CHAPTER 9
OPERATIONS GUIDELINES

9.0 GENERAL

An operations plan details each of the safety program components outlined in Chapter 4, and detailed in Chapters 5 through 8. The extent of an operations plan depends on the complexity of the dam itself – factors such as dam size, number and type of appurtenances and operating mechanisms.

The operation of a dam may involve adjusting the reservoir level, controlling debris by opening and closing valves, keeping records, and, in general, ensuring public safety. Proper operation procedures is extremely important for maintaining a safe structure. Many small dams do not need a full-time operator, but should be checked regularly. Special operational procedures to be followed during an emergency should be posted, particularly if the owner/operator is not always available.

9.1 OPERATIONS PLAN GUIDELINES

Establishing an operations procedure or plan calls for detailed documentation of the following:

- Dam and reservoir physical characteristics data
- Descriptions of dam components (Chapter 2)
- Operations instructions for operable mechanisms (Chapter 9)
- Inspection guidelines (Chapter 5)
- Instrumentation and monitoring guidelines (Chapter 6)
- Maintenance operations guidelines (Chapter 7)
- Emergency operations guidelines (Chapter 8)
- Bibliographical information (Appendix D)

As recommended in Chapter 4, collection and review of existing information on the dam design, construction and structural characteristics is the first step in developing a dam safety program. Guidelines for inspections, monitoring, maintenance, and emergency action planning are presented in the other indicated chapters.

The operation plan should have several seperate sections:

Section A: Background Data

1. Vital dam statistics
2. Description of appurtenances

Section B: Operations Instructions and Records

1. Operating instructions for operable mechanisms
2. Inspection instructions and forms
3. Monitoring instructions and forms
4. Maintenance instructions and forms
5. Biblography
6. Telephone list

Section C: Emergency Warning System

Sections A and B are described briefly below and a schedule of routine tasks is included. Instructions are included for frequent inspections, monitoring, and follow-up maintenance. The Emergency Warning System plan is discussed in Chapter 8.

9.1.1 Background Data

1. Vital dam statistics include:

a. General

- Type of dam
- Height of dam
- Length of crest
- Width of crest
- Angle of upstream slope
- Angle of downstream slope
- Available freeboard
- Capacity tables for reservoir
- Top of dam elevation
- Capacity tables of inflow and outflow works
- County location
- Township location
- Stream name
- Year completed
- Hazard classification

b. Spillway

- Type of spillway
- Length of spillway
- Spillway channel elevation
- Normal pool elevation
- Available freeboard
- Maximum observed flow and date of occurrence
- Discharge tables for spillway

c. Outlet

- Size, configuration and type of outlet
- Size and type of outlet control device
- Discharge tables for outlet
- Inlet invert elevation
- Outlet invert elevation
- Drainage systems and drain locations

9.1.2 Operations Instructions and Records

Operating instructions for operable mechanisms - The plan should provide complete, clear, step-by step instructions for operating all mechanisms associated with a dam including the outlet control valve and spillway gates. Proper sequences should be emphasized and sketches, drawings, and photographs to aid in identifying specific handles, cranks, buttons, etc should be included. The correct method of opening and closing guard gates, gate usage during low and high flow, openings at which excessive vibrations are experienced, and operating problems peculiar to a specific gate should also be listed. For hydraulic and electric gates, a schematic diagram should be provided showing each component (including back-up equipment) and its place in the operating sequence.

Instructions on the general operation of the reservoir, including the regulation of inflow and outlet ditches, should be given. These should state the maximum pool levels to be allowed at different times of the year, maximum and/or minimum carry over storage, maximum and/or minimum permissible outlet releases. They should also describe operation of the outlet to limit or prevent excessive spillway flow, and the method for periodic drainage of the reservoir to permit thorough outlet or upstream slope inspection.

Inspection and instrumentation - A clear, step-by-step set of instructions for conducting a comprehensive inspection of the dam and its surroundings should also be provided. Forms, for recording data such as those in Appendix A, should be used and copies of all completed inspection records should be kept.

Monitoring instructions - Clear instructions on how to use monitoring instruments and how to take measurements at monitoring points should be prepared, a map identifying each instrument and monitoring point should be included, and forms for recording the data should be provided. The monitoring points themselves, plus any seepage or other areas needing special attention should be kept clear of obscuring growth and be permanently marked, so they can be found during inspection. The help of a qualified engineer will be useful in developing this section.

Monitoring can only be beneficial if the observations are recorded in an orderly way and form a clear performance record. Thus, plotting or charting some of the readings will be necessary. Instructions on how to make and record each measurement or observation must be provided. If the owner's engineer is not going to plot or chart the data, instructions and forms should be developed to allow owners, operators, or maintenance personnel to do this work. An experienced consulting engineer may be helpful in preparing the needed formats.

Maintenance instructions - Instructions for performing periodic maintenance should be given in detail, so that new personnel can understand the task and experienced personnel can verify that they have completed the work properly. All needed maintenance work should be identified and listed. This list includes the tasks described in Chapter 7 such as:

1. Removing brush and trees
2. Removing debris
3. Regrading the crest and/or access roads
4. Removing harmful rodents
5. Operating and lubricating gates
6. Adding riprap when needed
7. Sealing joints in concrete facings
8. Cleaning drainpipes and outlets
9. Maintaining monitoring points
10. Maintaining security of operating equipment

Bibliography - All available reference material should be cataloged in a single list. Other title, author or agency responsible for publication, date and place of publication or brief description, and the permanent location of the material (for example filing cabinet in basement) should be included. Even materials without titles or authors, such as photographs and maintenance information, should be listed.

Telephone List - A comprehensive up-to-date listing of important telephone numbers should be maintained and include:

- The owner/operator (home and office) phones
- Employees actively involved with the dam
- The local emergency management agency
- State police
- The local police and fire departments
- The state agency responsible for dam safety
- Qualified local engineering consultants
- Downstream residents

9.2 SCHEDULE OF ROUTINE TASKS

A schedule should be established that includes both day-to day tasks and tasks performed less frequently during the year. Such a schedule serves to formalize inspection and maintenance procedures and makes it easy to determine when a task should be done. As suggested in Table 9.1, The frequency of a required task is often dependent upon the hazard classification of the dam (See Chapter 3).

9.3 RECORD KEEPING

As already suggested, operating a dam should include keeping accurate records of:

1. *Observations:* All observations should be recorded. Periodic observation of seepage is particularly important. Again, photographs are valuable for recording observations and documenting changes.
2. *Maintenance:* Written records of maintenance and major repairs are important for evaluating the safety of a dam.

3. *Rainfall and Water Levels:* A record of the date, time, and maximum elevation of extremely high water and associated rainfall or runoff is especially helpful in evaluating the performance of a dam and its spillway system. In particular, records should be kept for reservoirs that have widely fluctuating water levels.
4. *Drawdown:* A record should be kept of the amount, rate, and reason for pool level drawdown.
5. *Other Procedures:* A complete record of all operating procedures should be maintained.

