

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

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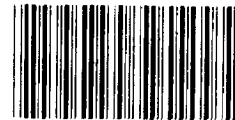
Improving The Safety Of Our Nation's Dams--Progress And Issues

Repeated failures of large dams, more than 100 since 1930, have caused the Federal Government concern over dam safety throughout the country. Since 1977 progress has been made in

- inspecting many potentially hazardous dams which the executive branch considers to be under State regulation;
- developing safety guidelines for Federal dams; and
- adopting many safer Federal dam design, construction, and operating practices.

However, States may need further Federal assistance because dam owners often are reluctant to accept recommended remedial measures and many States often lack the legislative authority, funds, or staff required to enforce the recommendations or maintain an inspection program of their own.

Further Federal agency efforts should be made. One of the more critical needs is to obtain information for the Congress to design a National Dam Safety Program identifying the Federal role.



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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses progress that has been made and matters that need further attention to achieve a national dam safety program. Disasters like the failures of the Teton Dam, Idaho, in 1976 and the Barnes Lake Dam near Toccoa, Georgia, in 1977 have demonstrated the need for such a program. The Congress and the President initiated major actions in recent years to meet that need, and our office recommended related actions in two 1977 reports.

Copies of this report are being sent to the President; the Secretaries of Agriculture, the Army, Defense, and the Interior; the Governors of the 50 States; and other interested parties.


Comptroller General
of the United States



D I G E S T

Recently the Federal Government has taken major steps toward addressing dam safety and alleviating the threat that unsafe dams pose throughout the United States. While much progress has been made to increase the safety of dams, some key issues remain to be resolved.

WHAT PROGRESS HAS BEEN MADE?

The Corps of Engineers is spending about \$100 million to inspect non-Federal dams in a major step toward compliance with the 1972 National Dam Inspection Act. The Corps inspected about 1,800 non-Federal dams during 1978, found deficiencies in many of those considered potentially most hazardous because of location, and recommended remedial measures to States and dam owners. The Corps program, although limited to inspecting 9,000 of the 43,500 dams in 4 years, is an important move toward developing a national safety program for non-Federal dams. (See p. 4.)

For Federal dams, an independent panel of dam safety experts, Federal agencies involved in dam safety, and an ad hoc Federal committee developed guidelines to help coordinate Federal agencies' dam safety efforts. As of February 1, 1979, all parties were reconsidering ways to make these guidelines more specific. (See p. 22.)

WHAT KEY ISSUES REMAIN?

While some safety improvements for Federal dams are still in process, the key safety issues to be resolved at this time concern non-Federal dams. Increasing the safety of these dams depends on dam owners' cooperation and States' willingness to continue efforts begun by the Corps non-Federal dam inspection program. Success will not come easy because:

--Many dam owners lack the financial resources, willingness, or understanding to take remedial

measures recommended in Corps inspection reports. GAO reviewed some inspection reports in five States and found that dam owners in these cases took only limited actions to implement the recommendations. (See p. 5.)

- States do not have legislative authority, funds, or trained personnel to conduct their own comprehensive programs. GAO's study of five selected States showed that, although some States have improved their programs in certain respects, many of the improvements, such as hiring additional personnel and providing training, are dependent upon Corps financing and may not continue when the Corps program ends in 1981. (See p. 9.)

The Federal Government is not responsible for State or dam owner actions to improve safety programs or make necessary repairs, but it can influence those actions and determine their adequacy to afford an acceptable level of protection from the risks of dam failures.

RECOMMENDATIONS

GAO recommends that the Secretary of the Army direct the Corps of Engineers to:

- Collect, analyze, and report to the Congress information necessary for judging the appropriate long-term Federal role in non-Federal dam safety. (The Corps is already collecting some of that information for purposes of reporting to the President on the first year's inspections. Ways are readily available to obtain the additional information for the Congress.) (See p. 20.)
- Monitor, on a continuing basis, State and dam owner actions to increase non-Federal dam safety. (Corps monitoring would reinforce the need for States and dam owners to take action on inspection report recommendations, help the Corps collect data for defining the appropriate Federal role, and have other benefits for increasing non-Federal dam safety.) (See p. 20.)

GAO also recommends that the Congress direct the Corps to:

- Propose, as soon as possible but before its non-Federal inspection program ends in 1981, legislation defining an appropriate long-term Federal role in non-Federal dam safety. (Collecting the data and monitoring the actions mentioned above would put the Corps in an ideal position to propose such legislation). (See p. 20.)

These steps would be a logical extension of the Corps non-Federal dam inspection program and would provide a method to gather timely, reliable information which the Congress urgently needs to consider a national dam safety program, including the Federal role. Corps officials indicated that the executive branch has not yet decided whether a report with dam safety proposals will be made to the Congress. (See p. 19.)

GAO also recommends other Federal safety measures relating to expediting and improving inventories of non-Federal dams (see p. 19), documenting Federal dam safety policies (see p. 24), and using the Federal guidelines as a model for non-Federal dam safety. (See p. 24.) GAO supports (1) a Presidential directive for the Corps to begin giving inspection priorities to States that are developing effective programs (see p. 9) and (2) certain actions which Federal agencies have recently initiated to improve the proposed Federal dam safety guidelines. (See p. 24.)

AGENCY COMMENTS

Agency comments were obtained and considered in finalizing this report. Except for certain matters concerning inventories of non-Federal dams (see p. 19), agency officials did not object to GAO's conclusions or recommendations.

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ABBREVIATIONS

GAO General Accounting Office

FCCSET Federal Coordinating Council
for Science, Engineering, and
Technology

CHAPTER 1

INTRODUCTION

According to a 1975 Corps of Engineers inventory there are about 50,000 public and private dams in the United States which are 25 feet or more in height or have a maximum impounding capacity of 50 acre-feet 1/ or more. These dams are used for many purposes including flood control, recreation, irrigation, and municipal and industrial water storage. The number of dams is reportedly increasing by about 1,600 per year. About 89 percent of the dams are non-Federal and about 40 percent present a significant or high hazard potential to downstream life and property if they should fail.

This is our third report in less than 2 years on dam safety. The previous two reports generally discussed the need for greater Federal action to increase the safety of both Federal and non-Federal dams throughout the United States. This report discusses what progress has been made and the matters which we believe require additional attention.

HISTORY OF THE NATIONAL DAM SAFETY ISSUE

More than 100 large dams in the United States have failed since 1930. Buffalo Creek and Canyon Lake Dams are two well-known dam failures from a long list which begins with the South Fork Dam near Johnstown, Pennsylvania, in 1889. Other failures include the Saint Francis Dam near Los Angeles in 1928, the Baldwin Hills Reservoir near Los Angeles in 1963, the Teton Dam in Idaho in 1976, and the Barnes Lake Dam near Toccoa, Georgia, in 1977.

