Foundation, Joint, Face. All drains should be examined to determine that they are capable of performing their design function.

f. Water Passages. All water passages and other concrete surfaces subject to running water should be examined for erosion, cavitation, obstructions, leakage or significant structural cracks.

g. Seepage or Leakage. The faces, abutments and toes of the concrete structures should be examined for evidence of seepage or abnormal leakage, and records of flow of downstream springs reviewed for variation with reservoir pool level. The sources of seepage should be determined if possible.

h. Monolith Joints - Construction Joints. All monolith and construction joints should be examined to determine the condition of the joint and filler material, any movement of joints, or any indication of distress or leakage.

i. Foundation. Foundation should be examined for damage or possible undermining of the downstream toe.

j. Abutments. The abutments should be examined for sign of instability or excessive weathering.

2. Embankment Structures.

a. Settlement. The embankments and downstream toe areas should be examined for any evidence of localized or overall settlement, depressions or sink holes.

b. Slope Stability. Embankment slopes should be examined for irregularities in alignment and variances from smooth uniform slopes, unusual changes from original crest alignment and elevation, evidence of movement at or beyond the toe, and surface cracks which indicate movement.

c. Seepage. The downstream face of abutments, embankment slopes and toes, embankment - structure contacts, and the downstream valley areas should be examined for evidence of existing or past seepage. The sources of seepage should be investigated to determine cause and potential severity to dam safety under all operating conditions. The presence of animal burrows and tree growth on slopes which might cause detrimental seepage should be examined.

d. Drainage Systems. All drainage systems should be examined to determine whether the systems can freely pass discharge and that the discharge water is not carrying embankment or foundation material. Systems used to monitor drainage should be examined to assure they are operational and functioning properly.

e. Slope Protection. The slope protection should be examined for erosion-formed gullies and wave-formed notches and benches that have reduced the embankment cross-section or exposed less wave resistant materials. The adequacy of slope protection against waves, currents, and surface runoff that may occur at the site should be evaluated. The condition of vegetative cover should be evaluated where pertinent.

3. Spillway Structures. Examination should be made of the structures and features including bulkheads, flashboards, and fuse plugs of all service and auxiliary spillways which serve as principal or emergency spillways for any condition which may impose operational constraints on the functioning of the spillway.

a. Control Gates and Operating Machinery. The structural members, connections, hoists, cables and operating machinery and the adequacy of normal and emergency power supplies should be examined and tested to determine the structural integrity and verify the operational adequacy of the equipment. Where cranes are intended to be used for handling gates and bulkheads, the availability, capacity and condition of the cranes and lifting beams should be investigated. Operation of control

systems and protective and alarm devices such as limit switches, sump high water alarms and drainage pumps should be investigated.

b. Unlined Saddle Spillways. Unlined saddle spillways should be examined for evidence of erosion and any conditions which may impose constraints on the functioning of the spillway. The ability of the spillway to resist erosion due to operation and the potential hazard to the safety of the dam from such operation should be determined.

c. Approach and Outlet Channels. The approach and outlet channels should be examined for any conditions which may impose constraints on the functioning of the spillway and present a potential hazard to the safety of the dam.

d. Stilling Basin (Energy Dissipators). Stilling basins including baffles, flip buckets or other energy dissipators should be examined for any conditions which may pose constraints on the ability of the stilling basin to prevent downstream scour or erosion which may create or present a potential hazard to the safety of the dam. The existing condition of the channel downstream of the stilling basin should be determined.

4. Outlet Works. The outlet works examination should include all structures and features designed to release reservoir water below the spillway crest through or around the dam.

a. Intake Structure. The structure and all features should be examined for any conditions which may impose operational constraints on the outlet works. Entrances to intake structure should be examined for conditions such as silt or debris accumulation which may reduce the discharge capabilities of the outlet works.

b. Operating and Emergency Control Gates. The structural members, connections, guides, hoists, cables and operating machinery including the adequacy of normal and emergency power supplies should be examined and tested to determine the structural integrity and verify the operational adequacy of the operating and emergency gates, valves, bulkheads, and other equipment.

c. Conduits, Sluices, Water Passages, Etc. The interior surfaces of conduits should be examined for erosion, corrosion, cavitation, cracks, joint separation and leakage at cracks or joints.

d. Stilling Basin (Energy Dissipator). The stilling basin or other energy dissipator should be examined for conditions which may impose any constraints on the ability of the stilling basin to prevent downstream scour or erosion which may create or present a potential hazard to the safety of the dam. The existing condition of the channel downstream of the stilling basin should be determined by soundings.

e. Approach and Outlet Channels. The approach and outlet channels should be examined for any conditions which may impose constraints on the functioning of the discharge facilities of the outlet works, or present a hazard to the safety of the dam.

f. Drawdown Facilities. Facilities provided for drawdown of the reservoir to avert impending failure of the dam or to facilitiate repairs in the event of stability or foundation problems should be examined for any conditions which may impose constraints on their functioning as planned.

5. Safety and Performance Instrumentation. Instruments which have been installed to measure behavior of the structures should be examined for proper functioning. The available records and readings of installed instruments should be reviewed to detect any unusual performance of the instruments or evidence of unusual performance or distress of the structure. The adequacy of the installed instrumentation to measure the performance and safety of the dam should be determined.

a. Headwater and Tailwater Gages. The existing records of the headwater and tailwater gages should be examined to determine the relationship between other instrumentation measurements such as stream flow, uplift pressures, alignment, and drainage system discharge with the upper and lower water surface elevations.

b. Horizontal and Vertical Alignment Instrumentation (Concrete Structures). The existing records of alignment and elevation surveys and measurements from inclinometers, inverted plumb bobs, gage points across cracks and joints, or other devices should be examined to determine any change from the original position of the structures.

c. Horizontal and Vertical Movement, Consolidation, and Pore-Water Pressure Instrumentation (Embankment Structures). The existing records of measurements from settlement plates or gages, surface reference marks, slope indicators and other devices should be examined to determine the movement history of the embankment. Existing piezometer measurements should be examined to determine if the pore-water pressures in the embankment and foundation would under given conditions impair the safety of the dam.

d. Uplift Instrumentation. The existing records of uplift measurements should be examined to determine if the uplift pressures for the maximum pool would impair the safety of the dam.

e. Drainage System Instrumentation. The existing records of measurements of the drainage system flow should be examined to establish the

normal relationship between pool elevations and discharge quantities and any changes that have occurred in this relationship during the history of the project.

f. Seismic Instrumentation. The existing records of seismic instrumentation should be examined to determine the seismic activity in the area and the response of the structures to past earthquakes.

6. Reservoir. The following features of the reservoir should be examined to determine to what extent the water impounded by the dam would constitute a danger to the safety of the dam or a hazard to human life or property.

a. Shore line. The land forms around the reservoir should be examined for indications of major active or inactive landslide areas and to determine susceptibility of bedrock stratigraphy to massive landslides of sufficient magnitude to significantly reduce reservoir capacity or create waves that might overtop the dam.

b. Sedimentation. The reservoir and drainage area should be examined for excessive sedimentation or recent developments in the drainage basin which could cause a sudden increase in sediment load thereby reducing the reservoir capacity with attendant increase in maximum outflow and maximum pool elevation.

c. Potential Upstream Hazard Areas. The reservoir area should be examined for features subject to potential backwater flooding resulting in loss of human life or property at reservoir levels up to the maximum water storage capacity including any surcharge storage.

d. Watershed Runoff Potential. The drainage basin should be examined for any extensive alterations to the surface of the drainage basin such as changed agriculture practices, timber clearing, railroad or highway construction or real estate developments that might extensively affect the runoff characteristics. Upstream projects that could have impact on the safety of the dam should be identified.

7. Downstream Channel. The channel immediately downstream of the dam should be examined for conditions which might impose any constraints on the operation of the dam or present any hazards to the safety of the dam. Development of the potential flooded area downstream of the dam should be assessed for compatibility with the hazard classification.

8. Operation and Maintenance Features.

a. Reservoir Regulation Plan. The actual practices in regulating the reservoir and discharges under normal and emergency conditions should be

APPENDIX E

Suggested Outline

Inspection Report
National Dam Inspection Program
(RCS-DAEN-CWE-17 AND OMB NO. 49-R0421)

TITLE SHEET
- Name of Dam
- ID Number from Inventory
- State, County and River or Stream where dam is located
- Owner
- Size and Hazard Classification
- Names of Inspectors
- Names of Review Board
- Approval Signature of District Engineer

TABLE OF CONTENTS

GENERAL ASSESSMENT

Give brief assessment of general condition of dam with respect to safety, including a listing of deficiencies, and recommendations indicating degree of urgency.

1. INTRODUCTION
   - a. Authority
   - b. Purpose and Scope of Inspection

2. PROJECT INFORMATION
   - a. Site Information
   - b. Description of Structures - Dam, Outlet, Spillway and other principal features.
   - c. Purpose of Dam
   - d. Design, Construction and Operating History

3. FIELD INSPECTION

   Briefly describe physical condition of the dam and appurtenant structures as they were observed during the field inspection. (If field inspection form is appended, only present summary.) Describe operational procedures, including any warning system, condition of operating equipment, and provision for emergency procedures. Describe any pertinent observations of the reservoir area and downstream channel adjacent to dam.

4. EVALUATION
   - a. Structural and Geotechnical
   - (1) General

(2) Embankment and/or Foundation Condition

(3) Stability

Briefly discuss pertinent information such as design, construction and operating records. Assess stability under maximum loading on basis of the record data, together with observations of field inspection and results of any additional, brief calculations performed by inspectors. If additional, detailed stability analyses are considered necessary, recommend that the owner engage a qualified engineer or firm to provide the analysis.

b. Hydrologic and Hydraulic

(1) Spillway Adequacy

Briefly describe pertinent record information such as hydrologic and hydraulic design data, flood of record, and previous analyses. Describe any hydraulic and hydrologic analyses made for this inspection. Present conclusion with respect to adequacy of spillway to pass the recommended spillway design flood without overtopping dam. If overtopping would occur, and if available from the type of analysis used, give maximum depth over top of dam and duration of overtopping, assuming the dam does not fail. Also indicate the largest flood, as a percentage of the probable maximum flood which can be passed without overtopping.

(2) Effects of Overtopping

If dam is overtopped by the recommended spillway design flood, provide assessment as to whether or not dam would likely fail, and if, in case of failure, the hazard to loss of life downstream of the dam would be substantially increased over that which would exist without failure. If information upon which to base a reasonable assessment is insufficient, so state and describe the needed data, and recommend that the necessary studies be performed by engineers engaged by the owner.

c. Operation and Maintenance

Assess operating equipment and procedures, emergency power for gate operation, and Emergency Action Plan. Assess quality of maintenance as it pertains to dam safety.

5. CONCLUSIONS

Provide conclusions on condition of dam and list all deficiencies. If dam is considered unsafe, so state and give reason.

6. RECOMMENDATIONS

List all recommended actions, including additional studies, installation of new surveillance procedures and devices, development of Emergency Action Plans, and remedial work. Recommend that a qualified engineering firm be retained to accomplish any recommended additional investigations and studies and also to design and supervise remedial works.

APPENDIXES

a. Inspection Checklist (if available)

b. Other Illustrations as follows:

(1) Include a map showing location of the dam. Usually a portion of a USGS quadrangle sheet can be used which will show the topography of the area, location of the dam, extent of the lake and drainage basin, and perhaps indicate the downstream development.

(2) If available, include a plan and section of the dam.

(3) General photographs of the dam and downstream channel should be included.

(4) Color photographs of deficiencies should be included. These should be held to the minimum required to illustrate the deficiencies.

(5) Available engineering data including Hydrologic/Hydraulic calculation and physical test results that might be available.

APPENDIX F

INSTRUCTIONS FOR UNSAFE DAM DATA SHEET
(RCS-DAEN-CWE-17 and OMB NO. 49-R0421)

The indicated information shall be provided in the format shown on Pg F-3 for each dam assessed to be unsafe during the reporting period. A separate data sheet should be provided for each unsafe dam. The information supplied should conform to the following:

a. Name - Name of dam.

b. Id. No. - Dam inventory identity number.

c. Location - List state county, river or stream and nearest D/S city or town where the dam is located.

d. Height - Maximum hydraulic height of dam.

e. Maximum Impoundment Capacity - List the capacity of the reservoir at maximum attainable water surface elevation including any surcharge loading.

f. Type - Type of dam, i.e., earth, rockfill, gravity, combination earth-gravity, etc.

g. Owner - Owner of dam.

h. Date Governor Notified of Unsafe Condition - The date and method of notification, such as, by telegram, letter, report, etc.

i. Condition of Dam Resulting in Unsafe Assessment - Brief description of the deficiencies discovered which resulted in the unsafe assessment.

j. Description of Danger Involved - Downstream (D/S) hazard potential category and a brief description of the danger involved.

k. Recommendations Given to Governor - Brief description of the actions recommended to Governor at time of notification of unsafe condition to eliminate or reduce the danger.

l. Urgency Category - State whether the unsafe condition of the dam is an emergency or non-emergency situation. An emergency situation should be considered to exist if the failure of the dam is judged to be imminent and requires immediate action to eliminate or reduce the danger.

m. Emergency Actions Taken - In case of an emergency situation, list the actions taken. For non-emergency situation, put NA for "not applicable."

n. Remedial Action Taken - For non-emergency situations list remedial actions taken.

o. Remarks - For other pertinent information.

Format for Unsafe Dam Data Sheet (RCS-DAEN-CWE-17 and OMB NO. 49-R0421)

NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS
UNSAFE DAM DATA SHEET

a. Name:
b. Type: c. Height: d. Id. No.
e. Location:
State: County:
Nearest D/S City, Town or Village:
River or Stream:
f. Owner:
g. Date Governor Notified of Unsafe Condition:
h. Condition of Dam Resulting in Unsafe Assessment:

i. Description of Danger Involved:

j. Recommendations Given to Governor:

k. Urgency Category:
l. Emergency Actions Taken:

m. Remarks:

(To be typed as needed)

APPENDIX G

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
MONTHLY PROGRESS REPORT
(RCS-DAEN-CWE-19)

I. Instructions for Monthly Progress Report. The indicated information shall be provided in the format shown on page G-2.

1. Division Reporting:

2. Date:

3. Information Required for Each State Regarding Total Number of Inspections Performed (A-E Inspections included) (Cumulative):

3.1. Number of Inspections Initiated by on-site inspection or the review of engineering data from project records.[1]

3.2. Number of Inspections Completed (The number of inspection reports which have been submitted to the District Engineer for review and approval).

3.3. Number of Dams Reported to the Governor as Unsafe.[2]

3.4. Number of Approved Inspection Reports Submitted to the Governor.

4. Information Required for Each State Regarding Inspections Performed Under A-E Contracts (Cumulative):

4.1. Number of Dams Contracted for Inspection by A-E's with State or Corps.

4.2. Number of Inspections Initiated by A-E's by on-site inspection or the review of engineering data from project records.[1]

4.3. Number of Inspections Completed by A-E's (The number of inspection reports which have been submitted to the District Engineer for review and approval).

4.4. Number of Approved Inspection Reports Prepared by A-E's Submitted to the Governor.

[1]Each of the initiated inspections reported should be planned for completion within a reasonable period of time (30 days).
[2]An unsafe dam is defined as a dam with deficiencies of such a nature that if not corrected could result in the failure of the dam with subsequent loss of lives or substantial property damage.

II. Formation for Monthly Progress Report.

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS

MONTHLY PROGRESS REPORT

1. Division Reporting:

2. Date:

3. Information Required for Each State Regarding Total Number of Inspections Performed (Cumulative):

State	Inspections Initiated (3.1)	Inspections Completed (3.2)	Unsafe Dams Reported (3.3)	Approved Reports (3.4)
Totals				

4. Information Required for Each State Regarding Inspections Performed Under A-E Contracts (Cumulative):

State	Dams Under A-E Contract (4.1)	A-E Inspections Initiated (4.2)	A-E Inspections Completed (4.3)	A-E Reports Approved (4.4)
Totals				

(To be typed as needed)

APPENDIX H

SUGGESTED
SCOPE OF WORK
CONTRACT FOR ARCHITECT-ENGINEER SERVICES
FOR SAFETY INSPECTION OF DAMS

WITHIN THE STATE OF _____

1. GENERAL DESCRIPTION OF SCOPE OF WORK. The services to be rendered by the Architect-Engineer (A-E) under the proposed contract shall include all engineering functions, hereinafter described, as needed to inspect the dams listed in Appendix A of this contract for the purpose of evaluating their risk of failure. A report which (a) describes the assessed condition of the dam, (b) provides conclusions as to which particular conditions could cause failure, (c) makes recommendations on remedial measures believed necessary, and (d) makes recommendations on whether and what type of future investigation should be conducted shall be provided for each inspected dam. The work shall proceed in accordance with Phase I of the Recommended Guidelines for Safety Inspection of Dams established by the Office of the Chief of Engineers (OCE) and the supplemented requirements listed in paragraph 3 below. The OCE guidelines are listed in Appendix B of this contract.

2. INFORMATION AND SERVICES TO BE FURNISHED BY THE GOVERNMENT. The Contracting Officer will furnish the following information and services to the A-E:

a. All information pertaining to each dam to be inspected as contained in the National Inventory of Dams.

b. Copies of recommended format for preparation of inspection report, engineering data check list and visual inspection check list.

c. All available pertinent information pertaining to the Dam Inspection Program and previous investigations having a bearing on inspections to be performed under this contract.

d. Right-of-entry for access to each dam site.

3. SERVICES TO BE RENDERED BY THE ARCHITECT-ENGINEER. The principal services, subject to the optional provisions of the contract, to be rendered by the A-E are itemized below:

a. Technical Investigations.

(1) Engineering Data Collection. To the extent feasible, the engineering data listed in Appendix I of the OCE guidelines relating to the design, construction and operation of the dam and appurtenant

structures, should be collected from existing records and reviewed to aid in evaluating the general condition of each dam, including an assessment of the hydraulic and hydrologic features and structural stability of the dam. Where the necessary engineering data are unavailable, inadequate or invalid, a listing shall be made of those specific additional data deemed necessary by the engineer in charge of the investigation and included in the inspection report. The engineering data checklist provided by the Contracting Officer shall be used as a guide to compile this data.

(2) Field Inspections. The field inspection of each dam shall include examination of the items listed in Appendix II of the OCE guidelines, electrical and mechanical equipment for operation of the control facilities, reservoir area, downstream channel in the vicinity of the dam and any other significant feature to determine how these features affect the risk of failure of the dam. The inspection shall be conducted in a systematic manner to minimize the possibility of any significant feature being overlooked. The visual inspection checklist provided by the Contracting Officer shall be used as a guide to document the examination of each significant feature.

Particular attention shall be given to detecting evidence of leakage, erosion, seepage, slope instability, undue settlement, displacement, tilting, cracking, deterioration, and improper functioning of drains and relief wells. The degree and quality of maintenance and regulating procedures for operation of the control facilities shall be assessed. The design and existing condition of such control facilities (i.e., spillway, outlet works, etc.) shall be evaluated. An assessment of the degree of siltation that is evident and its effect on the dam's reservoir shall be performed. Photographs and drawings should be used to record conditions in order to minimize written descriptions.

(3) Engineering Analyses.

(a) Evaluation of Hydraulic and Hydrologic (H&H) Features. Evaluation of the hydraulic and hydrological features of each dam shall be based on criteria set forth in the OCE guidelines. If it is determined that the available H&H data are insufficient, the Contracting Officer must be so informed and may exercise an option of requiring the A-E to perform an overtopping analysis at additional agreed-upon compensation. The methodology to be used by the A-E for this analysis will be based on the OCE guidelines and subject to the approval of the Contracting Officer.

(b) Evaluation of Structural Stability. The evaluation of structural stability of each dam is to be based principally on existing conditions as revealed by the visual inspection, available design and construction information, and records of performance. The objectives

are to determine the existence of conditions, identifiable by visual inspection or from records, which may pose a high risk of failure and to formulate recommendations pertaining to the need for any remedial improvements, additional studies, investigations, or analysis. The results of this phase of the inspection must rely substantially upon the experience and judgment of the inspecting engineer. Should it be determined that sufficient data are not available for a reasonable evaluation of the structural stability of a dam and appurtenances, the Contracting Officer should be informed which information is required prior to attempting to evaluate the risk of failure of the dam.

(c) Evaluation of Operational Features. Where critical mechanical/electrical operating equipment is used in controlling the reservoir of a dam, an evaluation of the operational characteristics of this equipment from the standpoint of risk of failure must be performed.

(d) Evaluation of Reservoir Regulation Plan and Warning System. The operational characteristics of each dam's existing reservoir regulation plan and warning system in event of a threatened failure shall be investigated.

b. Emergency Situations. The Contracting Officer must be immediately notified of any observed condition which is deemed to require immediate remedial action. After being notified, the Contracting Officer will contact the appropriate State personnel and will meet the A-E at the site to determine the appropriate course of action. This will not relieve the A-E of his responsibility to prepare a comprehensive inspection report at the earliest practicable date.

c. Qualifications of Investigators. The technical investigations shall be conducted by licensed professional engineers with a minimum of five years experience after licensing in the investigation, design and construction of earthfill, rockfill and concrete dams and/or in making risk of failure evaluations of completed dams. These engineers must be knowledgeable in the disciplines of hydrology, hydraulics, geotechnical, electrical, mechanical and structural engineering, as necessary. All field inspections should be conducted by engineers, engineering geologists and other specialists who are knowledgeable in the investigation, design, construction and operation of dams, including experts on mechanical and electrical operation of gates and controls, where needed.

d. Preparation of Report. A formal report shall be prepared for each dam inspected for submission to the Contracting Officer. Each report should contain the information specified in OCE guidelines and any other pertinent information. The recommended format provided by the Contracting Officer shall be used to document each report. The signature and registration identification of the professional engineer who directed the investigation and who was responsible for evaluation of the dam should be included in the report.