TABLE 9.1
OPERATION PLAN SCHEDULE OF ROUTINE TASKS
Hazard Classifications

Frequency	Category 1 High Hazard Many lives lost, Excessive damage	Category 2 Significant Few lives lost, Appreciable damage	Category 3 Low Hazard No lives lost, Minimal damage
(Minimum)			
Daily	Surveillance.	—	—
Weekly	Monitor seepage.	Surveillance.	—
Monthly	Collect and examine observation well data.	Collect and examine observation well data.	Surveillance. Monitor seepage. Collect and examine observation well data.
Quarterly	Inspect visually.	Inspect visually.	—
Bi annually	Test outlet and spillway components.	—	—
Annually	Inspection by engineer. Check alignments and movements.	Inspection by engineer. Test outlet and spillway components. Check alignments and movements.	Visual inspection. Test outlet.
As required	Routine maintenance and additional inspections.	Routine maintenance and additional inspections.	Routine maintenance and additional inspections. Check alignments and movements.
Immediately after floods and earthquakes	Additional inspections.	Additional inspections.	Additional inspections

CHAPTER 10

REDUCING THE CONSEQUENCES OF DAM FAILURE

10.0 SUPPLEMENTS TO A DAM SAFETY PROGRAM

This manual has stressed safety as both a fundamental need and a prime responsibility of the dam owner. Developing an effective dam safety program is the single most important measure a dam owner can take to reduce the possibility or consequences of dam failure. However, on a national scale, an acceptable level of dam safety is still far from being achieved. Losses are continuing to increase and may intensify as population growth and migration continue. From both the perspective of the nation and the dam owner, other steps must be taken to reduce loss of life and property and subsequent liability.

Liabilities which are determined following a dam failure strongly affect both organizations and people, governments and dam owners. Determination of liability is the legal means developed by society to recover damages due to a "wrong" (in this case, lack of dam safety) and is another aspect of the dam safety problem. A thorough understanding of this legal process can help the dam owner decide the steps to be taken to reduce liability.

A discussion of liability and its relation to a dam owner is presented below, followed by a discussion of three important measures beyond that of individual dam safety that dam owners can promote to reduce liability -- the use of insurance, the provision of governmental assistance, and the use of consultants.

10.1 LIABILITY

The following discussion reviews general principles concerning liability and the operation of reservoirs. Liability in specific instances, however, very much depends upon the dam, the accident, the owner and the jurisdiction in which the reservoir is located.

The liability of an owner of a reservoir is considered general civil ("tort") liability, A tort is simply a civil wrong for which an injured party may recover damages from the responsible party. In most circumstances, simply causing damage is not sufficient basis for the imposition of liability. Negligence must accompany the injury before liability is incurred. However, negligence is not a fixed concept; it has been modified and changed by court decisions over the years. In simplest terms, it has been described as the violation of a duty to act as a reasonable and prudent person would act; a violation which directly results in damage to another.

The questions of what "duty" is imposed by society and what standard of reasonable care is imposed by the duty have undergone enormous scrutiny and changes over the past 25 years. In many instances the duty to make a product safe or the duty to insure that one's property does not pose a danger to others, has been significantly increased.

While the concept of negligence has been substantially broadened, changes in the limits of negligence do not directly affect dam owners because a separate basis of liability has long been imposed upon them. This standard is one of "strict liability." Strict liability is not based upon fault or negligence, rather it is based solely upon resulting damage, regardless of fault. Strict liability is generally applied to those activities which are deemed "ultra-hazardous" and not capable of being rendered reasonably safe.

The whole concept of strict liability was first established in a case involving a reservoir -- the 1866 English case, Fletcher vs. Rylands, L.R. 1, Ex. 265. A reservoir was built in the vicinity of abandoned coal mines; the water from the reservoir found its way into the abandoned shafts and from there into active shafts and caused damage. Under present legal thought, the basis of liability for such an occurrence may well be negligent design (i.e., failure to adequately

investigate the surrounding circumstances at the time the reservoir was built). However, in the actual decision, it was assumed that no one could have known the abandoned mine shafts existed and specifically decided that the owner was not negligent. Nonetheless, the English Court established the concept of strict liability for reservoir owners, and the owner of the reservoir was found to be liable for the escape of water from the reservoir regardless of fault.

Fletcher vs. Rylands has subsequently been adopted by most U.S. courts and has been cited when similar circumstances are considered. It is the basis for imposing liability on the owner of a reservoir for all damages caused, regardless of fault and without need to prove negligence.

Thus, with a very limited number of exceptions, the general statement of liability for the owner or operator of a reservoir is:

"IF WATER ESCAPES FROM A DAM, REGARDLESS OF FAULT, THE OWNER IS RESPONSIBLE FOR ALL DAMAGES SUSTAINED."

It should be noted however, that all of the discussion concerning compensation for damages due to release of water from a reservoir deal solely with water that has previously been stored. In all circumstances to date, and in most states by specific statute, a reservoir owner may pass on all natural flood waters without incurring any liability downstream.

Strict liability has two relatively narrow exceptions: acts of God, or intentional acts of third parties, over whom the owner had no control. While acts of God are recognized as a defense, this does not include all natural occurrences over which the owner had no control, but is more narrowly limited to those events over which the owner had no control and also which the owner could not, using available expertise, have anticipated. The other exception – intentional acts of third parties – was established by the Wyoming Supreme Court in the Wheatland case. The Wheatland Irrigation District asserted that their reservoir had been damaged by saboteurs, and the Wyoming Supreme Court recognized that illegal, intentional acts by third parties which the owner could not protect against or anticipate were a viable defense to strict liability.

Still, where there is no remedial legislation, the circumstances in which a reservoir owner is not liable for all damages caused by the leaking or breaking of his dam are severely limited.

While the standard of liability imposed on a reservoir owner affords extremely limited relief, several states have enacted legislation which limits, in certain circumstances liability for damages. In many other states, by statute or common law, the owner of a reservoir is entitled to utilize (i.e., release water to) the "normal high water line" of a stream without incurring liability for property damaged within the "normal" flood area. However, the definition of the limits within which no liability is imposed vary from place to place and may not be clearly designated on maps. Nonetheless, the right to utilize defined or "historic" floodplain regions downstream of a reservoir can provide substantial relief from strict liability for a reservoir owner.

With the recent insurance crisis and soaring liabililty insurance rates, many states are considering legislation which would limit either the basis of liability or the amount of liability that can be imposed on a reservoir owner. Some states, for example, are considering legislation which would change the standard of liability for a reservoir owner from a standard of "strict liability" to one of proven negligence.

