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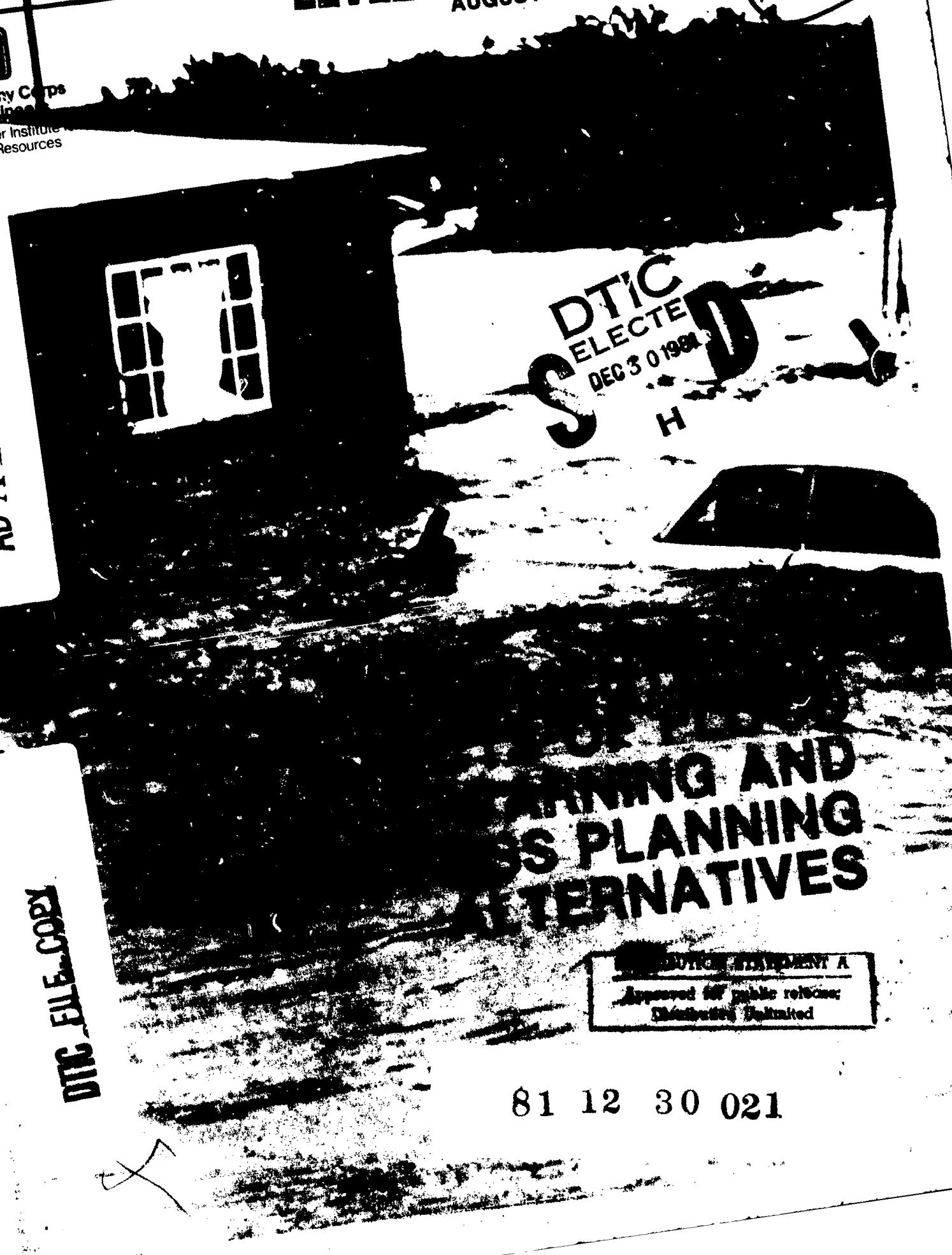

PLANNING AND ASSESSMENT OF FLOOD DAMAGE REDUCTION PLANNING ALTERNATIVES

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The objectives of the investigation were to shed light on the policy and procedural considerations related to planning, implementation and operation of flood warning and preparedness alternatives and to suggest implementation approaches. A review of the legal liability issues involved in implementing and operating flood warning systems is included.

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IMPLEMENTATION ASPECTS OF FLOOD WARNING AND PREPAREDNESS PLANNING ALTERNATIVES

a report
submitted to

Institute for Water Resources
Water Resources Support Center
U.S. Army Corps of Engineers
Kingman Building, Fort Belvoir, Virginia

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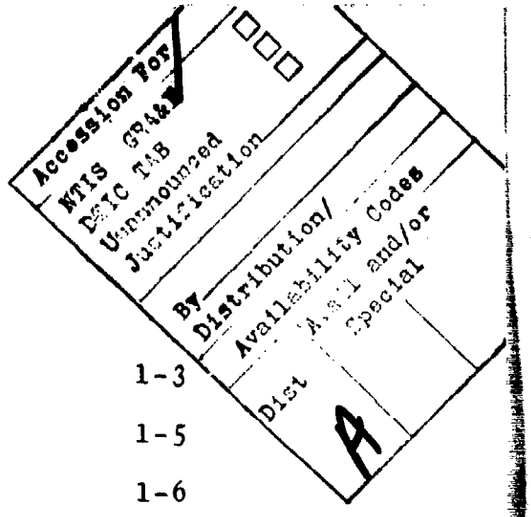

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AUTHORIZATION AND ACKNOWLEDGEMENT

The study on which this report is based was performed pursuant to Contract DACW72-78-C-0011 between the U.S. Army Coastal Engineering Research Center and the joint venture organization of H. James Owen, Consulting Engineer, and Wendell Associates. Notice to proceed with the study was effective 1 April 1978.

The information, knowledge and insights which have made this report possible have inevitably come from many sources. The authors have been enriched by all of them, and perhaps most of all by the many colleagues who over the years have given us the opportunities to develop experience in the several fields relevant to flood management. In addition, however, there are a limited number of individuals in the Corps and in other federal agencies who have been generous with their time and knowledge and whom we especially wish to thank. In doing so, the usual caution should be observed. None of the named persons, nor anyone other than the authors, bear any responsibility for the content of this report. Any reviews and recommendations are those of the authors.

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EXECUTIVE SUMMARY

INTRODUCTION

Flood warning and preparedness, largely a non-federal concern, is one of the measures now receiving increased attention pursuant to Section 73 of Public Law 93-251, the Water Resources Development Act of 1974. Until recently, the federal role was largely limited to modest involvement of NWS. The consideration and use of warning and preparedness alternatives is being hampered by lack of knowledge of the legal, institutional and other managerial aspects of their implementation and operation.

The investigation of the implementation aspects of flood warning and preparedness alternatives on which this report is based was undertaken pursuant to Contract DACW 72-78-C-0011 between the U.S. Army Institute for Water Resources and the joint venture of H. James Owen, Consulting Engineer, and Wendell Associates. The objectives of the investigation were to shed light on the policy and procedural considerations related to planning, implementation and operation of flood warning and preparedness alternatives and to suggest implementation approaches.

The scope of investigation did not permit analysis of every issue which might arise in connection with a flood warning and preparedness alternative through some combination of causes of flooding, mixture of governmental and private participants, and approaches to warning and preparedness. The issues addressed are those related to the types of cases most likely to arise in practice. Whenever possible, issues have been treated in generic terms to facilitate application of the findings to questions which arise in specific situations.

The reader is cautioned that the report is not intended to take the place of a legal analysis for any specific case. Many of the issues of law which are addressed have not been settled by legislative and judicial action and variations exist from place to place even where relevant law has been made. Much of the same sort of qualification applies to the portions of the report dealing with financial arrangements,

assurances and other matters. Comments on policy about these and other aspects remain only suggestive until specific policies are established by competent authorities.

ELEMENTS OF FLOOD WARNING AND PREPAREDNESS ALTERNATIVES

The concepts involved in a typical flood warning and preparedness system are straightforward. Rainfall amounts or stream levels upstream of an area are measured and the information is used to predict whether a flood is about to occur, when it will arrive and how severe it will be. Based on the advance warning, preplanned steps are taken to: 1) ensure the safety of persons in the threatened area; 2) protect public and private property; and 3) reduce other types of flood losses.

The components normally required for a flood warning system and preparedness plan include the flood recognition system, warning plan, preparedness plan and maintenance plan. Each of these may have several elements, depending on the type and sophistication of alternative appropriate to a particular case.

Flood Recognition System

The flood recognition system includes the collection of the basic data and information and some analytical procedure to make the flood prediction. A variety of ways exist for carrying out both the data collection and analysis steps. One simple approach is use of an upstream water level sensor which triggers an alarm when some pre-set water level is exceeded. This combines data collection and analysis into one unit. However, this sort of system furnishes only a minimal amount of information. It provides no clue to the rate of rise of flood waters or to the ultimate height which they will reach.

The more common approach is to rely for data collection on a network of volunteer observers or gages of a type which either report automatically by radio or can be accessed by telephone, or some combination of observers and automated gages. The means of communicating data vary but usually make use of either telephone, radio or messengers.

Processing of collected data and information may be as simple as using a chart or table to estimate flood severity based on rainfall measurement. At the opposite end of the spectrum, analysis may include use of computerized mathematical models to take into account a variety of physical conditions, integration of local and regional climatic data, and interpretation of radar and satellite imagery.

Warning Plan

The two key considerations in a warning plan are the procedures for issuing warnings and the means of warning dissemination. Procedures for issuing and disseminating warnings must identify who is to be warned at each stage of predicted flooding, whether or not there is to be confirmation that the warning message has been received and understood, and to whom the recipient is to relay the warning.

Difficulties arise in establishing warning procedures due to the unpredictable nature of storms and floods. Specific warnings issued early in a potential flood episode risk being substantially in error and causing either a gross overreaction or an unwarrented sense of security on the part of those warned. Delaying the issuance of warnings until the magnitude and timing of an impending flood are known precisely may leave little time for affected persons to react before flooding begins. Where enough time is available, this problem can sometimes be overcome by staging warnings with early alerts going only to local officials, emergency services agencies and other selected recipients.

The steps of distributing flood warnings to primary recipients such as local officials, radio and television stations, and emergency services agencies and the means by which they disseminate warnings to the general public are dominated by consideration of the means of communications to be used. Both reliability and thoroughness is required.

Preparedness Plan

Preparedness plans, like warning systems, must be tailored to the needs of the case at hand. Depending on

what is required, they may include provisions for evacuation of endangered areas, traffic control, curtailment or other special management of utility services, protection of property, flood fighting and numerous other activities. Sub-plans for each of these and other purposes may be constructed in a variety of ways.