Dam disasters in the early 1970s caused about 355 deaths and extensive property damage. This situation led to passage of the 1972 National Dam Inspection Act (Public Law 92-367, Aug. 8, 1972), which directed the Secretary of the Army, through the Corps of Engineers, to inspect the majority of the Nation's dams for protection of life and property. The Secretary was also to recommend to the Congress a comprehensive national program for dam safety, including the Federal role. However, the previous administration believed that dam inspection was a State responsibility and did not request inspection money for the Corps.

1/An acre-foot is the volume of water that would cover 1 acre to a depth of 1 foot, or 325,857 gallons.

By November 1976 no inspections had been conducted, and so the Corps recommended to the Congress a program which emphasized voluntary State actions to inspect and regulate about 43,500 non-Federal dams covered by the act. However, many States claimed they could not afford such a program without Federal help.

The Bureau of Reclamation's Teton Dam failed in June 1976, prompting a number of Government-sponsored reviews. Then, in April 1977 the President directed that certain actions be taken to coordinate Federal dam safety programs and develop proposed Federal dam safety guidelines. A report to the President on this was issued by an independent panel of dam experts on December 6, 1978.

In June 1977 we issued two reports concerning dam safety ("Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and the Corps of Engineers," CED-77-85, June 3, 1977, and "Slow Progress in Developing and Implementing a National Dam Safety Program," CED-77-94, June 29, 1977). Recommendations in the first report were designed to improve Federal dam safety, and in the second report they were primarily to improve non-Federal dam safety.

In the summer of 1977, the Congress appropriated \$15 million, later increased to \$18 million, for non-Federal dam inspections. In December 1977, following the Toccoa disaster which killed 39 persons, the President announced a Federal program to inspect non-Federal dams under the 1972 act and to update the 1975 dam inventory. The President set a program goal to update the inventory in 3 years and inspect in 4 years about 9,000 dams which could be highly hazardous to downstream populations. The Corps was to report to the President in December 1978 the results of 1,800 inspections completed during the first year. The entire program cost was estimated at \$70.6 million.

SCOPE OF REVIEW

We evaluated key aspects of the Corps dam safety program by examining selected reports and records, interviewing Federal and State officials and dam owners, and visiting some dam sites.

Most audit work was conducted at headquarters offices of the Corps of Engineers and the Departments of the Interior and Agriculture, Washington, D.C., and at selected Corps field offices. We interviewed State officials in Alabama, Kansas, Missouri, New York, Oregon, Pennsylvania, and Washington and talked with selected dam owners. We do not

identify dam owners in this report because information we obtained from them was on the understanding that their identities would not be disclosed.

CHAPTER 2

STATES, DAM OWNERS, AND THE FEDERAL GOVERNMENT

NEED TO TAKE FURTHER STEPS TO IMPROVE

NON-FEDERAL DAM SAFETY

The Corps program to inspect non-Federal dams is a major step toward compliance with the inspection provision of the 1972 National Dam Inspection Act. The Corps inspected many of the Nation's potentially most hazardous dams, found many deficiencies, and recommended remedial measures to States and dam owners. The inspection efforts, although limited to about 9,000 of the 43,500 non-Federal dams, also represent a move toward developing a national dam safety program which can extend beyond the Corps 4-year inspection program.

Success in attaining nationwide dam safety depends on dam owners' willingness to make their dams as safe as practicable and States' willingness to support efforts similar to the Corps program. However, these goals will not be met easily because

- many dam owners lack the financial resources, willingness, or understanding to take the remedial measures recommended in inspection reports; and
- many States do not have legislative program authority, funds, or personnel to conduct their own comprehensive programs.

Success in developing a lasting nationwide dam safety program may also require Federal involvement. The Congress has long recognized the need to define the Federal role in non-Federal dam safety and, in fact, included requirements in the 1972 act to provide information for that purpose. The Corps is obtaining some of that information and could readily obtain more as a part of its inspection program, but it is not planning to do so. Also, the Corps has not placed enough emphasis on correcting its dam inventory, which not only compounds the problem of defining the Federal role, but also impairs Corps inspection efforts.

THE CORPS IS NOW INSPECTING MANY DAMS

Corps officials expect, on the basis of the program's first year, that program costs will exceed initial estimates of about \$70.6 million by about \$30 million but that the Corps

will meet its 4-year goal to inspect about 9,000 dams. The following table compares program goals and actual experience for fiscal year 1978.

	<u>Goal</u>	<u>Actual</u>
Number of dams inspected	1,800	1,793
Cost of inspections per dam	\$7,500	\$8,500

To implement the inspection program for fiscal year 1978, Corps and State officials jointly determined which high hazard dams would be inspected during the year in each State. The inspections were made by assessing general safety conditions of the dams based on available data and visual observations. The inspectors identified areas requiring emergency measures and recommended any additional measures they considered necessary. States and dam owners were responsible for implementing these recommendations.

Of the 1,793 dams inspected, the Corps considered 354, or about 20 percent, unsafe, including 26 in need of emergency action. Also, according to the Corps, many dams not considered unsafe needed some remedial measures.

DAM OWNERS ARE OFTEN RELUCTANT TO CARRY OUT CORPS RECOMMENDATIONS

Dam owners are often reluctant to adopt recommendations in Corps inspection reports where the owners lack the financial resources, do not believe the recommended remedial measures justify their costs, or do not understand why the recommendations were made. On the other hand, dam owners often accept recommendations where the dam is on the verge of collapse or where the remedial cost to them is low.

From five States, we selected nine dams which were inspected in the Corps program to determine the responsiveness of dam owners to accept inspectors' recommendations. The Corps had classified five of the dams as unsafe with two requiring immediate action to avoid dam failure. The remaining four dams, while not classified as unsafe, would require substantial remedial work to meet Corps safety guidelines.

In all nine cases dam owners took only limited action to implement Corps recommendations. Emergency action was taken in two cases; but in one the Corps used Federal emergency funds to pay for much of the work required, and in the other the dam was small and the owner easily corrected the unsafe condition, a deteriorated outlet pipe. Owners often

made minor repairs which required little time or money, such as removing vegetation growing on dams and filling animal holes in dam embankments.