4. SUPERVISION AND APPROVAL OF WORK. All work performed under this contract shall be subject to the review and approval of the Contracting Officer or his designee. Meetings will be held on a regular basis in the District office, during which the progress of inspections will be discussed and questions relating to inspection reports previously received by the Contracting Officer will be addressed. Reports will be revised as necessary when required by the Contracting Officer.

5. COORDINATION. During the progress of work, the A-E shall maintain liaison with the *_____ and other local authorities through the Contracting Officer as required to assure the orderly progression of the inspection. Copies of all correspondence with such authorities shall be provided to the Contracting Officer.

6. SUBMISSION OF REPORT.

a. Each inspection report will be submitted for review to the Contracting Officer. Reports will be revised as required by the Contracting Officer. After all revisions have been made, the original and copies of each inspection report shall be submitted to the Contracting Officer.

b. Text of all reports shall be typewritten and printed on both sides of 8" x 10 1/2" paper. All notes, inspection forms, sketches or similar matter shall be legible, distinct and suitable for reproduction.

7. PERIOD OF SERVICES.

a. All inspections and reports included under this contract shall be completed within ___ days from date of Notice to Proceed.

b. If the option for performing an H&H analysis for any particular site is exercised, the A-E shall complete such analysis within ___ days from date of Notice to Proceed. However, the overall completion time stated in paragraph 7a above shall not change.

*NOTE: Write in the designated State Authority.

APPENDIX I

PROCEDURE FOR USING NASA LAND SATELLITE MULTISPECTRAL SCANNER DATA FOR VERIFICATION AND UPDATING THE NATIONAL INVENTORY OF DAMS

1. Purpose. This appendix states the objective, defines the scope, prescribes procedures, and assigns responsibilities for using NASA Land Satellite (LANDSAT) Multispectral Scanner data along with NASA's Surface Water Detection And Mapping (DAM) Computer program to assist in verification and updating the National Inventory of Dams.

2. Applicability. This appendix is applicable to all divisions and districts having Civil Works responsibilities except POD.

3. Reference. NASA, DETECTION AND MAPPING PACKAGE, Users Manuals, Volumes 1, 2a, 2b, and 3 dated June 1976, published by the Johnson Space Center, Houston, Texas.

4. Objectives. Provide a uniform method, nation-wide, to help insure that all dams subject to Public Law 92-367, 8 August 1972 are properly identified and located in the National Inventory of Dams.

5. Scope. The computer printer overlay maps produced by the procedure described in reference 3b will be used by district and/or state or contractor personnel as a tool to assist in verification and updating of the National Inventory of Dams.

6. Exceptions.

a. If a Division/District attempts the use of the procedure for a given region within their area of responsibility and finds the overlay maps cannot be used to assist in verification and updating the National Inventory of Dams, they may request an exception for a selected region.

A selected region may include areas where conditions can reasonably be assumed to be the same as the region where the procedure was tried.

b. Request for exceptions should be documented to include firm boundary definitions and appropriate justification to demonstrate why the procedure cannot be used. This request should be submitted to WRSC WASH DC 20314, through the normal engineering chain of command.

c. Map overlays will be produced for all areas of the Continental United States even if they are not used in a few selected regions. This processing is required for a future Computer Water Body Change Detection system.

7. Procedures. Acquisition of LANDSAT data, registration of satellite coordinates to earth latitude and longitude and computer processing to produce overlay maps will be accomplished by two Regional Centers. Nashville District and Seattle District have been designated as the Regional Centers, with each responsible for processing maps by state based on Divisional assignments in Appendix A. Regional Centers will support divisions as follows:

Regional Center	Division
Nashville District	New England
	North Atlantic
	South Atlantic
	Ohio River
	Lower Mississippi Valley
	North Central
Seattle District	Southwestern
	Missouri River
	North Pacific
	South Pacific

8. Responsibilities.

a. The Water Resources Support Center at Fort Belvoir has overall responsibility for coordination and monitoring of this activity between NASA, Division Offices, and Regional Centers, and for providing Regional Center funding.

b. Regional Centers are responsible for:

(1) Acquiring proper LANDSAT data tape from EROS Data Center (Sioux Falls, South Dakota). Actual data scene selection will be coordinated with Division and/or District to insure proper consideration is given to local priorities and seasonal coverage.

(2) Arranging computer processing support using NASA's DAM package.

(3) Establishing proper control between satellite scanner-oriented coordinates and earth latitude/longitude.

(4) Producing total coverage of map overlays at a scale of 1:24,000 and/or smaller scales as required by Divisions and/or Districts.

(5) Instructing District, State, or contractor personnel in the assembly and use of map overlays.

c. Divisions/Districts are responsible for:

(1) Designating one person from each Division and District as the point of contact with the Regional Center and provide this person's name and phone number to the Regional Center.

(2) Providing the Regional Center with map coverage of their area of responsibility. This will include state indexes and 7 1/2 minute quadrangle sheets (scale 1:24,000) where available.

(3) Coordinating with the Regional Center in selecting LANDSAT data tapes.

(4) Providing information to Regional Center on scale and priorities of desired computer produced map overlays.

(5) Assembling computer print-outs into overlay maps, and using as appropriate to assist in verification and updating the National Inventory of Dams.

9. Points of Contact. The points of contact in the Regional Centers for this program are as follows:

NAME	OFFICE SYMBOL	TELEPHONE
Jim Cook	DAEN-ORNED	(615) 251-7366 FTS 852-7366
Jack Erlandson	DAEN-NPSEN	(206) 764-3535 FTS 399-3535

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APPENDIX C

NATIONAL INVENTORY OF DAMS — PAGE 1
S2000 DATA BASE DESCRIPTION

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
0*	DAMS		
1*	ID (NAME X(7))	DAM IDENTIFICATION CODE	(01)

THE FIRST TWO CHARACTERS OF THE IDENTIFICATION CODE WILL BE THE TWO LETTER STATE ABBREVIATION IN ACCORDANCE WITH THE FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATION (FIPS PUB 6-2). IN CASES WHERE A DAM IS PHYSICALLY LOCATED IN TWO OR MORE STATES, ONE STATE WILL BE DESIGNATED AS THE PRINCIPAL STATE FOR THE IDENTITY. THE LAST FIVE CHARACTERS OF THE IDENTITY WILL BE A SEQUENTIAL NUMBER ASSIGNED TO IDENTIFY DAMS WITHIN A STATE.

2*	ST (NAME XX)	ALPHA STATE CODE	(03)

CONTAINS THE TWO (2) LETTER PRINCIPAL STATE ABBREVIATION IN ACCORDANCE WITH FIPS 6-2 AND IS AS FOLLOWS:

ALABAMA	AL	MARYLAND	MD	SOUTH CAROLINA	SC
ALASKA	AK	MASSACHUSETTS	MA	SOUTH DAKOTA	SD
ARIZONA	AZ	MICHIGAN	MI	TENNESSEE	TN
ARKANSAS	AR	MINNESOTA	MN	TEXAS	TX
CALIFORNIA	CA	MISSISSIPPI	MS	UTAH	UT
COLORADO	CO	MISSOURI	MO	VERMONT	VT
CONNECTICUT	CT	MONTANA	MT	VIRGINIA	VA
DELEWARE	DE	NEBRASKA	NE	WASHINGTON	WA
DIST OF COLUMBIA	DC	NEVADA	NV	WEST VIRGINIA	WV
FLORIDA	FL	NEW HAMPSHIRE	NH	WISCONSIN	WI
GEORGIA	GA	NEW JERSEY	NJ	WYOMING	WY
HAWAII	HI	NEW MEXICO	NM	SAMOA	AS
IDAHO	ID	NEW YORK	NY	PUERTO RICO	PR
ILLINOIS	IL	NORTH CAROLINA	NC	TERRITORIES	TT
INDIANA	IN	NORTH DAKOTA	ND	VIRGIN ISLANDS	VI
IOWA	IA	OHIO	OH	GUAM	GU
KANSAS	KS	OKLAHOMA	OK		
KENTUCKY	KY	OREGON	OR		
LOUISIANA	LA	PENNSYLVANIA	PA		
MAINE	ME	RHODE ISLAND	RI		

3*	ST-NUM(NAME XX)	NUMERIC STATE CODE (NOT FIPS)	

THIS IS A CODE ASSIGNED TO THIS DATA ELEMENT WHEN THE STATE NAME 'ST' IS ENTERED INTO THE DATA BASE. ALL STATES ARE LISTED ALPHABATICALLY AND ASSIGNED SEQUENTIAL NUMBERS BEGINNING WITH 01 FOR ALABAMA AND CONTINUING THROUGH THE LIST OF STATES AND TERRITORIES.

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
4*	DIV (NAME XXX)	RESPONSIBLE DIV. CODE	(02)

CONTAINS THE THREE (3) LETTER OFFICE SYMBOL FOR THE DIVISION MAKING THE REPORT IN ACCORDANCE WITH ABBR REPORT CODE, APPENDIX D, ER 18-2-1, CIVIL WORKS INFORMATION SYSTEM AS FOLLOWS:

DIVISION	CODE
LOWER MISSISSIPPI VALLEY DIVISION	LMV
MISSOURI RIVER DIVISION	MRD
NEW ENGLAND DIVISION	NED
NORTH ATLANTIC DIVISION	NAD
NORTH CENTRAL DIVISION	NCD
NORTH PACIFIC DIVISION	NPD
OHIO RIVER DIVISION	ORD
PACIFIC OCEAN DIVISION	POD
SOUTH ATLANTIC DIVISION	SAD
SOUTH PACIFIC DIVISION	SPD
SOUTHWESTERN DIVISION	SWD

5*	DIST (NAME XXX)	CORPS DIST. WHERE DAM LOCATED	(27A)

CONTAINS THE THREE (3) CHARACTER CORPS OF ENGINEERS ABBR REPORT CODE IN WHICH THE DAM IS GEOGRAPHICALLLY LOCATED IN ACCORDANCE WITH APPENDIX D,ER 18-2-1,CIVIL WORKS INFORMATION SYSTEM AS FOLLOWS:

LMVD		ORD	
MEMPHIS DISTRICT	LMM	HUNTINGTON DISTRICT	ORH
NEW ORLEANS DISTRICT	LMN	LOUISVILLE DISTRICT	ORL
ST. LOUIS DISTRICT	LMS	NASHVILLE DISTRICT	ORN
VICKSBURG DISTRICT	LMK	PITTSBURG DISTRICT	ORP
		POD	
MRD			
KANSAS CITY DISTRICT	MRK	SAD	
OMAHA DISTRICT	MRO	CHARLESTON DISTRICT	SAC
		JACKSONVILLE DISTRICT	SAJ
		MOBILE DISTRICT	SAM
NED		SAVANNAH DISTRICT	SAS
		WILMINGTON DISTRICT	SAW
NAD			
BALTIMORE DISTRICT	NAB	SPD	
NEW YORK DISTRICT	NAN	LOS ANGELES DISTRICT	SPL
NORFOLK DISTRICT	NAO	SACRAMENTO DISTRICT	SPK
PHILADELPHIA DISTRICT	NAP	SAN FRANCISCO DISTRICT	SPN

C NO	DATA BASE NAME		DATA DESCRIPTION	FORM4474 ITEM NO.
	NCD		SWD	
	BUFFALO DISTRICT	NCB	ALBUQUERQUE DISTRICT	SWA
	CHICAGO DISTRICT	NCC	FT WORTH DISTRICT	SWF
	DETROIT DISTRICT	NCE	GALVESTON DISTRICT	SWG
	ROCK ISLAND DISTRICT	NCR	LITTLE ROCK DISTRICT	SWL
	ST PAUL DISTRICT	NCS	TULSA DISTRICT	SWT
	NPD			
	ALASKA DISTRICT	NPA		
	PORTLAND DISTRICT	NPP		
	SEATTLE DISTRICT	NPS		
	WALLA WALLA DISTRICT	NPW		

6* CNTY-1(NAME XXX) PRIMARY COUNTY CODE (04)

CONTAINS THE THREE (3) DIGIT COUNTY IDENTIFICATION CODE IN ACCORDANCE WITH FIPS 6-2.

7* CNG-DST-1(NAME XX) PRIMARY CONGR. DIST. (05)

CONTAINS THE TWO (2) DIGIT NUMBER FOR CONGRESSIONAL DISTRICTS IN WHICH THE DAM IS LOCATED. CODES CAN BE FOUND IN AR 18-12-10.

8* NAME (NAME X(20)) OFFICIAL DAM NAME (09)

CONTAINS THE OFFICIAL NAME OF THE DAM. DO NOT ABBREVIATE UNLESS THE ABBREVIATION IS A PART OF THE OFFICIAL NAME. FOR DAMS THAT DO NOT HAVE A NAME, CREATE A NAME BY COMBINING THE TWO (2) LETTER STATE ABBREVIATION PLUS "NONAME" PLUS A SEQUENTIAL NUMBER. EXAMPLE: IF TWO DAMS IN THE STATE OF ALABAMA DO NOT HAVE NAMES, THEY WOULD BE NAMED AS ALNONAME1 AND ALNONAME2.

9* LAT (NAME X(7)) LATITUDE (10)

CONTAINS THE LATITUDE IN DEGREES, MINUTES AND TENTHS OF MINUTE. ALL GEOGRAPHICAL LOCATION ITEMS PERTAIN TO THE DAM AT ITS MAXIMUM SECTION. LATITUDE STORED AS DD-MM.M WHERE DD=DEGREES AND MM.M=MINUTES TO TENTHS.

10* LONG (NAME X(8)) LONGITUDE (11)

CONTAINS THE LONGITUTDE IN DEGREES,MINUTES AND TENTHS OF A MINUTE. ALL GEOGRAPHICAL LOCATION ITEMS PERTAIN TO THE DAM AT ITS MAXIMUM SECTION. LONGITUDE STORED AS DDD-MM.M WHERE DDD=DEGREES AND MM.M=MINUTES TO TENTHS.

11* RPT-DATE (DATE) LAST MODIFICATION DATE (12)

THIS DATE IS PROVIDED BY THE UPDATE PROGRAM ON THE DAY THE UPDATE IS RUN. IT OVERIDES ANY DATE THAT IS PROVIDED ON INPUT.

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM6474 ITEM NO.
12*	IMPND (NAME X(20))	IMPOUNDMENT NAME	(14)

CONTAINS THE OFFICIAL NAME OF THE LAKE OR RESERVOIR. LEAVE BLANK IF THE RESERVOIR DOES NOT HAVE A NAME.

13*	REG (NAME XX)	WRC REGION CODE	(15)

CONTAINS THE TWO (2) DIGIT NUMBER AS ASSIGNED BY THE U. S. WATER RESOURCES COUNCIL FOR THE REGION CODE. THE EXISTING REGION CODES WERE DEVELOPED IN 1976 AND APPEAR ON ALL EXISTING HYDROLOGIC UNIT MAPS AS PROVIDED BY THE UNITED STATES GEOLOGICAL SURVEY.

14*	BAS (NAME XX)	WRC BASIN CODE	(16)

CONTAINS THE TWO (2) DIGIT NUMBER AS ASSIGNED BY THE U. S. WATER RESOURCES COUNCIL FOR THE BASIN CODE. THE EXISTING BASIN CODES WERE DEVELOPED IN 1976 AND APPEAR ON ALL EXISTING HYDROLOGIC UNIT MAPS AS PROVIDED BY THE UNITED STATES GEOLOGICAL SURVEY.

15*	RIVER (NAME X(20))	RIVER-STREAM-TRIB.	(17)

CONTAINS THE OFFICIAL NAME OF THE RIVER OR STREAM ON WHICH THE DAM IS BUILT. IF THE STREAM IS WITHOUT A NAME, INDICATE AS TRIBUTARY TO THE RIVER IN WHICH IT FLOWS, E.G. TR-COLORADO IF OFF STREAM, ENTER THE NAME OF RIVER PLUS 'OFFSTREAM'.

16*	CITY (NAME X(10))	NEAREST DOWNSTREAM CITY	(18)

CONTAINS THE NAME OF THE NEAREST DOWNSTREAM CITY-TOWN-VILLAGE OF SUCH SIZE WHICH CAN BE LOCATED ON A GENERAL MAP OF THE AREA OR STATE.

17*	DST (INT 999)	DISTANCE TO D/S CITY	(19)

CONTAINS THE DISTANCE FROM THE DAM TO THE NEAREST DOWNSTREAM CITY-TOWN-VILLAGE TO THE NEAREST MILE.

18*	POP (INT 9(8))	POPULATION OF D/S CITY	(20)

CONTAINS THE POPULATION OF THE CITY-TOWN-VILLAGE GIVEN IN C16 (CITY).

19*	YR-CMPL (INT 9999)	YEAR DAM COMPLETED	(22)

CONTAINS THE YEAR WHEN THE MAIN DAM STRUCTURE WAS COMPLETED AND READY FOR USE. IF ONLY APPROXIMATE YEAR CAN BE DETERMINE, NOTE THIS IN REMARKS.

20*	STR-HGT (INT 9999)	STRUCTURAL HEIGHT	(24)

CONTAINS THE STRUCTURAL HEIGHT OF THE DAM, TO THE NEAREST FOOT, AND IS DEFINED ASITHE OVERALL VERTICAL DISTANCE FROM THE LOWEST POINT OF THE FOUNDATION SURFACE TO THE TOP OF THE DAM.

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
21*	HYD-HGT (INT 9999)	HYDRAULIC HEIGHT	(25)

CONTAINS THE HYDRAULIC HEIGHT OF THE DAM, TO THE NEAREST FOOT, AND IS DEFINED AS:THE EFFECTIVE HEIGHT OF THE DAM WITH RESPECT TO THE MAXIMUM STORAGE CAPACITY,MEASURED FROM THE NATURAL BED OF THE STREAM OR WATER-COURSE AT THE DOWNSTREAM TOE OF THE BARRIER, OR IF IT IS NOT ACROSS A STREAM OR WATERCOURSE, THE HEIGHT FROM THE LOWEST ELEVATION OF THE OUTSIDE LIMIT OF THE BARRIER TO THE MAXIMUM STORAGE ELEVATION.

22*	MX-CAP (INT 9(8))	MAXIMUM STORAGE AF	(26)

CONTAINS THE ACRE FEET OF STORAGE FOR THE MAXIMUM STORAGE WHICH IS DEFINED AS: THE TOTAL STORAGE SPACE IN A RESERVOIR BELOW THE MAXIMUM ATTAINABLE WATER SURFACE ELEVATION, INCLUDING ANY SURCHARGE STORAGE.

23*	NOR-CAP (INT 9(8))	NORMAL STORAGE AF	(27)

CONTAINS THE ACRE FEET OF NORMAL STORAGE 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.

24*	HAZ (NAME X)	DOWNSTREAM HAZARD CODE	(29)

CONTAINS THE ONE (1) DIGIT THAT MOST CLOSELY REPRESENTS THE HAZARD POTENTIAL THAT COULD OCCUR TO THE DOWNSTREAM AREA RESULTING FROM FAILURE OR MIS-OPERATION OF THE DAM OR FACILITIES AS FOLLOWS:

HAZARD POTENTIAL

CATEGORY	LOSS OF LIFE	ECONOMIC LOSS
3 = LOW	NONE EXPECTED	MINIMAL
2 = SIGNIFICANT	FEW	APPRECIABLE
1 = HIGH	MORE THAN FEW	EXCESSIVE

25*	CREST (INT 9(5))	CREST LENGTH	(30)

CONTAINS THE CREST LENGTH OF THE DAM, TO THE NEAREST FOOT, AND IS DEFINED AS: THE TOTAL HORIZONTAL DISTANCE MEASURED ALONG THE AXIS AT THE ELEVATION OF THE TOP OF THE DAM BETWEEN ABUTMENTS OR ENDS OF THE DAM. NOTE THAT THIS INCLUDES SPILLWAY WIDTH, POWERHOUSE SECTIONS, AND NAVIGATION LOCKS WHERE THEY FORM A CONTINUOUS PART OF THE DAM WATER RETAINING STRUCTURE. DETACHED SPILLWAYS, LOCKS, AND POWERHOUSES SHALL NOT BE INCLUDED.

26*	SP-TYPE (NON-KEY NAME X)	SPILLWAY TYPE	(31)

CONTAINS THE ONE (1) LETTER CODE THAT DESCRIBES THE TYPE OF SPILLWAY AND IS AS FOLLOWS:
C = CONTROLLED U = UNCONTROLLED N = NONE

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
27*	SP-WID (NON-KEY INT 9999)	SPILLWAY WIDTH	(32)

CONTAINS THE WIDTH OF THE SPILLWAY, TO THE NEAREST FOOT, AVAILABLE FOR DISCHARGE WHEN THE RESERVOIR IS AT ITS MAXIMUM DESIGNED WATER SURFACE ELEVATION.

28*	SP-DIS (NON-KEY INT 9(7))	MAX SPILLWAY DISCHARGE	(33)

CONTAINS THE NUMBER OF CUBIC FEET PER SECOND WHICH THE SPILLWAY IS CAPABLE OF DISCHARGING WHEN THE RESERVOIR IS AT ITS MAXIMUM DESIGNED WATER SURFACE ELEVATION.