If coupled with a redefinition of negligent actions, statutory modification of the basis of a reservoir owner's liability could have a significant effect. However, as noted above, the trend during the past 25 years has been to broaden, not narrow, the scope of negligent behavior by imposing broad expectations of prudence and foresight. Even if standards of "strict liability" are replaced by standards of "negligence," in the case of a reservoir owner, because the criteria of reasonable care and foresight are broadly interpreted, the change may not greatly affect the actual standard of liability imposed.

In summary, existing law holds a reservoir owner to the highest standard of care. Pending legislation may limit liability in certain circumstances, however the general statement remains unchanged: the owner is liable for all damages caused by water escaping from a reservoir -- despite the best efforts of the owner.

10.2 MEASURES TO REDUCE THE CONSEQUENCES OF DAM FAILURE

A dam owner can directly and indirectly influence the introduction and use of a variety of measures that will reduce the consequences of dam failure. Insurance can be purchased thus, spreading costs from a single dam owner to others. Land use measures, although difficult to institute, can be an even better means of mitigating future disasters. (If people are restricted from living in inundation zones, safety is obviously radically improved.) Increasing public awareness and governmental planning are also measures that can reduce the consequences of dam failure.

A dam owner can obtain insurance directly and should do so. The other measures discussed here: land use, public awareness and preparedness planning, are essentially controlled by local governments. Therefore, dam owners would be wise to to encourage as strongly as possible awareness and action in the public sector. Finally, a dam owner may also wish to hire consultants from the private sector when the information needed for prudent decisions exceeds their expertise.

10.2.1 Insurance - Insurance can provide liability and asset protection and thus, is important for dam owners. In many states a minimum level of insurance coverage is mandated by law; in others it is not. In either case, the level of insurance carried should be based on: state law, value of facilities at risk, potential downstream impacts, condition and age of the dam, likelihood of an incident occurring and the cost of available of insurance. Insurance spreads risk among a large group of people and can not only provide protection for the person or organization owning the dam, but also for employees and

governing boards who may be held personally liable. Types of coverage, availability and cost will vary from time to time, so it is, advisable to seek professional advice when considering the purchase of insurance. Some insurance companies and brokers specialize in issues related to dam failure. Recommendations of insurers can normally be obtained from insurance industry representatives or from the state agency responsible for dam safety. Not only can damage and liability be covered, the cost of business interruption, lost income, and workmen's compensation can also be provided.

Insurance can spread and reduce potential loss and as such should be an accepted cost of doing business. Many persons have avoided this cost and have paid severely for their shortsightedness.

10.2.2 Governmental assistance - One of the fundamential functions of government is to protect citizens from threats to their health, safety, and general welfare. Reducing the consequences of dam failure is clearly a duty of federal, state and local governments which have joint and separate responsibilities to the public concerning dam safety.

Land use planning, public awareness programs, and emergency preparedness planning are typically conducted at the local level -- the level of government most immediate and responsive to the dam owner. Federal agencies have technical expertise and can normally provide technical assistance when requested, but ultimately, each state is responsible for its own dam safety program.

Local government roles - Population settlement pattern and population growth strongly affect the costs of dam failures. More simply, if no one were allowed to settle in hazardous areas, few, if any, lives would be lost and little property damaged. Conversely, as settlement continues near dams and in inundation zones, the potential for disaster increases commensurately. "Low-hazard" dams are continually being transformed into "significant hazard" and "high hazard" dams as this settlement continues. Increased losses are inevitable unless significant land use measures are enacted to restrict the use of land in inundation zones. The strategies used will reflect federal, state, and local efforts, but local government must make the critical decisions and only rely on state and federal government for support. All elements of mitigation planning are based upon or affected by the way in which the affected land is used.

If the land has not been developed, the establishment of open space areas in potential inundation zones is a particularly effective way to reduce future costs of dam failure. Indeed, this is the best mitigation strategy to reduce future loss. Despite this utility, organized programs or strategies of land acquisition or settlement restriction exist in few states -- usually because of strong opposition among developers and land owners.

If land is already under development, zoning measures to limit high population density can be useful. Also, the establishment of "green areas" - parks or golf courses -- can be low cost means of limiting settlement in inundation zones. In some fully developed areas, flood proofing devices (walls, barriers) may prove useful.

In much of the nation, land has already been developed and residential construction in inundation zones is already in place. People that live in such areas may have a false sense of security and not be aware that a hazard even exists.

Experience has clearly shown that simple warning and evacuation procedures can save a significant number of lives. Table 10.1 demonstrates this success and the corresponding failure when early detection and warning are not available. Clearly, communities downstream from a dam should establish an early notification and warning system.

The stimulation of public awareness of this hazard and the development of warning and evacuation plans is clearly the responsibility of local government. The utility of such efforts cannot be overlooked; the aggregate return will be large over the long term.

Existing levels of awareness vary across the nation. Some people are fully aware of their exposure to this hazard while many do not even realize that they reside in an inundation zone. Obviously, tourists are usually less aware than permanent residents; camp grounds for example, are not normally posted with signs that point out the existence of a dam hazard. Clearly, awareness is the first step in mitigating the hazard and increasing safety.

Thus, counties, cities, towns and smaller unincorporated communities urgently need:

- **To develop programs to increase awareness of existing dam failure hazards, and more specifically, of who is in danger,**
- **To develop plans for warning and evacuating the population,**
- **To increase public familiarity with plans through publications, well publicized exercises and other means.**

Usually, a public awareness program will be well received and generate confidence in government. Media -- television, and newspapers -- radio are potentially the most effective way to educate people. Dam owners should encourage public awareness as well as warning and evacuation planning.

Table 10.1
Comparison of warning success for selected dam failures and flash floods

Event	Early direction & warning	Potential loss of life	Actual loss of life	Fatality rate (%)
Big Thompson, Colo. (Flash Flood)	No	2,500	139	5.6
Laurel Run Dam, Pa.	No	150	39	25.0
Kelly Barnes Dam, Ga.	No	200	39	20.0
Buffalo Creek, W. Va.	Some	4,000	125	3.1
Teton Dam, Idaho	Yes	35,000	11	<0.1
Southern Conn. June 1982 (20 dams failed)	Yes	Unknown	0	0
Lawn Lake, Colo.	Yes	4,000	3	<0.1
D.M.A.D, Utah	Yes	500	1	0.2

Source: Graham, 1983.

State government roles - Most state governments have actively attempted to reduce the possibility of and consequences of dam failure through any of several major programs.

While some local public and private organizations may capable of supervising dam safety, the authority and responsibility for such measures rest with state agencies that approve plans and specifications for the design and construction of dams, and conduct of inspections of existing dams. In most states, dam safety is monitored by the department of water resources, state engineer's office, or an equivalent agency in the executive branch of government. These agencies often determine the rules and regulations governing the design, construction, and maintenance of dams.

The state office of emergency preparedness is also concerned with dam safety. However, it deals mainly with planning for the protection of people - awareness, warning and evacuation planning. Disaster (including dam failure) response and recovery efforts are part of this program.