Maintenance Plan

Like a dam or levee, a flood warning and preparedness system requires continuing attention if it is to function properly. Maintenance must include periodic updating of the procedures and plan, testing of equipment and at least some minimal education and information efforts. The extensiveness and nature of the maintenance plan and the frequency of conducting maintenance activities depends on what the plan includes.

Combination Plan

While systems for flood recognition or for warning systems and preparedness can be developed separately, integrated programs are the most practicable. Mere warnings can be disseminated with the expectation that each recipient will use the information as best he or she can. However, if a system is to be a workable flood plain management alternative to flood control works or a genuine supplement to them and other flood plain management adjustments such as insurance and regulation, it must include the arrangements for both warning and effective response.

NEED FOR COOPERATIVE ACTION

Warning systems and preparedness plans are often in stand-by status for long periods. Creation of full time organizations for their administration and operation and assembly of the special resources required for their functioning is therefore usually found to be impractical. This favors distribution of responsibilities to organizations already in being which possess the requisite skills, authorities and resources.

Implementation and operation of warning and preparedness alternatives almost always calls for the cooperation of several parties. Few types of governmental units have the range of authorities and operating capabilities to carry out a complete program although cities and counties come close to doing so, especially in the case of fairly simple plans for a small watershed. However, it is more usual for programs to require the participation of a variety of local agencies and volunteer organizations, and at least some reliance on information from the National Weather Service.

PAST PRACTICE

The National Weather Service (NWS), Tennessee Valley Authority (TVA) and Corps of Engineers have all engaged to some extent in the development of flood warning and preparedness alternatives. However, the type and extent of involvement which has been provided by the agencies varies greatly.

NWS participation focusses on the arrangements for collection and analysis of data. Procedures for issuance and dissemination of warnings and development of a preparedness plan are left largely to the discretion of local interests. Technical assistance in planning includes analysis of the flood problem, advice on selecting approaches to flood recognition and analysis, and development of analytical tools. Financial assistance from the agency is limited to provision of inexpensive items such as plastic rain gages for use by observers and contribution of some services in installing and calibrating equipment. Aside from assisting with acquistion and installation of equipment, NWS's role in implementation of the warning system and preparedness plan is limited to training of local observers and forecasters. The degree of NWS participation in operation and maintenance of local flood warning systems varies from zero to performance of the analysis and prediction steps. The agency requires only minimal assurances from non-federal interests in return for the assistance it provides.

The Tennessee Valley Authority has been involved substantially only in one warning and preparedness program. In that case, for the City of Gatlinburg, TN,

TVA has followed a course of action somewhat similar to the NWS approach with respect to planning. Responsibility for planning of the alternative is divided with TVA providing detailed design of the flood recognition system and the city and private interests providing for development of the warning procedures and preparedness plan. However, TVA's approach differs significantly from that of the NWS with respect to financial assistance. TVA is providing 90 percent of the first costs of an automated and computerized system for data collection and analysis and 50 percent of the operation and maintenance costs for the first 10 years following implementation of the system. Whereas NWS frequently provides assistance to non-federal interests in equipment acquisition and installation, TVA is providing only specifications and the city of Gatlinburg is responsible for satisfactory acquisition and installation of the necessary hardware. TVA assumes no operational role in the warning system and plan other than providing assistance in liaison between other federal agencies and the city. With respect to assurances, TVA's approach is much more specific than that of NWS. The formal agreement between the agency and the city includes numerous requirements aimed at assuring competent design of the preparedness plan and proper operation of the warning system. The agreement provides for TVA's recovery of the equipment during the first ten years if local operations are not in accordance with its terms.

The Corps principal involvement in warning and preparedness has been its participation in development of an evacuation plan for Barbourville, KY. That planning effort was a coordinated undertaking of the Corps, city of Barbourville and the several other organizations and interests. All of the first and continuing costs for implementation of the plan are to be borne by non-federal interests. No assurances were required by the Corps in return for its assistance in planning. However, this example is of limited value as a precedent in connection with Section 73 because the Corps assistance was provided under the Flood Plain Management Services Program. The technical and financial assistance provided might well differ in the case of an alternative resulting from an authorized study of a local protection project.

These inconsistencies of approach reflect the capabilities and interests of the several agencies. More importantly, they point up the fact that broad guidance is lacking and suggest that more consideration of federal roles and functions is needed.

POLICY CONSIDERATIONS

Planning of warning and preparedness alternatives raises issues which require resolution before the alternative is put into practice. Dealing effectively with these issues requires consideration of certain basic matters affecting policy. Chief among these are financial capability, technical capability, and the impact of technical problems.

Financial Capability

The costs for implementing and operating warning and preparedness alternatives vary greatly according to the type and sophistication of systems which are employed. The costs are also of a variety of kinds. Some are one time initial costs, such as for equipment, while some are periodic over the life of the system and still others may not be encountered until a flood occurs and the plan is put into action. The costs also vary in how they can be met. Some can be met through services of particular participants while others can be met through a cash outlay from any available source. The variation in the timing, size and other characteristics of specific costs add considerably to the complexity of cost apportionment as does the fact that various units of government have differing sources and amounts of financial resources at their disposal.

The federal government is constrained with respect to how its financial contribution can be made for flood warning and preparedness alternatives. Section 73(b) of Public Law 93-251 does establish a basis for federal cost sharing where there is a pre-authorization study or small project. However, the past policy of the Congress in the case of the traditional types of local flood control projects has been to emphasize the federal role in the initial steps of implementation and leave to non-federal interests the continuing and

future costs of operation and maintenance. There is good reason to apply this same approach in the case of warning and preparedness alternatives because of the federal government's lack of ability to provide the continual on-site services needed in the operational stage and the convenience of avoiding interminable payments to non-federal interests for conducting operations and maintenance. However, restricting federal financial contributions to the traditional pattern adds to the complexity of cost apportionment in accord with Section 73(b) because some warning and preparedness alternatives may have almost negligible first costs.

States have relatively large financial capabilities and most or all of them could afford a fair share of the cost of implementing and operating flood warning and preparedness measures. Moreover, state legislatures can deal with cost apportionment by earmarking revenues, legislating the assignment of costs, creating new sub-state units of government to carry out certain functions and in other ways. However, state legislatures have seldom assumed all of the non-federal costs for flood loss reduction projects. Most follow a policy like that of the Congress with regard to emphasizing participation in initial costs.

Local governments vary greatly in their financial capability. They also differ in the ways their parent states have enabled them to raise revenue. However, they also have the greatest flexibility in tailoring the distribution of a financial burden in desired ways. Their constraints on financing are most likely to concern authority to spend funds for certain purposes or to assume the risk of liability. Also, local governments generally find it more convenient to provide services in lieu of cash and to defer investments in projects until after state and federal funds are committed.

Some costs associated with warning and preparedness alternatives can fall on private parties as, for example, the cost of radios or other special equipment needed to receive warnings. The great difference in the financial capability of individuals makes it important for planners to carefully assess the design of the warning system and preparedness plan with regard to its

requirements for private investment. A requirement for too large an investment on the part of private parties may amount to discrimination in the distribution of benefits.

Technical Capabilities

Success in the planning, implementation and operation of flood warning and preparedness alternatives requires that the associated responsibilities be assigned to those with adequate expertise, skills and organizational resources to carry them out. The several levels of government and the private sector have widely varying technical capabilities.

Federal and/or state agencies are best able in most cases to support and provide the specialized expertise required for analysis of the flood hazard, design of equipment systems and for addressing other technical aspects of planning. They can also deal efficiently with some things common to implementation like specification and acquisition of equipment and development of model ordinances. Federal and state agencies also have a limited capability to assist after implementation through supervisory inspections and provision of technical assistance in making any modifications to the plan which are needed over time.

But federal and state agencies cannot provide the detailed knowledge of local needs and resources required for planning. They can not integrate warning and preparedness procedures with other ongoing activities or adopt the plan. Neither can they provide day-to-day operations, carry out frequent testing of equipment, or assure timely and reliable execution of the preparedness plan when a flood threatens.

The allocation of responsibilities in a particular case would pose few difficulties if these types of technical capabilities were the only facts to be considered. However, the pattern which evolves must also satisfy the cost sharing provisions of Section 73 and fit with the availability of adequate legal authorities and financial capabilities. Arranging effective allocations of responsibilities and costs which meet all of these and other constraints may become a three dimensional jigsaw puzzle. Complex arrangements may be required for its satisfactory solution.

Technical Problems

Some purely technical problems also have implications for federal policy regarding implementation of flood warning and preparedness alternatives. One of the more important problems of this type is the unreliability of meteorological forecasting.

It is difficult to forecast weather accurately for a particular small area using only local data. False alarms may result in liabilities stemming from closing of businesses, evacuation of hospitals and other preparedness actions if they result in costs, injuries or deaths. In view of this risk, it appears that almost every flood warning system ought to take advantage of the NWS weather forecasting system to supplement local efforts. It provides types of useful information which are beyond the capability of local systems to collect.

LEGAL CONSIDERATIONS

The chief considerations of a legal nature which affect federal policy about implementation of flood warning and preparedness alternatives relate to adequacy of the legal authority of potential participants, liability, and the forging of commitments to participate in the plan.

Adequacy of Legal Authority

The distribution of responsibilities for planning, implementation, and operation must give due regard for the legal authority each party has at its disposal. Generally these authorities are contained in statutes. However, the specificity and nature of authorities given may vary.

Several federal agencies are well equipped with authorities necessary to participate in planning of flood warning and preparedness alternatives. The general authority to undertake flood loss reduction programs could be construed to authorize the necessary planning or provision of technical assistance to communities in such planning. Section 73 also provides relevant authority, especially when matched with an

appropriation specifically for a flood loss reduction project. In addition, agencies have available programs like the Corps' Flood Plain Management Services Program which offer flexible avenues for providing planning assistance to communities.

Implementation and operation of warning and preparedness alternatives require authorities that are different from those required for planning. Some general authorities of the needed type exist. NWS, for example, has considerable authority for an operational role in flood recognition and warning but generally considers it's authority to be limited in the area of preparedness. On the other hand, the Federal Emergency Management Agency has specific mandates with regard to operations related to preparedness and recovery. In addition, even agencies concerned with housing, transportation and other areas could probably find authority to participate in cases in which their interests were affected. But on the whole, authority of federal agencies to participate in implementation and operation is most likely to stem from a specific project or program for which the agency has responsibility.

States undoubtedly have the authority to develop and administer flood warning and preparedness systems. However, specific programs require a basis through enactments of the state legislature. Individual examination of the situation in a particular state is necessary to determine whether adequate delegations of power have been made.

Agencies of general purpose units of local governments derive their powers from their charters and often from specific acts of the legislature. Exercise of their powers is subject to direction of their local legislative bodies. While the view in times past has been that general purpose units of local government held only the powers expressly conferred on them, increasing numbers of jurisdictions now hold that they may engage in activities normally within the sphere of local government unless restricted from doing so by their charters or state statutes. The view that prevails in a particular location needs to be determined on a case by case basis.