29*	DAM-MAT (NON-KEY INT 9(9))	VOLUME OF DAM (CUBIC YDS)	(34)

CONTAINS THE TOTAL NUMBER OF CUBIC YARDS OCCUPIED BY THE MATERIALS USED IN THE DAM STRUCTURE. IF VOLUME OF SEPARATE MATERIALS IS KNOWN ENTER IN REMARKS. INCLUDE PORTIONS OF POWERHOUSE, LOCKS AND SPILLWAYS ONLY IF INTEGRAL PART OF THE DAM AND REQUIRED FOR STRUCTURAL STABILITY.

30*	NUM-LOCKS (NAME X)	NUMBER OF LOCKS	(37)

CONTAINS THE ONE (1) DIGIT NUMBER OF EXISTING NAVIGATION LOCKS FOR THE PROJECT. MAXIMUM NUMBER OF LOCKS IS FOUR (4).

31*	OWNER (NAME X(20))	OWNERS NAME	(46)

CONTAINS THE NAME OF THE OWNER, ABBREVIATE AS NECESSARY.

********** NOTE **********
FEDERAL AGENCIES WILL BE UNIFORMLY DESIGNATED BY MAJOR AND MINOR ABBREVIATIONS ACCORDING TO THE FOLLOWING LIST WHENEVER APPLICABLE TO ITEMS C31 THROUGH C38. ALL ABBREVIATIONS ARE TO BE LEFT JUSTIFIED WITHIN EACH FIELD WITH ONE BLANK SEPARATING MAJOR AND MINOR ABBREVIATIONS:

FEDERAL AGENCY NAME	MAJOR	MINOR
INTERNATIONAL BOUNDARY AND WATER COMMISSION	IBWC	
U.S. DEPARTMENT OF AGRICULTURE		
SOIL CONSERVATION SERVICE	USDA	SCS
FOREST SERVICE	USDA	FS
U.S. DEPARTMENT OF ENERGY		
FEDERAL ENERGY REGULATORY COMMISSION	DOE	FERC
TENNESSEE VALLEY AUTHORITY	TVA	

C NO	DATA BASE NAME	DATA DESCRIPTION		FORM#474 ITEM NO.
	U.S. DEPARTMENT OF INTERIOR			
	FISH AND WILDLIFE SERVICE		DOI	FWS
	GEOLOGICAL SURVEY		DOI	GS
	BUREAU OF LAND MANAGEMENT		DOI	BLM
	BUREAU OF RECLAMATION		DOI	BR
	BUREAU OF INDIAN AFFAIRS		DOI	BIA
	NATIONAL PARK SERVICE		DOI	NPS
	U.S. DEPARTMENT OF LABOR			
	MINE SAFETY AND HEALTH ADMINISTRATION		DOL	MSHA
	U.S. DEPARTMENT OF DEFENSE			
	U.S. ARMY		DOD	USA
	U.S. NAVY		DOD	USN
	U.S. AIR FORCE		DOD	USAF
	U.S. MARINE CORPS		DOD	USMC
	U.S. DEPARTMENT OF JUSTICE			
	BUREAU OF PRISONS		DOJ	BOP
	U.S. ARMY CORPS OF ENGINEERS ENTER DAEN FOR THE MAJOR ABBREVIATION AND THE THREE (3) CHARACTER CODE USED IN ITEM C5 (DIST) FOR THE MINOR ABBREVIATION.			
	OTHERS NOT LISTED ABOVE		USA	AGENCY NAME
32*	ENGR (NAME X(15))	DAM DESIGNER		(47)
	CONTAINS THE NAME OF THE ORGANIZATION THAT ENGINEERED THE MAIN DAM STRUCTURE. ABBREVIATE AS REQUIRED.			
33*	CONST (NAME X(15))	CONSTRUCTION FIRM		(48)
	CONTAINS THE NAME OF THE CONSTRUCTION AGENCY RESPONSIBLE FOR CONSTRUCTION OF THE MAIN STRUCTURE. ABBREVIATE AS REQUIRED.			
34*	REG-DES (NAME X(10))	AGENCY RESPON. FOR DESIGN		(49)
	CONTAINS THE NAME OF THE ORGANIZATION OTHER THAN THE OWNER HAVING REGULATORY OR APPROVAL AUTHORITY OVER THE DESIGN OF THE DAM. IF NO ORGANIZATION OTHER THAN THE OWNER HAS REGULATORY OR APPROVAL AUTHORITY OVER THE DESIGN OF THE DAM INDICATE NONE.			
35*	REG-CONST (NAME X(10))	AGENCY RESPON. FOR CONST.		(50)
	CONTAINS THE NAME OF THE ORGANIZATION OTHER THAN THE OWNER HAVING REGULATORY AUTHORITY OR INSPECTION RESPONSIBILITIES OVER THE CONSTRUCTION OF THE DAM. IF NO ORGANIZATION OTHER THAN THE OWNER HAS REGULATORY AUTHORITY OR INSPECTION RESPONSIBILITIES OVER THE			

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
36*	REG-OPER (NAME X(10))	AGENCY RESPON. FOR OPER.	(51)

CONTAINS THE NAME OF THE ORGANIZATION OTHER THAN THE OWNER HAVING REGULATORY AUTHORITY, OPERATIONAL CONTROL OR SURVEILLANCE RESPONSIBILITIES OVER THE OPERATION OF THE DAM. IF NO ORGANIZATION OTHER THAN THE OWNER HAS REGULATORY AUTHORITY, OPERATIONAL CONTROL OR SURVEILLANCE RESPONSIBILITIES OVER THE OPERATION OF THE DAM INDICATE NONE.

37*	REG-MAINT (NAME X(10))	AGENCY RESPON. FOR MAINT.	(52)

CONTAINS THE NAME OF THE ORGANIZATION OTHER THAN THE OWNER HAVING REGULATORY AUTHORITY OR INSPECTION OR SURVEILLANCE RESPONSIBILITIES OVER THE MAINTENANCE OF THE DAM. IF NO ORGANIZATION OTHER THAN THE OWNER HAS REGULATORY AUTHORITY OR INSPECTION OR SURVEILLANCE RESPONSIBILITIES OVER THE MAINTENANCE OF THE DAME INDICATE NONE.

38*	INSP (NAME X(15))	RESPONSBILE INSPECTOR	(53)

CONTAINS THE NAME OF THE ORGANIZATION THAT PERFORMED THE LAST SAFETY INSPECTION. ABBREVIATE AS REQUIRED. IF NO INSPECTION HAS BEEN PERFORMED ENTER NONE.

39*	INSP-DATE (DATE)	DATE OF LAST INSPECTION	(54)

CONTAINS THE DATE WHEN THE INSPECTION WAS PERFORMED. IT IS STORED IN SYSTEM 2000 DATE FORMAT AND ENTERED AS DDMMMYY WHERE DD IS FOR THE DAY MMM IS THE THREE (3) LETTERS OF THE MONTH AND YY IS THE LAST TWO (2) DIGITS OF THE YEAR, EG 15JAN79.

40*	INSP-AUTH (NON-KEY NAME X(25))	AUTHORITY FOR INSPECTION	(55)

CONTAINS THE LEGISLATIVE OR REGULATORY AUTHORITY FOR PERFORMING THE INSPECTION INDICATED IN ITEM C38, EG PL-367, WATER CODE, STATE OF CALIF, ETC.

41*	CNTY (NAME X(12))	PRIMARY COUNTY NAME	

CONTAINS THE FULL NAME OF THE COUNTY IDENTIFIED IN ELEMENT C6 (CNTY-1) THIS IS GENERATED AT UPDATE TIME. SEE FIPS 6-2.

42*	OWNER-CD (NAME X)	OWNERSHIP CODE	(278)

CONTAINS THE ONE (1) CHARACTER CODE TO DISTINGUISH OWNERSHIP OF THE DAM AS FOLLOWS:
N = NON-FEDERAL G = FEDERAL GOV AGENCIES C = CORPS OF ENGINEERS

43*	FED-REG (NAME X)	FEDERALLY REGULATED	(27C)

CONTAINS THE ONE (1) CHARACTER CODE TO IDENTIFY IF THE DAM IS REGULATED BY A FEDERAL AGENCY AS FOLLOWS: N = NO Y = YES

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
44*	PVT-FED (NAME X)	PVT DAM ON FEDERAL LAND	(27D)

CONTAINS THE ONE (1) CHARACTER CODE TO IDENTIFY IF THE DAM IS A PRIVATE DAM LOCATED ON FEDERAL LAND AS FOLLOWS:
N = NO Y = YES

45*	SCS (NAME X)	ASSISTANCE BY SCS	(27E)

CONTAINS THE ONE (1) DIGIT CODE TO INDICATE THE EXTENT OF ASSISTANCE RECEIVED BY THE OWNER FROM THE SOIL CONSERVATION SERVICE AS FOLLOWS:
N = NONE T = TECHNICAL ASSISTANCE F = FINANCIAL ASSISTANCE OR
B = BOTH TECHNICAL AND FINANCIAL ASSISTANCE.

46*	VER-DATE (DATE)	VERIFICATION DATE FOR DATA	(27F)

CONTAINS THE DATE THE DATA WAS VERIFIED AS BEING COMPLETE AND CORRECT IN THE NATIONAL INVENTORY OF DAMS DATA BASE. THE DATE IS STORED IN SYSTEM 2000 DATE FORMAT AND IS ENTERED AS IN ITEM C39 (INSP-DATE).

47*	MAJ-PURP (NAME X)	MAJOR PURPOSE OF DAM	(23)

CONTAINS THE ONE (1) LETTER CODE THAT DESCRIBES THE MAJOR OR PRIMARY PURPOSE FOR WHICH THE RESERVOIR IS USED AS FOLLOWS:

I = IRRIGATION	S = WATER SUPPLY	D = DEBRIS CONTROL
H = HYDROELECTRIC	R = RECREATION	O = OTHER
C = FLOOD CONTROL	N = NAVIGATION	P = STOCK OR SMALL FARM POND

48*	REMARKS1 (NON-KEY NAME X(6))	REMARKS	(28)

CONTAINS THE REMARKS PREFACED WITH THE ITEM NUMBER (FORM 4474)
IT PERTAINS TO EG 22-ORIGINALLY CONSTRUCTED IN 1928. ALL REMARKS APPLY TO PART 1 OF THE INPUT DATA.

49*	REMARKS2 (NON-KEY NAME X(6))	REMARKS	(56)

CONTAINS THE REMARKS PREFACED WITH THE ITEM NUMBER (FORM 4474)
IT PERTAINS TO EG 34-2,500,000 CY CONCRETE, 475,000 CY EARTHFILL.
ALL REMARKS APPLY TO PART 2 OF THE INPUT DATA.

50*	MAJ-TYPE (NAME XX)	MAJOR DESIGN TYPE	(21)

CONTAINS THE TWO (2) LETTER CODE TO DESCRIBE THE TYPE OF THE MAIN PORTION OF THE DAM AS FOLLOWS:

RE = EARTH	CB = BUTTRESS	OT = OTHER
ER = ROCKFILL	VA = ARCH	(DESCRIBE OTHER IN REMARKS)
PG = GRAVITY	MV = MULTI-ARCH	

NATIONAL INVENTORY OF DAMS
S2000 DATA BASE DESCRIPTION

FORM8474
ITEM NO.

C NO	DATA BASE NAME	DATA DESCRIPTION
51*	INV (NAME X)	INVENTORY STATUS FLAG

FLAG WHICH INDICATES WHETHER THE DAM MEETS THE CRITERIA FOR DAMS INVENTORY AS WRITTEN IN PUBLIC LAW 92-367 (SEE APPENDIX III, ER 1110-2-106).
THIS IS GENERATED BY THE UPDATE PROGRAM. A VALUE OF "Y" INDICATES THE DAM MEETS THE CRITERIA. A VALUE OF "N" INDICATES THE DAM FAILS THE CRITERIA.

52*	SSC	CURRENT SAFETY STATUS FLAG

THIS IS A PROGRAM GENERATED ELEMENT WHICH FLAGS THOSE DAMS WHICH HAVE BEEN DESIGNATED AS EMERGENCY UNSAFE AND HAVE NOT HAD ANY EMERGENCY CORRECTIVE ACTIONS TAKEN (CA = "EC"). A VALUE OF E IS ASSIGNED TO THIS TYPE OF DAM, OTHERWISE THE FIELD IS BLANK.

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
100*	AREA-2 (RG)		
101*	S1-2 (NAME XX IN 100)	SECONDARY STATE CODE	(06)
	CONTAINS THE SECONDARY STATE CODE. FORMAT SAME AS ITEM C2 (ST).		
102*	CNTY-2 (NAME XXX IN 100)	SECONDARY COUNTY CODE	(07)
	CONTAINS THE SECONDARY COUNTY CODE. FORMAT SAME AS ITEM C6 (CNTY-1).		
103*	CNG-DST-2 (NAME XX IN 100)	SECONDARY CONGR. DIST.	(08)
	CONTAINS THE SECONDARY CONGRESSIONAL DISTRICT. FORMAT SAME AS ITEM C7 (CNG-DST-1).		
200*	POPULAR-NAME (RG)		
201*	NAME-POP (NAME X(15) IN 200)	POPULAR NAME OF DAM	(13)
	CONTAINS THE POPULAR NAME OF THE DAM IF OTHER THAN THE OFFICIAL NAME OF THE DAM. IF NO POPULAR NAME LEAVE BLANK.		
300*	PURPOSE (RG)		
301*	PURP (NAME X IN 300)	OTHER PURPOSES OF DAM	(23)
	CONTAINS THE OTHER PURPOSES OF THE RESERVOIR. CODES ARE THE SAME AS ITEM C47 (MAJ-PURP) AND CAN HAVE AS MANY AS 9 OTHER PURPOSES AND SHOULD BE ENTERED IN ORDER OF THE RELATIVE DECREASING IMPORTANCE OF THE PROJECT PURPOSE.		
400*	POWER (RG)		
401*	POW-INS (DEC 9(5).9 IN 400)	POWER INSTALLED (MW)	(35)
	CONTAINS THE INSTALLED CAPACITY TO ONE TENTH OF A MEGAWATT AS OF THE REPORT DATE.		
402*	POW-PROP (DEC 9(5).9 IN 400)	POWER PROPOSED (MW)	(36)
	CONTAINS THE FUTURE ADDITIONAL CAPACITY PROPOSED FOR INSTALLATION TO THE ONE TENTH OF A MEGAWATT.		
500*	TYPE-OF-DAM (RG)		
501*	TYPE (NAME XX IN 500)	OTHER DESIGN TYPES	(21)
	CONTAINS THE OTHER DESIGN TYPES OF THE DAM AND CODED THE SAME AS ITEM C50 (MAJ-TYPE) AND CAN HAVE AS MANY AS FIVE (5) OTHER DESIGN TYPES.		

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
600*	NAV-LOCKS (RG)		
601*	LOC-LEN (NON-KEY INT 9999 IN 600)	LENGTH OF LOCKS	(38)
	CONTAINS TO THE NEAREST FOOT THE LENGTH OF THE NAVIGATION LOCK(S). CAN HAVE AS MANY AS FOUR (4) LOCKS PER DAM.		
602*	LOC-WID (NON-KEY INT 999 IN 600)	WIDTH OF LOCKS	(39)
	CONTAINS TO THE NEAREST FOOT THE WIDTH OF THE NAVIGATION LOCK(S). CAN HAVE AS MANY AS FOUR (4) LOCKS PER DAM.		
700*	INSPECTION (RG)		
701*	INSP-INIT (DATE IN 700)	DATE INSPECTION INITIATED	(57)
	CONTAINS THE DATE THE DAM INSPECTION BEGAN.		
702*	UNSAFE (NAME X IN 700)	UNSAFE DESIGNATION CODE	(58)
	CONTAINS U IF DAM IS FOUND TO BE UNSAFE. CONTAINS R IF STATE HAS NOTIFIED CORPS THAT IT IS SATISFIED THAT THE DAM HAS BEEN REPAIRED. OTHERWISE THE FIELD IS NULL.		
703*	URG (NAME X IN 700)	URGENCY CODE	(59)
	CONTAINS A ONE (1) LETTER DESIGNATION FOR THE URGENCY CODE AS FOLLOWS: E = EMERGENCY N = NON-EMERGENCY ENTER ONLY IF ITEM 58 IS U OTHERWISE LEAVE BLANK.		
704*	INSP-COMPL (DATE IN 700)	DATE INSPECTION COMPLETED	(60)
	CONTAINS THE DATE THE INSPECTION WAS COMPLETED AND THE DRAFT REPORT FURNISHED TO THE DISTRICT.		
705*	RPT-APPR (DATE IN 700)	DATE REPORT APPROVED	(61)
	CONTAINS THE DATE THE REPORT WAS APPROVED BY THE DISTRICT ENGINEER.		
706*	GOV-NOTIF (DATE IN 700)	DATE GOV NOTIFIED OF UNSAFE COND	(62)
	CONTAINS THE DATE THE GOVERNOR WAS NOTIFIED OF THE UNSAFE CONDITION OF THE DAM. MUST BE ENTERED IF ITEM 58 IS U OTHERWISE LEAVE BLANK.		
708*	INSPECTOR (NAME XX IN 700)	INSPECTED BY CODE	(63)
	CONTAINS A TWO (2) CHARACTER CODE TO DESIGNATE THE TYPE OF INSPECTOR AS FOLLOWS: SP = STATE PERSONNEL SC = AE HIRED BY THE STATE DP = CORPS PERSONNEL DC = AE HIRED BY THE CORPS		

FORM4474

C NO	DATA BASE NAME	DATA DESCRIPTION	ITEM NO.
709*	INSP-RMK (NON-KEY NAME X(6) IN 700)	INSPECTION REMARKS	(66)

CONTAINS APPROPRIATE REMARKS FOR EXPLAINATION OF THE INSPECTION DATA.

707*	GOV-RPT (DATE IN 700)	DATE GOV FURNISHED FINAL RPT	(64)

CONTAINS THE DATE THE FINAL APPROVED REPORT WAS FURNISHED TO THE GOVERNOR.

750* DEFICIENCY (RG IN 700)

751*	DEF (NAME XX IN 750)	DEFICIENCY CODES	(65)

CONTAINS A TWO (2) CHARACTER CODE FOR THE DEFICIENCIES FOUND DURING THE INSPECTION OF THE DAM. CAN HAVE AS MANY AS SIX (6) DEFICIENCIES FOR EACH INSPECTION. CODES ARE AS FOLLOWS:

OP = OPERATIONAL SC = SPILLWAY CAPACITY TOO SMALL
SA = STABILITY SR = STRUCTURAL
SE = SEEPAGE OT = OTHER

ENTER IN ORDER OF SIGNIFICANCE EG IF THE PRIMARY REASON A DAM WAS FOUND TO BE UNSAFE WAS SPILLWAY CAPACITY, IT SHOULD BE LISTED FIRST FOLLOWED BY OTHER DEFICIENCIES FOUND.

800* CORR-ACT (RG)

801*	CA (NAME XX IN 800)	CORRECTIVE ACTION CODE	(67)

CONTAINS A TWO (2) CHARACTER CODE FOR CORRECTIVE ACTIONS TAKEN TO ALLEVIATE THE UNSAFE CONDITION. MULTIPLE CORRECTIVE ACTION CODES ARE ACCEPTABLE. CORRECTIVE ACTION CODES ARE AS FOLLOWS:

NON-EMERGENCY ACTIONS:
RI = REPAIRS INITIATED
RC = REPAIRS COMPLETED
NO = NONE
EC = ALL REQUIRED EMERGENCY ACTIONS COMPLETED
SU = DAM UNDER SURVEILLANCE
ON = OTHER NON-EMERGENCY ACTIONS

EMERGENCY ACTIONS:
BR = DAM BREACHED
RL = RESERVOIR LOWERED
SP = SPILLWAY CAPACITY INCREASED
RD = RESERVOIR DRAINED
OE = OTHER EMERGENCY ACTIONS

802*	CA-DATE (DATE IN 800)	DATE OF CORRECTIVE ACTION	(68)

CONTAINS THE DATE THAT THE CORRECTIVE ACTION WAS TAKEN. MULTIPLE CORRECTIVE ACTION DATES ASSOCIATED WITH EACH CORRECTIVE ACTION ARE ACCEPTABLE.

C NO	DATA BASE NAME	DATA DESCRIPTION	FORM4474 ITEM NO.
803*	CA-RMK (NON-KEY NAME X(6) IN 800)	CORRECTIVE ACTION REMARK	(69)

CONTAINS ANY REMARKS ASSOCIATED WITH EACH CORRECTIVE ACTION AND ITS ASSOCIATED CORRECTIVE ACTION DATE.

804*	EC (NAME X IN 800)	EMERGENCY CODE

CONTAINS THE ONE (1) CHARACTER "E" IF THE CORRECTIVE ACTION CODE IS ONE OF THE EMERGENCY ACTION CODES AS STATED IN ITEM C801, OTHERWISE THE FIELD IS NULL. THIS CODE IS GENERATED BY THE UPDATE PROGRAM AUTOMATICALLY.