Federal government roles - The Federal Emergency Management Agency (FEMA) develops and maintains guidelines for dam safety policy, as well as programs for preparedness, emergency response and recovery planning and mitigation planning. FEMA coordinates all federal dam safety programs, and otherwise promotes both federal and nonfederal programs to reduce the hazard posed by unsafe dams.

The Federal Energy Regulatory Commission (FERC) supervises the dam safety program mandated by the Federal Power Act. It issues rules and regulations to ensure that licensed projects are adequately constructed, operated and maintained to protect life, health and property. FERC's jurisdiction includes dams at hydroelectric projects on navigable streams or on federally owned land projects using surplus water or waterpower from federally owned dams; and dams affecting interstate or foreign commerce.

The Department of the Army, Corps of Engineers, is authorized by the Federal Water Pollution Control Act of 1972 and the River and Harbor Act of 1899 to issue permits for work involving the nation's waterways. Under the National Dam Safety Act of 1972, the Corps, working with individual states, inventoried 68,153 dams, inspected 8,818, and established a list of hazard criteria.

Five agencies within the Department of Agriculture are involved with nonfederal dams. These include the Agricultural Stabilization and Conservation Service (ASCS), the Farmer's Home Administration (FMHA), the Forest Service, the Rural Electrification Administration (REA) and the Soil Conservation Service (SCS). Technical engineering is the responsibility of the Soil Conservation Service.

The U.S. Department of the Interior, Office of Surface Mining (OSM) provides support to state regulatory agencies that conduct dam inspection and monitoring as it relates to surface mining. The Department's Bureau of Reclamation also manages a program of water development which includes providing water for irrigation, the hydroelectric power industry, and recreation.

10.2.3 Consultants role in dam safety - A dam is a special kind of structure which is conceptually simple but made of many complicated components. Several engineering skills are needed to design, build, inspect and repair a dam, and it is uncommon that a dam owner has all of these technical skills. Even if the dam owner did have these skills, it is unlikely that an owner could devote the time and effort necessary to do the work properly. Thus, private consultants can play an important role in a dam safety program, and owners should consider contracting with consulting firms for assistance.

When hiring a consultant, certain steps will insure that an owner obtains what is really needed. The initial screening of possible consultants should be based on professional qualifications. A list of consultants who have experience with dams may be available from the state office managing dam safety. The owner should then investigate the background and experience of the company and the specific experience of the individuals who will do the work.

The owner should be sure to define as clearly as possible the work to be done. Although some owners select a consulting firm based on qualifications and then work with the firm to define the work to be done, an owner can often define the scope of work himself, and then receive bids and proposals from several consultants. This latter arrangement usually results in the lowest cost for a given piece of work.

If many of the items discussed in this guidebook are new and unfamiliar to a dam owner, a consultant should be contacted immediately. Professional consultants help conduct a proper and safe evaluation of a dam, and can help develop and execute an effective dam safety program. Of course, a dam owner should have confidence in the consultant he hires. When a consultant makes recommendations, they must be taken seriously.

APPENDIX A
INSPECTION FORMS

NAME OF DAM: _____ INSPECTION DATE: _____

EMBANKMENT
1 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
CREST	1	SURFACE CRACKING				
	2	CAVE IN, ANIMAL BURROW				
	3	LOW AREA(S)				
	4	HORIZONTAL ALIGNMENT				
	5	RUTS AND/OR PUDDLES				
	6	VEGETATION CONDITION				
	7					
	8					
UPSTREAM SLOPE	9	SLIDE, SLOUGH, SCARP				
	10	SLOPE PROTECTION				
	11	SINKHOLE, ANIMAL BURROW				
	12	EMB.-ABUT. CONTACT				
	13	EROSION				
	14	VEGETATION CONDITION				
	15					
	16					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

NAME OF DAM: _____ INSPECTION DATE: _____

EMBANKMENT
2 of 2

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATION	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
DOWNSTREAM SLOPE	17	WET AREA(S) (NO FLOW)				
	18	SEEPAGE				
	19	SLIDE, SLOUGH, SCARP				
	20	EMB.-ABUT. CONTACT				
	21	CAVE IN, ANIMAL BURROW				
	22	EROSION				
	23	UNUSUAL MOVEMENT				
	24	VEGETATION CONTROL				
	25					
	26					
INSTRUMENTATION	27	PIEZOMETERS/OBSERV. WELLS				
	28	STAFF GAUGE AND RECORDER				
	29	WEIRS				
	30	SURVEY MONUMENTS				
	31	DRAINS				
	32	FREQUENCY OF READINGS				
	33	LOCATION OF RECORDS				
	34					
	35					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

NAME OF DAM: _____ INSPECTION DATE: _____

DOWNSTREAM AREA AND MISC.

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
DOWNSTREAM AREA	36	ABUTMENT LEAKAGE				
	37	FOUNDATION SEEPAGE				
	38	SLIDE, SLOUGH, SCARP				
	39	DRAINAGE SYSTEM				
	40					
	41					
	42	DOWNSTREAM HAZARD DESCRIPTION				
	43	DATE OF LAST UPDATE OF EMERGENCY ACTION PLAN				
MISCELLANEOUS	44	RESERVOIR SLOPES				
	45	ACCESS ROADS				
	46	SECURITY DEVICES				
	47					
	48					
	49					
	50					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

NAME OF DAM: _____ INSPECTION DATE: _____

SPILLWAYS

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
ERODIBLE CHANNEL	51	SLIDE, SLOUGH, SCARP				
	52	EROSION				
	53	VEGETATION CONDITION				
	54	DEBRIS				
	55					
	56					
NON-ERODIBLE CHANNEL	57	SIDEWALLS				
	58	CHANNEL FLOOR				
	59	UNUSUAL MOVEMENT				
	60	APPROACH AREA				
	61	WEIR OR CONTROL				
	62	DISCHARGE AREA				
	63					
	64					
DROP INLET	65	INTAKE STRUCTURE				
	66	TRASHRACK				
	67	STILLING BASIN				
	68					
	69					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

NAME OF DAM: _____ INSPECTION DATE: _____

OUTLET WORKS

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
OUTLET WORKS	70	INTAKE STRUCTURE				
	71	TRASHRACK				
	72	STILLING BASIN				
	73	PRIMARY CLOSURE				
	74	SECONDARY CLOSURE				
	75	CONTROL MECHANISM				
	76	OUTLET PIPE				
	77	OUTLET TOWER				
	78	EROSION ALONG DAM TOE				
	79	SEEPAGE				
	80	UNUSUAL MOVEMENT				
	81					
	82					
	83					

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

NAME OF DAM: _____ INSPECTION DATE: _____

CONCRETE/MASONRY DAMS

AREA INSPECTED	ITEM NO.	CONDITION	OBSERVATIONS	CHECK ( ) ACTION NEEDED: MONITOR	INVESTI-GATE	REPAIR
UPSTREAM FACE	84	SURFACE CONDITIONS				
	85	CONDITION OF JOINTS				
	86	UNUSUAL MOVEMENT				
	87	ABUTMENT-DAM CONTACTS				
	88					
	89					
	90	SURFACE CONDITIONS				
DOWNSTREAM FACE	91	CONDITION OF JOINTS				
	92	UNUSUAL MOVEMENT				
	93	ABUTMENT-DAM CONTACTS				
	94	DRAINS				
	95	LEAKAGE				
	96					
	97					
CREST	98	SURFACE CONDITIONS				
	99	HORIZONTAL ALIGNMENT				
		VERTICAL ALIGNMENT				
		CONDITION OF JOINTS				
		UNUSUAL MOVEMENTS				

ADDITIONAL COMMENTS: REFER TO ITEM NO. IF APPLICABLE.