Liability

The conduct of almost any activity can result in injury or damage which might give rise to liability. Operation of flood warning systems and execution of preparedness plans are not much different in this respect from operation of other types of flood damage reduction measures or activities aimed at other objectives. However, flood warning and preparedness systems are usually brought into play under stressful conditions and there has been limited development of specific law and precedent about the liabilities attendant to their use. For these reasons, concern about the potential severity of liabilities has sometimes been expressed. Since law and precedent is largely lacking, an appraisal of the risk of liability must rely on general rules of law.

Governments acting within the scope of their authorities have no liability for any injury or damage which may be inflicted, so long as their sovereign immunity has not been waived. However, the federal government and most states have "consent statutes" which do waive at least a part of their sovereign immunity. Cities, counties, and special purpose districts are not sovereign in their own right and have only such immunity from suits as their parent state provides them. In most cases, state statutes have made local governments subject to suit on virtually the same basis as private entities. If this situation exists, participation in a warning and preparedness program will subject the government to liability on the same basis as for its other activities.

But not every fault gives rise to liability. In order for liability to exist there must have first been a duty of performance, forebearance or protection. Where no duty exists, there is no responsibility for what may occur and thus no liablity. Second, the conduct omitted or improperly performed must be the proximate cause of the injury or loss. Third, where several causes contribute to a particular injury or damage the plaintiff must prove that the defendant's act or ommission was substantially enough associated with the harm to merit the assessment of liability. And fourth, the injured party must have relied on the performance of whatever duty was owed. Only the matter

of the existance of a duty can be analyzed productively in the abstract. Determination of proximate cause, correlative liability and reliance rests upon the circumstances of each particular case.

One way of approaching the determination of whether a duty exists is to question whether conduct of the activity in question is obligatory or permissive. If obligatory, failure of the government to furnish it or faulty performance would give rise to liability. If the activities are permissive, the failure to perform or faulty performance gives rise to no liability for the reason that no one has a right to expect anything in the first place. The obligatory duty to perform could arise in a number of ways including constitutional charge, enactment of an appropriate statute, or traditional practice. No very good case can be made that any of these ways have resulted in making warning and preparedness an obligatory activity of government.

A second approach to determining the existence of a duty is to ask whether the activity at point is governmental or proprietary in nature. The former are those traditionally performed by governments and not readily susceptible of performance by private enterprise. Proprietary functions are those which are or could be performed by private enterprise. The rule is that governments may be liable for fault in performance of proprietary activities because private entities would be liable under like conditions.

There is also a well established legal consideration that holds that even though a good samaritan may have had no obligation to begin with, any good deed undertaken must be peformed with reasonable care. Application of this rule would argue for governmental liability in cases of faulty performance of the warning and preparedness function. On the other side, one court has held that if the warnings are addressed to the general public there is no liability even if there is negligence and damage resulting from reliance on the information. The reasoning in the latter case is that a warning addressed to the world in general is not necessarily given in response to an obligation to anyone in particular.

Consideration of these several points reveals the confused state of the law regarding warning and

preparedness which exists at the present time and the impossibility of saying with certainty what courts and legislatures might do in particular instances. However, it appears that with regard to preparedness programs, there could be little or no controversy as to their status as a governmental function. This is probably true also for the warning function. Moreover, warning and preparedness are probably also permissive in nature, except where state statute has made them otherwise. The upshot of this is that the risk of liability is relatively small.

If it is assumed that warning and preparedness are the sorts of activities for which liability might be assessed, then whatever risks of liability accompany participation in a warning and preparedness program must be considered in light of those which exist in the absence of such a program. There are points which argue for having warning and preparedness programs.

It is well established that owners and operators of facilities frequented by large groups of people or the general public owe their patrons or employees reasonable care aimed at protecting their safety. A good warning system will often discharge enough of the duty owed to potential flood victims so that the risk of liability is largely relieved. This is important to a wide range of private, commercial and industrial property owners as well as to governments in their role as owners and operators of facilities.

Some types of institutions need more than just warning to relieve the risk of liability in the event of a flood. For example, schools and hospitals have special responsibilities because the persons in their care are presumed less able than the general population to care for themselves for one reason or another. Utility services such as for gas and electricty also face unusual problems. Either continuation of service or imprudent curtailment of service during a flood may lead to damages and injury giving rise to liabilities. In these and other cases, both warning and preparedness may prove essential to relieve the risk of liability. It appears that populations will increasingly expect and demand warning of flood conditions and appropriate preparedness. Accordingly, the fact that local governments enjoy little sovereign immunity makes it clear

that they will be increasingly liable for failure to provide good programs where warning and preparedness is found to be a suitable technique for protection or loss reduction.

On balance between these several diverse interpretations of the law, it is clear that the greatest risk of liability stems from half-hearted efforts which mislead the public into reliance and then fail to achieve their objectives.

Commitments to Participate

Because warning and preparedness alternatives generally require the participation of several entities, it is important to assure that each of the planned actions are performed in a timely and appropriate fashion. Several means are available for this purpose including contracts, memorandums of understanding, and joint powers agreements. The decision as to which should be used in a particular case depends in large part on the parties involved and the anticipated means of enforcement. Contracts are most appropriate where enforcement is through the courts while memoranda of understandng generally depend for enforcement on administrative action. In any event, the key point is assuring that the desired performance will be obtained.

It should be noted that the usefulness of these several types of agreements is limited. Contracts and other specific arrangements are best suited to establishing responsibility for ongoing activities such as equipment maintenance or providing the framework within which private parties provide equipment and services on short notice. They are less suited for assuring that critical response actions will be taken since any enforcement would be after the flood had occurred. The enforcement action would only serve to confirm the breakdown in the warning and preparedness system.

One means of dealing with the above limitation on the usefulness of agreements is the possibility of using them to shift or place liability and thereby increase the participants motivation to perform properly.

APPROACHES TO IMPLEMENTATION

Numerous issues are involved in distributing the functions and responsibilities associated with flood warning and preparedness alternatives among federal and non-federal participants. Chief among these are the ones related to planning, financing, implementation and operation, commitments to implement, and assurances.

Planning

One issue concerning planning relates to the extent of involvement of non-federal interests. It appears that their involvement should be greater than is usually the case for planning of traditional types of flood control projects for several reasons. First, design of warning and preparedness alternatives depends in part on understanding of local organizational arrangements, past experience in local emergency operations and other factors for which federal agencies can claim no special expertise. Second, what is required in operation and maintenance of a warning and preparedness plan is different than for structures and requires participants to accept the plan and be well motivated to make it successful. Extensive participation in planning facilitates accomplishing this. And third, flood warning and preparedness alternatives must mesh with other ongoing non-federal activities and local participation is necessary to achieve this.

Joint planning of flood warning and preparedness alternatives would be preferable but few institutional arrangements exist which permit truly joint federal/non-federal planning efforts. The nearest practicable approach is coordinated planning in which each party is assigned certain tasks. Non-federal planning responsibilities might include provision of readily available information, conduct of certain inventories, and participation in decision-making. Some of the types of readily available information which would commonly be needed are those concerning existing emergency plans and procedures, existing hydrologic and other data collection systems operated by non-federal interests, available resources of equipment and personnel, existing mass warning systems, existing

communications capabilities, and utility and transportation systems. Inventories which might be useful include those to identify demographic and socioeconomic characteristics of the area to be protected, to locate and describe critical facilties, to identify special warning participants and to ascertain the availability and suitability of such things as evacuation destinations. The non-federal decision-making role would likely include participation with the federal government in selecting the general type of flood recognition system and means of warning and almost unilateral decision as to procedures for plan adoption and such things as selection of the local party to be in charge of operations.

This type of division would then leave to the federal planners the hydrologic, hydraulic and other analyses of the flood hazard, identification of alternative concepts for warning and preparedness, leadership in detailed development of the various subplans and cooperation with non-federal interests in the development of acceptable implementing arrangements.

A second planning issue concerns the level of detail of plans to be produced. Detailed planning is to be prefered for several reasons. Section 73 of Public Law 93-251 and the Principles and Standards require comparable consideration to be given to all measures. Compliance with those requirements necessitates relatively full investigation of each alternative. The detail in which planning is done also effects the potential success of the plan when called into use. Faulty planning may result in liabilities. In addition, generalized broad scale planning does not afford much opportunity for intended participants to make a realistic assessment of their capability to fill assigned roles. Also of course, too little detail in planning may not generate the confidence necessary to secure approval of the completed plan by local officials and legislative bodies.

These needs for detail conflict with the frequent desire of those responsible for operation and maintenance to have flexibility in plan execution. Fortunately, this can be easily resolved by presenting only critical aspects as a formal part of the plan. Noncritical details such as lists of materials,

personnel requirements and the specifics of operational procedures can be presented as desirable levels of performance to be provided at the discretion of those managing emergency response.

Financing

The division of costs between federal and non-federal parties for implementation and operation of flood warning and preparedness alternatives is settled relatively well in terms of amount by the provisions of Section 73(b), subject to some interpretation of what constitutes the "project" cost to be divided. The key remaining issues related to finance concern the specific types of activities for which each party is to bear the expenses and the mechanics for implementing the division of financial responsibilities.

Division among parties of the costs for flood warning and preparedness alternatives cannot be related directly to the pattern in use for the traditional types of flood control projects because the balance between first and continuing costs is considerably different in most cases. In addition, the division is constrained by considerations of workability, particularly with regard to state and local governments' preferences for deferment of investments and provision of services in lieu of cash. Local governments and, to an extent state governments, are better equipped to assume costs for testing and maintenance of equipment, public information and other continuing activities, day-to-day monitoring of weather conditions, and coordination of local operations.

There are two major approaches to cost sharing which might be taken. First, non-federal interests might be assigned responsibility for some fixed set of implementation and operation actions. This approach is similar to that employed for traditional flood control measures. Since the fixed division of responsibilities would seldom produce a cost apportionment precisely in accord with Section 73(b), suuplemental payments one way or another would be necessary to achieve that objective. A second approach to attaining proper proportioning of costs is to assign non-federal participants full responsibility for implementation and operation,

offset by a payment from the federal government to non-federal interests.

Implementation and Operation

Responsibility for implementation and operation of traditional types of local flood control measures are distributed such that the federal government provides all implementation except for land rights, bridge adjustments and a few other matters. Non-federal interests then operate and maintain the completed project and the federal role at that stage is limited to inspection and review of periodic reports. The issue which arises with respect to flood warning and preparedness alternatives is whether that same pattern of allocating responsibilities can or should prevail.