APPENDIX D

INVENTORY AND INSPECTION DATA

TABLE 1

PERFORMANCE OF DAM INVENTORY

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
ALABAMA	47	3	1733	97					1780
ALASKA	103	62			64	38			167
ARIZONA	225	57			170	43			395
ARKANSAS	11	1					1076	99	1087
CALIFORNIA	210	16			1100	84			1310
COLORADO					1786	100			1786
CONNECTICUT	1		364	49	375	51			740
DELAWARE	56	58	40	42					96
FLORIDA	175	27	251	39	216	34			642
GEORGIA	40	1	3265	99					3305
HAWAII	123	100							123
IDAHO					371	100			371
ILLINOIS	10	1	920	99					930

TABLE 1 (continued)

PERFORMANCE OF DAM INVENTORY

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
INDIANA	117	15	681	85					798
IOWA					2053	100			2053
KANSAS							5031	100	5031
KENTUCKY	174	17			859	83			1033
LOUISIANA					340	100			340
MAINE	1		618	100					619
MARYLAND	2	1	28	14	176	85			206
MASSACHUSETTS	3		1292	100					1295
MICHIGAN	76	3			1649	73	535	24	2260
MINNESOTA					864	100			364
MISSISSIPPI	2990	100							2990
MISSOURI					3599	100			3599
MONTANA	72	2					3446	98	3518

TABLE 1 (continued)

PERFORMANCE OF DAM INVENTORY

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
NEBRASKA					1739	100			1739
NEVADA	29	14	16	8	159	78			204
NEW HAMPSHIRE	2		237	41	341	59			580
NEW JERSEY	183	23	62	8			562	69	807
NEW MEXICO	92	23	10	2	185	44	130	31	417
NEW YORK			156	11	1223	89			1379
NORTH CAROLINA	6				1629	100			1635
NORTH DAKOTA					380	100			380
OHIO	37	3	85	8	950	89			1072
OKLAHOMA	1195	28	430	10	2611	62			4236
OREGON					653	100			653
PENNSYLVANIA	20	2	1101	98					1121
RHODE ISLAND	1	1	31	23	110	76			142
SOUTH CAROLINA					1942	100			1942

TABLE 1 (continued)

PERFORMANCE OF DAM INVENTORY

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
SOUTH DAKOTA					1993	100			1993
TENNESSEE	62	7			783	93			845
TEXAS					5695	100			5695
UTAH	54	13			352	87			406
VERMONT	1		82	31	186	69			269
VIRGINIA	184	13			1234	87			1418
WASHINGTON	109	13			702	87			811
WEST VIRGINIA					472	100			472
WISCONSIN					1031	100			1031
WYOMING					1487	100			1487
PUERTO RICO					70	100			70
VIRGIN ISLANDS	8	100							8
TRUST TERRITORIES	3	100							3
TOTAL	6422	9	11402	17	39549	58	10780	16	68153

TABLE - 2

NATIONAL INVENTORY OF DAMS

NUMBER OF DAMS VERIFIED

STATE	DAMS MEETING PL 92-367 NUMBER VERIFIED	DAMS MEETING PL 92-367 TOTAL NUMBER	DAMS MEETING PL 92-367 PERCENT VERIFIED	DAMS FAILING PL 92-367 NUMBER VERIFIED	DAMS FAILING PL 92-367 TOTAL NUMBER	DAMS FAILING PL 92-367 PERCENT VERIFIED	TOTAL NUMBER IN DATA BASE
ALABAMA	1704	1704	100.0	76	76	100.0	1780
ALASKA	104	104	100.0	63	63	100.0	167
ARIZONA	386	386	100.0	9	9	100.0	395
ARKANSAS	1046	1046	100.0	41	41	100.0	1087
CALIFORNIA	1269	1269	100.0	41	41	100.0	1310
COLORADO	1786	1786	100.0	0	0	100.0	1786
CONNECTICUT	705	705	100.0	35	35	100.0	740
DELAWARE	91	91	100.0	5	5	100.0	96
FLORIDA	621	621	100.0	21	21	100.0	642
GEORGIA	3289	3289	100.0	16	16	100.0	3305
HAWAII	121	121	100.0	2	2	100.0	123
IDAHO	364	364	100.0	7	7	100.0	371
ILLINOIS	919	919	100.0	11	11	100.0	930
INDIANA	786	786	100.0	12	12	100.0	798
IOWA	2049	2049	100.0	4	4	100.0	2053
KANSAS	5000	5000	100.0	31	31	100.0	5031
KENTUCKY	1007	1007	100.0	26	26	100.0	1033
LOUISIANA	256	256	100.0	84	84	100.0	340
MAINE	489	489	100.0	130	130	100.0	619
MARYLAND	203	203	100.0	3	3	100.0	206
MASSACHUSETTS	1151	1151	100.0	144	144	100.0	1295
MICHIGAN	782	782	100.0	1470	1478	99.5	2260
MINNESOTA	622	622	100.0	242	242	100.0	864
MISSISSIPPI	2707	2707	100.0	283	283	100.0	2990
MISSOURI	3288	3288	100.0	311	311	100.0	3599
MONTANA	3179	3179	100.0	339	339	100.0	3518
NEBRASKA	1739	1739	100.0	0	0	100.0	1739

TABLE - 2 (CONTINUED)

NATIONAL INVENTORY OF DAMS

NUMBER OF DAMS VERIFIED

STATE	DAMS MEETING PL 92-367 NUMBER VERIFIED	DAMS MEETING PL 92-367 TOTAL NUMBER	DAMS MEETING PL 92-367 PERCENT VERIFIED	DAMS FAILING PL 92-367 NUMBER VERIFIED	DAMS FAILING PL 92-367 TOTAL NUMBER	DAMS FAILING PL 92-367 PERCENT VERIFIED	TOTAL NUMBER IN DATA BASE
NEVADA	200	200	100.0	4	4	100.0	204
NEW HAMPSHIRE	546	546	100.0	34	34	100.0	580
NEW JERSEY	781	781	100.0	26	26	100.0	807
NEW MEXICO	412	412	100.0	5	5	100.0	417
NEW YORK	1270	1270	100.0	109	109	100.0	1379
NORTH CAROLINA	1274	1274	100.0	361	361	100.0	1635
NORTH DAKOTA	380	380	100.0	0	0	100.0	380
OHIO	1009	1009	100.0	63	63	100.0	1072
OKLAHOMA	4177	4207	99.3	29	29	100.0	4236
OREGON	607	607	100.0	46	46	100.0	653
PENNSYLVANIA	1080	1080	100.0	41	41	100.0	1121
RHODE ISLAND	138	138	100.0	4	4	100.0	142
SOUTH CAROLINA	1932	1932	100.0	9	10	90.0	1942
SOUTH DAKOTA	1991	1992	99.9	0	1	0.0	1993
TENNESSEE	830	833	99.6	12	12	100.0	845
TEXAS	5625	5625	100.0	70	70	100.0	5695
UTAH	394	394	100.0	12	12	100.0	406
VERMONT	264	264	100.0	5	5	100.0	269
VIRGINIA	1416	1416	100.0	2	2	100.0	1418
WASHINGTON	401	401	100.0	410	410	100.0	811
WEST VIRGINIA	440	440	100.0	32	32	100.0	472
WISCONSIN	1016	1016	100.0	15	15	100.0	1031
WYOMING	1487	1487	100.0	0	0	100.0	1487
GUAM	1	1	100.0	0	0	100.0	1
PUERTO RICO	41	41	100.0	29	29	100.0	70
TERRITORIES	2	2	100.0	0	0	100.0	2
VIRGIN ISLANDS	8	8	100.0	0	0	100.0	8
TOTAL	63385	63419	99.9	4724	4734	99.8	68153

TABLE - 3

STRUCTURAL HEIGHT OF DAMS

STATE	MINIMUM HEIGHT (FT)	MAXIMUM HEIGHT (FT)	HEIGHT RANGES (FT) 7 - 24	25 - 39	40 - 99	100-199	200-299	300-MAX	TOTAL NUMBER	TOTAL STORAGE CAPACITY (AC-FT)
ALABAMA	7	305	1028	502	150	23	0	1	1704	13,923,390
ALASKA	7	170	64	20	17	3	0	0	104	1,856,845
ARIZONA	7	710	92	142	101	33	13	5	386	41,156,156
ARKANSAS	7	256	616	252	160	13	5	0	1046	24,195,259
CALIFORNIA	7	756	268	291	444	184	55	27	1269	57,704,302
COLORADO	7	468	782	551	367	62	16	8	1786	11,485,377
CONNECTICUT	7	223	454	164	70	15	2	0	705	2,466,899
DELAWARE	7	135	73	14	3	1	0	0	91	109,214
FLORIDA	7	100	349	177	94	1	0	0	621	60,023,927
GEORGIA	7	464	2078	935	263	9	3	1	3289	13,312,825
HAWAII	11	135	27	49	43	2	0	0	121	59,695
IDAHO	7	717	120	105	101	27	5	6	364	15,860,677
ILLINOIS	7	138	370	375	169	5	0	0	919	6,447,391
INDIANA	7	181	295	338	144	9	0	0	786	5,501,057
IOWA	7	132	296	1311	438	4	0	0	2049	6,069,077
KANSAS	7	202	2216	2347	421	15	1	0	5000	15,430,868
KENTUCKY	7	363	290	474	199	34	7	3	1007	29,200,874
LOUISIANA	7	105	184	44	27	1	0	0	256	11,136,861
MAINE	7	266	387	59	39	2	2	0	489	8,480,109
MARYLAND	7	296	106	57	33	6	1	0	203	1,351,918
MASSACHUSETTS	7	280	870	177	88	12	4	0	1151	7,234,032
MICHIGAN	7	170	618	103	57	4	0	0	782	36,046,628
MINNESOTA	7	135	372	191	57	2	0	0	622	16,027,281
MISSISSIPPI	8	117	2105	525	75	2	0	0	2707	9,983,589
MISSOURI	8	252	631	2202	435	19	1	0	3288	22,954,056
MONTANA	7	570	2258	768	116	28	5	4	3179	42,221,441
NEBRASKA	7	170	702	834	192	11	0	0	1739	5,583,877
NEVADA	7	726	93	50	50	5	1	1	200	31,425,214
NEW HAMPSHIRE	7	180	421	83	37	5	0	0	546	5,371,204

TABLE-3 (CONTINUED)

STRUCTURAL HEIGHT OF DAMS

STATE	MINIMUM HEIGHT (FT)	MAXIMUM HEIGHT (FT)	HEIGHT RANGES (FT) 7 - 24	25 - 39	40 - 99	100-199	200-299	300-MAX	TOTAL NUMBER	TOTAL STORAGE CAPACITY (AC-FT)
NEW JERSEY	7	188	656	80	39	6	0	0	781	2,387,049
NEW MEXICO	7	402	149	137	92	25	6	3	412	12,915,884
NEW YORK	7	375	740	305	192	26	5	2	1270	13,209,669
NORTH CAROLINA	8	480	638	445	154	30	5	2	1274	9,953,711
NORTH DAKOTA	7	210	242	79	55	3	1	0	380	27,248,631
OHIO	7	232	280	457	254	16	2	0	1009	7,362,537
OKLAHOMA	8	525	1247	2219	716	23	1	1	4207	33,659,316
OREGON	8	519	253	176	132	25	11	10	607	13,293,337
PENNSYLVANIA	7	410	461	279	286	44	8	2	1080	9,440,446
RHODE ISLAND	8	109	117	16	4	1	0	0	138	313,919
SOUTH CAROLINA	7	435	1305	508	107	8	2	2	1932	17,472,313
SOUTH DAKOTA	7	245	1172	745	63	9	3	0	1992	34,549,360
TENNESSEE	7	318	387	300	116	21	8	1	833	18,626,174
TEXAS	7	278	2823	1842	920	35	5	0	5625	79,989,755
UTAH	7	502	158	107	93	27	8	1	394	[illegible],924,978
VERMONT	7	265	163	60	31	8	2	0	264	1,097,734
VIRGINIA	7	300	656	506	231	16	6	1	1416	10,773,184
WASHINGTON	7	610	219	76	56	18	20	12	401	29,145,976
WEST VIRGINIA	7	534	43	121	184	57	16	19	440	3,494,047
WISCONSIN	7	122	725	211	79	1	0	0	1016	9,284,150
WYOMING	7	325	647	696	123	13	6	2	1487	14,373,301
GUAM	135	135	0	0	0	1	0	0	1	9,500
PUERTO RICO	15	239	3	6	17	12	3	0	41	416,165
TERRITORIES	31	53	0	1	1	0	0	0	2	171
VIRGIN ISLANDS	18	51	2	5	1	0	0	0	8	335
TOTAL	0	756	31251	22517	8336	962	239	114	63419	860,561,685

TABLE - 4

STRUCTURAL HEIGHT OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HEIGHT RANGES (FT) 7 - 24	25 - 39	40 - 99	100-199	200-299	300-MAX	TOTAL NUMBER	TOTAL STORAGE CAPACITY (AC-FT)
1700-1899	1636	791	218	15	0	1	2661	9,757,989
1900	903	136	34	1	0	0	1074	1,418,689
1901	48	26	14	1	0	0	89	308,523
1902	47	34	11	0	0	0	92	251,117
1903	44	29	24	1	0	0	98	211,573
1904	76	35	22	0	0	0	133	553,912
1905	72	39	28	1	0	0	140	462,205
1906	47	29	27	2	1	0	106	1,191,099
1907	61	37	23	2	0	0	123	346,755
1908	91	44	31	2	0	0	168	388,147
1909	81	34	25	2	1	0	143	7,194,583
1910	202	76	55	8	0	1	342	2,945,466
1900-1910	1672	519	294	20	2	1	2508	15,272,069
1911	120	43	38	5	1	0	207	4,328,251
1912	112	57	32	6	1	0	208	2,060,748
1913	88	37	37	11	1	0	174	2,404,565
1914	125	50	31	3	2	0	211	3,096,843
1915	131	47	29	6	0	1	214	2,697,420
1916	67	38	24	3	1	2	135	6,562,030
1917	85	40	17	6	2	1	151	2,089,907
1918	93	35	16	8	0	0	152	919,679
1919	104	26	20	6	1	0	157	1,786,665
1920	459	108	40	10	0	0	617.	1,485,846
1911-1920	1384	481	284	64	9	4	2226	27,431,554
1921	69	33	22	1	0	0	125	33,475,493
1922	76	44	30	8	1	0	159	3,076,241
1923	98	37	36	12	0	1	184	2,880,988
1924	83	47	41	10	3	0	184	2,615,411
1925	179	62	49	6	3	1	300	3,318,672
1926	93	65	38	10	2	1	209	5,422,030
1927	104	42	33	16	2	1	198	2,691,488
1928	138	46	44	15	2	0	245	7,033,899
1929	116	41	31	7	3	3	201	2,770,441
1930	465	140	45	6	5	0	661	6,080,007
1921-1930	1421	557	369	91	21	7	2466	69,364,670

TABLE - 4 (CONTINUED)

STRUCTURAL HEIGHT OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HEIGHT RANGES (FT) 7 - 24	25 - 39	40 - 99	100-199	200-299	300-MAX	TOTAL NUMBER	TOTAL STORAGE CAPACITY (AC-FT)
1931	81	39	24	10	2	2	158	8,464,483
1932	92	34	27	7	1	1	162	2,714,231
1933	115	45	19	4	0	0	183	10,636,763
1934	177	91	25	2	1	0	296	1,380,519
1935	400	152	63	8	2	1	626	11,072,286
1936	332	122	60	7	2	1	524	36,127,741
1937	359	139	54	9	0	0	561	7,472,043
1938	357	148	61	13	6	1	586	10,368,128
1939	221	99	50	14	3	1	388	8,087,437
1940	664	297	81	10	1	1	1054	9,916,022
1931-1940	2798	1166	464	84	18	8	4538	106,240,653
1941	165	74	44	14	3	0	300	11,755,072
1942	129	61	28	11	2	2	233	17,668,004
1943	113	39	19	9	4	1	185	6,881,359
1944	139	42	12	3	2	1	199	14,535,992
1945	369	144	20	1	2	3	539	5,757,382
1946	253	89	24	6	0	0	372	954,111
1947	246	122	37	2	0	0	407	1,193,973
1948	397	145	59	10	1	2	614	4,103,865
1949	355	123	64	20	4	1	567	10,866,590
1950	1401	574	115	12	4	1	2107	7,090,158
1941-1950	3567	1413	422	88	22	11	5523	80,806,506
1951	353	168	76	12	6	1	616	28,009,385
1952	512	267	80	21	5	1	886	11,792,557
1953	467	267	110	19	10	3	876	49,681,305
1954	570	351	118	14	5	2	1060	23,951,390
1955	1126	560	164	14	4	0	1868	5,437,186
1956	521	409	143	16	3	2	1094	18,670,055
1957	540	433	147	11	7	1	1139	31,795,173
1958	730	534	169	11	8	3	1455	17,351,698
1959	528	621	178	13	3	2	1345	9,528,633
1960	1887	1216	282	17	3	2	3407	14,723,884
1951-1960	7234	4826	1467	148	54	17	13746	210,939,266

TABLE - 4 (CONTINUED)

STRUCTURAL HEIGHT OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HEIGHT RANGES (FT) 7 - 24	25 - 39	40 - 99	100-199	200-299	300-MAX	TOTAL NUMBER	TOTAL STORAGE CAPACITY (AC-FT)
1961	515	616	223	21	11	3	1389	14,003,729
1962	700	626	271	23	5	3	1628	31,613,742
1963	729	825	311	26	8	6	1905	21,115,433
1964	774	787	300	16	6	3	1886	21,227,287
1965	1395	1104	341	27	11	1	2879	17,806,078
1966	672	805	280	20	6	4	1787	65,905,863
1967	686	769	318	17	5	4	1799	13,682,891
1968	853	801	294	25	4	8	1985	23,144,207
1969	678	692	266	19	8	0	1663	24,089,760
1970	1035	827	285	14	4	2	2167	19,244,248
1961-1970	8037	7852	2889	208	68	34	19088	251,833,238
1971	463	644	256	26	4	1	1394	11,399,584
1972	519	733	242	24	2	2	1522	6,298,186
1973	456	570	260	33	13	9	1341	18,840,963
1974	412	560	204	26	4	2	1208	10,929,873
1975	418	508	211	18	6	2	1163	6,599,677
1976	343	538	196	17	4	2	1100	5,515,507
1977	335	586	150	28	1	5	11[illegible]	4,332,051
1978	247	378	163	26	7	4	8[illegible]	11,391,578
1979	194	240	116	20	2	3	575	11,611,597
1980	89	129	107	24	2	1	352	8,556,064
1971-1980	3476	4886	1905	242	45	31	10585	95,475,076
1981	26	26	23	2	0	0	77	1,957,579
1982	0	0	1	0	0	0	1	85
1981-1990	26	26	24	2	0	0	78	1,957,664
1700-1899	1636	791	218	15	0	1	2661	9,757,989
1900-1910	1672	519	294	20	2	1	2508	15,272,069
1911-1920	1384	481	284	64	9	4	2226	27,431,554
1921-1930	1421	557	369	91	21	7	2466	69,364,670
1931-1940	2798	1166	464	84	18	8	4538	106,240,653
1941-1950	3567	1413	422	88	22	11	5523	80,806,506
1951-1960	7234	4826	1467	148	54	17	13746	210,939,266
1961-1970	8037	7852	2889	208	68	34	19088	251,833,238
1971-1980	3476	4886	1905	242	45	31	10585	95,475,076
1981-1990	26	26	24	2	0	0	78	1,957,664
TOTALS	31251	22517	8336	962	239	114	63419	860,561,685

TABLE - 5

MAXIMUM STORAGE CAPACITY OF DAMS BY HYDRAULIC HEIGHT

HYDRAULIC HEIGHT (FT)	STORAGE CAPACITY RANGES (AC-FT) 10-49	50-999	1000-24,999	25,000-49,999	50,000-99,999	100,000-149,999	150,000-MAX	TOTAL NUMBER
7	0	854	182	11	5	2	0	1054
8	0	1330	214	13	7	0	2	1566
9	0	1009	141	6	3	1	8	1168
10	0	2085	234	5	7	2	13	2344
11	0	1227	121	4	1	0	6	1359
12	0	2384	194	10	6	1	10	2565
13	0	1658	133	10	4	2	9	1816
14	0	1853	138	3	9	2	5	2010
15	0	2800	166	10	2	2	9	2989
16	0	2078	142	9	5	1	6	2241
17	0	1820	118	3	3	4	1	1969
18	0	2323	159	6	5	0	19	2512
19	0	1593	97	3	5	2	4	1704
20	0	3009	207	7	3	3	11	3240
21	0	1560	125	1	6	1	4	1697
22	0	1797	157	5	9	1	5	1974
23	0	1538	132	4	1	0	5	1680
24	0	1503	155	3	2	4	7	1674
25	1210	2423	234	5	3	1	2	3878
26	483	1359	157	5	1	1	0	1926
27	327	1185	175	5	4	0	3	1699
28	296	1257	211	2	1	1	3	1771
29	178	887	180	2	1	1	3	1252
30	296	1681	271	7	2	4	6	2267
31	189	723	167	6	1	2	4	1012
32	100	785	182	4	2	2	7	1082
33	97	636	177	3	7	1	1	922
34	58	603	162	4	1	0	5	833
35	82	766	251	12	4	7	3	1125
36	42	410	181	1	6	1	2	643
37	34	386	143	3	2	1	0	569
38	34	414	183	8	5	2	3	649
39	19	275	131	3	4	3	2	437
40	36	461	215	7	2	3	5	729
41	21	211	120	2	0	3	1	358
42	14	219	135	6	3	1	3	381
43	16	195	130	3	0	0	4	348
44	9	172	112	3	1	1	3	301
45	14	224	154	3	5	1	4	405
46	8	125	114	3	2	2	2	256
47	9	139	105	7	4	0	0	255
48	6	120	96	1	1	1	3	228
49	5	104	77	4	2	0	1	189
50	8	168	173	7	4	4	8	372
51	4	62	64	2	3	1	2	138
52	3	85	87	6	0	0	5	186
53	8	46	77	7	1	1	3	143