APPENDIX B
REPORT FORM

DAM INCIDENT REPORT FORM

DATE _____ TIME _____

NAME OF DAM _____

STREAM NAME _____

LOCATION _____

COUNTY _____

OBSERVER _____

OBSERVER TELEPHONE _____

NATURE OF PROBLEM _____

_____

LOCATION OF PROBLEM AREA _____
(Looking Downstream)

_____

EXTENT OF PROBLEM AREA _____

_____

FLOW QUANTITY AND COLOR _____

_____

WATER LEVEL IN RESERVOIR _____

WAS SITUATION WORSENING _____

EMERGENCY STATUS _____

CURRENT WEATHER CONDITIONS _____

_____

ADDITIONAL COMMENTS: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

APPENDIX C
GLOSSARY

ABUTMENT
That part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment. Right and left abutments are those on respective sides of an observer looking downstream.

ACTIVE STORAGE
The volume of a reservoir that is available for power generation, irrigation, flood control, or other purposes. Active storage excludes flood surcharge. It is the reservoir capacity less inactive and dead storages. The terms "useful storage," "unable storage," or "working storage" are sometimes used but are not recommended.

AIRVENT PIPE
A pipe designed to provide air to the outlet conduit to reduce turbulence during release of water. Extra air is usually necessary downstream of constrictions.

APPURTENANT STRUCTURES
Ancillary features of a dam, such as the outlet, spillway, powerhouse, tunnels, etc.

AQUEDUCT
An artificial channel for conveying water, i.e., a canal, pipe, or tunnel; hence the terms "connecting aqueduct" and "diversion aqueduct."

ARCH DAM
A concrete or masonry dam that is curved so as to transmit the major part of the water pressure to the abutments.

Double Curvature Arch Dam
An arch dam that is curved vertically as well as horizontally.

Arch Buttress Dam
See Buttress Dam.

Arch Gravity Dam
See Gravity Dam.

AUXILIARY SPILLWAY
See Spillway.

AXIS OF DAM
A plane or curved surface, arbitrarily chosen by a designer, appearing as a line in a plan or cross section to which the horizontal dimensions of the dam can be referred.

BACKWATER CURVE
The longitudinal profile of the water surface in an open channel where the depth of flow has been increased by an obstruction, an increase in channel roughness, a decrease in channel width, or a flattening of the bed slope.

BASE WIDTH (Base Thickness)
The maximum width or thickness of a dam measured horizontally between upstream and downstream faces and normal to the axis of the dam but excluding projections for outlets, etc.

BERM
A horizontal step or bench in the sloping profile of an embankment dam.

BLANKET

Drainage Blanket
A drainage layer placed directly over the foundation material.

Grout Blanket
See Consolidation Grouting.

Upstream Blanket
An impervious layer placed on the reservoir floor upstream of a dam. In the case of an embankment dam, the blanket may be connected to the impermeable element in a dam.

BUTTRESS DAM
A dam consisting of a watertight upstream face supported at intervals on the downstream side by a series of buttresses.

Arch Buttress Dam (Curved Buttress Dam)
A buttress dam that is curved in plan.

Multiple Arch Dam
A buttress dam whose upstream part comprises a series of arches.

Cofferdam
A temporary structure enclosing all or part of a construction area so that construction can proceed in a dry area. A "diversion cofferdam" diverts a river into a pipe, channel, or tunnel.

CONCRETE LIFT
In concrete work the vertical distance between successive horizontal construction joints.

CONDUIT
A closed channel for conveying discharge through or under a dam.

CONSOLIDATION GROUTING (Blanket Grouting)
The injection of grout to consolidate a layer of the foundation, resulting in greater impermeability and/or strength.

CONSTRUCTION JOINT
The interface between two successive placings or pours of concrete where a bond, not permanent separation is intended.

CORE WALL
A wall built of impervious material, usually concrete or asphaltic concrete, in the body of an embankment dam to prevent leakage.

CREST GATE
See Gate.

CREST LENGTH
The length of the top of a dam, including the length of spillway, powerhouse, navigation lock, fish pass, etc. where these structures form part of the length of a dam. If detached from a dam, these structures should not be included.

CREST OF DAM
The crown of an overflow section of a dam. In the United States, the term "crest of dam" is often used when "top of dam" is meant. To avoid confusion, the terms "crest of spillway" and "top of dam" may be used to refer to the overflow section and the dam proper, respectively.

CRIB DAM
A gravity dam built up of boxes, cribs, crossed timbers, or gabions and filled with earth or rock.

CULVERT
(a) A drain or waterway built transversely under a road, railway, or embankment, usually consisting of a pipe or covered channel of box section. (b) A gallery or waterway constructed through any type of dam, which is normally dry but is used occasionally for discharging water; hence the terms "scour culvert," "drawoff culvert," and "spillway culvert."

CURTAIN
See Grout curtain

CURVED BUTTRESS DAM (Arch Buttress Dam)
See Buttress Dam.

CURVED GRAVITY DAM
See Gravity Dam.

CUTOFF
An impervious construction or material which reduces seepage or prevents it from passing through foundation material.

CUTOFF TRENCH
An excavation later to be filled with impervious material to form a cutoff. Sometimes used incorrectly to describe the cutoff itself.

CUTOFF WALL
A wall of impervious material (e.g., concrete, asphaltic concrete, steel sheet piling) built into the foundation to reduce seepage under the dam.

DAM
A barrier built across a watercourse for impounding or diverting the flow of water.

DEAD STORAGE
The storage that lies below the invert of the lowest outlet and that, therefore, cannot be withdrawn from the reservoir.

DESIGN FLOOD
See Spillway Design Flood.

DIAMOND HEAD BUTTRESS DAM
See Buttress Dam.

DIAPHRAGM
See Membrane.