It is important to note that the sorts of actions required to implement a warning and preparedness alternative are very different than those required to implement a levee or flood wall. Acquisition of land rights and construction are minor in the case of most flood warning and preparedness alternatives. Limitation of the local role to the same items as for traditional projects would result in almost total federal responsibility for implementation since hardware normally constitutes a major cost. The opposite possibility is to assign all implementation responsibilities to the non-federal interests. However, this would probably discourage local interests from selecting that approach.

It should also be recognized that the major responsibilities in implementation of a flood warning and preparedness alternative concern organizational arrangements, agreements between parties, adoption of the plan, recruitment and training of participants, development of detailed procedures and other items of that type. Many of these are responsibilities which the federal government cannot or at least is not very well equipped to discharge.

The intermediate path which seems preferable is to divide implementation responsibilities on the basis of some relatively uniform assignment of tasks to federal and non-federal interests. This best parallels past policy and enables best use of federal and non-federal technical capabilities and legal authorities. It also

allows some opportunities to match the pattern of responsibilities to the division of costs.

The situation with regard to division of operational responsibilities for a warning and preparedness plan is somewhat less troublesome than that for implementation. The approach with traditional flood control measures has been to turn over full responsibility for operation to non-federal interests and this works well for warning and preparedness alternatives. In fact, it would be difficult to assign responsibilities otherwise given the operational advantages of being on-site in operation of the warning system and the need for timely action in executing preparedness plans. The exceptions to this are the need for warning systems to rely to some extent on the nationwide weather forecasting system of the National Weather Service and the need in operating some sophisticated systems for technical capability not available locally.

Commitments to Implement and Operate

The crux of any system is the assurance that it will work despite variations in participant's capabilities and the stress they place on fulfilling promises made when the system was conceived. It is impossible to assure that mistakes won't be made or equipment won't malfunction but the risks of poor performance or non-performance can be reduced through strong and clear commitments by the implementors and operators to performance of their specific roles.

The creation of the plan implies a certain level of commitment. It describes what steps are to be taken, who is to do what, and provides for coordination of the many required actions. The preparation and adoption of the plan is testimony on the part of those who develop and adopt it that they belive it possible to prevent losses through the system they adopt. The fact that the plan exists and describes the conduct desired on the part of various parties may impel people to proceed in accordance with it. The degree that this is so depends in part on the extent to which all of the important participants have participated in plan development and understand the importance of their role. The role of contracts and other agreements in strengthening commitments to participation has been mentioned earlier.

The plan can also be made into law to enhance its binding character. This has the advantage of committing private as well as public parties to observe evacuation orders, traffic controls and other emergency procedures making up the plan. It also provides a legal basis for imposing the greater obligations on private interests which may be necessary during a time of emergency.

Assurances

Despite efforts to commit participants, flood warnings and preparedness alternatives carry the same dangers of inadequate implementation and operation as do other types of programs. Loss of interest, changes in local policies and priorities or any of a number of other things can result in provision of less than the intended protection.

Not every detail of operation and maintenance of a flood warning and preparedness alternative could be prescribed nor would that inflexibility be desirable. However, it might be desirable to require local interests to control land use in both flood plain and upland areas, and carry out information and education activities. Assurances would also be appropriate with regard to maintenance of equipment, any necessary inspections and inventories, training of personnel, and other items of that sort.

Two avenues are generally open to create and enforce such assurances. The first, direct federal regulation, is not very applicable. Federal flood control programs depend on the constitutional authority of Congress over interstate and foreign commerce. That basis is not very applicable to flood warning and preparedness. The second approach might be to use contracts which legally bind the parties to perform. But as noted earlier, action to enforce a contract for emergency services is likely to occur after the damage has been done. Even if contracts or other arrangements provided for recovering equipment in the case of poor performance, the recovery imposes little penalty on non-federal interests since their lack of performance is likely to reflect their lack of much further interest in the program.

Absent the means to make performance a legally enforceable obligation in a way that is useful, the best assurance may be the careful appraisal of the intensity of interest exhibited by the non-federal participants. If they are strongly enough motivated, federal investment may be a good risk. Strong emphasis needs to be placed on information and education to generate the support underlying the staying power of the program.

GENERAL FINDINGS

The following seven findings constitute general observations concerning important matters underlying the more specific conclusions and recommendations which follow them.

1. Governmental Interest

A federal, state and local governmental interest exists in flood warning and preparedness alternatives for four reasons, namely:

A. Relationship to overall resource management;

B. Reduction of flood losses;

C. Avoidance of future costs for flood plain management; and

D. Complementarity with other goals.

2. Guarding Against Liability

Schools, hospitals and certain other types of public and private organizations and facilities have special responsibilities to protect persons in their care or on their premises. Deaths, injuries and property damage which result from flooding can give rise to legal liabilities. Adequate warning of impending floods can be an effective guard against the finding of liability in some cases.

The risk of liability arising in connection with operation of a warning system is small in comparison to the risk of liability in the absence of a system.

3. Implementation Requirements

The actions required for implementation and operation of flood warning and preparedness alternatives can

vary greatly because of differences in the areas which they are to serve, their specific objectives, approaches toward achieving those objectives and other factors.

4. Implementation Costs

The principal costs for implementing and operating flood warning and preparedness alternatives are those related to equipment, materials and supplies, modification of utility systems and other facilities, labor associated with monitoring of weather conditions and conduct of public information programs, execution of the preparedness plan, and costs implicit in the assumption of liabilities.

5. Complexity of Implementation Arrangements

Development of arrangements for implementation of flood warning and preparedness alternatives requires the integrated consideration of the technical and financial capabilities and the legal authorities of federal and non-federal participants, relevant law on cost sharing, and factors affecting practical workability. Ideal arrangements which fit all of the constraints and meet all of the requirements in a simple and effective fashion are not readily available. Only major points of such arrangements can be settled for uniform application. The details of implementation arrangements must be individually designed for each case. Successful design will prove challenging.

6. Lack of Analogy to Structural Measures

Flood warning and preparedness alternatives differ from traditional flood control works in several ways important to the development of implementation arrangements. The distribution of costs between planning, implementation and operation are significantly different as are the lack of need for significant amounts of land acquisition, the important role of interorganizational arrangements, and intermittent nature of operations. These differences make it impossible to follow closely the framework for implementation arrangements set forth in Section 3 of the 1936 Flood Control Act (Public Law 74-738).

7. Non-Federal Participation

The participation of local governments and the private sector is far more important in the planning and implementation of flood warning and preparedness

alternatives than is the case for traditional types of flood control measures. Federal agencies lack legal authority to undertake all aspects of implementation and cannot efficiently conduct planning on a unilateral basis. Local governments normally have most or all of the legal authorities required for development and conduct of warning and preparedness programs.

CONCLUSIONS AND RECOMMENDATIONS

1. CONSISTENCY IN PAST FEDERAL PRACTICE

Conclusion

Future federal involvement in flood warning and preparedness alternatives on a widespread basis will be limited because federal agencies are presently pursuing divergent paths with respect to the nature and extent of federal participation in the planning, financing, implementation, operation and maintenance of such measures.

Recommendation No. 1

The National Weather Service, Corps of Engineers, Soil Conservation Service and Tennessee Valley Authority should each issue guidance describing the nature and extent of assistance to be provided by the agency in planning, implementation and operation of flood warning and preparedness alternatives. Such guidance should describe:

A. Range of planning tasks which will be partially or wholly carried out by agency staff;

B. Purposes and amounts of financial assistance to be provided and cost sharing arrangements;

C. Whether and to what extent implementation responsibilities will be assumed by the agency;

D. Whether and to what extent operational responsibilities will be assumed by the agency; and

E. Assurances to be required of non-federal interests as a condition of federal assistance.

The guidance should recognize that in the absense of a study resolution, at least the Corps of Engineers has no responsibility except to provide technical assistance in planning to non-federal interests.

Recommendation No. 2

The development and issuance of guidance by the several agencies should be coordinated to avoid the development of conflicting federal roles and policy.

2. LACK OF ATTENTION TO IMPLEMENTATION ARRANGEMENTS

Conclusion

Past federal practice in development of flood warning and preparedness alternatives exhibits little attention to the design of effective implementation arrangements or to the evaluation of those arrangements which have been used.

Recommendation No. 3

Regardless of the federal role in implementation and operation, a portion of the effort devoted by federal agencies to planning or evaluation of flood warning and preparedness alternatives should be spent for investigation of implementation arrangements.

Recommendation No. 4

Guidance pursuant to Recommendation No. 1(A) should provide for analysis of the technical and financial capability and legal authority of agencies and organizations expected to participate in planning to assure their ability to do so.

3. ALLOCATION OF RESPONSIBILITY FOR PLANNING

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in planning and evaluation of flood warning and preparedness alternatives with due regard for efficiency and their

respective technical capabilities. The guidance should recognize that federal participation may not always be essential.

Recommendation No. 5.

Guidance pursuant to Recommendation No. 1 should stress the need for joint planning by federal and non-federal participants where available institutional arrangements permit that approach. Fully coordinated planning should be required where joint planning is impractical.

Recommendation No. 6.

Guidance pursuant to Recommendation No. 1 should focus federal agency efforts in planning of flood warning and preparedness alternatives on:

A. Hydrologic, hydraulic, economic, environmental, engineering and other technical analyses of the flood hazard and needs of the area to be served;

B. Formulation of alternative concepts for warning and preparedness;

C. Design, evaluation and specification of the technical aspects of data collection systems and equipment, communications systems and equipment, data analysis and flood prediction procedures, and similar component parts of the alternative;

D. Identification of resources needed and other requirements for successful implementation and operation of the alternative; and

E. Provision of assistance to non-federal interests in developing implementation arrangements.

4. ALLOCATION OF RESPONSIBILITY FOR IMPLEMENTATION

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in implementation of flood warning and preparedness alternatives with due regard for their respective legal authorities

and their technical and financial capabilities. The guidance should recognize that federal participation is not always essential.

Recommendation No. 7.

Guidance pursuant to Recommendation No. 1 should specify the basic responsibilities to be assumed by federal agencies in implementation of authorized flood warning and preparedness alternatives including but not limited to:

A. Specification, acquisition and installation of equipment and materials for data collection and analysis, warning dissemination, and other related purposes;

B. Initial training of participants;

C. Development and provision of educational and informational materials; and

D. Provision of technical assistance in ordinance preparation, hearings and information meetings.

5. ALLOCATION OF RESPONSIBILITY FOR OPERATION

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in operation of flood warning and preparedness alternatives with due regard for practicality, effectiveness and their respective legal authority. Typically, federal agencies would have no local role.

Recommendation No. 8.

Guidance pursuant to Recommendation No. 1 should emphasize assignment of responsibility to local, non-federal interests for operation of the flood warning system and execution of the preparedness plan excepting:

A. Inclusion wherever possible of arrangements for local warning systems to take advantage of the weather forecasting program of the National Weather Service; and

B. Operation by the National Weather Service of data collection and analysis systems where the

complexity of the system or other aspects of operation exceed the technical capability of local interests.