TABLE - 5 (CONTINUED)

MAXIMUM STORAGE CAPACITY OF DAMS BY HYDRAULIC HEIGHT

HYDRAULIC HEIGHT (FT)	STORAGE CAPACITY RANGES (AC-FT) 10-49	50-999	1000-24,999	25,000-49,999	50,000-99,999	100,000-149,999	150,000-MAX	TOTAL NUMBER
54	1	49	78	5	3	2	2	140
55	2	56	77	7	4	0	3	149
56	0	37	62	5	2	1	2	109
57	1	27	51	7	3	2	3	94
58	4	40	57	5	1	1	5	113
59	1	35	33	0	0	1	5	75
60	3	66	74	9	6	4	2	164
61	0	25	38	5	1	0	3	72
62	0	28	42	4	8	2	4	80
63	0	28	46	3	2	0	5	84
64	1	23	29	5	1	1	3	63
65	2	36	58	8	5	2	5	116
66	1	16	24	1	2	0	4	48
67	1	16	30	3	2	1	1	54
68	0	17	39	1	2	1	5	65
69	1	6	26	4	2	0	3	42
70	2	21	46	5	3	2	4	83
71	0	10	26	1	3	2	1	43
72	1	14	15	1	3	3	0	37
73	0	14	31	1	2	0	4	52
74	1	11	25	0	2	2	8	49
75	0	17	33	4	7	3	7	71
76	0	4	18	4	1	0	2	29
77	1	4	15	1	0	2	4	29
78	1	5	15	2	3	0	7	31
79	0	4	7	0	2	0	3	16
80	0	17	45	2	4	0	7	75
81	0	3	17	1	1	2	5	29
82	0	8	17	1	1	2	3	32
83	0	6	14	1	2	3	2	28
84	0	4	21	1	1	2	1	30
85	1	13	24	4	4	1	5	52
86	0	6	17	2	0	2	2	29
87	1	2	15	2	2	1	2	25
88	2	5	12	1	1	0	3	24
89	0	1	10	1	0	1	1	14
90	1	11	21	4	8	3	5	53
91	0	2	11	3	4	0	2	22
92	0	0	12	2	1	2	3	20
93	0	3	10	1	1	0	5	20
94	1	3	6	4	1	0	3	14
95	0	5	13	3	2	4	4	31
96	0	1	5	2	1	0	4	13
97	0	1	7	1	0	1	3	13
98	0	4	7	0	1	0	2	14
99	1	1	5	2	0	0	8	17
100	2	10	19	5	5	1	9	51
OVER 100	6	129	296	86	94	68	330	1009
TOTALS	5485	49333	8876	460	351	198	716	65419

TABLE - 6

SIZE CLASSIFICATION* OF DAMS

STATE	SMALL	INTER-MEDIATE	LARGE	TOTAL NUMBER
ALABAMA	1530	141	33	1704
ALASKA	71	23	10	104
ARIZONA	204	136	46	386
ARKANSAS	802	213	31	1046
CALIFORNIA	500	512	257	1269
COLORADO	1231	470	85	1786
CONNECTICUT	524	164	17	705
DELAWARE	60	30	1	91
FLORIDA	292	234	95	621
GEORGIA	2980	295	14	3289
HAWAII	86	33	2	121
IDAHO	201	121	42	364
ILLINOIS	668	234	17	919
INDIANA	577	195	14	786
IOWA	1555	480	14	2049
KANSAS	4589	383	28	5000
KENTUCKY	705	251	51	1007
LOUISIANA	179	51	26	256
MAINE	259	199	31	489
MARYLAND	151	43	9	203
MASSACHUSETTS	886	249	16	1151
MICHIGAN	496	267	19	782
MINNESOTA	370	216	36	622
MISSISSIPPI	2474	226	7	2707
MISSOURI	2912	353	23	3288
MONTANA	2924	213	42	3179
NEBRASKA	1499	226	14	1739
NEVADA	117	74	9	200
NEW HAMPSHIRE	351	179	16	546
NEW JERSEY	653	112	16	781
NEW MEXICO	268	113	31	412
NEW YORK	885	335	50	1270
NORTH CAROLINA	1093	143	38	1274
NORTH DAKOTA	247	125	8	380

TABLE - 6 (CONTINUED)

SIZE CLASSIFICATION* OF DAMS

STATE	SMALL	INTER-MEDIATE	LARGE	TOTAL NUMBER
OHIO	669	295	45	1009
OKLAHOMA	3368	794	45	4207
OREGON	387	169	51	607
PENNSYLVANIA	645	370	65	1080
RHODE ISLAND	106	31	1	138
SOUTH CAROLINA	1763	152	17	1932
SOUTH DAKOTA	1858	118	16	1992
TENNESSEE	631	165	37	833
TEXAS	3805	1719	101	5625
UTAH	221	140	33	394
VERMONT	165	89	10	264
VIRGINIA	1138	253	25	1416
WASHINGTON	236	107	58	401
WEST VIRGINIA	160	187	93	440
WISCONSIN	672	316	28	1016
WYOMING	1271	185	31	1487
GUAM	0	1	0	1
PUERTO RICO	11	16	14	41
TERRITORIES	2	0	0	2
VIRGIN ISLANDS	7	1	0	8
TOTAL	49454	12147	1818	63419

*SIZE CLASSIFICATION

CATEGORY	IMPOUNDMENT	
	STORAGE (AC-FT)	HEIGHT(FT)
SMALL	< 1000	< 40
INTERMEDIATE	>= 1000 & < 50,000	>= 40 & < 100
LARGE	>= 50,000	>=100

TABLE - 7

TYPES OF DAMS

STATE	EARTH	ROCKFILL	GRAVITY	BUTTRESS	ARCH	MULTI-ARCH	OTHER	TOTAL
ALABAMA	1635	7	46	6	6	0	4	1704
ALASKA	25	24	5	8	8	0	34	104
ARIZONA	342	6	11	2	17	5	3	386
ARKANSAS	978	27	30	2	4	0	5	1046
CALIFORNIA	970	57	97	5	66	16	58	1269
COLORADO	1734	33	8	0	11	0	0	1786
CONNECTICUT	528	59	75	3	2	0	38	705
DELAWARE	81	0	2	1	0	0	7	91
FLORIDA	474	0	2	0	0	0	145	621
GEORGIA	3237	7	13	6	0	0	26	3289
HAWAII	120	0	0	0	1	0	0	121
IDAHO	306	14	30	1	5	1	7	364
ILLINOIS	890	2	22	0	1	0	4	919
INDIANA	765	2	16	0	1	0	2	786
IOWA	1984	2	62	0	0	0	1	2049
KANSAS	4984	0	13	0	0	0	3	5000
KENTUCKY	924	9	20	0	0	0	54	1007
LOUISIANA	251	0	4	0	0	0	1	256
MAINE	98	98	270	3	1	0	19	489
MARYLAND	178	1	14	6	1	0	3	203
MASSACHUSETTS	881	75	175	0	5	0	15	1151
MICHIGAN	587	3	175	4	3	2	8	782
MINNESOTA	407	11	184	1	0	0	19	622
MISSISSIPPI	2701	0	5	1	0	0	0	2707
MISSOURI	3218	12	15	3	5	0	35	3288
MONTANA	3116	18	25	3	9	0	8	3179
NEBRASKA	1720	0	6	7	0	0	6	1739
NEVADA	191	0	2	3	3	0	1	200
NEW HAMPSHIRE	295	33	209	3	3	0	3	546

TABLE - 7 (CONTINUED)

TYPES OF DAMS

STATE	EARTH	ROCKFILL	GRAVITY	BUTTRESS	ARCH	MULTI-ARCH	OTHER	TOTAL
NEW JERSEY	673	4	58	2	11	1	32	781
NEW MEXICO	385	4	13	1	5	0	4	412
NEW YORK	798	17	371	14	5	0	65	1270
NORTH CAROLINA	1103	19	34	17	37	3	61	1274
NORTH DAKOTA	340	1	12	2	0	0	25	380
OHIO	945	1	38	3	1	0	21	1009
OKLAHOMA	4169	3	23	5	4	1	2	4207
OREGON	528	21	31	3	8	3	13	607
PENNSYLVANIA	842	38	140	3	1	0	56	1080
RHODE ISLAND	130	1	3	0	0	0	4	138
SOUTH CAROLINA	1882	2	32	1	0	0	15	1932
SOUTH DAKOTA	1986	1	4	0	1	0	0	1992
TENNESSEE	771	6	43	4	1	0	8	833
TEXAS	5489	6	76	32	0	0	22	5625
UTAH	363	11	9	2	4	1	4	394
VERMONT	164	1	94	0	1	0	4	264
VIRGINIA	1278	15	87	21	6	0	9	1416
WASHINGTON	318	17	36	5	19	0	6	401
WEST VIRGINIA	322	8	19	3	0	0	88	440
WISCONSIN	487	5	506	8	4	1	5	1016
WYOMING	1462	9	5	0	4	0	7	1487
GUAM	1	0	0	0	0	0	0	1
PUERTO RICO	22	1	14	3	0	0	1	41
TERRITORIES	1	0	1	0	0	0	0	2
VIRGIN ISLANDS	7	0	1	0	0	0	0	8
TOTALS	58086	691	3186	461	0	34	961	63419

TABLE -8

TYPES OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	EARTH	ROCKFILL	GRAVITY	BUTTRESS	ARCH	MULTI-ARCH	OTHER	TOTAL
1700-1899	2000	112	382	6	14	0	147	2661
1900	767	64	187	6	5	0	45	1074
1901	65	2	13	0	1	0	8	89
1902	72	3	9	3	0	0	5	92
1903	67	5	21	1	3	0	1	98
1904	87	4	32	2	1	0	7	133
1905	81	5	43	0	4	0	7	140
1906	77	2	20	0	1	0	6	106
1907	78	3	32	4	1	0	5	123
1908	122	3	38	0	0	0	5	168
1909	107	5	26	1	2	0	2	143
1910	238	11	66	4	4	0	19	342
1900-1910	1761	107	487	21	22	0	110	2508
1911	146	2	46	5	5	0	3	207
1912	146	2	46	3	2	2	7	208
1913	99	5	57	7	3	0	3	174
1914	136	8	45	5	3	1	13	211
1915	150	6	41	4	4	1	8	214
1916	90	7	30	1	0	2	5	135
1917	91	7	39	2	2	2	8	151
1918	95	2	41	4	1	4	5	152
1919	88	9	46	1	5	0	8	157
1920	444	26	112	10	8	0	17	617
1911-1920	1485	74	503	42	33	12	77	2226
1921	78	3	34	3	2	1	4	125
1922	97	7	41	7	2	0	5	159
1923	109	8	44	7	7	2	7	184
1924	106	3	55	4	5	3	8	184
1925	200	9	65	9	5	4	8	300
1926	147	6	40	3	7	2	4	209
1927	114	5	47	5	16	2	9	198
1928	161	9	49	2	12	1	11	245
1929	127	5	45	3	12	2	7	201
1930	544	15	77	3	6	0	16	661
1921-1930	1683	70	497	46	74	17	79	2466

TABLE -A (CONTINUED)

TYPES OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	EARTH	ROCKFILL	GRAVITY	BUTTRESS	ARCH	MULTI-ARCH	OTHER	TOTAL
1931	110	5	35	2	5	0	1	158
1932	125	0	21	4	7	0	5	162
1933	142	6	22	1	2	0	10	183
1934	228	4	42	3	3	0	16	296
1935	521	9	73	3	4	0	16	626
1936	424	5	77	4	6	0	8	524
1937	469	5	69	2	3	0	13	561
1938	498	10	59	3	9	0	7	586
1939	321	3	47	1	9	1	6	388
1940	979	8	50	3	1	1	12	1054
1931-1940	3817	55	495	26	49	2	94	4538
1941	258	5	28	4	2	0	3	300
1942	196	1	28	1	3	0	4	233
1943	158	3	17	3	0	1	3	185
1944	176	3	15	0	0	0	5	199
1945	510	4	17	1	3	0	4	539
1946	356	1	11	1	2	0	1	372
1947	382	3	16	1	2	0	3	407
1948	576	6	26	0	2	0	4	614
1949	532	5	21	0	4	0	5	567
1950	2027	14	49	6	2	0	9	2107
1941-1950	5171	45	228	17	20	1	41	5523
1951	585	6	18	1	0	0	6	616
1952	845	2	23	1	4	0	11	886
1953	830	4	26	3	2	0	11	876
1954	1019	6	21	3	1	1	9	1060
1955	1808	6	32	4	2	0	16	1868
1956	1047	5	25	3	2	0	12	1094
1957	1102	5	21	1	2	0	8	1139
1958	1407	8	26	2	3	1	8	1455
1959	1313	10	11	0	1	0	10	1345
1960	3344	14	27	3	2	0	17	3407
1951-1960	13300	66	230	21	19	2	108	13746

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TABLE -8 (CONTINUED)

TYPES OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	EARTH	ROCKFILL	GRAVITY	BUTTRESS	ARCH	MULTI-ARCH	OTHER	TOTAL
1961	1334	11	19	1	5	0	19	1389
1962	1573	12	21	1	3	0	18	1628
1963	1848	9	24	4	2	0	18	1905
1964	1825	11	38	1	2	0	9	1886
1965	2821	11	30	1	0	0	16	2879
1966	1748	5	18	2	3	0	11	1787
1967	1739	4	33	2	3	0	18	1799
1968	1939	7	19	1	6	0	13	1985
1969	1616	6	24	1	1	0	15	1663
1970	2121	6	21	0	3	0	16	2167
1961-1970	18564	82	247	14	28	0	153	19088
1971	1362	11	9	0	1	0	11	1394
1972	1494	4	14	1	0	0	9	1522
1973	1291	11	16	0	2	0	21	1341
1974	1176	4	18	0	0	0	10	1208
1975	1123	12	11	0	0	0	17	1163
1976	1075	6	7	0	0	0	12	1100
1977	1068	4	11	2	1	0	19	1105
1978	777	10	17	0	0	0	21	825
1979	540	7	8	1	1	0	18	575
1980	325	11	3	0	0	0	13	352
1971-1980	10231	80	114	4	5	0	151	10585
1981	73	0	3	0	0	0	1	77
1982	1	0	0	0	0	0	0	1
1981-1990	74	0	3	0	0	0	1	78
1700-1899	2000	112	382	6	14	0	147	2661
1900-1910	1761	107	487	21	22	0	110	2508
1911-1920	1485	74	503	42	33	12	77	2226
1921-1930	1683	70	497	46	74	17	79	2466
1931-1940	3817	55	495	26	49	2	94	4538
1941-1950	5171	45	228	17	20	1	41	5523
1951-1960	13300	66	230	21	19	2	108	13746
1961-1970	18564	82	247	14	28	0	153	19088
1971-1980	10231	80	114	4	5	0	151	10585
1981-1990	74	0	3	0	0	0	1	78
TOTALS	58086	691	3383	0	264	34	961	63419

TABLE - 9

MAJOR PURPOSE OF DAMS

STATE	IRRIG-ATION	HYDRO-ELECTRIC	FLOOD CONTROL	WATER SUPPLY	RECREAT-ION	NAV-IGATION	DEBRIS CONTROL	STOCK OR FARM POND	OTHER	TOTAL
ALABAMA	10	13	82	41	1350	16	4	75	113	1704
ALASKA	0	28	1	60	7	0	2	0	6	104
ARIZONA	76	5	68	89	48	0	0	17	83	386
ARKANSAS	60	5	140	104	661	14	1	27	34	1046
CALIFORNIA	234	157	94	652	44	1	38	0	49	1269
COLORADO	1002	17	141	231	233	0	58	90	14	1786
CONNECTICUT	1	20	43	167	422	0	0	1	51	705
DELAWARE	2	0	1	6	38	0	0	0	44	91
FLORIDA	41	1	164	16	164	10	14	20	191	621
GEORGIA	149	5	344	47	2285	2	4	360	93	3289
HAWAII	108	0	3	7	0	0	0	0	3	121
IDAHO	276	23	2	1	15	0	0	8	39	364
ILLINOIS	4	7	63	118	652	10	0	19	46	919
INDIANA	4	5	128	58	567	0	1	6	17	786
IOWA	2	3	54	54	236	9	2	1658	31	2049
KANSAS	17	0	1077	86	141	0	9	3640	30	5000
KENTUCKY	22	3	186	233	401	30	33	13	86	1007
LOUISIANA	5	0	34	22	165	8	2	0	20	256
MAINE	1	82	57	49	157	1	2	1	139	489
MARYLAND	8	4	21	37	101	0	0	2	30	203
MASSACHUSETTS	106	38	109	298	549	3	1	2	45	1151
MICHIGAN	4	96	21	16	560	0	0	3	82	782
MINNESOTA	6	43	169	16	60	8	43	26	251	622
MISSISSIPPI	28	0	541	10	1922	5	9	15	177	2707
MISSOURI	289	6	200	238	1755	6	98	362	334	3288
MONTANA	783	18	72	67	53	0	2	2108	76	3179
NEBRASKA	250	45	669	18	66	0	1	264	426	1739
NEVADA	105	0	16	9	17	0	1	9	43	200
NEW HAMPSHIRE	0	50	35	83	310	0	1	1	66	546

TABLE - 9 (CONTINUED)

MAJOR PURPOSE OF DAMS

STATE	IRRIG-ATION	HYDRO-ELECTRIC	FLOOD CONTROL	WATER SUPPLY	RECREAT-ION	NAV-IGATION	DEBRIS CONTROL	STOCK OR FARM POND	OTHER	TOTAL
NEW JERSEY	27	6	23	97	600	0	1	1	26	781
NEW MEXICO	94	0	188	21	38	0	2	2	67	412
NEW YORK	6	117	75	252	630	32	0	11	147	1270
NORTH CAROLINA	127	47	60	154	830	3	1	6	46	1274
NORTH DAKOTA	18	0	53	30	150	0	0	73	56	380
OHIO	4	2	85	171	617	3	62	11	54	1009
OKLAHOMA	97	1	2139	156	307	4	5	1466	32	4207
OREGON	401	44	10	38	49	0	0	2	63	607
PENNSYLVANIA	8	11	114	321	495	17	4	3	107	1080
RHODE ISLAND	0	0	1	31	60	0	0	2	44	138
SOUTH CAROLINA	48	33	78	34	1505	0	1	146	87	1932
SOUTH DAKOTA	82	0	21	1653	199	0	0	9	28	1992
TENNESSEE	10	13	124	38	470	6	2	97	73	833
TEXAS	737	14	1705	1302	1109	0	21	512	225	5625
UTAH	285	12	19	10	29	0	5	5	29	394
VERMONT	0	65	13	24	136	0	0	0	26	264
VIRGINIA	134	32	122	116	939	1	0	8	64	1416
WASHINGTON	100	60	14	51	118	1	3	0	54	401
WEST VIRGINIA	0	4	148	56	98	14	2	1	117	440
WISCONSIN	44	118	81	9	524	8	24	91	117	1016
WYOMING	908	3	47	102	18	0	1	297	111	1487
GUAM	0	0	0	1	0	0	0	0	0	1
PUERTO RICO	16	17	0	3	0	0	0	5	0	41
TERRITORIES	0	0	0	2	0	0	0	0	0	2
VIRGIN ISLANDS	6	0	0	1	0	0	0	0	1	8
TOTALS	6745	1273	9655	7506	21900	212	460	11475	4193	63419

TABLE - 10

MAJOR PURPOSE OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	IRRIG-ATION	HYDRO-ELECTRIC	FLOOD CONTROL	WATER SUPPLY	RECREAT-ION	NAV-IGATION	DEBRIS CONTROL	STOCK OR FARM POND	OTHER	TOTAL
1700-1899	282	125	61	510	1290	23	3	68	299	2661
1900	85	27	48	160	637	2	4	12	99	1074
1901	20	8	1	29	21	0	0	9	1	89
1902	31	8	2	24	22	1	0	2	2	92
1903	28	17	1	20	21	0	1	5	5	98
1904	41	16	2	30	32	0	0	6	6	133
1905	29	19	2	42	31	1	0	6	10	140
1906	38	15	3	21	23	1	0	3	2	106
1907	43	19	1	23	21	3	0	4	9	123
1908	74	18	0	29	32	2	0	7	6	168
1909	58	14	2	33	23	1	0	4	8	143
1910	101	28	6	64	105	12	1	12	13	342
1900-1910	548	189	68	475	968	23	6	70	161	2508
1911	81	30	5	41	36	1	0	0	13	207
1912	77	22	3	46	40	4	0	2	14	208
1913	51	30	2	33	40	1	0	5	12	174
1914	74	24	1	41	54	1	1	3	12	211
1915	74	16	1	36	55	5	0	9	18	214
1916	43	22	1	34	23	1	0	2	9	135
1917	55	16	1	25	36	3	0	3	12	151
1918	51	19	2	36	34	0	0	3	7	152
1919	26	22	3	35	54	0	0	2	15	157
1920	107	23	16	96	301	0	3	26	45	617
1911-1920	639	224	35	423	673	16	4	55	157	2226
1921	30	15	3	29	37	0	0	1	10	125
1922	31	20	8	36	51	1	0	1	11	159
1923	36	37	5	36	53	0	0	4	13	184
1924	36	38	4	47	46	1	1	4	7	184
1925	43	32	2	68	127	0	1	8	19	300
1926	33	16	2	61	86	1	1	3	6	209
1927	37	36	2	29	86	2	0	0	6	198
1928	36	34	8	48	96	1	0	9	13	245
1929	39	22	4	48	68	2	0	7	11	201
1930	67	27	13	81	337	0	0	98	38	661
1921-1930	388	277	51	483	987	8	3	135	134	2466