Dam owners were reluctant to implement recommendations such as determining the cause of seepage; evaluating a dam's stability; modifying spillway capacity; and removing, redesigning, or rebuilding dams. Some owners said that they:

- Could not afford to make recommended repairs.
- Could probably live with the risk of failure if repairs were expensive.
- Would not do anything unless the Corps proved repairs were needed.
- Would resist lowering their reservoir to the extent recommended.
- Did not know how to make the recommended evaluations or to set up recommended warning systems.
- Wanted to wait for recommendations on their other dams.
- Might go to court rather than voluntarily implement recommendations which did not justify the cost.
- Disagreed with the Corps criteria for determining spillway adequacy, the basis of judging some dams as unsafe.
- Wanted to wait for results of studies by independent consultants.

The following examples illustrate dam owners' difficulties in different sections of the country.

Example 1

This example involved two dams along the same stream. The upstream dam was a 65-foot high earth-and-rock facility. Its inspection report, dated March 1978, listed unsafe conditions including inadequate spillway, unstable embankment, and lack of a structural provision to draw the reservoir down. The report recommended either removing the dam or redesigning and rebuilding it. The dam owner told us that he would probably not have the money to implement either alternative, but he hoped to be able to hire a consulting engineer in the near future to determine other alternatives.

The downstream dam, a 190-foot high earth-and-rock facility, was owned by a city and managed by a city water board. This dam was located in such a way that if the upstream dam failed, the downstream dam and population could be affected. The March 1978 inspection report on the downstream dam made recommendations concerning structural drawdown capabilities, spillway capacity, seepage, and emergency warnings.

A city water board official told us that the board had installed seepage monitoring devices on the downstream dam, but that future actions would depend on (1) the outcome of a consulting engineer's study of the feasibility of installing structural capability to lower the reservoir and (2) what the upstream dam owner does to correct unsafe conditions at that dam. According to a water board official, if the drawdown capability could be installed without major modifications to the dam, the city would probably do it; otherwise, the water board might decide that the added safety would not justify an investment that could easily exceed \$2 million and the city would probably live with the "very low risk" of ever having to use a drawdown capability.

The State in which the two dams are located had no dam safety program. Implementation of recommendations was at the owner's discretion.

Example 2

This case concerned a 90-foot high concrete dam that was owned by a small city which used it as its sole source of municipal water. The inspection report, dated January 1978, revealed an inadequate spillway capacity, questioned the dam's stability, and recommended further engineering studies.

City officials told us that the city had no plans to implement the recommendations because they considered the dam safe. They were reluctant to finance costly studies and repairs until the dam was proven to be unsafe. They questioned the Corps assumption of the "probable maximum flood" size, which they said was substantially greater than any flood in the dam's 60-year life. They said that even if such a flood occurred there would be time to notify the people living downstream of any impending danger. They did not understand recommendations such as the one to establish a downstream warning system because they believed that they had an adequate warning system; a caretaker lived at the dam and had a telephone and radio to use in emergencies.

The State formally disagreed with the Corps recommendations relating to spillway capacity and dam stability on the basis that the Corps standards were unrealistically high. However, a State official told us that the State would encourage the owner to arrange for the recommended studies. The State had an established dam safety program with authority to enforce remedial actions.

Example 3

A 68-foot high earthen dam, used for recreation purposes, was owned by a development company which was constructing homes near the dam. The May 1978 Corps inspection report recommended lowering the reservoir because the dam was unstable at high pool levels.

The owner told us that lowering the reservoir to the recommended level would probably be an irreversible action, because the reservoir was initially filled by pumping water from a nearby reservoir which no longer exists. He was afraid that, without the reservoir at its present level, housing sales would drop substantially. He said that it would be very costly to build up the downstream slope of the dam, which the report stated was too steep for stability, and that such action would destroy the only road into the housing development.

The owner told us that these actions could ruin him financially; however, he hired a professional engineer to evaluate the recommendations. The engineer told us that he disagreed with some of the recommendations and had developed some arguments against them. The dam owner and engineer planned to meet with the State and Corps to discuss alternatives. The State had a dam safety program with enforcement authority.

IMPROVING STATE EFFORTS IS VITAL FOR A CONTINUING PROGRAM

The Corps of Engineers used its fiscal year 1978 inspection program to provide funds, personnel, and other means to encourage States to establish effective dam safety programs. Some improvements were made, but many of them depended on Federal funding available under the Corps program and may not continue after that program ends in about 3 years. At that time, unless States are prepared to assume responsibility for non-Federal dam safety, the potential benefits of the Corps program may greatly diminish.

In its November 1976 report to the Congress, the Corps reported that 11 States and territories had no laws concerning dam supervision. The Corps considered the legislative authority of many of the others inadequate to cover the various activities necessary for dam safety. Twenty-four indicated that their dam safety regulations did not fully meet needs, and 20 stated that they planned to modify existing regulations.

At that time, the States agreed with the Corps that the responsibility for non-Federal dams is and should continue to rest with the States. The President supported this when he announced the program on December 2, 1977, and directed the Corps to encourage and prepare States to quickly initiate effective dam safety programs.

To comply with that directive, the Corps used a variety of methods during fiscal year 1978, including

- obtaining commitments that State Governors would try to implement existing State legislation related to dam safety, introduce any new legislation required, and assist the Corps in its inventory and inspection efforts in a manner that would train State personnel;
- assisting some States in preparing or supporting legislative proposals to create or strengthen State dam safety programs;
- inviting State personnel to accompany inspectors; and,
- contracting with some States to make inspections and/or update the inventory.

In five States visited, we inquired into ways that the Corps helped to improve State program legislation, staffing, funding, and training for dam safety. We found that:

- Legislation authorizing some elements of a dam safety program existed in four of the five States. Two of the four States had proposals pending before their legislatures to strengthen their dam safety programs. In one of those States, the Corps met with State legislators to discuss the dam safety issue and support a bill to strengthen the State's program. In the fifth State, the Corps helped write the legislation to establish a State dam safety program.
- Additional personnel were hired to perform inspections and/or update inventories under the Corps program in

three of the four States which had safety programs. Most of the new personnel were paid with Corps program funds. The Corps contracted with two States to perform the inspections or make inventory updates, and a third State used Federal funds to hire two new people. A fourth State approved 11 new positions for the State's dam safety program.

- Funding levels for State dam safety programs remained the same as before the Corps inspection program for four of the five selected States. The fifth State increased its dam safety program funding by \$100,000 per year for a 2-year period but was not certain this increase would continue after that. The Corps did not participate in obtaining this increase.
- State dam safety personnel were trained mainly on the job in three of the four States with active programs. In the fourth State, the Corps paid travel and tuition costs for State employees to attend several short courses at various universities on subjects directly related to dam inspections, such as hydraulics.