DIKE (Levee)
A long low embankment whose height is usually less than 4 to 5 meters and whose length is more than 10 or 15 times the maximum height. Usually applied to embankments or structures built to protect land from flooding. If built of concrete or masonry the structure is usually referred to as a flood wall. Also used to describe embankments that block areas on a reservoir rim that are lower than the top of the main dam and that are quite long. In the Mississippi River basin, where the old French word levee has survived, the term now applies to flood protecting embankments whose height can average up to 10 to 15 meters.

DIVERSION CHANNEL CANAL, OR TUNNEL
A waterway used to divert water from its natural course. These terms are generally applied to temporary structures such as those designed to bypass water around a dam site during construction. "Channel' is normally used instead of "canal" when the waterway is short. Occasionally these terms are applied to permanent structures.

DRAINAGE AREA
An area that drains naturally to a particular point on a river.

DRAINAGE LAYER OR BLANKET
A layer of permeable material in a dam to relieve pore pressure or to facilitate drainage of fill.

DRAINAGE WELLS (Relief Well)
A vertical well or borehole, usually downstream of impervious cores, grout curtains, or cutoffs, designed to collect and direct seepage through or under a dam to reduce uplift pressure under or within a dam. A line of such wells forms a drainage curtain.

DRAWDOWN
The lowering of water surface level due to release of water from a reservoir.

EARTH DAM OR EARTHFILL DAM
See Embankment Dam.

EMBANKMENT
A slope of fill material, usually earth or rock, that is longer than it is high. The sloping side of a dam.

Embankment Dam (Fill Dam)
Any dam constructed of excavated natural materials or of industrial waste materials.

Earth Dam (Earthfill Dam)
An embankment dam in which more than 50% of the total volume is formed of compacted fine-grained material obtained from a borrow area.

Homogeneous Earthfill Dam
An embankment dam constructed of similar earth material throughout, except internal drains or drainage blankets; distinguished from a zoned earthfill dam.

Hydraulic Fill Dam
An embankment dam constructed of materials, often dredged, that are conveyed and placed by suspension in flowing water.

Rockfill Dam
An embankment dam in which more than 50% of the total volume comprises compacted or dumped pervious natural or crushed rock.

Rolled Fill Dam
An embankment dam of earth or rock in which the material is placed in layers and compacted by using rollers or rolling equipment.

Zoned Embankment Dam
An embankment dam, of which is composed of zones of selected materials having different degrees of porosity, permeability, and density.

EMERGENCY ACTION PLAN
A predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in an area affected by a dam break.

EMERGENCY GATE
A standby or reserve gate used only when the normal means of water control are not available.

EMERGENCY SPILLWAY
See Spillway.

ENERGY/DISSIPATING VALVE
Any device constructed in a waterway to reduce or destroy the energy of fast-flowing water.

EPICENTER
The point on the earth's surface directly above the focus of an earthquake.

FACE
The external surface of a structure, e-g, the surface of a wall of a dam.

FACING
With reference to a wall or concrete dam, a coating of material, masonry or brick, for architectural or protection purposes, e.g., stonework facing, brickwork facing With reference to an embankment dam, an impervious coating or face on the upstream slope of the dam.

FAILURE
The uncontrolled release of water from a dam.

FILTER (Filter Zone)
A band or zone of granular material that is incorporated into a dam and is graded (either naturally or by selection) so as to allow seepage to flow across or down the filter without causing the migration of material from zones adjacent to the filter.

FLASHBOARDS
A length of timber, concrete, or steel pl aced on the crest of a spi llway to raise the retention water level el but that may be quickly removed in the event of a flood . either by a tripping device or by deliberately designed failure-of the flashboard or its supports.

FLOODPLAIN
An area adjoining a body of water or natural stream that has been or may be covered by flood water.

FLOODPLAIN MANAGEMENT
A management program to reduce the consequences of flooding - either by natural runoff or by dam failure - to existing and future properties in a flood-plain.

FLOOD ROUTING
The determination of the attenuating effect of storage on a flood passing through a valley, channel, or reservoir.

FLOOD SURCHARGE
The volume or space in a reservoir between the controlled retention water level and the maximum water level. Flood surcharge cannot be retained in the reser-voir but will flow over the spillway until the controlled retention water level is reached. (The term "wet freeboard" for describing tbe depth of flood surcharge is not recommended; see Freeboard),

FL OOD WALL
A concrete wall constructed adjacent to a stream for the purpose of pieventing flooding of property on the landward side of the wall; normally constructad in lieu of or to supplement a levee where the land required for levee construction is expensive or not available.

FOUNDATION OF DAM
The natural material on which the dam structure is placed.

FREEBOARD
The vertical distance between a stated water level and the top of a dam. "Net freeboard," "dry freeboad, " "flood freeboard," or "residual Freeboard" is the vertical distance between the estimated maximum water level and the top of a dam, "Gross freeboard" or "total freeboard" is the vertical distance between the maximum planned controlled retention water level and the top of a dam. (That part of tbe "gross freeboard" attributable to the depth of flood surcharge is some-times referred to as the "wet freeboard," but this term is not recommended; it is preferable that freeboard be used with reference to the top of the dam

GALLERY
(a) A passageway within the body of a dam or abutment; hence the terms "grouting gallery," "inspection gallery," and "drainage gallery." (b) A long and rather narrow hall; hence the following terms for a power plant: "valve gallery," "transformer gallery," and "busbar gallery."

GATE
A device in which a leaf or member is moved across the waterway from an external position to control or stop the flow.

Bulkhead Gate
A gate used either for temporary closure of a channel or conduit to empty it for inspection or maintenance or for closure against flowing water when the head difference is small, e.g., for diversion tunnel closure. Although a bulkhead gate is usually opened and closed under nearly balanced pressures, it nevertheless may be capable of withstanding a high pressure differential when in the closed position.

Crest Gate (Spillway Gate)
A gate on the crest of a spillway to control overflow or reservoir water level.

Emergency Gate
A standby or reserve gate used only when the normal means of water control is not available.

Fixed Wheel Gate (Fixed Roller Gate, Fixed Axle Gate)
A gate having wheels or rollers mounted on the end posts of the gate. The wheels bear against rails fixed in side grooves or gate guides.

Flap Gate
A gate hinged along one edge, usually either the top or bottom edge. Examples of bottom-hinged flap gates are tilting gates and belly gates, so-called due to their shape in cross section.

Flood Gate
A gate to control flood release from a reservoir.

Guard Gate (Guard Valve)
A gate or valve that operates fully open or closed. It may function as a secondary device for shutting off the flow of water in case the primary closure device becomes inoperable, but is usually operated under balanced pressure, no-flow conditions.

Outlet Gate
A gate controlling the outflow of water from a reservoir.

Radial Gate (Tainter Gate)
A gate with a curved upstream plate and radial arms hinged to piers or other supporting structures.

Regulating Gate (Regulating Valve)
A gate or valve that operates under full pressure and flow conditions to throttle and vary the rate of discharge.