TABLE - 10 (CONTINUED)

MAJOR PURPOSE OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	IRRIG-ATION	HYDRO-ELECTRIC	FLOOD CONTROL	WATER SUPPLY	RECREAT-ION	NAV-IGATION	DEBRIS CONTROL	STOCK OR FARM POND	OTHER	TOTAL
1931	31	17	1	33	62	3	0	6	5	158
1932	26	10	0	37	71	0	0	13	5	162
1933	30	4	3	27	93	4	0	16	6	183
1934	41	7	5	40	134	7	0	45	17	296
1935	64	11	17	87	297	4	1	103	42	626
1936	75	8	20	88	166	4	2	124	37	524
1937	44	17	25	78	183	10	0	132	72	561
1938	66	12	22	137	169	13	1	117	49	586
1939	79	8	7	54	143	5	1	74	17	388
1940	81	10	28	188	418	3	1	280	45	1054
1931-1940	537	104	128	769	1736	53	6	910	295	4538
1941	38	39	21	50	82	0	2	51	17	300
1942	24	13	14	43	71	1	1	49	17	233
1943	22	8	9	34	56	1	2	35	18	185
1944	28	1	5	30	83	1	0	46	5	199
1945	56	6	9	64	247	0	0	132	25	539
1946	68	3	8	64	135	0	1	75	18	372
1947	67	6	3	69	149	0	0	99	14	407
1948	85	9	32	115	254	0	2	97	20	614
1949	107	10	20	111	195	0	1	107	16	567
1950	200	17	37	230	967	1	8	578	69	2107
1941-1950	695	112	158	810	2239	4	17	1269	219	5523
1951	142	10	51	117	177	0	2	89	28	616
1952	154	8	52	160	330	2	4	122	54	886
1953	170	18	69	145	278	0	4	147	45	876
1954	155	9	113	181	392	0	7	150	53	1060
1955	179	15	177	204	840	1	3	372	77	1868
1956	131	12	161	187	361	6	10	177	49	1094
1957	122	14	201	174	368	0	8	197	55	1139
1958	125	15	256	184	533	3	4	262	73	1455
1959	121	4	332	170	358	2	4	281	73	1345
1960	175	4	525	279	1271	2	20	990	141	3407
1951-1960	1474	109	1937	1801	4908	16	66	2787	648	13746

TABLE - 10 (CONTINUED)

MAJOR PURPOSE OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	IRRIG-ATION	HYDRO-ELECTRIC	FLOOD CONTROL	WATER SUPPLY	RECREAT-ION	NAV-IGATION	DEBRIS CONTROL	STOCK OR FARM POND	OTHER	TOTAL
1961	100	13	432	147	342	0	17	278	60	1389
1962	138	12	437	156	490	3	22	282	88	1628
1963	138	8	599	177	525	3	33	312	110	1905
1964	135	14	498	207	553	5	13	342	119	1886
1965	142	17	622	175	1153	4	16	606	144	2879
1966	126	7	499	148	506	0	12	380	109	1787
1967	129	8	481	124	516	6	13	373	149	1799
1968	130	6	422	185	659	8	17	389	169	1985
1969	125	3	391	135	544	9	9	317	130	1663
1970	130	5	328	149	859	7	25	503	160	2167
1961-1970	1293	93	4709	1603	6148	45	177	3782	1238	19088
1971	91	3	290	118	468	4	12	290	119	1394
1972	114	3	334	95	488	3	22	351	112	1522
1973	101	12	287	86	458	2	16	224	155	1341
1974	86	4	275	76	344	2	27	290	104	1208
1975	94	2	271	55	312	3	32	307	87	1163
1976	119	2	289	52	247	1	15	276	99	1100
1977	142	1	262	57	271	2	15	258	97	1105
1978	58	7	228	32	183	2	21	174	120	825
1979	47	2	129	36	114	2	9	152	84	575
1980	33	5	116	22	56	0	9	64	47	352
1971-1980	885	40	2481	629	2941	21	178	2386	1024	10585
1981	4	0	27	3	10	3	0	13	17	77
1982	0	0	0	0	0	0	0	0	1	1
1981-1990	4	0	27	3	10	3	0	13	18	78
1700-1899	282	125	61	510	1290	23	3	68	299	2661
1900-1910	548	189	68	475	968	23	6	70	161	2508
1911-1920	639	224	35	423	673	16	4	55	157	2226
1921-1930	388	277	51	483	987	8	3	135	134	2466
1931-1940	537	104	128	769	1736	53	6	910	295	4538
1941-1950	695	112	158	810	2239	4	17	1269	219	5523
1951-1960	1474	109	1937	1801	4908	16	66	2787	648	13746
1961-1970	1293	93	4709	1603	6148	45	177	3782	1238	19088
1971-1980	885	40	2481	629	2941	21	178	2386	1024	10585
1981-1990	4	0	27	3	10	3	0	13	18	78
TOTALS	6745	1273	9655	7506	21900	212	460	11475	4193	63419

TABLE - 11

HAZARD POTENTIAL OF DAMS

STATE	HAZARD ONE	HAZARD TWO	HAZARD THREE	TOTAL NUMBER
ALABAMA	184	417	1103	1704
ALASKA	24	24	56	104
ARIZONA	75	85	226	386
ARKANSAS	125	201	720	1046
CALIFORNIA	405	484	380	1269
COLORADO	223	362	1201	1786
CONNECTICUT	241	252	212	705
DELAWARE	8	29	54	91
FLORIDA	75	120	426	621
GEORGIA	181	1064	2044	3289
HAWAII	54	16	51	121
IDAHO	107	128	129	364
ILLINOIS	129	242	548	919
INDIANA	224	211	351	786
IOWA	41	109	1899	2049
KANSAS	145	310	4545	5000
KENTUCKY	213	232	562	1007
LOUISIANA	7	45	204	256
MAINE	47	172	270	489
MARYLAND	30	61	112	203
MASSACHUSETTS	245	425	481	1151
MICHIGAN	120	197	465	782
MINNESOTA	35	141	446	622
MISSISSIPPI	84	161	2462	2707
MISSOURI	623	787	1878	3288
MONTANA	131	659	2389	3179
NEBRASKA	59	238	1442	1739
NEVADA	29	35	136	200
NEW HAMPSHIRE	84	175	287	546

TABLE - 11 (CONTINUED)

HAZARD POTENTIAL OF DAMS

STATE	HAZARD ONE	HAZARD TWO	HAZARD THREE	TOTAL NUMBER
NEW JERSEY	197	365	219	781
NEW MEXICO	125	59	228	412
NEW YORK	358	426	486	1270
NORTH CAROLINA	314	286	674	1274
NORTH DAKOTA	24	96	260	380
OHIO	260	518	231	1009
OKLAHOMA	194	360	3653	4207
OREGON	91	109	407	607
PENNSYLVANIA	613	266	201	1080
RHODE ISLAND	19	32	87	138
SOUTH CAROLINA	131	471	1330	1932
SOUTH DAKOTA	99	152	1741	1992
TENNESSEE	145	275	413	833
TEXAS	601	818	4206	5625
UTAH	136	127	131	394
VERMONT	45	56	163	264
VIRGINIA	119	299	998	1416
WASHINGTON	130	98	173	401
WEST VIRGINIA	277	108	55	440
WISCONSIN	108	261	647	1016
WYOMING	45	61	1381	1487
GUAM	0	1	0	1
PUERTO RICO	27	7	7	41
TERRITORIES	0	1	1	2
VIRGIN ISLANDS	2	3	3	8
TOTALS	8008	12637	42774	63419

TABLE - 12

HAZARD POTENTIAL OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HAZARD 1	%	HAZARD 2	%	HAZARD 3	%	TOTAL
1700-1899	584	22	832	31	1245	47	2661
1900	128	12	389	36	557	52	1074
1901	26	29	21	24	42	47	89
1902	25	27	21	23	46	50	92
1903	29	30	25	26	44	45	98
1904	40	30	33	25	60	45	133
1905	41	29	40	29	59	42	140
1906	31	29	28	26	47	44	106
1907	25	20	31	25	67	54	123
1908	44	26	37	22	87	52	168
1909	36	25	29	20	78	55	143
1910	84	25	108	32	150	44	342
1900-1910	509	20	762	30	1237	49	2508
1911	57	28	47	23	103	50	207
1912	46	22	63	30	99	48	208
1913	56	32	55	32	63	36	174
1914	58	27	44	21	109	52	211
1915	51	24	52	24	111	52	214
1916	30	22	40	30	65	48	135
1917	38	25	35	23	78	52	151
1918	40	26	39	26	73	48	152
1919	42	27	47	30	68	43	157
1920	84	14	180	29	353	57	617
1911-1920	502	23	602	27	1122	50	2226
1921	36	29	32	26	57	46	125
1922	50	31	43	27	66	42	159
1923	44	24	65	35	75	41	184
1924	52	28	65	35	67	36	184
1925	80	27	97	32	123	41	300
1926	70	33	54	26	85	41	209
1927	69	35	59	30	70	35	198
1928	78	32	66	27	101	41	245
1929	52	26	58	29	91	45	201
1930	98	15	174	26	389	59	661
1921-1930	629	26	713	29	1124	46	2466

TABLE -12 (CONTINUED)

HAZARD POTENTIAL OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HAZARD 1	%	HAZARD 2	%	HAZARD 3	%	TOTAL
1931	43	27	43	27	72	46	158
1932	41	25	49	30	72	44	162
1933	39	21	49	27	95	52	183
1934	44	15	73	25	179	60	296
1935	100	16	125	20	401	64	626
1936	72	14	104	20	348	66	524
1937	91	16	107	19	363	65	561
1938	97	17	103	18	386	66	586
1939	70	18	95	24	223	57	388
1940	83	8	208	20	763	72	1054
1931-1940	680	15	956	21	2902	64	4538
1941	56	19	50	17	194	65	300
1942	47	20	43	18	143	61	233
1943	29	16	36	19	120	65	185
1944	31	16	45	23	123	62	199
1945	37	7	117	22	385	71	539
1946	37	10	64	17	271	73	372
1947	51	13	72	18	284	70	407
1948	81	13	114	19	419	68	614
1949	85	15	97	17	385	68	567
1950	145	7	423	20	1539	73	2107
1941-1950	599	11	1061	19	3863	70	5523
1951	77	13	112	18	427	69	616
1952	98	11	171	19	617	70	886
1953	112	13	172	20	592	68	876
1954	124	12	214	20	722	68	1060
1955	161	9	331	18	1376	74	1868
1956	141	13	219	20	734	67	1094
1957	125	11	222	19	792	70	1139
1958	137	9	268	18	1050	72	1455
1959	124	9	211	16	1010	75	1345
1960	208	6	613	18	2586	76	3407
1951-1960	1307	10	2533	18	9906	72	13746

TABLE -12 (CONTINUED)

HAZARD POTENTIAL OF DAMS BY YEAR CONSTRUCTED

YEAR CONSTRUCTED	HAZARD 1	%	HAZARD 2	%	HAZARD 3	%	TOTAL
1961	169	12	225	16	995	72	1389
1962	196	12	292	18	1140	70	1628
1963	208	11	329	17	1368	72	1905
1964	201	11	355	19	1330	71	1886
1965	252	9	436	15	2191	76	2879
1966	169	9	300	17	1318	74	1787
1967	180	10	307	17	1312	73	1799
1968	182	9	346	17	1457	73	1985
1969	167	10	286	17	1210	73	1663
1970	180	8	382	18	1605	74	2167
1961-1970	1904	10	3258	17	13926	73	19088
1971	180	13	248	18	966	69	1394
1972	160	11	263	17	1099	72	1522
1973	170	13	265	20	906	68	1341
1974	124	10	218	18	866	72	1208
1975	136	12	244	21	783	67	1163
1976	122	11	179	16	799	73	1100
1977	119	11	188	17	798	72	1105
1978	111	13	136	16	578	70	825
1979	81	14	108	19	386	67	575
1980	79	22	53	15	220	63	352
1971-1980	1282	12	1902	18	7401	70	10585
1981	12	16	18	23	47	61	77
1982	0	0	0	0	1	100	1
1981-1990	12	15	18	23	48	62	78
1700-1899	584	22	832	31	1245	47	2661
1900-1910	509	20	762	30	1237	49	2508
1911-1920	502	23	602	27	1122	50	2226
1921-1930	629	26	[illegible]	[illegible]	[illegible]	46	2466
1931-1940	680	15	[illegible]	[illegible]	[illegible]	64	4538
1941-1950	599	11	[illegible]	[illegible]	3863	70	5523
1951-1960	1307	10	[illegible]	18	9906	72	13746
1961-1970	1904	10	3258	17	13926	73	19088
1971-1980	1282	12	1902	18	7401	70	10585
1981-1990	12	15	18	23	48	62	78
TOTALS	8008	13	12637	20	42774	67	63419

TABLE - 13

PERFORMANCE OF DAM INSPECTIONS

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
ALABAMA	19	12	146	88					165
ALASKA	14	88	2	13					16
ARIZONA	20	23	7	8	45	51	16	18	88
ARKANSAS	1	1					124	99	125
CALIFORNIA					120	100			120
COLORADO	58	26	18	8			143	65	219
CONNECTICUT	1		345	100					346
DELAWARE	1	7	13	93					14
FLORIDA	7	17	35	83					42
GEORGIA	15	6	237	94					252
HAWAII	3	6	50	94					53
IDAHO					61	100			61
ILLINOIS	16	8	159	82	19	10			194
INDIANA	5	2	282	98					287
IOWA	27	60			18	40			45
KANSAS	79	44			99	56			178
KENTUCKY	16	5	304	95					320
LOUISIANA	8	100							8
MAINE	1	2	63	98					64
MARYLAND	2	5	30	77	7	18			39
MASSACHUSETTS	3	1	366	99					369
MICHIGAN	4	3	16	11	12	8	118	79	150
MINNESOTA	4	7	4	7	6	10	44	76	58
MISSISSIPPI	16	20					64	80	80
MISSOURI	45	7	562	93					607
MONTANA	8	7	54	47			54	47	116
NEBRASKA	37	76	11	22	1	2			49
NEVADA	17	1	11	39					28
NEW HAMPSHIRE	2	1	227	99					229

TABLE-13 (CONTINUED)

PERFORMANCE OF DAM INSPECTIONS

STATE	CORPS	%	CORPS AE	%	STATE	%	STATE AE	%	TOTAL
NEW JERSEY	1		68	18			314	82	383
NEW MEXICO	9	8	17	15	1	1	85	76	112
NEW YORK	5	2	127	40	94	29	93	29	319
NORTH CAROLINA					69	32	150	68	219
NORTH DAKOTA	20	35			37	65			57
OHIO	1		109	50	110	50			220
OKLAHOMA	32	17	39	21	16	9	99	53	186
OREGON	7	18			31	82			38
PENNSYLVANIA	20	3	712	97					732
RHODE ISLAND	1	3	31	97					32
SOUTH CAROLINA	10	8	120	92			1	1	131
SOUTH DAKOTA	31	26	67	56	22	18			120
TENNESSEE	22	16			57	40	62	44	141
TEXAS	30	4	98	14	553	82			681
UTAH					65	50	66	50	131
VERMONT	1	1	83	99					84
VIRGINIA	54	24	159	70	14	6			227
WASHINGTON	19	20	74	80					93
WEST VIRGINIA	10	5	74	35	98	46	30	14	212
WISCONSIN	4	3	4	3			119	94	127
WYOMING	31	69	14	31					45
PUERTO RICO					26	100			26
VIRGIN ISLANDS	1	100							1
TOTAL	738	9	4738	55	1581	18	1582	18	8639

TABLE - 14

UNSAFE DAMS

STATE	NUMBER INSPECTED	EMERGENCY	NON-EMERGENCY	TOTAL UNSAFE	PERCENT UNSAFE
ALABAMA	165	3	88	91	55.2
ALASKA	16	0	2	2	12.5
ARIZONA	88	1	31	32	36.4
ARKANSAS	125	2	47	49	39.2
CALIFORNIA	120	0	4	4	3.3
COLORADO	219	0	37	37	16.9
CONNECTICUT	346	0	60	60	17.3
DELAWARE	14	0	4	4	28.6
FLORIDA	42	0	10	10	23.8
GEORGIA	252	7	178	185	73.4
HAWAII	53	8	18	26	49.1
IDAHO	61	0	30	30	49.2
ILLINOIS	194	1	19	20	10.3
INDIANA	287	3	99	102	35.5
IOWA	45	1	9	10	22.2
KANSAS	178	0	30	30	16.9
KENTUCKY	320	5	100	105	32.8
LOUISIANA	8	0	0	0	0.0
MAINE	64	0	5	5	7.8
MARYLAND	39	0	4	4	10.3
MASSACHUSETTS	369	0	56	56	15.2
MICHIGAN	150	0	36	36	24.0
MINNESOTA	58	2	6	8	13.8
MISSISSIPPI	80	4	32	36	45.0
MISSOURI	607	46	405	451	74.3
MONTANA	116	2	34	36	31.0
NEBRASKA	49	0	7	7	14.3
NEVADA	28	0	14	14	50.0
NEW HAMPSHIRE	229	0	12	12	5.2

TABLE - 14 (CONTINUED)

UNSAFE DAMS

STATE	NUMBER INSPECTED	EMERGENCY	NON-EMERGENCY	TOTAL UNSAFE	PERCENT UNSAFE
NEW JERSEY	383	0	52	52	13.6
NEW MEXICO	112	0	28	28	25.0
NEW YORK	319	8	113	121	37.9
NORTH CAROLINA	219	3	99	102	46.6
NORTH DAKOTA	57	0	5	5	8.8
OHIO	220	3	79	82	37.3
OKLAHOMA	186	3	68	71	38.2
OREGON	38	0	6	6	15.8
PENNSYLVANIA	732	3	200	203	27.7
RHODE ISLAND	32	1	8	9	28.1
SOUTH CAROLINA	131	10	84	94	71.8
SOUTH DAKOTA	120	0	57	57	47.5
TENNESSEE	141	2	78	80	56.7
TEXAS	681	2	224	226	33.2
UTAH	131	2	78	80	61.1
VERMONT	84	3	11	14	16.7
VIRGINIA	227	2	44	46	20.3
WASHINGTON	93	0	27	27	29.0
WEST VIRGINIA	212	5	71	76	35.8
WISCONSIN	127	0	26	26	20.5
WYOMING	45	0	15	15	33.3
PUERTO RICO	26	0	2	2	7.7
VIRGIN ISLANDS	1	0	0	0	0.0
TOTALS	8639	132	2752	2884	33.4

TABLE - 15

PRIMARY DEFICIENCIES OF UNSAFE DAMS

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
ALABAMA	0	5	6	79	1	0	91
ALASKA	1	1	0	0	0	0	2
ARIZONA	1	1	6	18	6	0	32
ARKANSAS	0	0	5	46	0	0	49
CALIFORNIA	0	3	0	1	0	0	4
COLORADO	0	2	0	35	0	0	37
CONNECTICUT	0	0	1	58	1	0	60
DELAWARE	0	1	0	3	0	0	4
FLORIDA	0	0	0	10	0	0	10
GEORGIA	0	16	8	157	1	3	185
HAWAII	4	3	3	16	0	0	26
IDAHO	0	3	2	24	1	0	30
ILLINOIS	0	0	7	8	4	1	20
INDIANA	0	0	2	100	0	0	102
IOWA	0	5	0	5	0	0	10
KANSAS	0	2	0	28	0	0	30
KENTUCKY	0	7	8	89	1	0	105
LOUISIANA	0	0	0	0	0	0	0
MAINE	0	0	0	5	0	0	5
MARYLAND	0	0	0	4	0	0	4
MASSACHUSETTS	0	0	1	55	0	0	56
MICHIGAN	0	0	4	24	8	0	36
MINNESOTA	0	1	1	6	0	0	8
MISSISSIPPI	0	2	1	33	0	0	36
MISSOURI	1	11	30	395	1	13	451
MONTANA	0	0	0	35	1	0	36
NEBRASKA	0	0	1	6	0	0	7
NEVADA	0	0	0	12	2	0	14
NEW HAMPSHIRE	0	0	0	12	0	0	12

TABLE - 15 (CONTINUED)

PRIMARY DEFICIENCIES OF UNSAFE DAMS

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
NEW JERSEY	0	1	13	37	1	0	52
NEW MEXICO	0	0	0	28	0	0	28
NEW YORK	5	10	23	77	6	0	121
NORTH CAROLINA	0	8	16	75	3	0	102
NORTH DAKOTA	0	0	0	5	0	0	5
OHIO	0	1	4	74	2	1	82
OKLAHOMA	36	6	8	19	2	0	71
OREGON	0	2	0	3	0	1	6
PENNSYLVANIA	0	8	21	146	27	1	203
RHODE ISLAND	0	0	2	7	0	0	9
SOUTH CAROLINA	2	15	14	56	5	2	94
SOUTH DAKOTA	0	1	0	56	0	0	57
TENNESSEE	0	2	7	69	0	2	80
TEXAS	0	0	0	226	0	0	226
UTAH	0	2	5	72	1	0	80
VERMONT	0	0	3	11	0	0	14
VIRGINIA	0	4	3	38	1	0	46
WASHINGTON	0	1	0	24	1	1	27
WEST VIRGINIA	4	29	17	25	1	0	76
WISCONSIN	0	1	0	25	0	0	26
WYOMING	0	1	1	13	0	0	15
PUERTO RICO	0	0	1	1	0	0	2
TOTALS	54	155	222	2351	77	25	2884