6. ALLOCATION OF MAINTENANCE RESPONSIBILITY

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in maintenance of authorized flood warning and preparedness alternatives with due regard for their respective legal authorities and technical capabilities and for protection of the federal government's investment in planning and implementation.

Recommendation No. 9.

Guidance pursuant to Recommendation No. 1 should emphasize assignment to non-federal interests of responsibility for maintenance of flood warning systems and flood preparedness plans excepting:

A. Annual inspections to assure readiness;

B. Provision of technical assistance in modifying the warning system or plan after implementation;

C. Approval of any substantive modifications to the warning system or plan;

D. Participation in and/or observation of drills, training exercises and other periodidc efforts to practice operations pursuant to the plan; and

E. Review and evaluation of post-flood reports on operations of the warning system and preparedness plan for purposes of practice or in response to actual or perceived flood threats.

7. POTENTIAL FOR DISCRIMINATORY BENEFITS

Conclusion

Selection of approaches taken in the technical aspects of flood warning and preparedness alternatives and in the design of implementation arrangements may result in inequitable distribution of benefits among intended beneficiaries.

Recommendation No. 10.

Guidance pursuant to Recommendation No. 1 should stress careful analysis of warning and preparedness alternatives and the arrangements for their implementation and operation to assure all persons intended to be served by the measure receive equitable benefits regardless of economic status, location, physical handicaps or other reasons.

8. LACK OF DEFINITIVE LAW

Conclusion

Little case and statutory law exists to guide consideration of the legal aspects of implementing and operating flood warning and preparedness alternatives; action is needed to establish a foundation for the consistent interpretation of general principles of law which are relevant.

Recommendation No. 11.

In order to resolve some of the uncertainties which now exist, it should be made clear by state law that public agencies with assigned responsibilities are liable for neglect, omission or unprofessional performance in giving warnings, but that considerable latitude is to be accorded in the light of the necessity for them to exercise discretion and judgment in disseminating warnings.

9. NEED FOR DETAILED LEGAL ANALYSIS

Conclusion

Generalized analysis of legal aspects is inadequate as a basis for design of implementation arrangements for flood warning and preparedness alternatives. Each set of arrangements must be tailored to local conditions.

Recommendation No. 12.

Design of implementation arrangements for flood warning and preparedness arrangements ought to include detailed review of the proposed arrangements by local legal counsel.

Recommendation No. 13.

An appropriate agency of the federal government ought to prepare a state by state summary which identifies major aspects of law relevant to each state including:

A. Sovereign immunity;

B. Authority of municipal corporations to own property outside their boundaries;

C. Authority to order evacuation pursuant to a preparedness plan.

10. PLACEMENT OF LIABILITY

Conclusion

Concern for liability is likely to be an obstacle to acceptance of flood warning and preparedness alternatives notwithstanding the moderate nature of the risk, in part because the parties to which it attaches may be uncertain.

Recommendation No. 14.

Implementation arrangements should make use of contracts as required to specify placement of liability to the detail possible.

11. PLAN ENFORCEMENT

Conclusion

One of the major obstacles to effective operation of a warning system and execution of a preparedness plan is the possibility of parties not acting in accord with the plan.

Recommendation No. 15.

Implementation arrangements should include provisions for making the plan into law through an appropriate ordinance.

CHAPTER 1

INTRODUCTION

Flood losses constitute one of the more serious national problems of resource management. Average annual damages are variously estimated to be about $1.0-3.0 billion and continuing to rise.[1] Approximately 185 flood related deaths are reported annually by the National Climatic Center.[2] About seven percent of the United States--some 209 thousand square miles--is subject to flooding.[3] Flood loss reduction is a major responsibility of the federal government and accounts for the expenditure of large sums of money with further large amounts dedicated to mitigation of flood impacts through relief, rehabilitation and other programs.

National flood loss reduction programs in the last decade have departed from the previous almost exclusive reliance on dams, levees and other structures to impound or otherwise control high flows. Recent policy and program initiatives have increasingly stressed use of all available measures for reducing losses. Development of A Unified National Program for Flood Plain Management[4] expresses the federal executive branch's current support for consideration of all types of measures. Congress, through Section 73 of the Water

[1] "Guidelines for Implementing Executive Order 11988," Federal Register, U.S. Water Resources Council, Vol. 43, No. 29, Friday, February 10, 1978.

[2] H. Michael Mogil, John C. Monroe and Herbert S. Groper, The National Weather Service's Flash Flood Warning and Disaster Preparedness Programs, Second Conference on Hydrometeorology, October 25-27, 1977.

[3] U.S. Department of Agriculture, National Inventory of Soil and Water Conservation Needs, 1967.

[4] U.S. Water Resources Council, A Unified National Program for Flood Plain Management, July 1976.

Resources Development Act of 1974, Public Law 93-251, both formalized and extended the growing federal commitment to measures reducing susceptibility to and impact of losses for general application to all federal flood control efforts. Flood warning and preparedness planning is one of the several measures now receiving increased attention. Others include acquisition of properties located on flood plains, flood insurance, various means of controlling or directing land use, and design techniques for new structures and modifications of existing structures to increase resistance to damage and/or increase the height of flooding at which damages occur.

Development of the knowledge and procedures necessary for full and routine use of these diverse approaches to flood loss reduction has not progressed uniformly. Economic, engineering, social, environmental, legal, hydrologic and other aspects have been studied in widely varying degrees. The extensiveness of each measure's application generally reflects the adequacy of the present state-of-the-art. Land use control measures featuring regulation of flood plain lands is an approach relatively well understood in terms of its legal and hydrologic aspects and mechanisms for implementation. Consequently, it has been widely employed. In contrast, regulation of land use to prevent flood problems due to urbanization of upland areas is not so well understood with respect to its engineering, hydrologic and other aspects, thus it is used less often.

Providing the full consideration of all flood loss reduction techniques incumbent on federal agencies and encouraged on the part of state and local agencies requires that comparable knowledge of the technical, managerial, and other facets of each type of measure be available to planners, decision-makers and the general public. Less than equivalent understanding of each measure invites bias in the plan selection process and commitment to unworkable plans.

Dams, levees, channel enlargements and other measures which reduce flood losses through control of flood waters have been used for many years. Well developed procedures exist for analysis and planning and technology is highly refined. Compared to measures

for flood control, those aimed at reducing susceptibility to losses or their impacts are, for the most part, ill defined. It is not to be expected that the state-of-the-art for all flood loss reduction measures can be quickly brought to some uniformly and satisfactorily high level. Far too much is involved. Research, experimentation in use, and experience over significant time periods will be required to develop the concepts, analytical tools and other technologies, sort out appropriate governmental roles, fully institutionalize approaches and judge the efficacy of each measure.

One area generally in need of study is implementation of flood warning and preparedness alternatives. Knowledge and capability concerning the technical design and installation of equipment for warning systems has far outrun understanding of the legal, financial, institutional and other management considerations. Unless problems related to these important aspects are identified and dealt with, a beneficial alternative may often go unused.

STUDY OBJECTIVES

The study has had two overall objectives. The first is to shed light on both the policy and procedural considerations related to planning, implementation, and operation of flood loss reduction alternatives employing flood warning and preparedness planning. The second is to suggest implementation approaches for federal agencies, state and local governments and, to the extent appropriate, private entities.

More specifically, the study is to assist consideration of this type of alternative through:

1. Identification and description of the management aspects of planning, designing, implementing, and operating flood warning and preparedness planning alternatives which need to be considered as policies and procedures are developed including, but not limited to:

A. Legal issues;

B. Institutional arrangements; and

C. Mechanisms for implementation;

2. Investigation and evaluation of the legal, institutional and other issues which are identified; and

3. Discussion of policies and approaches to planning and implementation of cooperative programs of flood warning and preparedness planning including:

A. Patterns of federal-state-local- private cooperation and participation;

B. Identification and analysis of responsibilities and types of liability which each cooperating entity would likely incur under each pattern; and

C. Comparison of the distribution of responsibilities and liabilities under approaches which include flood warning and preparedness planning with methods in which this flood loss reduction technique is not used.

It also has been recognized that other broader purposes would be served to the extent these objectives were achieved including: a) supporting implementation of Section 73, The Unified National Program for Flood Plain Management, and various other national and agency policy directives; b) encouraging a uniform approach to the planning and implementation of flood warning and

preparedness alternatives by all concerned federal agencies; and c) promoting effective intergovernmental cooperation in planning and implementation.

SCOPE OF STUDY

The types of flood warning systems and the content of flood preparedness plans which can be designed are highly variable. So too are the types of legal and institutional questions which might be posed about their implementation and operation. This plus differences in the several causes of flooding and in the mixture of governmental levels and private interests which might be included in a particular case give rise to an almost infinite number of variations in the management aspects of flood warning and preparedness planning alternatives. Identification of all of the issues in a single effort is patently impossible, let alone their analysis and the suggestion of solutions.

What the study provides is a sampling in which some types of flooding, some mixtures of governmental and private interests and some types of warning systems and preparedness plans are examined. For example, both flash floods and slower rising floods along rivers are considered, while flooding along seashores and lakeshores from storm surges is not. Several types of flood recognition systems are considered as well as preparedness plans which provide only for personal safety and for the added element of damage reduction. Attention has been given to local, special purpose, state, regional and federal governments and to interstate situations but not to implementation of warning systems of an international nature.

The sampling of conditions, purposes and participants have been selected to reflect the types of cases most likely to arise in practice and to surface those issues having the most substance and widest application. Wherever possible, issues have been treated in generic terms to facilitate application of the analyses, conclusions and recommendations to questions which may arise in specific situations.

Identification of issues and development of suggestions for dealing with them is carried out based largely on the investigators' experience and identification of problems by analytical methods. Others involved in planning warning systems and developing preparedness plans were consulted and a search was made for relevant literature. A case study has been employed to demonstrate the recommendations.

INTENDED USE OF REPORT

The report is intended to be of use to all those responsible for or having an interest in use of flood warning systems and preparedness plans. Emphasis is placed on meeting the needs of water resources planners to formulate, propose and describe the management aspects of flood warning and preparedness alternatives.

Planners and others can use the report in several ways. The report provides a brief summary of the components of warning systems and preparedness plans. While not intended as a technical guide, the report may be useful in early conception of an overall approach. The summary of components and the identification of issues can assist planners in identifying needs for information and data, allocating effort and funds for study and determining the types of detailed investigations which are required for the case at hand. The analysis of implementation issues provides at least a partial basis for identifying the range of participants who ought to be involved in the planning process and their potential roles in ultimately implementing a warning and preparedness alternative. There is also discussion of the federal interest in flood warning and preparedness planning which may be useful to the planner in addressing cost sharing and allocation of operational responsibilities. Those who would use the report for these several purposes are cautioned to read the whole report. The complexity of the subject matter makes it particularly easy to incorrectly use materials taken out of context.