Slide Gate (Sluice Gate)
A gate that can be opened or closed by sliding it in supporting guides.

GRAVITY DAM
A dam constructed of concrete and/or masonry that relies on its weight for stability.

Arch Gravity Dam
An arch dam in which part of the water pressure is transmitted to the abutments by horizontal thrust and part to the foundation by cantilever action.

Curved Gravity Dam
A gravity dam that is curved in plan.

Hollow Gravity Dam (Cellular Gravity Dam)
A dam that has the outward appearance of a standard gravity dam but that is of hollow construction.

GROSS STORAGE (Reservoir Capacity (Gross Capacity of Reservoir)
The gross capacity of a reservoir from the river bed up to maximum controlled retention water level. It includes active, inactive, and dead storage.

GROUT BLANKET
See Blanket.

GROUT CAP
A concrete pad or wall constructed to facilitate pressure grouting of the grout curtain beneath it.

GROUT CURTAIN (Grout Cutoff)
A barrier produced by injecting grout into a vertical zone, usually narrow horizontally, in the foundation to reduce seepage under a dam.

HEIGHT ABOVE LOWEST FOUNDATION
The maximum height from the lowest point of the general foundation to the top of the dam.

HYDRAULIC HEIGHT
The height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

HYDROGRAPH
A graphic representation of discharge, stage, or other hydraulic property with respect to time for a particular point on a stream. (At times the term is applied to the phenomenon the graphic representation describes; hence a flood hydrograph is the passage of a flood discharge past the observation point.)

INACTIVE STORAGE
The storage volume of a reservoir measured between the invert level of the lowest outlet and minimum operating level.

INCLINOMETER (Inclometer)
An instrument, usually consisting of a metal or plastic tube inserted in a drill hole and a sensitized monitor either lowered into the tube or fixed within the tube. This measures at different points the tube's inclination to the vertical. By integration, the lateral position at different levels of the tube may be found relative to a point, usually the top or bottom of the tube, assumed to be fixed. The system may be used to measure settlement.

INTAKE
Any structure in a reservoir, dam, or river through which water can be drawn into an aqueduct.

INTENSITY SCALE
An arbitrary scale used to describe the severity of earthquake-induced shaking at a particular place. The scale is not based on measurement but on direct observation. Several scales are used (e.g., the Modified Mercalli scale, the MSK scale) all with grades indicated by Roman numerals from I to XII.

INTERNAL EROSION
See Piping.

INUNDATION MAP
A map delineating the area that would be inundated in the event of a dam failure.

LEAKAGE
Uncontrolled loss of water by flow through a hole or crack.

LINING
With reference to a canal, tunnel, shaft, or reservoir, a coating of asphaltic concrete, reinforced or unreinforced concrete, shotcrete, rubber or plastic to provide watertightness, prevent erosion, reduce friction, or support the periphery of the structure. May also refer to lining, such as steel or concrete, of outlet pipe or conduit.

LIVE STORAGE
The sum of active and inactive storage volumes. When there is no inactive storage, as in some irrigation reservoirs, the terms "live storage" and "active storage" are equivalent.

LOW LEVEL OUTLET (Bottom Outlet)
An opening at a low level from a reservoir generally used for emptying or for scouring sediment and sometimes for irrigation releases.

MAGNITUDE (see also Richter Scale)
A rating of an earthquake independent of the place of observation. It is calculated from seismographic measurements and is properly expressed in ordinary numbers and decimals based on a logarithmic scale. Each higher number expresses an amount of earthquake energy that is 10 times greater than that expressed by the preceding lower number, e.g., a magnitude 6 earthquake has 10 times more energy than a magnitude 5.

MASONRY DAM
A dam constructed mainly of stone, brick, or concrete blocks that may or may not be joined with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.

MAXIMUM CREDIBLE EARTHQUAKE (MCE)
The severest earthquake that is believed to be possible at a site on the basis of geologic and seismological evidence. It is determined by regional and local studies including a complete review of all historic earthquake data of events sufficiently nearby to affect the site, all faults in the area, and attenuations due to faults to the site.

MAXIMUM CROSS SECTION OF DAM
A cross section of a dam at the point of maximum height of the dam.

MAXIMUM WATER LEVEL
The maximum water level, including flood surcharge, the dam is designed to withstand.

MEMBRANE (Diaphragm)
A sheet or thin zone or facing made of a flexible material that is sometimes referred to as a diaphragm wall or diaphragm.

MINIMUM OPERATING LEVEL
The lowest level to which the reservoir is drawn down under normal operating conditions.

MORNING GLORY SPILLWAY
See Spillway.

NORMAL WATER LEVEL
For a reservoir with a fixed overflow sill the lowest crest level of that sill. For a reservoir whose outflow is controlled wholly or partly by movable gates, siphons or other means, it is the maximum level to which water may rise under normal operating conditions, exclusive of any provision for flood surcharge.

OPERATING BASIS EARTHQUAKE
A hypothetical earthquake used for design purposes. A more moderate standard than the Maximum Credible Earthquake (see), it is based on regional and local geology and seismology studies and is considered likely to occur during the life of the dam.

ONE-HUNDRED YEAR (100-Year) EXCEEDANCE INTERVAL
The flood magnitude expected to be equalled or exceeded on the average of once in 100 years. It may also be expressed as an exceedance frequency with a percent chance of being exceeded in any given year.

OUTLET
An opening through which water can be freely discharged from a reservoir.

OVERFLOW DAM (Overtoppable Dam)
A dam designed to be overtopped.

PARAPET WALL
A solid wall built along the top of a dam for ornament, for the safety of vehicles and pedestrians, or to prevent overtopping.

PEAK FLOW
The maximum instantaneous discharge that occurs during a flood. It is coincident with the peak of a flood hydrograph.

PERVIOUS ZONE
A part of the cross section of an embankment dam comprising material of high permeability.

PHREATIC SURFACE
The free surface of groundwater at atmospheric pressure.

PIEZOMETER
An instrument for measuring pore water pressure within soil, rock, or concrete.

PIPING
The progressive development of internal erosion by seepage, appearing downstream as a hole or seam discharging water that contains soil particles.

PORE PRESSURE
The interstitial pressure of water within a mass of soil rock, or concrete.

PRESSURE CELL
An instrument for measuring pressure within a mass of soil, rock, or concrete or at an interface between one and the other.

PRESSURE RELIEF PIPES
Pipes used to relieve uplift or pore water pressure in a dam foundation or in the dam structure.

PROBABLE MAXIMUM FLOOD (PMF)
A flood that would result from the most severe combination of critical meteorologic and hydrologic conditions possible in the region.

One-Half PMF
A flood with a peak flow equal to one-half of the peak flow of a probable maximum flood.

PROBABLE MAXIMUM PRECIPITATION (PMP)
The maximum amount and duration of precipitation that can be expected to occur on a drainage basin.

