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CHAPTER

Chapter 1: An Approach to Dam Safety

1.0 General

This manual is a safety guide for dam owners. The continuing need for dam safety is critical because of the thousands of dams now in place and the many new ones being built each year. Although these dams are essential elements of the national infrastructure, the risks to the public posed by their possible failure are great; a large and growing number of lives and valuable property are at stake. Though many are concerned about dam safety, the legal and moral responsibility essentially rests with the dam owner.

1.1 Urgency for Safety

The critical need for dam safety is clear. World and national statistics on dam failures show an unacceptable record of deaths and property losses. The record for U.S. losses from major dam failures in recent years, shown in Table 1.1 is also discouraging. Actual national losses are much higher than indicated because the statistics shown exclude small dam failures and many combinations of dam failure and natural flooding events—a specific example from Texas is the two dams that failed near Hearne in May 2004. The Johnstown, Pennsylvania, disaster of 1889 is regarded as one of the nation's great catastrophes, and the potential for future similar catastrophes due to dam failure remains strong. Only a cooperative effort in dam safety involving owners and communities can lessen this potential.

1.2 Dam Ownership and Safety

This manual can be applied to dams owned and operated by a wide range of organizations and people, including state and local governments, public and private agencies, and private citizens. Typical reasons for building dams include water storage for human consumption, agricultural production, power generation, flood control, reduction of soil erosion, industrial use, and recreation. Thus, dam owners serve society by meeting important state needs and may also personally profit from dam operations. However, those are not sufficient reasons for building or owning a dam if the owner cannot keep people and property safe in potential inundation zones.

Both financially and morally, successful dam ownership and the maintenance of safety standards go hand in hand. Investment in dam safety should be accepted as an integral part of project costs and not viewed as an expendable item that can be eliminated if a budget becomes tight (Jansen, 1980). The costs of dam safety are small in comparison to those that follow dam failure, particularly in today's litigious society. Liability due to a failure would probably negate years of potential profits. Owning a dam brings many different concerns and possible rewards, but in the end success will largely be measured by a continuing record of safety.

1.3 The Increasing Complexity of the Dam-Safety Problem

As national needs for water intensify and its value increases, more dams are being built. At the same time, many existing dams are reaching or passing their design life spans and, for various reasons, people continue to settle near dams. As builders are forced to use poorer sites for dams, the job of protecting life and property becomes more difficult. Therefore, as dam construction continues and the population grows, exposure of the public to dam-failure hazards increases and the overall safety problem becomes more difficult.

Governments across the nation have shown increasing concern for this problem and have enacted laws, statutes, and regulations that increase the dam owner's responsibility. In most states, including Texas, owners are held strictly liable for losses or damages resulting from dam failure. Concurrently, liability insurance costs have risen rapidly.

1.4 Role of the TCEQ

The Texas Commission on Environmental Quality is responsible for administering state dam-safety laws, which are found in Section 12.052 of the Texas Water Code and Chapter 299 of the Texas Administrative Code.

The staff of the TCEQ has four primary areas of activity in the dam-safety program: (1) safety evaluations of existing dams, (2) review of plans and specifications for dam construction and major

Table 1.1
Loss of Life and Property Damage
From Notable U.S. Dam Failures, 1963-2006

Name & Location of Dam	Date of Failure	Number of Lives Lost	Damages
Mohegan Park, CT	3/63	6	\$3 million.
Little Deer Creek, UT	6/63	1	Summer cabins damaged.
Baldwin Hills, CA	12/63	5	41 houses destroyed, 986 houses damaged, 100 apartment buildings damaged.
Swift, MT	6/64	19	Unknown.
Lower Two Medicine, MT	6/68	9	Unknown.
Lee Lake, MA	3/68	2	6 houses destroyed, 20 houses damaged, 1 manufacturing plant damaged or destroyed.
Buffalo Creek, WV	2/72	125	546 houses destroyed, 538 houses damaged.
Lake "O" Hills, AR	4/72	1	Unknown.
Canyon Lake, SD	6/72	33	Unable to assess damage because dam failure accompanied damage caused by natural flooding.
Bear Wallow, NC	2/76	4	1 house destroyed.
Teton, ID	6/76	11	771 houses destroyed, 3,002 houses damaged, 246 businesses damaged or destroyed.
Laurel Run, PA	7/77	40	6 houses destroyed, 19 houses damaged.
Sandy Run & 5 others, PA	7/77	5	Unknown.
Kelly Barnes, GA	11/77	39	9 houses, 18 house trailers, & 2 college buildings destroyed; 6 houses, 5 college buildings damaged.
Lawn Lake, CO	7/82	3	18 bridges destroyed, 117 businesses & 108 houses damaged. Campgrounds, fisheries, power plant damaged.
D.M.A.D., UT	6/83	1	Unknown.
Nix Lake Dam, TX	3/89	1	Unknown.
Silver Lake, MI	5/03	0	\$102,000,000.
Big Bay Lake, MS	3/04	0	98 houses, 2 churches, fire station, bridge, \$2.2 million
Kaloko Res., HI	3/06	7	Unknown.