Some State officials told us that they do not know whether their States will commit the funds and staff needed to continue an effective safety program once the Corps effort ends in about 3 years. Corps officials told us that, while few dramatic improvements were made in many State programs in fiscal year 1978, they expect changes to occur within the next year. In that regard, the President announced that funding priority for dam inspections after fiscal year 1978 would be dependent on State governments showing that they will adopt a comprehensive, effective program to inspect dam construction and operation.

In summary, some States have increased their dam safety efforts in response to the Corps program, but many of the improvements may be short term and dependent on temporary Federal funding through the Corps. Further encouragement, such as the President's directive to give States that show a willingness to adopt inspection programs priority for inspection funds, seems necessary for States to develop and maintain lasting dam safety programs.

MORE INFORMATION IS NEEDED FOR DEFINING THE
FEDERAL ROLE IN NON-FEDERAL DAM SAFETY

The Congress has long recognized the need to define the Federal role in non-Federal dam safety, but until recently when the dam inspection program began, information on dam conditions and costs of conducting a safety program was limited. Now an excellent opportunity exists to collect that additional information quickly and reliably under the Corps program. The Corps is collecting some of that data for a report to the President and ways are readily available to collect additional information and make it available to the Congress. But the Corps has no plans for gathering the additional information, and the executive branch has not decided whether to report to the Congress.

The need to define the Federal role
has long been recognized

The 1972 National Dam Inspection Act directed the Secretary of the Army, through the Corps of Engineers, to make recommendations for a comprehensive national dam safety program, including the Federal role. In a November 1976 report presenting its recommended program, the Corps primarily emphasized voluntary State participation for non-Federal dams, even though many States advised the Corps they could not carry out such a program without Federal funding. In the 1977 audit, we concluded that the Corps report was inadequate because the Corps had not performed required inspections or otherwise obtained sufficient information on which to recommend a national dam safety program.

The House Committee on Government Operations, in its February 1978 report (House Report No. 95-880) on dam safety, agreed with our position and stated that it was not possible to design a national program or define a Federal role because there was lack of basic information which only inspections and an accurate inventory could provide.

The President's December 2, 1977, announcement of the Corps non-Federal dam inspection program included an objective to "provide data for better definition of a viable national dam safety program, including the Federal role."

In the 95th Congress, two major bills (H.R. 10988 and S. 2437) proposed a Federal role in non-Federal dam safety. (See app. I.)

Some information has been collected
but more is needed

Until the Corps began its dam inspection program in December 1977, not much data relating to dam conditions, inspections costs, and similar information was compiled on non-Federal dams. Since then, the Corps has collected considerable information by inspecting high hazard, 1/ non-Federal dams with the help of State and private consultant personnel. Corps personnel have acquired knowledge of inspection needs and costs, existing conditions, and remedial measures necessary for these dams. Also, because Corps personnel work closely with the States, they have a better understanding of the status of State safety programs and of the States' willingness and capability to improve those programs.

Generally, however, the information the Corps is collecting relates only to initial inspection costs and condition of high hazard dams. Its goal is to inspect all potentially high hazard dams and a limited number of others. The Corps collection efforts do not encompass the majority of dams which should be included in a comprehensive national dam safety program and do not provide certain cost and other data even on those dams being inspected.

The five items below show the kinds of information that the Corps is not collecting that would be useful in designing a comprehensive national dam safety program which includes the Federal role:

- Condition of dams in the significant and low hazard categories. These categories constitute about 80 percent of all non-Federal dams listed in the Corps inventory. Corps headquarters officials stated that there is no reason to believe the general condition of those dams would be radically different than high hazard dams. However, State and Corps field officials were uncertain about the conditions of those dams and stated that the only way to determine their

1/A dam's hazard classification refers not to the dam's condition but the potential effect that its failure would have on life and property in areas downstream from the dam. Generally, there are three hazard classifications (high, significant, and low); a high hazard dam has potential for causing loss of more than a few lives or excessive property damage.

condition would be to inspect some of them. They said that low and significant hazard dams, on the average, are smaller and probably receive less attention and maintenance than high hazard dams.

- Initial inspection costs of significant and low hazard dams. The average inspection cost per high hazard dam under the fiscal year 1978 program was about \$8,500. This cost may be substantially higher than for dams in the significant and low hazard categories. A dam safety official from one State which has an active program told us that there will be no need for detailed inspections on low hazard dams or some significant hazard dams, which means that inspection costs for these dams could be substantially less.
- Condition of and inspection costs for small dams. There are great numbers of dams throughout the Nation that are smaller than the 25-foot high or 50-acre-foot size criteria used for the Corps inspection program. Failure of many of these could also cause property damage, human suffering, or loss of life. For the most part, no one knows the number, location, or condition of these dams because the criteria in the National Dam Inspection Act excludes them from the inventory and the Corps inspection program ignores them.
- Design and repair costs for dams in all hazard categories. This information would be of tremendous value in judging whether and to what extent dam owners need financial assistance to carry out inspection report recommendations. Some legislation proposed in the 95th Congress included provisions for such assistance.
- Frequency and cost of recurring inspections. After the Corps completes initial inspections and States implement their own dam safety programs, periodic inspections will become a large part of the daily routine and cost of a State program. The Corps average initial inspection cost of about \$8,500 per dam cannot be used to estimate recurring inspection costs, and inspections of high hazard dams may not be appropriate for determining the inspection frequency on low and significant hazard dams.

Ways to collect additional information

The Corps can collect additional information in a number of ways for defining the Federal role in non-Federal dam safety. One way to obtain much of the information is for the Corps to verify the 1975 national dam inventory. Inventory verification, including site visits to all dams which have not been visited in the past year, would reveal the general condition and hazard potential of the great number of dams in the significant and low hazard categories and could identify obvious dam deficiencies; indicate the depth of inspections which should be made; and provide some insight into costs of inspection, design, and remedial actions. As discussed on page 16, the Corps is beginning to verify the 1975 inventory and plans to visit a number of dam sites in the process, but progress is slow.

Another way to collect additional information is for the Corps to supplement present inspections of high hazard dams by inspecting dams chosen by means of a statistical sample representing the universe of non-Federal dams. The Corps acknowledged that such a sample might be helpful and recognized that inspections during the first year were biased toward dams suspected of being unsafe. The Corps does not plan to inspect a sample of dams but told us that it might make additional inspections if significant data gaps become apparent. Sample inspections could supply specific information for filling many data gaps that exist under the present Corps inspection approach--such as specific inspection costs, inspection frequencies, and design and repair work that would be representative of dams in the significant and low hazard categories.