Others interested in facilitating use of warning and preparedness alternatives through policy development, legislation and in other ways will find the

report as useful for the questions it raises as for the answers it provides. A large number of questions were identified during the study which could be answered most easily through new policy development or creation of statutory law.

Local, state and other officials and private parties considering assumption of responsibilties for implementation and operation of a flood warning and preparedness alternative could use the report as at least a starting point for appraising the liabilities attendant to such action. The report is, of course, not intended to take the place of a legal analysis for any specific case.

All of those who consider using the information contained in the report should be cautioned that the legal analyses are of differing authoritativeness because there is great variation in the degree to which the several issues considered have been definitively settled by judicial and legislative action. It is possible in some cases to state with certainty what rule applies or to draw on some precedent for guidance. However, there has been a long standing tendency to avoid specific resolution of difficult questions of disaster law, particularly when they involve matters of liability. The hope has been that people will do whatever seems necessary in time of emergency and that everything will work out for the best. The reader should carefully note the analyses of issues for descriptions of assumptions and other qualifications of the findings.

OVERVIEW OF THE REPORT

Chapter 2 of the report provides a brief general discussion of flood loss reduction and major approaches employed for that purpose. Flood warning and preparedness is discussed and several types of flood warning systems and preparedness plans are described. The chapter raises no issues and poses no questions. It is included only to provide enough background information for those not already familiar with warning and preparedness measures to read the remainder of the report with some understanding of their application.

Chapter 3 of the report describes the approaches employed at present or in the recent past in planning and/or implementing flood warning and preparedness alternatives by the National Weather Service, Corps of Engineers and Tennessee Valley Authority.

Chapter 4 introduces and discusses several basic policy issues relating to the general concept of warning and preparedness alternatives. The intent of the chapter is to provide a broad background against which more detailed questions of policy can be subsequently discussed.

Chapter 5 of the report lays a legal foundation for consideration of questions concerning implementation of warning and preparedness alternatives. Hypothetical cases are described to aid in illustration of situations which might be encountered and alternative solutions are described wherever possible.

Chapter 6 brings together the technical, policy and legal considerations into a discussion of implementation approaches.

Chapter 7 presents a case study. The physical and institutional setting is described along with a potential warning and preparedness alternative. An analysis of the situation is provided and alternative approaches to several aspects of implementation are evaluated. Based on the evaluation, a recommendation is made regarding the approach to implementation most likely to be effective.

Chapter 8 draws on the remainder of the report to present conclusions and recommendations.

A categorized bibliography follows the main body of the report. It comprises a listing of materials examined by the investigators during the course of the study. It is recommended to readers interested in flood warning and preparedness. However, users should be advised that few of the included publications shed much light on the type of management issues addressed by the study.

STUDY METHODOLOGY

Identification of issues related to planning and implementation of flood warning and preparedness alternatives was approached in four steps. It was begun by noting those obvious questions which might be asked about any flood loss reduction program or governmental activity. This listing was extended by adding those issues specific to warning and preparedness alternatives with which the investigators were personally familiar through practice and those which could be surmised to occur under reasonably predictable conditions.

Following the initial effort of issue identification, a review of the literature was undertaken using a dual approach. The first was to locate, collect and survey a large body of articles, reports and planning guidance materials related to flood warning and preparedness planning with a view toward gleaning from them such issues as might have been identified and described by others either purposefully or as an incidental part of work performed for another purpose. The second approach was to search specifically through the legal literature for treatment of relevant topics.

The third approach to identification of issues was through scenario development. Combinations of various types of warning systems, preparedness plans, governmental structure and other factors have been postulated and examined. Actions necessary to implement the warning systems and preparedness plans have been identified in detail and considered as to what issues might be related to their performance.

Assistance from others with relevant experience was sought following preliminary identification of issues in the foregoing three ways. Numerous interviews were conducted with federal agencies' legal counsels, administrators and planners. During these interviews, comments were solicited to modify the statement of the issues, identify additional issues and suggest how issues should be approached.

The methodology for analysis of the issues was less straightforward because of its nature. With the questions in hand, analysis proceeded using existing statutory and case law, analogy to existing law where nothing directly applicable was available, and the investigators' interpretation of what the law ought to be when even analogies were unavailable.

CHAPTER 2

FLOOD LOSS REDUCTION

Floods and the reduction of losses which resulted from them were not of much governmental concern prior to 1917. Until that time the only major legislation relating to flood control provided for drainage of certain swamp lands[1] and for establishment of the Mississippi River Commission with responsibility for flood control and navigation on the lower Mississippi River. The Federal government and states were absorbed principally in canal building and improvement of rivers and harbors for navigation, reclamation of the West's arid lands, and public water supply.

Interest in flood control increased after severe floods in 1915 and 1916. In 1917, Congress assigned responsibility to the Corps of Engineers for planning and carrying out flood control works on the Mississippi River.[2] Following this came a series of individually authorized federal flood control studies and projects by the Corps of Engineers and other federal agencies. The increasing interest and experience in flood control culminated in the 1936 Flood Control Act which initiated a national flood control program and assigned jurisdiction over federal flood control studies and improvements on waterways to the Corps of Engineers.[3] Successive legislation expanded the Corps of Engineers' role and created other agencies with responsibilities for pursuing various aspects of flood control.

State legislatures gradually took an active interest in flood control and began instituting flood loss reduction activities as well as enabling cities, counties, and a wide variety of special purpose districts both to cooperate with federal agencies in flood

[1] Economic Research Service, U.S. Department of Agriculture, A History of Federal Water Resources Programs, 1800-1960. June 1970.

[2] 39 Stat. 950.

[3] 49 Stat. 1570, 33 U.S.G.

control programs and carry out local projects. The governmental agencies involved in flood control are now numerous. They have a significant impact on the daily lives of many citizens.

APPROACHES TO FLOOD LOSS REDUCTION

Early procedures for reducing flood losses emphasized use of levees and dredging to increase the carrying capacities of streams and diversions to route damaging flows away from developed areas. Study of the use of impoundments by the Corps was authorized in the 1928 Flood Control Act[4] and reservoirs quickly became an important part of the program for reducing floods. These several techniques have remained the principal tools in the federal government's attack on flood problems.

Other approaches have gradually been incorporated or suggested for inclusion in the national flood loss reduction programs. Conservation and land treatment to reduce runoff while conserving soil became important after experience with the dustbowl of the 1930's. At about the same time, the first suggestions were made that there ought to be a program through which individuals might obtain insurance for flood losses and that use of flood plains ought to be limited. Relief efforts for floods and other types of disasters became institutionalized in various programs including preparedness planning for mitigation of hardships caused by and following floods. The several flood control and loss reduction techniques were complemented by the National Weather Service's program for prediction and warning of flood occurrences.

Reliance on new programs came slowly. The approach employing dams, levees and other works to control or impound flood waters predominated into the 1960's. However, it became apparent in that period that annual flood losses were continuing to increase despite the large investments for control works and that increased employment of other measures was also

[4] Sec. 10, 45 Stat. 534, 538.

needed. A 1965 report by a presidential task force recommended a comprehensive national program, federal assistance in flood preparedness planning, establishment of land use controls and expanded use of other techniques.[5] In 1974, Congress mandated the full consideration of all techniques in any federal project involving flood control.[6] The Executive Branch followed suit slightly later with adoption of The Unified National Program for Flood Plain Management which called for a multifaceted approach to reducing flood losses.

In May of 1977, President Carter issued an executive order on flood plain management which attempts to reduce flood hazards and protect flood plains from unwise development by federal projects and programs.[7] That was followed by a water policy message urging improved flood protection through nonstructural measures.[8]

The present day efforts at flood loss reduction are generally conceived as being part of an overall program of flood plain management and are divided into the three approaches of modification of floods, including flood control; reducing susceptibility to flooding; and reducing its impact. The individual methods comprising these approaches include:[9]

[5] Task Force on Federal Flood Control Policy, A Unified National Program for Managing Flood Losses. House Document No. 465. 89th Congress, 2nd Session. Washington, DC. 1965.

[6] Section 73 of the Water Resources Development Act of 1973, Public Law 93-251.

[7] President James E. Carter. Executive Order 11988. The White House, Washington, DC. May 23, 1977.

[8] President James E. Carter. Water Policy Message. The White House, Washington, DC. June 6, 1978.

[9] Task Force on Federal Flood Control Policy. Op Cit.

1. Measures for controlling floods:

   A. Dams and reservoirs;

   B. Dikes, levees and flood walls;

   C. Channel alterations;

   D. High flow diversions;

   E. Land treatment measures; and

   F. On-site detention measures;

2. Measures to reduce susceptibility to flooding:

   A. Land use (flood plain) regulation;

   B. Zoning, subdivision, building code, housing code, sanitary and well code, and other regulations;

   C. Design and location of services and utilities;

   D. Land rights acquisition and open space use;

   E. Redevelopment and renewal;

   F. Permanent evacuation;

   G. Floodproofing;

   H. Flood forecasting and warning systems;

   I. Disaster preparedness and response planning; and

   J. Flood fighting;

3. Measures to reduce the impact of flooding:

   A. Provision of information and education;

   B. Flood insurance;

   C. Tax adjustments; and

   D. Post-flood relief and recovery aid.

INTERPRETATION AND LEGISLATIVE HISTORY OF SECTION 73[10]

As already indicated, Section 73 of the Water Resources Development Act of 1974 sets a requirement that federal agencies consider nonstructural measures along with structural solutions to flood loss reduction or control. However, the statute does not attempt to prescribe the steps or elements of such consideration. Further, the Act provides that the non-federal cost of a nonstructural measure will not exceed 20 percent of the project cost. What steps, activities or procurements are to be included in the definition of "project" for purposes of calculating the exact cost distribution are not enumerated or defined. Accordingly, application of Section 73 to particular situations and instances requires interpretation in addition to the plain and obvious meaning of the words.

By the words it used, Congress conveyed instructions to the federal agencies.[11] When the words do not speak fully for themselves, other evidence must be

[10] See 119 Cong. Rec. 299405, 32879, 33696, 33875, 33905, 34197 and 120 Cong. Rec. 70,85, 282, 294, 303, 325, 700, 2890, 3277, 3834, 3896, 4341, 6512.

[11] "The Committee believes very strongly in the value of this section and expects that its full potential will be explored by those Federal Agencies involved in the formulation of flood control projects and plans under this new authority." Congressman Clausen 120 Cong. Rec. 3280.

adduced as to what Congress intended to direct or require. So far as it goes, the legislative history of Section 73 is the first resort beyond the actual language of the provision. Nevertheless, the point of departure is the statute. It reads:

> Sec. 73 (a) In the survey, planning, or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages including, but not limited to, floodproofing of structures; flood plain regulation; acquisition of flood plain lands for recreational, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially and environmentally acceptable means of reducing or preventing flood damages.
> (b) Where a nonstructural alternative is recommended, non-Federal participation shall be comparable to the value of lands, easements, and rights-of-way which would have been required of non-Federal interests under section 3 of the Act of June 27, 1936 (Public Law Numbered 738, Seventy-fourth Congress), for structural protection measures, but in no event shall exceed 20 percentum of the project costs.