TABLE - 16

UNSAFE DAMS WITH SINGLE DEFICIENCY

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
ALABAMA	0	2	0	48	1	0	51
ALASKA	0	0	0	0	0	0	0
ARIZONA	0	0	0	13	4	0	17
ARKANSAS	0	0	0	43	0	0	43
CALIFORNIA	0	2	0	1	0	0	3
COLORADO	0	0	0	27	0	0	27
CONNECTICUT	0	0	1	35	0	0	36
DELAWARE	0	0	0	2	0	0	2
FLORIDA	0	0	0	10	0	0	10
GEORGIA	0	1	1	77	0	3	82
HAWAII	0	3	0	2	0	0	5
IDAHO	0	2	2	22	0	0	26
ILLINOIS	0	0	0	0	0	0	0
INDIANA	0	0	0	96	0	0	96
IOWA	0	0	0	4	0	0	4
KANSAS	0	0	0	17	0	0	17
KENTUCKY	0	1	2	66	0	0	69
LOUISIANA	0	0	0	0	0	0	0
MAINE	0	0	0	5	0	0	5
MARYLAND	0	0	0	4	0	0	4
MASSACHUSETTS	0	0	0	44	0	0	44
MICHIGAN	0	0	3	11	1	0	15
MINNESOTA	0	0	0	1	0	0	1
MISSISSIPPI	0	1	0	28	0	0	29
MISSOURI	0	0	0	28	1	0	29
MONTANA	0	0	0	21	1	0	22
NEBRASKA	0	0	1	6	0	0	7
NEVADA	0	0	0	8	2	0	10
NEW HAMPSHIRE	0	0	0	11	0	0	11

TABLE - 16 (CONTINUED)

UNSAFE DAMS WITH SINGLE DEFICIENCY

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
NEW JERSEY	0	0	1	21	1	0	23
NEW MEXICO	0	0	0	8	0	0	8
NEW YORK	0	0	2	20	1	0	23
NORTH CAROLINA	0	3	1	32	2	0	38
NORTH DAKOTA	0	0	0	5	0	0	5
OHIO	0	0	0	19	1	0	20
OKLAHOMA	0	0	0	0	0	0	0
OREGON	0	2	0	3	0	1	6
PENNSYLVANIA	0	1	3	88	14	1	107
RHODE ISLAND	0	0	1	5	0	0	6
SOUTH CAROLINA	0	5	5	22	2	2	36
SOUTH DAKOTA	0	1	0	54	0	0	55
TENNESSEE	0	1	2	39	0	2	44
TEXAS	0	0	0	221	0	0	221
UTAH	0	1	1	52	0	0	54
VERMONT	0	0	0	8	0	0	8
VIRGINIA	0	0	2	13	0	0	15
WASHINGTON	0	0	0	10	0	1	11
WEST VIRGINIA	1	3	0	8	0	0	12
WISCONSIN	0	0	0	10	0	0	10
WYOMING	0	1	0	13	0	0	14
PUERTO RICO	0	0	0	1	0	0	1
TOTALS	1	30	28	1282	31	10	1382

TABLE - 17

UNSAFE DAMS WITH MULTIPLE DEFICIENCIES

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
ALABAMA	0	27	21	38	0	0	40
ALASKA	1	2	1	2	1	0	2
ARIZONA	1	1	9	12	11	0	15
ARKANSAS	0	1	3	6	1	1	6
CALIFORNIA	0	1	0	1	0	0	1
COLORADO	0	8	4	9	1	0	10
CONNECTICUT	2	7	17	23	2	2	24
DELAWARE	0	2	0	2	0	0	2
FLORIDA	0	0	0	0	0	0	0
GEORGIA	0	45	60	97	5	86	103
HAWAII	8	3	8	21	0	13	21
IDAHO	0	1	2	3	2	0	4
ILLINOIS	12	10	13	19	9	20	20
INDIANA	1	3	4	6	0	0	6
IOWA	0	5	0	5	2	1	6
KANSAS	1	11	5	12	3	0	13
KENTUCKY	0	22	21	34	1	0	36
LOUISIANA	0	0	0	0	0	0	0
MAINE	0	0	0	0	0	0	0
MARYLAND	0	0	0	0	0	0	0
MASSACHUSETTS	0	2	10	12	0	2	12
MICHIGAN	4	4	12	18	15	0	21
MINNESOTA	4	3	1	6	5	3	7
MISSISSIPPI	0	4	1	7	2	2	7
MISSOURI	12	78	220	410	28	368	422
MONTANA	1	2	6	14	2	7	14
NEBRASKA	0	0	0	0	0	0	0
NEVADA	0	3	1	4	0	0	4
NEW HAMPSHIRE	0	0	1	1	0	0	1

TABLE - 17 (CONTINUED)

UNSAFE DAMS WITH MULTIPLE DEFICIENCIES

STATE	INOPERABLE COMPONENTS	STABILITY OF STRUCTURE	SEEPAGE	INADEQUATE SPILLWAY	STRUCTURAL	OTHER	NUMBER OF DAMS
NEW JERSEY	0	1	15	28	0	14	29
NEW MEXICO	3	2	6	20	0	20	20
NEW YORK	31	41	55	92	40	40	98
NORTH CAROLINA	2	17	36	55	6	30	64
NORTH DAKOTA	0	0	0	0	0	0	0
OHIO	0	15	41	59	11	23	62
OKLAHOMA	60	41	50	66	31	61	71
OREGON	0	0	0	0	0	0	0
PENNSYLVANIA	12	42	68	89	25	3	96
RHODE ISLAND	0	2	2	2	0	0	3
SOUTH CAROLINA	7	32	29	50	18	6	58
SOUTH DAKOTA	0	1	1	2	0	0	2
TENNESSEE	0	13	23	34	4	10	36
TEXAS	1	2	3	5	1	2	5
UTAH	0	15	13	22	9	3	26
VERMONT	0	4	4	4	0	0	6
VIRGINIA	1	8	18	28	3	26	31
WASHINGTON	3	4	5	15	1	11	16
WEST VIRGINIA	9	56	47	56	16	4	64
WISCONSIN	8	5	6	16	6	7	16
WYOMING	0	1	1	0	0	0	1
PUERTO RICO	0	0	1	0	0	1	1
TOTALS	180	547	842	1405	257	766	1502

TABLE - 1A

OWNERS OF UNSAFE DAMS

STATE	TOTAL UNSAFE DAMS	FEDERAL	STATE, CITY, OR COUNTY	WATER RESOURCES DEVELOPMENT DISTRICT*	PRIVATE CAMPS AND CLUBS	CHURCHES, HUSPITALS, SCHOOLS	CIVIC SER-VICE ORGAN-IZATIONS**	WATER & IRRIGATION COMPANIES	PRIVATE CORPS.	PROPERTY OWNERS ASSOC.	ONE OR MORE INDIVI-DUALS	OWNER NOT IDEN-TIFIED
ALABAMA	91	0	8	2	4	0	2	2	12	3	56	2
ALASKA	2	0	0	0	0	0	0	0	0	0	1	1
ARIZONA	32	0	15	9	0	0	0	1	2	1	4	0
ARKANSAS	49	1	10	2	1	4	0	0	5	13	13	0
CALIFORNIA	4	0	1	3	0	0	0	0	0	0	0	0
COLORADO	37	0	16	3	0	0	0	13	3	0	2	0
CONNECTICUT	60	0	18	0	2	1	0	7	18	5	9	0
DELAWARE	4	0	3	0	0	0	0	0	0	0	1	0
FLORIDA	10	0	4	0	0	1	0	0	2	3	0	0
GEORGIA	185	0	29	5	7	4	0	2	29	8	98	3
HAWAII	26	1	0	0	0	0	0	2	20	1	2	0
IDAHO	30	0	2	4	0	0	0	14	6	0	4	0
ILLINOIS	20	0	5	2	0	0	0	1	2	5	5	0
INDIANA	102	0	20	5	2	2	0	3	11	12	47	0
IOWA	10	0	7	0	0	0	0	0	0	0	3	0
KANSAS	30	0	10	5	0	0	0	0	5	1	9	0
KENTUCKY	105	0	30	12	3	2	0	0	25	1	32	0
LOUISIANA	0	0	0	0	0	0	0	0	0	0	0	0
MAINE	5	0	2	0	0	0	0	0	3	0	0	0
MARYLAND	4	0	3	0	0	0	0	0	0	1	0	0
MASS.	56	0	22	3	1	0	0	0	25	2	3	0
MICHIGAN	36	0	19	0	0	0	1	0	6	1	9	0
MINNESOTA	8	0	8	0	0	0	0	0	0	0	0	0
MISS.	36	0	5	0	4	0	1	0	5	9	11	1
MISSOURI	451	0	48	11	6	9	7	0	133	39	198	0
MONTANA	36	0	20	4	0	0	0	8	5	0	3	0
NEBRASKA	7	0	3	1	0	0	1	0	1	0	1	0
NEVADA	14	0	5	0	0	0	0	0	6	0	3	0
NEW HAMP.	12	0	6	0	0	0	0	0	3	2	1	0

TABLE - 18 (CONTINUED)

OWNERS OF UNSAFE DAMS

STATE	TOTAL UNSAFE DAMS	FEDERAL	STATE, CITY, OR COUNTY	WATER RESOURCES DEVELOPMENT DISTRICT*	PRIVATE CAMPS AND CLUBS	CHURCHES, HOSPITALS, SCHOOLS	CIVIC SERVICE ORGANIZATIONS**	WATER & IRRIGATION COMPANIES	PRIVATE CORPS.	PROPERTY OWNERS ASSOC.	ONE OR MORE INDIVIDUALS	OWNER NOT IDENTIFIED
NEW JERSEY	52	1	18	1	2	3	2	3	7	6	3	6
NEW MEXICO	28	0	9	9	0	0	1	1	7	0	1	0
NEW YORK	121	0	69	4	2	1	0	1	25	7	9	3
N. CAROLINA	102	0	26	0	12	3	0	0	24	6	31	0
N. DAKOTA	5	0	1	4	0	0	0	0	0	0	0	0
OHIO	82	0	33	1	1	1	0	5	16	6	18	1
OKLAHOMA	71	0	30	16	4	1	0	0	9	5	6	0
OREGON	6	0	3	0	0	0	0	2	1	0	0	0
PENN.	203	0	59	0	10	2	4	49	26	12	41	0
RHODE IS.	9	0	3	0	0	0	1	3	1	0	1	0
S. CAROLINA	94	7	16	3	0	1	1	3	23	3	37	0
S. DAKOTA	57	1	32	0	0	1	1	0	2	0	20	0
TENNESSEE	80	0	16	1	0	3	0	2	6	6	46	0
TEXAS	226	0	43	119	10	0	0	5	15	3	31	0
UTAH	80	0	2	4	0	1	0	61	10	0	2	0
VERMONT	14	0	10	1	1	0	0	0	2	0	0	0
VIRGINIA	46	0	17	2	1	1	0	2	6	3	14	0
WASHINGTON	27	0	3	6	2	0	1	4	3	5	2	1
W. VIRGINIA	76	0	24	1	4	2	0	2	32	1	10	0
WISCONSIN	26	0	23	0	0	0	0	0	3	0	0	0
WYOMING	15	0	4	0	0	0	0	5	2	0	4	0
PUERTO RICO	2	0	1	0	0	0	0	0	1	0	0	0
TOTALS	2884	11	761	243	79	43	23	197	548	170	791	18

* INCLUDES IRRIGATION, DRAINAGE, CONSERVATION AND WATER SUPPLY DISTRICTS.
** INCLUDES BOY SCOUTS, GIRL SCOUTS, YMCA, AND SIMILAR SERVICE ORGANIZATIONS.

TABLE -19

SAMPLING INSPECTION OF SIGNIFICANT HAZARD POTENTIAL CATEGORY NON-FEDERAL DAMS LOCATED ON FEDERAL LANDS

PART ONE

STATE	CATEGORIES: AGE OF DAMS 0-5	6-50	50+	HYDRULIC HEIGHT 6-40	41-100	100+	MAXIMUM CAPACITY 50-1000	1001-50000	50000+	RATINGS: 3	4	5	6	7	8	9	AVG
ALABAMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALASKA	0	9	1	7	2	1	7	2	1	0	6	1	2	0	1	0	5
ARIZONA	1	16	5	9	13	0	10	12	0	0	4	8	9	1	0	0	5
ARKANSAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CALIFORNIA	1	47	67	49	40	26	41	58	16	0	11	25	34	29	12	4	6
COLORADO	1	54	23	54	24	0	49	29	0	0	25	32	20	1	0	0	5
CONNECTICUT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELAWARE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLORIDA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEORGIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAWAII	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IDAHO	0	12	6	14	4	0	5	13	0	0	4	7	5	2	0	0	5
ILLINOIS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
INDIANA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IOWA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KANSAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KENTUCKY	0	4	0	4	0	0	4	0	0	0	4	0	0	0	0	0	[illegible]
LOUISIANA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINE	0	2	1	3	0	0	1	2	0	0	1	1	1	0	0	0	5
MARYLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MASSACHUSETTS	0	0	4	4	0	0	2	2	0	0	0	2	2	0	0	0	6
MICHIGAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINNESOTA	0	0	2	2	0	0	0	1	1	0	0	0	1	1	0	0	7
MISSISSIPPI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MISSOURI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MONTANA	1	24	13	38	0	0	34	4	0	1	22	13	2	0	0	0	4
NEBRASKA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEVADA	3	10	3	13	1	2	13	3	0	1	9	3	3	0	0	0	5
NEW HAMPSHIRE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE -19 (CONTINUED)

SAMPLING INSPECTION OF SIGNIFICANT HAZARD POTENTIAL CATEGORY NON- FEDERAL DAMS LOCATED ON FEDERAL LANDS

PART ONE

	CATEGORIES									RATINGS							
	AGE OF DAMS			HYDROLIC HEIGHT			MAXIMUM CAPACITY										
STATE	0-5	6-50	50+	6-40	41-100	100+	50-1000	1001-50000	50000+	3	4	5	6	7	8	9	AVG
NEW JERSEY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NEW MEXICO	0	24	0	17	7	0	20	4	0	0	16	5	3	0	0	0	4
NEW YORK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NORTH CAROLINA	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	4
NORTH DAKOTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OHIO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OKLAHOMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OREGON	0	1	0	0	0	1	0	1	0	0	0	0	0	1	0	0	7
PENNSYLVANIA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RHODE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH CAROLINA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH DAKOTA	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	4
TENNESSEE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TEXAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UTAH	4	37	32	64	9	0	49	24	0	1	29	27	13	3	0	0	5
VERMONT	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	4
VIRGINIA	1	17	3	9	11	1	10	11	0	0	5	7	8	1	0	0	5
WASHINGTON	0	2	0	1	1	0	1	1	0	0	1	0	1	0	0	0	5
WEST VIRGINIA	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	5
WISCONSIN	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	4
WYOMING	0	8	3	9	2	0	3	7	1	0	2	6	1	2	0	0	5
PUERTO RICO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TERRITORIES	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIRGIN ISLANDS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	12	272	163	302	114	31	253	175	19	3	143	138	105	41	13	4	5

TABLE -20

SAMPLING INSPECTION OF SIGNIFICANT HAZARD POTENTIAL CATEGORY NON-FEDERAL DAMS LOCATED ON FEDERAL LANDS

PART TWO

STATE	NUMBER DAMS	NUMBER INSPECTED	UNSAFE DAMS	
			EMERGENCY	NON-EMERGENCY
ALABAMA	0	0	0	0
ALASKA	10	7	0	0
ARIZONA	22	7	1	1
ARKANSAS	0	0	0	0
CALIFORNIA	115	0	0	0
COLORADO	78	14	0	2
CONNECTICUT	0	0	0	0
DELAWARE	0	0	0	0
FLORIDA	0	0	0	0
GEORGIA	0	0	0	0
HAWAII	0	0	0	0
IDAHO	18	4	0	0
ILLINOIS	0	0	0	0
INDIANA	0	0	0	0
IOWA	0	0	0	0
KANSAS	0	0	0	0
KENTUCKY	4	3	0	0
LOUISIANA	0	0	0	0
MAINE	3	0	0	0
MARYLAND	0	0	0	0
MASSACHUSETTS	4	0	0	0
MICHIGAN	0	0	0	0
MINNESOTA	2	0	0	0
MISSISSIPPI	0	0	0	0
MISSOURI	0	0	0	0
MONTANA	38	9	0	0
NEBRASKA	0	0	0	0
NEVADA	16	3	0	0
NEW HAMPSHIRE	0	0	0	0

TABLE -20 (CONTINUED)

SAMPLING INSPECTION OF SIGNIFICANT HAZARD POTENTIAL CATEGORY NON-FEDERAL DAMS LOCATED ON FEDERAL LANDS

PART TWO

STATE	NUMBER DAMS	NUMBER INSPECTED	UNSAFE DAMS	
			EMERGENCY	NON-EMERGENCY
NEW JERSEY	0	0	0	0
NEW MEXICO	24	4	0	0
NEW YORK	0	0	0	0
NORTH CAROLINA	1	1	0	1
NORTH DAKOTA	0	0	0	0
OHIO	0	0	0	0
OKLAHOMA	0	0	0	0
OREGON	1	0	0	0
PENNSYLVANIA	0	0	0	0
RHODE ISLAND	0	0	0	0
SOUTH CAROLINA	0	0	0	0
SOUTH DAKOTA	1	0	0	0
TENNESSEE	0	0	0	0
TEXAS	0	0	0	0
UTAH	73	16	1	2
VERMONT	1	1	0	0
VIRGINIA	21	18	0	0
WASHINGTON	2	0	0	0
WEST VIRGINIA	1	0	0	0
WISCONSIN	1	1	0	0
WYOMING	11	10	0	1
PUERTO RICO	0	0	0	0
TERRITORIES	0	0	0	0
VIRGIN ISLANDS	0	0	0	0
TOTAL	447	98	2	7

TABLE - 21

FEDERAL OWNERSHIP OF DAMS

STATE	TOTAL DAMS	AEC	DOD					DOE	DOI					DOJ	FAA	IBWC	NASA	TVA	USDA	
			COE	USA	USAF	USN	USMC	FERC	BIA	BLM	BR	FWS	NPS	BOP					FS	SCS
ALABAMA	34	0	13	6	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	1
ALASKA	22	0	1	4	1	8	0	2	2	0	0	0	0	0	0	0	2	0	2	0
ARIZONA	70	0	3	0	0	0	0	0	4	35	12	0	0	0	0	0	0	0	16	0
ARKANSAS	55	0	30	6	1	0	0	0	0	0	0	3	2	0	0	0	0	0	13	0
CALIFORNIA	172	0	30	8	7	0	4	0	2	1	62	1	22	0	0	0	0	0	35	0
COLORADO	101	0	6	11	6	0	0	1	0	17	58	1	0	1	0	0	0	0	20	0
CONNECTICUT	8	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DELAWARE	20	0	17	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
FLORIDA	49	0	43	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GEORGIA	27	0	9	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
HAWAII	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IDAHO	31	0	3	0	0	0	0	0	6	2	19	0	0	0	0	0	0	0	1	0
ILLINOIS	30	0	15	2	0	0	0	1	0	0	0	7	0	0	0	0	0	0	5	0
INDIANA	16	0	10	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0
IOWA	17	0	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KANSAS	34	0	17	7	0	0	0	0	0	0	9	1	0	0	0	0	0	0	0	0
KENTUCKY	58	0	45	9	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
LOUISIANA	20	0	11	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
MAINE	22	0	0	0	3	0	0	0	0	0	0	16	1	0	0	0	0	0	2	0
MARYLAND	19	0	9	5	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	1
MASSACHUSETTS	13	0	11	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
MICHIGAN	68	0	1	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	30	1
MINNESOTA	89	0	23	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	36	0
MISSISSIPPI	25	0	10	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	12	0
MISSOURI	69	0	31	8	0	0	0	0	0	0	0	7	0	0	0	0	0	0	23	0
MONTANA	509	0	2	0	0	0	0	0	28	411	24	24	0	0	0	0	0	0	20	0
NEBRASKA	32	0	13	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	7	0
NEVADA	36	0	2	0	0	3	0	0	6	8	5	9	3	0	0	0	0	0	0	0
NEW HAMPSHIRE	15	0	9	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	2	0

TABLE - 21 (CONTINUED)