The third way for the Corps to obtain additional information is by monitoring State efforts to increase non-Federal dam safety. Some States that conduct dam inventories, inspections, or enforcement actions might have readily available and reliable sources for many kinds of information needed--such as costs and frequencies of inspections and design and repair costs for various sizes and categories of dams. If the Corps identified those States, determined what reliable information was available in each, and collected what it needed, such actions could significantly reduce data collection time and expense for the Corps. Those efforts could also help to define the continuing Federal role in States that do not have dam safety programs.

Another way of collecting additional information is for the Corps to perform more inspections by reducing the detail of present inspections and/or reporting requirements. Reporting costs may make up 40 to 60 percent of total inspection costs. Some Corps headquarters officials believed that any reductions in the inspection scope or report detail would adversely affect the reliability or usefulness of the inspections. However, some consultants and State officials believed that the Corps could provide effective but less costly inspections if well-documented and well-written trip reports replaced some of the present detailed inspection reports. This alternative may be especially viable for new dams, dams with sufficient design and construction documentation, or recently inspected dams.

The Corps does not plan to collect
needed additional information

In a letter to the Chief of Engineers dated August 25, 1978, we asked if the Corps planned to obtain the additional information needed to design a national dam safety program. The Corps responded that it did not plan to do so because some of the information is very difficult to obtain, some is of doubtful practical value, some will not be significantly different from what is now being collected, or local government units may be responsible for gathering this information.

Corps officials also replied that our questions appeared to be based on a concept that the Federal Government will somehow assume responsibility for the safety of all dams in the United States that meet the definition in the 1972 National Dam Inspection Act. They said they have no reason to make such an assumption, and consequently they limited their information-gathering activities.

The basis for our questions was that the Congress needs more information to define the continuing Federal role in non-Federal dam safety and that the Corps inspection program provides an excellent opportunity for collecting that information quickly and reliably. The Congress still needs this information and the program still provides the opportunity.

THE INVENTORY OF NON-FEDERAL DAMS
NEEDS IMPROVEMENT

The Corps gave low priority to verifying and updating its inventory of non-Federal dams in fiscal year 1978. It gave high priority to inspecting as many dams as possible even though the existing inventory did not provide a

reliable basis for selecting dams for inspection. Without an accurate inventory, the Corps does not have this reliable basis, and the Congress will have incomplete data for designing a comprehensive national dam safety program.

A complete, reliable inventory including site visits is a prerequisite for conducting a dam safety program. The 1972 act provided for the Corps to inventory dam structures throughout the United States. In 1975 the Corps developed an inventory but used inadequate definitions and data collection procedures. In our June 29, 1977, report (see p. 5), we told the Congress that the inventory had many errors, such as dams listed more than once or not listed at all and erroneous descriptive data for many dams. We reported that the Congress needs inventory information to decide on a national dam safety program requiring Federal participation.

A continuing inventory problem, which we also reported in 1977, concerns inconsistent definitions of high, significant, and low potential hazard dams. In one State a dam is not classified as high hazard unless six lives are threatened by a dam failure; in another State a threat to more than two lives is the cutoff point; and in a third State, if one life is threatened, the dam is given a high hazard rating. These problems were evident before the Corps inspection program began, yet the Corps did not clarify these definitions which weakened the reliability of any inventory updating.

The Corps initially spent about \$3 million to compile the 1975 national inventory and estimated that it will take 3 years and an additional \$3.6 million to update it. About \$1.6 million was spent in fiscal year 1978 for inventory verification, which included taking satellite pictures to locate water bodies, doing some desk audits of existing records, and making limited site visits and air reconnaissance flights.

As of October 1, 1978, only about 1,200 of approximately 43,500 non-Federal dams were reported as verified to the Corps central data base. A Corps headquarters official told us that most of these dams were verified probably because they had been inspected under the program.

Many State officials we visited indicated that updating the inventory initially would help in selecting which dams to inspect. They said that an updated inventory could give them some idea of structural conditions and disclose dams previously unrecorded or misclassified, information which the Congress could use in designing a non-Federal dam

safety program. In a limited effort to review existing records, one State added about 200 dams, including 32 high hazard dams, to the State's original inventory of 670 dams. Another State, by flying over the State and making site visits, reduced its reported 346 high hazard dams to an estimated 75 to 140 dams. Many dams classified as high hazard were reclassified as low or significant hazard as a result of inspections.

Many State officials, architectural-engineering consultants, and dam owners stated that the Corps should give the inventory as high a priority as inspections until the update is complete. Some Corps district, division, and headquarters officials stated that they would like to put more emphasis on the inventory, but that the inspection priority has not allowed this. In November 1977, Corps headquarters instructed the field that "the updating of the inventory of dams should be started immediately." In October 1978 the updating was still not being emphasized, although a Corps official told us it would be emphasized more in fiscal year 1979 and subsequent years.

CONCLUSIONS AND AGENCY COMMENTS

Recent disasters like the failures of Teton Dam in Idaho and Barnes Lake Dam near Toccoa, Georgia, demonstrated the need for nationwide efforts to increase the safety of all dams. Generally, the need was to develop programs to protect the public from dam failures by periodically inspecting all dams during and after construction, reporting the conditions found, monitoring and enforcing necessary remedial actions by dam owners, and providing necessary danger warnings to downstream populations.

States have primary responsibility for developing such programs for non-Federal dams, with Federal involvement where necessary. The failure of many States to develop effective programs dealing with continuing dam disasters led to the recently initiated Corps program to inspect non-Federal dams throughout the United States and report the conditions found.

The Corps 4-year program is not a substitute for effective State programs, and does not provide for inspecting the majority of non-Federal dams, including about 11,000 significant hazard dams. However, it is a major step toward coping with the problem. Now States need to take additional steps, such as providing regular inspections of all dams and monitoring and enforcing necessary remedial actions by

dam owners. If States do not take these steps, the Corps limited effort may not be of much lasting value for increasing non-Federal dam safety.

When judged on the basis of first-year results, the Corps limited effort appears successful; dams were inspected, the inspections disclosed unsafe or potentially unsafe dam conditions, and the inspection reports recommended remedial actions. However many owners were reluctant to carry out recommendations for lack of financing, disagreement about criteria used to make the recommendations, or other problems.

At the same time, many States lacked legislative authority, funds, or staff to deal with this owner reluctance. Hopefully, more disasters will not be necessary to stimulate State action, especially since some essential measures like emergency warning and evacuation systems may not be difficult to implement in many cases.

The fact that many States have not established dam safety programs indicates that some lasting Federal role should be considered for protecting the public from potentially unsafe non-Federal dams. The Federal role could be considered before the Corps program ends in 1981, because reliable data can be obtained quickly from the Corps inspections and monitoring efforts. Indeed we believe the data should be collected as soon as possible because the Federal role needs to be defined now.