An initial inquiry is whether nonstructural measures include warning and preparedness. Some of the methods of this type are enumerated in subsection (a) of the statute, but it will be observed that warning and preparedness are not specifically mentioned. On the other hand, the enumeration is proceeded by the phrase "including but not limited to." This means that the enumeration is not intended to be a complete specification of all the measures which qualify as nonstructural and that are to be considered pursuant to the Section.

A warning system is clearly designed to give persons the opportunity to guard themselves against

injury and property loss from inundation. While it may involve the use of equipment such as gages, communications devices, and even computerized data processing systems, measures such as dams, floodwalls, or similar public works are not included in the means of providing the protection made possible by a warning. Consequently, warning systems are clearly nonstructural measures coming within the meaning of the catchall phrase "including but not limited to."

A similar interpretation is appropriate for preparedness. This may consist of evacuation plans, stockpiling of disaster supplies, traffic control measures to be taken at times when floods are actually occurring or imminent and in a subsequent recovery period, or a comprehensive plan and implementation system to cover the foregoing and many additional actions useful in developing readiness for meeting flood emergencies. Since such items are not dependent upon and may exist in the absence of engineering works, preparedness consists of one or more nonstructural measures and so is included within the scope of Section 73.

The legislative history of Section 73 contains relatively little that cannot be gleaned from an examination of the actual language of the Act. Comment on the floor alluded to the value of nonstructural measures in connection with environmental preservation and improvement.[12] As compared with construction of flood flow retention works, these techniques do not alter environmental conditions. Rather, they seek to conform land uses and human activities to existing patterns of inundation and to rely upon accommodation instead of control as a means of reducing danger and losses.

This environmental comparison does make it clear that the several nonstructural methods are to be considered along with construction of control works whenever a possible flood control project is under investigation and analysis. At the very least, the legislative history indicates that the approaches that do not require physical works should be compared with those that do in order to ascertain which method or

[12] 119 Cong. Rec. 33877

combination of methods will be best from the point of view of the environment.[13]

In judging the place to be accorded to legislative history in this instance, it should also be observed that Section 73 is a brief provision in a long bill which included specific authorizations of many projects. Most of the attention of the individual members, the committees, and the Congress as a whole was on these other provisions which traditionally are regarded as bread and butter items by influential interests in congressional districts and in the country as a whole. Accordingly, the absence of a great amount of debate or explanation for Section 73 should not be regarded as strange. Rather, it should be assumed that the obvious merit of considering, and employing where appropriate, measures having easily understood protective values was not thought to require elaboration. Nor is it surprising that only a very few of the specific authorizations in the bill were expressly for nonstructural measures.

There is no discussion of the 80-20 cost sharing ratio between federal and non-federal interests set forth in subsection (b). A Corps report on the Prairie de Chien project authorized by Section 2 of the 1974 Act asserts that an 80 percent federal and 20 percent non-federal sharing of costs is what experience shows to be the general situation in flood control construction projects, but the evidence in support of such a finding is not presented in the form of data either there or in the legislative history. This rationale for the 80-20 formula just mentioned may or may not represent the understanding of Congress at the time the law was enacted.

Finally, it should be observed that although the division of costs is usually thought of in terms of an 80-20 formula, the statutory language does not make it so hard and fast. The non-federal share is to be roughly equivalent to what such interests would provide on a project for control works, with a maximum 20 percent figure. Consequently, Congress has made it possible for the federal government to contribute more than 80 percent of project cost (however defined) in

[13] Ibid.

some cases. In fact, if on a particular project a proper analogy to non-federal cost items on control works produces a responsibility for less than 20 percent, the meaning of subsection (b) is that the federal contribution should be more than 80 percent. Nevertheless, it needs to be remembered that Section 73 (b) is only an authorization. Of itself, it provides no money from which the Corps or any other federal agency can pay for particular projects or programs.

FLOOD WARNING AND PREPAREDNESS

Flood warning and preparedness systems are but one of many presently recognized approaches to reduction of flood losses. This approach is increasing rapidly in importance for a variety of reasons, not the least of which are concern for catastrophic flood losses, financial costs and adverse environmental impacts.

Traditional flood control measures are usually constrained by economics to protection against modest levels of flooding. Except in the cases of spillways for dams and protection of unusually valuable property, most projects have been and are being designed to protect against the 100 year or standard project flood or against some intermediate level determined by analysis of costs and benefits. The modest protection provided by many control works installed under this practice is illustrated by the fact that 127 presidentially-declared flood disasters in the last five years have resulted from floods greater than the 100 year flood.[14] In the event of catastrophic levels of flooding, less than adequate flood control works may provide some reduction in flood severity or, if they fail under the unanticipated conditions, they may heighten the severity of flooding, and drastically increase loss of both life and property. Potential for catastrophic losses is increasing as development increases on the flood plains and in the uplands.

[14] Office of Technology Assessment, Congress of the United States. Issues and Options in Flood Hazard Management. (Draft) Washington, DC. June 1978

Flood warning and preparedness alternatives have some features which lend themselves to use in situations with the potential for catastrophic losses even though the same economic constraints are applied in their development as for control measures. Flood recognition systems largely function irrespective of the level of floding as do communications arrangements and organizational plans. Evacuation processes can be expanded to encompass larger areas and procedures for public information, plan maintenance and other activities comprising such alternatives are insensitive to the level of flooding so far as any substantive cost is concerned. Warning and preparedness systems therefore are particularly useful protection against high levels of flooding whether used alone, as a supplement to flood control works or in conjunction with other non-structural measures.

Warning and preparedness alternatives have many of the same advantages in comparison to some other measures which reduce susceptibility to or impact of losses that they do in comparison to flood control measures in the event of catastrophic levels of flooding. Floodproofing is limited both by physical and economic considerations. Land use control techniques, whether based on regulatory or compensatory approaches are usually employed in areas subject to the 100 year flood or less and commonly exempt certain developments to achieve political acceptability. With the exceptions of flood fighting, provision of education and information, and provision of post-flood relief and recovery, warning and preparedness stands alone in its applicability to conditions of catastrophic flooding.

The direct, secondary and social costs of warning and preparedness alternatives are modest compared to those for most flood control works. Whereas the cost for dams, levees, floodwalls and other measures of that ilk is commonly in the millions of dollars, the cost for implementation of warning and preparedness systems is more likely to be in the thousands or tens of thousands. Implementation of warning and preparedness alternatives removes little or no land from use, disrupts no transportation corridors, and does not interfere with commerce during installation. Such alternatives may, in fact, provide substantial secondary

benefits through their provision of a core around which other emergency services and plans can be arranged.

Environmental impacts of flood control measures are generally thought to be adverse in diverse ways which have been well publicized. To the contrary, warning and preparedness alternatives have few if any discernable environmental impacts. They involve no noise or increase in traffic during installation, disrupt no wildlife habitat and have little impact on aesthetics.

In addition to the foregoing, warning and preparedness alternatives have numerous other advantages relating to low energy requirements, low operational costs, and inherent flexibility in their original design and susceptibility to future modification to meet changing conditions.

In view of their advantages, warning systems and preparedness plans might have been employed on a widespread basis in the past but this has not been the case. Their use has been limited in part by the diffusion of related responsibilities among several federal agencies. Responsibility for the meteorological aspects of predicting severe weather and hydrologic prediction of runoff and flood stages has been and is the responsibility of the National Weather Service. However, until recently, NWS has put little emphasis on how communities and individuals prepare to make effective use of what flood warnings were provided. The Defense Civil Preparedness Agency encouraged communities to undertake preparedness planning but focused on preparation for war related disasters. Flood preparedness was usually considered in planning supported by the Defense Civil Preparedness Agency only as one of several types of disasters addressed by an "all hazards" plan. Preparedness planning by the Federal Disaster Assistance Administration has tended to emphasize planning for recovery from disasters as opposed to their mitigation. Programs of agencies charged specifically with flood control responsibilities like the Corps, Soil Conservation Service and Tennessee Valley Authority lacked both the meteorological and preparedness planning aspects to foster development of warning and preparedness alternatives.

As a result of this fragmentation of responsibility, warning and preparedness did not come into sharp focus as a flood loss reduction measure until the early seventies. Since then, the situation has changed rapidly. The NWS is now actively assisting communities in preparedness planning. Communities are also encouraged by the National Flood Insurance Program regulations to consider warning and preparedness programs and flood control agencies are beginning to formulate warning and preparedness alternatives as part of their flood control planning efforts.

TYPES OF FLOOD WARNING SYSTEMS

A flood warning system in its most basic form consists of three elements[15] including:

1. A flood recognition element providing some means to identify an impending flood and estimate its time of arrival and severity;

2. A warning issuance element providing procedures for decision-making regarding whether warnings should be issued, to whom, when, and what message content should be released; and

3. A warning dissemination element which deals with the means, procedures and techniques of distributing warnings to the public and to various types of special recipients such as local officials, emergency service agencies and persons or organizations requiring unusual amounts of time to take protective action.

The boundaries between these three elements are somewhat flexible and depend upon the details of how

[15] Owen H. J. Guide for Flood and Flash Flood Preparedness Planning. Prepared for the U.S. Department of Commerce, National Weather Service May 1977.

the warning system is designed. For example, conduct of the several elements often overlaps in time with operation of the flood recognition system continuing throughout a flood as a basis for issuance and dissemination of successive warnings. Similarly, dissemination of warnings to some special recipients such as local officials and emergency service agencies may take place while issuance of a warning to the general public is still being considered.

Each of the three elements in a flood warning system can be constructed in diverse ways according to the available resources and the level of performance which the system is to provide. The principal variations involve the extent to which the flood recognition element depends on information provided by the NWS or obtained at the local level. Three general categories of warning systems have evolved called watch/warn, self-help, and flash flood alarm.

Flood Recognition Element

Watch/warn systems take their name from the NWS terminology for flood and other severe weather announcements. "Flood watches" are issued for areas when meteorological conditions are such that flooding could result. "Flood warnings" are issued when flooding is imminent or has begun. Watch/warn type systems rely upon the NWS announcements as a means of recognizing flood threats. Since NWS distributes such announcements to news media, this type of warning system combines flood recognition with parts of the warning issuance and dissemination steps. Communities may supplement the customary service from NWS by subscribing to a teletype service, purchasing special radios or making other arrangements to improve and assure watch and warning messages are received.