FEDERAL OWNERSHIP OF DAMS

STATE	TOTAL DAMS	AEC	DOD					DOE	DOI					DOJ	FAA	IBWC	NASA	TVA	USDA	
			COE	USA	USAF	USN	USMC	FERC	BIA	BLM	BR	FWS	NPS	BOP					FS	SCS
NEW JERSEY	23	0	6	7	0	2	0	0	0	0	0	0	8	0	0	0	0	0	0	0
NEW MEXICO	168	0	7	0	0	0	0	1	34	97	20	7	0	0	0	0	0	0	2	0
NEW YORK	21	0	11	1	0	0	0	0	5	0	0	0	4	0	0	0	0	0	0	0
NORTH CAROLINA	41	0	7	15	0	0	0	0	0	0	0	4	7	0	0	0	0	4	4	0
NORTH DAKOTA	60	0	5	0	0	0	0	0	0	0	4	48	0	0	0	0	0	0	3	0
OHIO	39	2	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
OKLAHOMA	88	0	26	17	0	0	0	0	1	0	8	24	9	0	0	0	0	0	3	0
OREGON	101	0	19	0	0	0	0	0	0	36	32	2	0	0	0	0	0	0	12	0
PENNSYLVANIA	59	0	52	3	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0
RHODE ISLAND	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH CAROLINA	31	0	1	9	1	0	0	0	0	0	0	14	3	0	0	0	0	0	3	0
SOUTH DAKOTA	105	0	6	0	0	0	0	0	0	1	9	4	51	0	0	0	0	0	34	0
TENNESSEE	65	0	6	3	3	0	0	1	0	0	0	11	0	0	0	0	0	36	5	0
TEXAS	61	0	25	12	1	0	0	0	0	0	5	2	3	0	0	4	0	0	8	1
UTAH	60	0	0	0	0	0	0	0	3	14	22	1	2	0	0	0	0	0	18	0
VERMONT	6	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VIRGINIA	70	0	7	19	0	4	3	0	0	1	0	0	24	0	2	0	0	2	3	0
WASHINGTON	73	0	15	3	0	3	0	0	2	0	21	9	1	8	0	0	0	0	11	0
WEST VIRGINIA	28	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
WISCONSIN	47	0	14	1	0	0	0	0	1	0	0	19	0	0	0	0	0	0	12	0
WYOMING	142	0	0	0	0	0	0	0	2	84	33	0	0	0	0	0	0	0	23	0
GUAM	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	2951	2	655	175	32	36	7	6	96	707	335	288	141	10	2	4	2	53	396	4

TABLE - 22

REMEDIAL MEASURES FOR UNSAFE DAMS

STATE	MEASURES				
	COMPLETED	INITIATED	BREACHED	NONE	TOTAL
ALABAMA	16	21	1	53	91
ALASKA	1	0	0	1	2
ARIZONA	0	9	1	22	32
ARKANSAS	0	2	0	47	49
CALIFORNIA	0	2	0	2	4
COLORADO	12	17	0	8	37
CONNECTICUT	3	3	0	54	60
DELAWARE	2	1	0	1	4
FLORIDA	2	3	0	5	10
GEORGIA	0	8	1	176	185
HAWAII	0	6	0	20	26
IDAHO	1	4	0	25	30
ILLINOIS	0	11	0	9	20
INDIANA	0	9	0	93	102
IOWA	0	7	0	3	10
KANSAS	2	4	0	24	30
KENTUCKY	0	23	7	75	105
LOUISIANA	0	0	0	0	0
MAINE	0	0	0	5	5
MARYLAND	0	0	0	4	4
MASSACHUSETTS	0	0	0	56	56
MICHIGAN	15	9	1	11	36
MINNESOTA	0	3	0	5	8
MISSISSIPPI	22	6	1	7	36
MISSOURI	3	205	4	239	451
MONTANA	1	14	0	21	36
NEBRASKA	0	7	0	0	7
NEVADA	0	9	0	5	14
NEW HAMPSHIRE	0	0	0	12	12

TABLE - 22 (CONTINUED)

REMEDIAL MEASURES FOR UNSAFE DAMS

STATE	MEASURES				
	COMPLETED	INITIATED	BREACHED	NONE	TOTAL
NEW JERSEY	0	45	1	6	52
NEW MEXICO	0	27	0	1	28
NEW YORK	5	9	0	107	121
NORTH CAROLINA	1	18	0	83	102
NORTH DAKOTA	0	3	0	2	5
OHIO	0	50	3	29	82
OKLAHOMA	2	12	2	55	71
OREGON	0	0	0	6	6
PENNSYLVANIA	33	17	0	153	203
RHODE ISLAND	0	2	0	7	9
SOUTH CAROLINA	4	84	2	4	94
SOUTH DAKOTA	6	51	0	0	57
TENNESSEE	5	12	2	61	80
TEXAS	3	6	1	216	226
UTAH	0	50	0	30	80
VERMONT	1	1	1	11	14
VIRGINIA	9	23	1	13	46
WASHINGTON	3	20	0	4	27
WEST VIRGINIA	5	22	0	49	76
WISCONSIN	1	2	0	23	26
WYOMING	1	8	0	6	15
PUERTO RICO	2	0	0	0	2
TOTALS	161	845	29	1849	2884

TABLE 23

COSTS OF REMEDIAL MEASURES

State	Name of Dam	I.D. No.	Type	Structural Height (Ft)	Crest Length (Ft)	Remedial Measures	Costs of Remedial Measures Engr. ($1,000)	Const. ($1,000)	Total ($1,000)
Alabama	Lake Purdy Dam	AL 01311	Earth	55	213	Extensive Grouting	53	500	553
Arizona	Lake Patagonia	AZ00029	Earth	158	970	Spillway capacity increased	173.6	1,302.6	1,476.2
	Buckeye #1	AZ00143	Earth	43	37,441	Embankment drain installed	197.5	672.5	870
	Graveyard Wash	AZ00066	Earth	36	2,500	Embankment drain installed	60	300	360
	Pena Blanca	AZ00028	Rockfill-Earth	75	235	Embankment raised	.45	3	3.46
	Concrete	AZ00025	Arch-Buttress	46	205	Breached	--0--	8	8
	Golder	AZ00003	Earth-Rockfill	142	2,500	Breached	10	345	355
	Perrin	AZ00018	Earth-Rockfill	37	317	Breached	--0--	3	3
	River Reservoir #3	AZ00007	Earth-Rockfill	55	1,150	Phase II Study on Embankment -6 holes drilled-4 piezometers installed	8	--0--	8
	Lone Pine	AZ00012	Earth	115	900	Phase II Study - 3 holes drilled	60	--0--	60
Colorado	Chambers Lake	CO 00127	Earth	58	2,125	Constructed new spillway. Outlet works repaired	--0--	95	95
	Milton Seaman	CO 00143	Earth	105	410	Performed dam-break analysis. Repaired spillway.	63	34	97
	Evergreen	CO 00328	Gravity	50	380	Stabilized gravity section.	--0--	--0--	289

TABLE 23 (Continued)

COSTS OF REMEDIAL MEASURES

State	Name of Dam	I.D. No.	Type	Structural Height (Ft)	Crest Length (Ft)	Remedial Measures	Costs of Remedial Measures Engr.	Const.	Total
							($1,000)		
Colorado (continued)	Humphreys Dam	CO 00772	Arch	85	186	Performed overtopping analysis.	12	--0--	--0--
	North Poudre #3	CO 00838	Earth	38	1,170	Constructed new spillway.	38	215	253
	Halligan	CO 01169	Arch	95	357	Performed overtopping analysis.	31	--0--	--0--
Delaware	Lake Como	DE00028	Earth	16	100	Repaired embankment including slope protection. Provided adequate spillway. Removed gas & water pipes, trees, & poles from embankment.	125	600	725
	Records Pond	DE00057	Earth-Other	11	500	Provided an adequate spillway. Cleared embankments.	18.7	187	205.7
Idaho	Barber	ID00207	Other	48	2,000	Removed deteriorated planks from rock cribs, replaced rock ballast, covered spillway surfaces with reinforced gunite.	--0--	--0--	250
Illinois	Lake Marian	IL00905	Earth	51	745	Breached by State.	--0--	--0--	200
Iowa	Middle Pond	IA01699	Earth	25	250	Increased spillway capacity to 0.5 PMF	--0--	5	5
	IA Noname	IA01926	Earth	50	400	Increased spillway capacity to 0.5 PMF	--0--	4	4

TABLE 23 (Continued)

COSTS OF REMEDIAL MEASURES

State	Name of Dam	I.D. No.	Type	Structural Height (ft)	Crest Length (Ft)	Remedial Measures	Costs of Remedial Measures Engr. ($1,000)	Const. ($1,000)	Total ($1,000)
Minnesota	Sauk River	MN00508	Gravity	12	139	Study	10	--0--	10
	Elk River	MN00516	Gravity	15	207	Study	26	--0--	26
	Kettle River	MN00513	Gravity	25	321	Study	20	--0--	20
	Lanesboro	MN00517	Other	34	193	Study	22	--0--	22
	Grindstone River	MN00543	Gravity	23	58	Study	20	--0--	20
	New London	MN00062	Gravity	22	13	Study	18	--0--	18
	Norway Lake	MN00035	Gravity	13	400	Study	5	--0--	5
	Rapidan	MN00512	Other	83	414	Study	25	--0--	25
	Fishhook River	MN00234	Gravity	20	1,050	Study	20	--0--	20
	Zumbro Lake	MN00358	Gravity	65	570	Study	63	--0--	63
New Jersey	Columbia Dam	NJ00124	Other	18	330	Provided an adequate spillway. Provided a functional means of lowering the lake level. Made repairs needed to insure stability of dam. Repaired erosion damage and protected banks with riprap.	25	420	445

TABLE 23 (Continued)

COSTS OF REMEDIAL MEASURES

State	Name of Dam	I.D. No.	Type	Structural Height (Ft)	Crest Length (Ft)	Remedial Measures	Costs of Remedial Measures Engr. ($1,000)	Const. ($1,000)	Total ($1,000)
New York	Rainbow Lake Dam	NY00018	Other	27	75	Removed stop logs to drain impoundment and provided additional spillway capacity.	---	.5	.5
	New Rochelle Reservoir No. 1	NY00020	Gravity	30	680	Installed filter blanket to control seepage problem.	10	100	110
	Watervliet Reservoir Dam	NY00088	Buttress	48	380	Section of water supply pipe repaired.	3	22	25
	Diamond Mills Paper Co. Dam	NY00089	Gravity	35	350	Repaired concrete wall.	3	25	28
	Harrower Pond Dam	NY00207	Gravity	25	175	Breached after impoundment drained.	---	3.2	3.2
	Jamesville Reservoir Dam	NY00418	Gravity	53	446	Repaired bulging buttress section.	100	950	1,050
Ohio	Fair Haven (Gina) Lake Dam	OH00930	Earth	30	200	Dam breached.	---	17	17
South Carolina	SC Noname 23026	SC00025	Earth	150	800	Seepage corrected. Embankment erosion corrected. Brush and vegetation removed. Spillway stabilized and spillway capacity increased.	---	700	700
South Dakota	Jones Lake	SD00758	Earth	21	850	New Spillway added.		7	7

TABLE 23 (Continued)

COSTS OF REMEDIAL MEASURES

State	Name of Dam	I.D. No.	Type	Structural Height (Ft)	Crest Length (Ft)	Remedial Measures	Costs of Remedial Measures Engr.	Const.	Total
							($1,000)		
Tennessee	Arrow Lake	TN11902	Earth	22	1,100	Spillway capacity increased.	50	360	410
Washington	Elwha Dam	WA00242	Gravity	160	490	Repaired and stabilized gravity section.	230	320	550
	Wenas Dam	WA00002	Earth	47	365	Constructed new spillway. Raised embankment.	---	---	1,500
	Zosela Mill Pond Dam	WA0006 7	Other	15	260	Reconstructed right spillway. Replaced riprap on embankment. Reinforced wood stoplog structure.	25	51	76
West Virginia	Laurel Lake	WV05901	Earth	47	395	Enlarged spillway. Modified dam.	37.4	577	614.4
Wyoming	Wagner	WY01482	Earth	49	2,300	Cracks & slides in embankment subexcavated & recompacted.	.2	2.7	2.9

TABLE 24

C O S T S

State	INVENTORY Number of Dams	INVENTORY Total Costs ($1000)	INVENTORY Average Costs ($1000)	INSPECTION Number of Dams	INSPECTION Total Costs ($1000)	INSPECTION Average Costs ($1000)
ALABAMA	1780	377.7	0.212	167	1297.2	7.8
ALASKA	167	175.1	1.048	16	150.6	9.4
ARIZONA	395	106.0	0.268	89	718.6	8.1
ARKANSAS	1087	161	0.148	127	1014.0	8.0
CALIFORNIA	1310	80.8	0.062	120	2149.5	17.9
COLORADO	1786	476.7	0.267	219	1758.8	8.1
CONNECTICUT	740	130.0	0.176	365	3411.5	9.4
DELAWARE	96	28.0	0.300	15	125.2	8.3
FLORIDA	642	101.0	0.157	45	300.0	6.7
GEORGIA	3305	446.9	0.135	252	1743.0	6.9
HAWAII	123	21.0	0.170	53	603.0	11.4
IDAHO	371	87.0	0.235	61	662.0	10.9
ILLINOIS	930	491.0	0.528	194	2177.0	11.2
INDIANA	798	226.7	0.284	287	1905.3	6.6

TABLE 24 (continued)

C O S T S

State	INVENTORY Number of Dams	INVENTORY Total Costs ($1000)	INVENTORY Average Costs ($1000)	INSPECTION Number of Dams	INSPECTION Total Costs ($1000)	INSPECTION Average Costs ($1000)
IOWA	2053	66.0	0.032	45	300.0	6.7
KANSAS	5031	336.1	0.067	180	1090.3	6.1
KENTUCKY	1033	130.0	0.126	321	2043.3	6.4
LOUISIANA	340	70.3	0.207	8	68.6	8.6
MAINE	619	301.3	0.487	65	594.0	9.1
MARYLAND	206	47.9	0.230	40	313.1	7.8
MASSACHUSETTS	1295	336.1	0.260	383	3581.8	9.4
MICHIGAN	2260	246.9	0.109	151	1496.0	9.9
MINNESOTA	864	125.1	0.146	61	604.1	9.9
MISSISSIPPI	2990	291.0	0.097	81	870.0	10.7
MISSOURI	3599	997.9	0.208	613	6273.2	10.2
MONTANA	3518	505.8	0.159	118	1516.7	12.9
NEBRASKA	1739	77.8	0.045	49	343.1	7.0
NEVADA	204	98.3	0.482	28	482.3	17.2

TABLE 24 (continued)

COSTS

State	INVENTORY Number of Dams	INVENTORY Total Costs ($1000)	INVENTORY Average Costs ($1000)	INSPECTION Number of Dams	INSPECTION Total Costs ($1000)	INSPECTION Average Costs ($1000)
NEW HAMPSHIRE	580	92.2	0.160	238	2177.8	9.1
NEW JERSEY	807	294.0	0.400	388	3097.5	8.0
NEW MEXICO	417	76.0	0.182	113	1065.5	9.4
NEW YORK	1379	564.0	0.409	324	2877.8	8.9
NORTH CAROLINA	1635	134.5	0.082	262	1421.1	5.4
NORTH DAKOTA	380	57.6	0.152	57	364.4	6.5
OHIO	1072	88.2	0.087	221	1649.6	7.5
OKLAHOMA	4236	602.0	0.142	186	1615.0	8.7
OREGON	653	64.6	0.099	41	598.9	14.6
PENNSYLVANIA	1121	266.0	0.240	749	6924.9	9.2
RHODE ISLAND	142	26.9	0.242	33	307.0	9.3
SOUTH CAROLINA	1942	191.0	0.098	132	958.6	7.3
SOUTH DAKOTA	1993	85.1	0.043	120	1001.4	8.3
TENNESSEE	845	378.0	0.450	141	1157.1	8.2

TABLE 24 (continued)

C O S T S

State	INVENTORY Number of Dams	INVENTORY Total Costs ($1000)	INVENTORY Average Costs ($1000)	INSPECTION Number of Dams	INSPECTION Total Costs ($1000)	INSPECTION Average Costs ($1000)
TEXAS	5695	386.9	0.068	699	5159.6	7.4
UTAH	406	97.0	0.239	134	1507.6	11.3
VERMONT	269	43.6	0.234	86	814.4	9.5
VIRGINIA	1418	383.5	0.271	227	1989.1	8.8
WASHINGTON	811	108.2	0.133	100	1320.1	13.2
WEST VIRGINIA	472	54.0	0.114	214	2091.0	10.0
WISCONSIN	1031	140.0	0.136	128	1279.2	10.0
WYOMING	1487	26.3	0.018	45	359.7	8.0
PUERTO RICO	70	40.0	0.571	26	247.1	9.5
TERRITORIES	3	0	0	0	0	0
VIRGIN ISLANDS	8	0	0	1	10.9	10.9
TOTAL	68153	10739.0	0.158	8818	77587.5	8.8
WRSC	--	340.0	--	--	--	--
MRK	--	309.0	--	--	--	--
TOTAL	68153	11388.0	0.167	8818	77587.5	8.8

APPENDIX E

EVALUATION OF STATE DAM SAFETY PROGRAMS

Attributes
(* Indicates Adequate)

	State	Dam Safety Legislation	Review of Design Plans & Specs.	Inspection During Constrctn	Issuance of Impounding Permits	Periodic Inspection of Compltd Projects	Rqrmnts for Remedial Measures	State Funding	Technical Staffing	Planned Future Program	Existing Program
1.	Alabama[1]										
2.	Alaska		*	*	*	*	*				
3.	Arizona	*	*	*	*	*	*	*	*		*
4.	Arkansas		*	*	*	*	*				
5.	California	*	*	*	*	*	*	*	*		*
6.	Colorado	*	*	*	*	*	*	*	*		*
7.	Connecticut	*	*	*	*	*	*				
8.	Delaware[1]								*		
9.	Florida	*	*	*	*	*	*				
10.	Georgia	*	*	*	*	*	*	*	*		*
11.	Hawaii[1]		*	*							
12.	Idaho	*	*	*	*	*	*		*	*	
13.	Illinois	*	*	*	*		*	*	*	*	

[1] No enacted dam safety legislation.

APPENDIX E

EVALUATION OF STATE DAM SAFETY PROGRAMS

Attributes
(* Indicates Adequate)

	State	Dam Safety Legislation	Review of Design Plans & Specs.	Inspection During Constrctn	Issuance of Impounding Permits	Periodic Inspection of Compltd Projects	Rqrmnts for Remedial Measures	State Funding	Technical Staffing	Planned Future Program	Existing Program
14.	Indiana	*	*			*	*	*	*	*	
15.	Iowa	*	*	*	*	*	*		*	*	
16.	Kansas	*	*		*		*			*	
17.	Kentucky	*	*	*	*	*	*	*	*		*
18.	Louisiana	*	*	*	*	*	*			*	
19.	Maine		*				*				
20.	Maryland	*	*	*	*	*	*	*	*		*
21.	Massachusetts	*					*				
22.	Michigan	*	*	*	*	*	*			*	
23.	Minnesota	*	*	*	*	*	*		*	*	
24.	Mississippi	*	*				*				
25.	Missouri		*	*	*	*	*				
26.	Montana										

A P P E N D I X E

EVALUATION OF STATE DAM SAFETY PROGRAMS

Attributes
(* Indicates Adequate)

	State	Dam Safety Legislation	Review of Design Plans & Specs.	Inspection During Constrctn	Issuance of Impounding Permits	Periodic Inspection of Compltd Projects	Rqrmnts for Remedial Measures	State Funding	Technical Staffing	Planned Future Program	Existing Program
27.	Nebraska	*	*	*	*	*	*	*	*		*
28.	Nevada	*	*	*	*		*			*	
29.	New Hampshire	*	*	*	*	*	*			*	
30.	New Jersey	*	*	*	*	*	*	*	*		*
31.	New Mexico	*	*	*	*	*	*	*	*		*
32.	New York	*	*	*	*	*	*			*	
33.	North Carolina	*	*	*	*	*	*		*	*	
34.	Nor[illegible] Dakota	*	*	*	*	*	*	*	*		*
35.	Ohio	*	*	*	*	*	*			*	
36.	Oklahoma	*	*			*	*				
37.	Oregon	*	*	*	*	*	*		*		
38.	Pennsylvania	*	*	*	*	*	*	*	*		*
39.	Rhode Island	*	*	*	*	*	*	*	*		*

A P P E N D I X E

EVALUATION OF STATE DAM SAFETY PROGRAMS

Attributes
(* Indicates Adequate)

	State	Dam Safety Legislation	Review of Design Plans & Specs.	Inspection During Constrctn	Issuance of Impounding Permits	Periodic Inspection of Compltd Projects	Rqrmnts for Remedial Measures	State Funding	Technical Staffing	Planned Future Program	Existing Program
40.	South Carolina	*	*	*	*	*	*	*	*		*
41.	South Dakota [1]		*		*		*		*		
42.	Tennessee	*	*	*	*	*	*		*	*	
43.	Texas	*	*	*	*	*	*	*	*		*
44.	Utah	*	*	*	*	*	*	*	*		*
45.	Vermont	*	*	*	*		*				
46.	Virginia	*	*	*	*	*	*		*		
47.	Washington		*				*				
48.	West Virginia		*	*		*	*			*	
49.	Wisconsin	*	*	*	*	*	*		*	*	
50.	Wyoming	*	*	*	*	*	*	*	*		*
51.	Puerto Rico [1]						*		*		
52.	Virgin Islands	*	*	*		*	*			*	

[1] No enacted dam safety legislation.

A P P E N D I X E

EVALUATION OF STATE DAM SAFETY PROGRAMS

Attributes
(* Indicates Adequate)

	State	Dam Safety Legislation	Review of Design Plans & Specs.	Inspection During Constrctn	Issuance of Impounding Permits	Periodic Inspection of Compltd Projects	Rqrmnts for Remedial Measures	State Funding	Technical Staffing	Planned Future Program	Existing Program
53.	Pacific Island Trust Territories	[1]									
	TOTALS	40	47	40	39	38	48	18	29	17	16

[1] No enacted dam safety legislation

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