One role that we believe should be considered is a more concentrated Federal monitoring of State and dam owner actions to increase non-Federal dam safety. The Corps is in an ideal position to initiate Federal monitoring as part of its non-Federal dam inspection program. By doing so now the Corps could

- direct its present inspection program toward those States and dam owners most in need of help and encouragement;
- obtain more information for the Congress to consider on whether States and dam owners will need help and encouragement beyond the present Corps program to achieve lasting improvements in dam safety;
- reinforce the need for States and dam owners to act quickly to correct unsafe conditions; and
- help the Corps develop better recommendations on remedial actions considering cost, criteria, risk,

and other practical problems which dam owners face in correcting unsafe conditions.

As its 4-year program progresses and more data becomes available on non-Federal dams, the Corps will be in an excellent position to recommend to the Congress legislation for a national dam safety program. In 1976 the Corps made recommendations for a program, but its proposed legislation encompassed only Federal dams. Our 1977 report discussed the weaknesses in those recommendations, such as the inability or reluctance of States to establish dam safety programs of their own and the lack of information available to aid the Congress in designing a nationwide program.

In obtaining agency comments for this report, we reminded Corps officials of those weaknesses and asked them if they planned to obtain the additional information and report it to the Congress. Corps officials told us that a decision has not yet been reached on those matters. They added that they are obtaining some of that data for a report to the President, showing results of their first year's inspections, but that the further actions we suggested are not within their current program's scope as outlined in December 1977.

Concerning monitoring, Corps officials advised us that they have established procedures for followup to determine State and dam owner actions on inspection report recommendations. However, they said that, except for major actions in emergency cases, the procedures have not yet been implemented to any great extent and, therefore, the Corps has obtained very little feedback information.

We also discussed with Corps officials the desirability of giving higher priority to updating and verifying the 1975 national dam inventory. In our opinion, better inventory data is not only needed as soon as possible to help define the Federal role in non-Federal dam safety but also to provide an adequate basis for selecting dams for inspection. Corps officials told us they gave higher priority to completing as many inspections as possible in the first year and will give inventory work higher priority in the future.

Another inventory matter we discussed with Corps officials was the desirability of further defining hazard categories. They expressed reluctance to do so, because they said difficult judgments are involved in individual cases. We believe the effort would be worthwhile because States face similar difficulties and greater consistency in classifications among States seems essential if a national inventory is to be meaningful.

RECOMMENDATIONS TO THE SECRETARY OF THE ARMY

To help ensure continuing Federal attention to an issue of national significance, we recommend that the Secretary of the Army direct the Chief, Corps of Engineers, to:

- Collect and analyze sufficient information to determine an appropriate long-term Federal role in non-Federal dam safety and make that information available to the Congress.
- Monitor on a continuing basis State and dam owner actions to increase non-Federal dam safety.
- Verify and update the 1975 inventory of non-Federal dams as soon as possible, after clarifying definitions of hazard categories.

RECOMMENDATION TO THE CONGRESS

We recommend that the Congress direct the Chief, Corps of Engineers, as soon as possible, but before its non-Federal inspection program ends in 1981, to propose legislation defining an appropriate continuing Federal role in non-Federal dam safety.

CHAPTER 3

A SAFETY PROGRAM FOR FEDERAL DAMS IS EMERGING

The Federal Government has focused considerable attention on the adequacy of Federal dam safety since Teton Dam failed in 1976. Some problems remain to be solved, but major improvements are underway, including development of Federal dam safety guidelines. In addition, some agencies, including the Bureau of Reclamation and the Corps of Engineers, improved their own dam safety practices.

ACTIONS TAKEN IN RESPONSE TO RECOMMENDATIONS IN AN EARLIER GAO REPORT ON FEDERAL DAM SAFETY

Generally, except for documentation of policies, Federal agencies acted on recommendations in our June 3, 1977, report on Federal dam safety. The recommendations related to the need for the Bureau of Reclamation and/or the Corps of Engineers to provide

- written instructions on independent review of storage dams and design intent;
- improved policies and procedures regarding instrumentation, reservoir filling, availability of outlet drains, and emergency preparedness plans; and
- improved coordination with the U.S. Geological Survey.

Appendix II of this report summarizes agency actions on each of our prior recommendations. In some cases, agencies did not fully accept our recommendations but planned or took alternative actions which may be as effective. Apparently, they have accepted other recommendations, such as those relating to reservoir filling and design intent. Still other recommendations, such as those on emergency preparedness and instrumentation, are being evaluated to determine the best way to develop overall agency policy.

Agencies did not act on our recommendations to document agency policies relating to (1) independent review of Bureau project design and site investigations and (2) the timely completion of outlet drains for Bureau and Corps dam projects. Our 1977 audit showed that agency officials did not always carry out agency intent when they did not document requirements and that this lack of documentation could have contributed to the Teton Dam failure.

ACTIONS TAKEN TO COORDINATE
FEDERAL DAM SAFETY PROGRAMS AND
DEVELOP FEDERAL GUIDELINES

At the President's direction, several groups worked together to develop guidelines which will help coordinate dam safety efforts of all Federal agencies and possibly serve as a model for non-Federal dam safety. As of February 1, 1979, the groups were reconsidering the guidelines to make them more specific.

On April 23, 1977, the President directed a three-step review of the procedures and criteria used by Federal agencies involved in the planning, construction, operation, and ultimate disposal of dams. As the first step, Federal departments and agencies reviewed their own practices which could affect the safety and integrity of dams. As a second step, an ad hoc interagency committee on dam safety programs, convened by the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) recommended ways to improve Federal dam safety and developed proposed Federal dam safety guidelines. Its report entitled "Improving Federal Dam Safety" was issued November 15, 1977. In a third step, an independent panel of dam safety experts, established by the Director of the Office of Science and Technology Policy, reviewed and evaluated the agencies' report and the proposed Federal guidelines.

The proposed Federal guidelines covered many elements of work such as reviews, staffing, research and testing, coordination, documentation, instrumentation, inspection and emergency preparedness. The guidelines were very general in their requirements for instrumentation, emergency preparedness, and independent review. For example, the proposed guideline for instrumentation stated:

"Depending on the size of dam and site specific foundation conditions and dam design and materials, consideration should be given to installation of a designed instrumentation system to observe changing conditions in the foundation, in the dam, and in the abutments during the construction, reservoir filling, and project operations."

This guideline did not discuss the (1) need for prompt evaluation of data, (2) need for qualified personnel to read the data, (3) factors that should be measured at concrete and earth dams, and (4) need for a range of instrument performance.