Source: Graham, 1983, 2004

rehabilitation work, (3) periodic inspections of construction work on new and existing dams, and (4) review and approval of emergency action plans.

1.5 Role of the Consultant in Dam Safety

A dam is a special kind of structure—simple in concept but with many compli-

cated components. There is no such thing as a standard dam design; furthermore, each dam site is unique. The existence of a dam necessitates the involvement of many specialists to analyze, design, build, inspect, and repair it. This wide variety of consultants will include civil, geotechnical, mechanical, and electrical engineers.

As owner, you should know more about your dam than anyone else. A consultant can advise you on such important items as:

- The overall stability of the dam under normal and flood conditions.
- Any repairs or maintenance needed by the dam and appurtenant works. The consultant should identify the severity of any problems and indicate in what order to repair them.
- Cost estimates for repair work.
- Adequacy of the spillway to pass the design flood.
- An assessment of downstream hazards.
- The dam owner's preparation and procedures to deal with emergency conditions.

Hazardous conditions at the dam should be reported verbally and in writing to the dam owner and the TCEQ. A written report from the owner's consultant is essential for every inspection. It is uncommon that a dam owner has all of the technical skills needed to monitor the condition of the dam. Thus, the role of the consulting engineer is critical in dam safety.

1.6 Role of the Dam Owner in Dam Safety

An owner should be aware of and use both direct and indirect means of achieving dam safety. He can, of course, monitor and work on factors directly in his control (for example, structural integrity), which are detailed below. However, the owner may also seek to influence governmental policy and work for positive change in statutes and laws that affect dam safety (example, zoning laws). Such indirect influence by an owner could contribute significantly to reducing the likelihood and consequences of dam failure and, thus, to overall community safety.

Liability, insurance coverage, and the roles of the state and federal governments should all be well-understood by an owner. In Texas, liability can be imposed upon a

dam owner who fails to maintain, repair, or operate the dam safely and properly. This liability can apply not only to the individual dam owner, but also to any company that possesses the dam, or any person who operates or maintains it. If an unsafe condition existed prior to a new dam owner's term of ownership, the new owner cannot be relieved of liability should the dam fail during this term. Thus, the potential owner must carefully inspect the structural integrity of any dam prior to purchase and then inspect, maintain, and repair it thereafter. The current dam owner has a responsibility to disclose the conditions of the dam before selling the property.

Legally, the dam owner must do what is necessary to avoid injuring

persons or property—this usually applies to circumstances and situations which a reasonable person could anticipate. In order to meet your responsibility to maintain the dam in a reasonable and safe condition, you, the owner, should conduct regular inspections of the dam and maintain or repair deficient items. Regular inspections by qualified professionals are necessary to identify all problems and correcting them.

In addition to being well informed concerning liability, you should have a thorough understanding of your dam's physical and social environment, including knowledge of natural and technological hazards that threaten it, an understanding of the developing human settlement patterns around the dam, and an under-

standing of other events that can lead to structural failure. These indirect means of achieving dam safety are covered in more detail in Chapters 2, 3 and 10.

Owners can also influence the safety of dams in more direct ways. They can and should develop their own safety programs, which should include such important elements as inspection, monitoring through instrumentation, maintenance, emergency action planning, and proper operation. Such programs are directly related to a specific dam's structure and its immediate environment and depend on the owner's knowledge of the dam and how it works. Chapter 2 stresses the need for owner's knowledge about the dam, while Chapters 4 and 9 cover how to develop a safety program.