PUMPED STORAGE RESERVOIR
A reservoir filled entirely or mainly with water pumped from outside its natural drainage area.

REGULATING DAM
A dam impounding a reservoir from which water is released to regulate the flow in a river.

RELIEF WELL
See Drainage Well.

RESERVOIR AREA
The surface area of a reservoir when filled to controlled retention water level.

RESERVOIR ROUTING
The computation by which the interrelated effects of the inflow hydrograph, reservoir storage, and discharge from the reservoir are evaluated.

RESERVOIR SURFACE
The surface of a reservoir at any level.

RICHTER SCALE
A scale proposed by C.F. Richter to describe the magnitude of an earthquake by measurements made in well-defined conditions and with a given type of seismograh. The zero of the scale is fixed arbitrarily to fit the smallest recorded earthquakes. The largest recorded earthquake magnitudes are near 8.7 and are the result of observations and not an arbitrary upper limit like that of the intensity scale.

RIPRAP
A layer of large uncoursed stones, broken rock, or precast blocks placed in random fashion on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel as a protection against wave and ice action. Very large riprap is sometimes referred to as armoring.

RISK ASSESSMENT
As applied to dam safety, the process of identifying the likelihood and consequences of dam failure to provide the basis for informed decisions on a course of action.

ROCKFILL DAM
See Embankment Dam.

ROLLCRETE
A no-slump concrete that can be hauled in dump trucks, spread with a bulldozer or grader, and compacted with a vibratory roller.

SEEPAGE
The interstitial movement of water that may take place through a dam, its foundation, or its abutments.

SEEPAGE COLLAR
A projecting collar, usually of concrete, built around the outside of a pipe, tunnel, or conduit under an embankment dam, to lengthen the seepage path along the outer surface of the conduit.

SILL
(a) A submerged structure across a river to control the water level upstream. (b) The crest of a spillway. (c) A horizontal gate seating, made of wood, stone, concrete or metal at the invert of any opening or gap in a structure, hence the expressions "gate sill" and "stoplog sill."

SLOPE
(a) The side of a hill or mountain. (b) The inclined face of a cutting or canal or embankment. (c) Inclination from the horizontal. In the Untied States, it is measured as the ratio of the number of units of horizontal distance to the number of corresponding units of vertical distance. The term is used in English for any inclination and is expressed as a percent when the slope is gentle, in which case the term "gradient" is also used.

SLOPE PROTECTION
The protection of a slope against wave action or erosion.

SLUICEWAY
See low-level outlet.

SPILLWAY
A structure over or through which flood flows are discharged. If the flow is controlled by gates, it is a controlled spillway; if the elevation of the spillway crest is the only control, it is an uncontrolled spillway.

Auxiliary Spillway (Emergency Spillway)
A secondary spillway designed to operate only during exceptionally large floods.

Fuse Plug Spillway
An auxiliary or emergency spillway comprising a low embankment or a natural saddle designed to be overtopped and eroded away during a very rare and exceptionally large flood.

Primary Spillway (Principal Spillway)
The principal or first-used spillway during flood flows.

Shaft Spillway (Morning Glory Spillway)
A vertical or inclined shaft into which flood water spills and then is conducted through, under, or around a dam by means of a conduit or tunnel. If the upper part of the shaft is splayed out and terminates in a circular horizontal weir, it is termed a "bellmouth" or "morning glory" spillway.

Side Channel Spillway
A spillway whose crest is roughly parallel to the channel immediately downstream of the spillway.

Siphon Spillway
A spillway with one or more siphons built at crest level. This type of spillway is sometimes used for providing automatic surface-level regulation within narrow limits or when considerable discharge capacity is necessary within a short period of time.

SPILLWAY CHANNEL (Spillway Tunnel)
A channel or tunnel conveying water from the spillway to the river downstream.

SPILLWAY DESIGN FLOOD (SDF)
The largest flood that a given project is designed to pass safely. The reservoir inflow-discharge hydrograph used to estimate the spillway discharge capacity requirements and corresponding maximum surcharge elevation in the reservoir.

STILLING BASIN
A basin constructed to dissipate the energy of fast-flowing water, e.g., from a spillway or bottom outlet, and to protect the river bed from erosion.

STOPLOGS
Large logs or timber or steel beams placed on top of each other with their ends held in guides on each side of a channel or conduit providing a cheaper or more easily handled temporary closure than a bulkhead gate.

STORAGE
The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood crest through a natural stream channel.

STORAGE RESERVOIR
A reservoir that is operated with changing water level for the purpose of storing and releasing water.

TAILRACE
The tunnel, channel, or conduit that conveys the discharge from the turbine to the river; hence the terms "tailrace tunnel" and "tailrace canal."

TAILWATER LEVEL
The level of water in the tailrace at the nearest free surface to the turbine or in the discharge channel immediately downstream of the dam.

TOE OF DAM
The junction of the downstream face of a dam with the ground surface, also referred to as downstream toe. For an embankment dam the junction of the upstream face with ground surface is called the upstream toe.

TOP OF DAM
The elevation of the uppermost surface of a dam, usually a road or walkway, excluding any parapet wall, railings, etc.

TOP THICKNESS (Top Width)
The thickness or width of a dam at the level of the top of the dam. In general, the term "thickness" is used for gravity and arch dams and "width" is used for other dams.

TRANSITION ZONE (Semipervious Zone)
A part of the cross section of a zoned embankment dam comprising material of intermediate size between that of an impervious zone and that of a permeable zone.

TRASH RACK
A screen located at an intake to prevent the ingress of debris.

TUNNEL
A long underground excavation usually having a uniform cross section. Types of tunnel include: headrace tunnel, pressure tunnel, collecting tunnel, diversion tunnel, power tunnel, tailrace tunnel, navigation tunnel, access tunnel, scour tunnel, drawoff tunnel, and spillway tunnel.

UNDERSEEPAGE
The interstitial movement of water through a foundation.

UPLIFT
The upward pressure in the pores of a material (interstitial pressure) or on the base of a structure.

UPSTREAM BLANKET
See Blanket.

VALVE
A device fitted to a pipeline or orifice in which the closure member is either rotated or moved transversely or longitudinally in the waterway so as to control or stop the flow.

WATERSHED DIVIDE
The divide or boundary between catchment areas (or drainage areas).

WATERSTOP
A strip of metal, rubber, or other material used to prevent leakage through joints between adjacent sections of concrete.

WEIR
(a) A low dam or wall built across a stream to raise the upstream water level, termed fixed-crest weir when uncontrolled. (b) A structure built across a stream or channel for the purpose of measuring flow, sometimes called ameasuring weir or gauging weir. Types of weir include broad-crested weir, sharp-crested weir, drowned weir, and submerged weir.

APPENDIX D
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APPENDIX E
STATE BACKGROUND AND PERSPECTIVE

(Each state is encouraged to include this information prior to dissemination of the manual.)

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