We discussed the importance of these details in our prior report, and interagency subcommittee reports upon which these guidelines were based included this level of detail.

A comparison of instrumentation, emergency preparedness, and independent review policies of the Department of Agriculture's Soil Conservation Service and Forest Service illustrate the wide latitude that such general requirements allow. For example:

- The Soil Conservation Service has no policy statements requiring instrumentation. Soil Conservation Service officials stated that they use instrumentation on an as-needed basis.
- The Forest Service established a written policy in February 1978 which calls for installation of a designed instrumentation system based on the size of the dam and site-specific conditions. The policy also established minimum foundation and embankment instruments for all high hazard dams over 20-feet high.

In a report issued on December 6, 1978, the independent panel concluded that the proposed Federal guidelines lacked enough detail to be effective in evaluating Federal agency practices or as a model for non-Federal dam safety programs. The panel also believed that the proposed guidelines should place more emphasis on certain matters, including emergency preparedness plans and independent review. The panel also discussed a need for

- establishing a Federal dam safety office to monitor Federal agency progress in implementing effective dam safety management practices;
- establishing an information clearinghouse on dam safety so that an agency designing a new structure could obtain information on upstream and downstream structures; and
- ensuring that all nonfederally owned dams which have been created or maintained by Federal initiatives or authority will continue to be subject to appropriate programs of periodic inspection, reevaluation, and remedial action as necessary.

At the completion of our review in October 1978, the FCCSET was considering the panel's draft report, including the question of degree of detail needed for Federal dam

safety guidelines. In addition, the FCCSET was developing a plan to integrate the dam safety research activities of the various Federal agencies. Also, the administration was planning to create a Federal dam safety office within the Federal Emergency Management Agency. 1/

CONCLUSIONS, AGENCY COMMENTS, AND
RECOMMENDATIONS CONCERNING FEDERAL DAM SAFETY

We concur with the independent panel's conclusions that the Federal dam safety guidelines should be more specific and should place more emphasis on emergency preparedness plans and independent review. Generally, we also concur with actions Federal agencies have taken in response to our June 3, 1977, report, except that certain dam safety policies need to be documented.

To help ensure compliance with agency intent, we recommend that the Secretary of the Interior direct the Commissioner of Reclamation and that the Secretary of the Army direct the Chief of Engineers to incorporate in agency regulations those existing policies intended to increase dam safety.

As discussed in chapter 2, the States are having difficulty developing effective safety programs for non-Federal dams, and the Corps of Engineers is encouraging them to increase their efforts. The Federal dam safety guidelines, once approved, may benefit the States in many respects. The guidelines will apply Government-wide and so will cover a wide range of dam types, sizes, locations, and safety conditions that a State may encounter in a program of its own. Also, the guidelines will cover the same phases of work involved in non-Federal dams from site investigation through dam operation. Therefore, we recommend that the Chairman, Federal Coordinating Council for Science, Engineering, and Technology, furnish the Federal dam safety guidelines, when approved, to State governments for use as a model for non-Federal dam safety.

1/The Federal Emergency Management Agency was established in 1978 by the administration to improve Federal emergency management and assistance by consolidating several existing agencies and functions into a new independent agency.

On this section of the report, we received comments from officials of the Bureau of Reclamation, Department of the Interior; Corps of Engineers, Department of the Army; and the Forest Service and Soil Conservation Service, Department of Agriculture. None of these officials objected to our conclusions and recommendations. Bureau officials told us that they plan to incorporate their existing policies into regulations.

ACTIONS IN THE 95TH CONGRESSRELATING TO DAM SAFETY

Public Law 95-96 (H.R. 7553)

Makes appropriations for fiscal year 1978 to the Department of the Army for general investigations which encompass dam safety inspections. Introduced June 2, 1977. Presented to President July 28; signed into law August 7.

1/ H. R. 11153 (Meeds)

Authorizes the Secretary of the Interior to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety of dams purposes. Introduced February 24, 1978 (House Report No. 95-1125).

H. R. 10988 (Ryan)

Provides for a national program for inventory and inspection of dams, standards, and guidelines relating to dam safety and inspection and technical and financial assistance to States that conduct dam safety and inspection programs. Introduced February 15, 1978.

H. R. 6094 (Ryan)

Establishes in the Department of the Interior an Office of Dam Safety and Construction to plan, design, and construct certain dams. Directs the Secretary of the Interior to promulgate safety regulations for dam construction. Transfers to the Secretary all dam planning, design, and construction functions of United States departments and agencies. Establishes a Dam Safety Review Panel to examine

1/S. 2820 and companion bill H.R. 11153 became Public Law 95-578. On November 2, 1978, the President signed the Reclamation Safety of Dams Act of 1978 (Public Law 95-578) which authorizes the Secretary of the Interior to recommend such modification of dams as he determines to be required for structural safety; provides authorizations of not to exceed \$100 million to carry out the provisions of the act; requires a 60-day review period by the Congress of specific project reports before funds are obligated for actual construction to modify an existing dam; and states that part of the costs of dam modification incurred under this act need not be repaid by dam users.

and assess dam safety. Directs the U.S. Geological Survey to examine proposed dam construction sites. Directs the Office of Management and Budget to carry out certain transfer functions. Introduced April 5, 1977.

1/ S. 2820 (Jackson)

Authorizes the Secretary of the Interior to construct, restore, operate, and maintain new or modified features at existing Federal reclamation dams for safety of dams purposes. Introduced April 4, 1978. (S. Rept. No. 95-810). Measure passed Senate July 28, 1978.

S. 2444 (Randolph)

Grants the Secretary of the Army, acting through the Chief of Engineers, the authority to enter and inspect any damsite, and to have access to records and documents concerning such dam site, pursuant to the national program of inspection of dams. Introduced January 27, 1978 (S. Rept. No. 95-830). Measure passed Senate June 9, 1978.

S. 2437 (McClure)

Provides Federal assistance to States for development and implementation of effective dam safety programs, and allows dam owners in States with approved programs to obtain Federal guarantees for reinsurance on liability insurance. Introduced January 26, 1978 (S. Rept. No. 95-834). Measure passed Senate June 9, 1978.

S. 1253 (McClure)

Establishes a national dam safety program whereby Federal agencies shall regulate the safety of dams operated by such agencies or located on lands for which such agencies are responsible. Requires such agencies to inspect dams within their jurisdiction and oversee dam construction or modification of existing dams. Introduced April 6, 1977; referred to the Committee on Environment and Public Works.

S. 1254 (McClure)

Establishes a national dam safety program whereby Federal agencies shall regulate the safety of dams operated by such agencies or located on lands for which such agencies

1/See footnote 1/, p. 26.

are responsible. Requires such agencies to inspect dams within their jurisdiction and oversee dam construction or modification of existing dams. Introduced April 6, 1977; referred to the Committee on Environment and Public Works.

SOURCE: Congressional Research Service, Issue Brief
1B77123, September 11, 1978.

ACTIONS TAKEN IN RESPONSE TO
RECOMMENDATIONS IN GAO'S JUNE 3, 1977,
REPORT ON FEDERAL DAM SAFETY

We made recommendations in our 1977 report concerning (1) independent review, (2) design intent, (3) instrumentation, (4) reservoir filling, (5) outlet works, (6) emergency preparedness, and (7) coordination with the U.S. Geological Survey. The following summarizes the actions taken by the Bureau of Reclamation and the Corps of Engineers on these recommendations as of October 1978 when we completed our review.

INDEPENDENT REVIEW

Although the Bureau uses independent consultants to review the project designs and site investigations for all major dams, this change from past policy has not been incorporated into Reclamation Instructions. Bureau officials told us that they will do so, as we recommended.

Corps draft regulations encourage the use of independent consultants "for projects where safety is in any way questionable, or where difficult foundation problems or unique designs are involved." Corps officials do not believe it is necessary to use independent consultants on all storage dams where there is, or could be, potential hazard to public safety, as we recommended in our prior report.

Because of the questionable design practices used on the Teton Dam, we recommended that the Bureau use an independent consultant to review its policies and procedures related to design practices. The Bureau employed a consultant for this purpose as part of a larger review. The consultant was expected to complete his work in March 1979.

DESIGN INTENT

We recommended that the Bureau establish written procedures to better ensure that its designers' intent is adequately implemented during construction. To implement this recommendation, the Bureau developed Reclamation Instructions and memorandums which call for (1) assigning the responsibility for the technical adequacy and accuracy of a dam's design and geological information to a specified designer and geologist, (2) including more detailed information in design documents provided to construction personnel, and (3) establishing a schedule of frequent site

visits to the damsite by designers and geologists to ensure that the design conforms to actual field conditions.

INSTRUMENTATION

We recommended that the Bureau and Corps reevaluate their policies and procedures for instrumenting dams. Specifically, we recommended that both agencies (1) establish written policies for factors that should be measured at damsites at a minimum, regardless of the site conditions, (2) better define those situations where more than the minimum instrumentation should be seriously considered and/or implemented, (3) require that all instrumentation be installed before reservoir filling, (4) establish expected ranges for instruments at a particular site so that onsite personnel can recognize adverse conditions which may affect dam safety, and (5) either ensure that the people at the site are qualified to interpret the instruments or require that instrumentation data is sent immediately to knowledgeable designers for analysis.

Bureau of Reclamation

Bureau officials told us that they agree with our recommendations, and that they are being implemented on a dam-by-dam basis. For example, since the Teton Dam failure in 1976, instrumentation has been installed at all Bureau dams either completed or in the initial filling stage. Also, instrumentation data is being evaluated to determine the normal range of an instrument's performance at each damsite.

The Bureau has not developed Reclamation Instructions to implement our recommendations. The Bureau established an Instrumentation Section at the Engineering and Research Center in Denver, which is responsible for developing overall policies to improve the Bureau's dam instrumentation program. Some actions being taken and proposed to make such improvements and address our recommendations include:

- Research into ways to use automatic equipment for accumulating, transmitting, processing, and displaying instrumentation data. This should reduce the time between data accumulation and data review.
- Establishment of a committee to develop guidelines for minimum instrumentation. The monitoring programs at all existing dams will be evaluated in relation to these minimum standards.

--Development of a formal training program for personnel involved in operating and maintaining dams. This training, now being implemented, will ultimately provide instrument readers with a greater understanding of operating principles, reading procedures, and ranges within which readings from selected instruments should fall.

Corps of Engineers

The Corps has not (1) developed written policies for factors that should be measured at damsites at a minimum, regardless of the site conditions, or (2) better defined those situations where more than the minimum instrumentation should be considered and/or implemented. Corps officials told us that the designers are responsible for determining the type and quantity of instrumentation at each damsite. These decisions are evaluated during the Corps review process.

On the other hand, the Corps is developing a dam safety training program for operations personnel. The primary objective of this program is to qualify the personnel working at each dam to recognize signs of structural distress and to become familiar with procedures which must be implemented when such evidence is found.

The Corps also issued interim guidance on the timely evaluation of instrumentation data. This guidance calls for establishment of an expected or normal range of performance for each instrument. The guidance also stipulates that instrument readings outside the normal range should be telephoned immediately to the knowledgeable engineer.

RESERVOIR FILLING

We recommended that the Bureau and the Corps establish guidelines for (1) reservoir filling and (2) 24-hour surveillance during critical phases of construction. Both agencies have issued interim guidance on these matters. The Bureau and Corps determine the need for 24-hour surveillance during reservoir fill and the rate of reservoir fill on a dam-by-dam basis.

OUTLET WORKS

Bureau and Corps officials told us that it is their policy to complete the outlet works prior to reservoir fill, as we recommended. Neither agency has put this policy in writing.

EMERGENCY PREPAREDNESS

We recommended that the Bureau and Corps revise their guidelines and procedures to establish a stronger emergency preparedness program in relation to dam failures. Specifically, we said that:

- Emergency preparedness plans should be prepared for all major dams before reservoirs are filled.
- At a minimum, the plans should include the names, addresses, and telephone numbers of key personnel to contact.
- The plans should also include maps which show lands that would be flooded if a failure occurred (inundation maps).

In November 1977 the Bureau requested that each of its regions complete draft standing operating procedures of its existing dams. The standing operating procedures contain information regarding emergency procedures. In January 1978 the regions were asked to survey all Bureau dams to determine the extent of emergency preparedness needed for each dam. As we completed our review, the Bureau was evaluating the results of these two requests and expected to issue its policy on this subject in January 1979.

The Corps approved Engineering Regulations in May 1978 which require the preparation of an emergency plan for each of its dams. These plans are required to include, among other things, (1) emergency notification procedures, (2) inundation maps, and (3) plans to lower the reservoir. In addition, the emergency notification procedures are to be reviewed at least annually with local, State, and other Federal agencies and are to include an analysis of all available types of communications.

COORDINATION WITH THE U.S.
GEOLOGICAL SURVEY

The Bureau and the U.S. Geological Survey established a Memorandum of Understanding in January 1978 which provides for the exchange of geologic and seismologic information relating to an actual or potential damsite, as we recommended. The Corps has finalized a similar agreement and prepared regulations governing the exchange of such technical information.

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