Watch/Warn systems for flood recognition are the least expensive for most communities. However, the accuracy and detail available using this approach varies greatly with location. Both the accuracy of flood predictions and the length of time available between the warning and the onset of flooding increase when applied to large streams or river systems and when

the communities warned are a considerable distance downstream. Watch/ warning systems are of limited value for warning in headwater areas and along small streams where floods may result from local rains undetected by the NWS system of widely scattered precipitation gages.

Self-help systems supplement information available from the NWS by providing for the local collection of information on precipitation and stream level and for local prediction of flood severity. The data collection component of self-help systems can vary from a few observers who provide information on rainfall in their vicinity to sophisticated automatic gaging networks costing many thousands of dollars. The flood prediction component may similarly vary from use of a simple chart relating rainfall to flood severity to computerized forecasting employing complex mathematical models.

Flash flood alarm systems are based on use of a water level sensor located at some suitable upstream point. Set to trip at some preselected water level, the sensor activates a signal device at a location attended on a 24 hour basis.

Warning Issuance Element

The warning issuance element is primarily one of procedure. The matters involved are decisions as to whether a warning should be issued based on the information available from whatever flood recognition system is used, the proper content of any warning messages which are issued, and the audience to whom each warning should be directed. Responsibility for the decision-making forming this element may vary from a single individual to a chain of command requiring several approvals. Those involved may include police, fire, civil defense and other local officials as well as representatives of state and federal agencies.

A large part of the warning issuance element may be left to the NWS if a community employs a watch/warn flood recognition system. NWS staff will decide when warnings are appropriate and telephone or otherwise contact local officials and release warning messages

for radio and television distribution. Radio and television stations, local officials and others then make their own decisions on wider distribution of the warnings.

With self-help systems, local officials are generally in possession of considerable advance warning and can observe the onset and progress of rains likely to cause floods. The time which is available with this type of flood recognition system enables designing the warning issuance element in a more refined way. Release of warnings can be carefully staged from alerting of emergency services through evacuation of endangered areas.

Flash flood alarm systems are usually employed when warning times are short. The warning issuance element of systems employing flash flood alarms is normally correspondingly simple. When the alarm rings, verification of upstream flooding is made and dissemination of warnings begun immediately.

Warning Dissemination Element

Warning dissemination encompasses the delivery of warning messages to their intended audience. The technique used to communicate the warning depends on the nature of the message, available means of communication, time of day, type of intended recipient and other factors. Radio, television, sirens and other means are frequently used. In some cases warnings may be delivered door to door to insure the message content is received and understood.

Dissemination of warnings may be relatively simple in situations where time is short. As warning time lengthens, dissemination may include delivery of a series of messages of increasing accuracy and specificity. Dissemination may also differentiate between audiences and provide warnings to some at an earlier stage than for others, including very early alerts to police, fire and other emergency service agencies which are not released at all to the general public.

Flood Warning System Design Problems

Design of a flood warning system in general terms is not difficult. Examination of the physical setting of an area, severity of the flood problem and availability of financial and other resources can lead rather quickly to identification of the type(s) of warning system applicable to and useful for the area. Designs frequently combine several flood recognition techniques and provide redundancy in dissemination procedures to minimize false alarms and other types of poor performance.

The more troublesome problems involve trade-offs between length of warning time and reliability. Warnings of an impending flood can be made with a high assurance that a flood will in fact occur if announcement is delayed until precipitation sufficient to cause flooding has already fallen or until immediately upstream areas are flooded. However, the time then remaining for dissemination of the warning and for protective action is limited to that required for rainfall to flow overland to the watercourse and/or the flood to travel downstream. The amount of time can be lengthened by issuing warnings based in part on precipitation already received and in part on precipitation expected on the basis of radar data, satellite imagery, rainfall in adjacent areas and other less sure information. Warnings made in anticipation of precipitation obviously have some probability of proving false. A similar problem arises in deciding when the public should be alerted. Choices can arise as to using sirens or otherwise alerting the public in the night or waiting until daylight hours. The decision again affects the remaining time for action which is afforded the public.

TYPES OF PREPAREDNESS PLANS

Preparedness plans are distinguished by the number and types of elements they contain. The most basic plans provide only for evacuation and rescue. Increasingly fuller plans may include elements devoted to

damage reduction, recovery, public information, plan implementation and plan maintenance.[16] Each of these elements may in turn be divided into numerous separate activities.

Evacuation and Rescue Element

As may be appropriate to a particular case, the evacuation and rescue element may provide for requesting or ordering the evacuation of appropriate areas, provision of shelter and care for evacuees, traffic control, transportation assistance and other actions to safeguard lives. It may also include provision of security for evacuated areas, rescue of those who refuse to evacuate or become isolated, and provision of medical care for the injured.

Community-wide plans for evacuation and rescue may need to be supplemented in some cases by specific plans for individual large structures such as factories and hotels (site-specific plans).

Damage Reduction Element

The damage reduction element of preparedness plans is particularly important because it provides the benefits needed to justify investment in the warning system and preparedness plan. Several types of damage reduction actions may be included such as conduct of flood fighting, temporary relocation or elevation of property, protection of vital records and documents, and debris management. Where appropriate, damage reduction may include special management of utilities to either maintain service or intentionally curtail it in areas about to be inundated. Special efforts may also be made to disperse fire and other equipment as protection against loss of routes crossing bridges or low areas.

As in the case of the evacuation element, specific plans for individual structures may be necessary.

[16] Ibid.

Among other things, such plans might provide for implementation of flood proofing measures and flooding of basements to prevent collapse.

Recovery Element

The ease of recovery depends in part on the severity and duration of the flooding experienced. It also depends on the size of the portion of the community and its resources which were not affected and are available as a base for carrying out the recovery element. The ease and rapidity of recovery also depends on how well the community has prepared for the task. The recovery element of preparedness plans generally applies to the immediate post-flood period. It therefore pertains to such things as care for survivors, injured and dead; maintenance of public health; return of utility services to operation; clearance of debris; and rehabilitation or destruction of damaged structures. It may go further and include specific arrangements for securing and coordinating assistance from various federal, state and other sources.

Public Information Element

The public information element of preparedness plans concerns two levels of activity. The first is generalized education and information activities to create a general awareness of the flood hazard, the existance of the warning system and like matters. The second level of information concerns that relevant to the immediate period of a flood. This may include advance preparation of warning messages, development of instructions of various types and development of arrangements for distributing information.

Plan Implementation Element

Preparedness plans are largely creatures of administrative and organizational arrangements. Implementation of the plan requires attention to numerous aspects which build relationships between the several parties

involved. Among others, these include allocation of responsibilities for operation of the warning system and execution of the preparedness plan, coordination of activities, mutual aid pacts between communities, and negotiation of contracts for use of equipment and personnel. Provision also may be made for adoption of the plan officially by the local government. How needed site-specific plans will be encouraged or required and identification of the authorities to carry out the actions comprising the plan should be included.

Plan Maintenance Element

Flood warning systems and flood preparedness plans require attention if they are to function properly. The plan maintenance element provides for this necessary attention. Maintenance activities may include routine updating of information such as telephone numbers and names and/or more thorough analysis of the situation to determine if one or another part of the warning system or preparedness plan has become obsolete. Maintenance also involves testing and care of equipment and practice of procedures to insure participants can perform their assigned roles.

COSTS FOR WARNING AND PREPAREDNESS ALTERNATIVES

Several types of costs are involved in implementing and operating warning and preparedness alternatives including:

- Purchase and installation of hardware for monitoring, data collection and processing, and communications;
- Expenses for modification of utility systems and facilities to enable efficient execution of the plan;

- Purchase of equipment and materials needed to execute each element of the preparedness plan such as water rescue and flood fighting equipment;

- Ongoing labor charges for monitoring, maintenance of the preparedness plan and equipment, and for a continuing public information program;

- Costs associated with activation of the flood warning system, issuance of warnings, and expenses of executing the preparedness plan; and

- Costs in the form of liabilities associated with implementation and operation of the alternative.

The overall cost of a particular warning and preparedness alternative is highly variable and depends on a number of considerations. Some of the factors which usually have an important influence on costs are type of flood recognition system selected, need for mass warning systems, requirement for development of site-specific preparedness plans, and the thoroughness of actions to be taken when a flood threatens. However, any number of other things could prove a dominate cost factor in a given case.

Hardware costs are practically nil for a flood recognition system using observers with small plastic rain gages who telephone rainfall information to some central location. At the opposite end of the spectrum, equipment costs for a flood recognition system might be in the range of $50,000 for a moderately sized watershed if automatic monitoring of precipitation and computerized forecasting of runoff is used. In between these extremes are systems which add reliance on warning issued by the National Weather Service, mix automated and manual procedures, or depend on stream level sensors. Flood recognition systems which incorporate several approaches or serve larger areas can, of course, cost much more.

Communications gear is not usually a major item since police, fire, public works and other agencies usually have well developed communications systems. Typical expenses for warning system purposes are those for tone activated VHF weather radios ($40-100), radio relay stations ($5,000-15,000) and perhaps leased telephone lines. The total communications cost depends, of course, on what exists and the remaining needs.

Costs of modification of structures and utility systems may involve large expenditures up to several percent of the value of the structure if permanent flood proofing is considered as a part of the preparedness plan.[17] On the other hand such costs may amount only to installation of a few valves at appropriate locations on gas lines to enable curtailment of service to selected areas. In the latter case, the associated cost may be a few thousand dollars or less. Contingency flood proofing may involve even less in the way of costs.

Purchase of equipment and materials necessary to execute the preparedness plan could be very slight in the case of larger communities which have large and diverse resources of equipment readily available. For smaller communities, the cost could be significant. The types of items needed might include: boats, motors, and other associated equipment for water rescue; stockpiles of sandbags, dry sand and small hand tools; hand held radios; stocks of food; and a wide range of other items. The quantities of such items which a community must set aside in a safe area also depends on the portion of the community vulnerable to flooding. Even relatively large communities may prove to be short of usable resources if the entire area is flooded. Conversely, small communities may get along fairly well so long as the area flooded is limited and most community resources are left intact.

[17] Johnson, William K. Physical and Economic Feasibility of Nonstructural Flood Plain Management Measures. The Hydrologic Engineering Center, U.S. Army Corps of Engineers. Davis, CA March 1978.

The continuing costs associated with operation of the flood recognition system and maintenance of the preparedness plan are comparatively small. They include those for periodic servicing of equipment, coordination between participants, updating and practice of the plan and whatever effort is required for maintaining surveillance of flood conditions. Altogether, these costs may be only a few thousand dollars a year for even a fairly sophisticated warning system and preparedness plan. As important perhaps as their small size is the fact that these types of costs are almost entirely labor and can often be absorbed easily within budgets for ongoing activities.

Review of the literature does not reveal that any analysis has been made of the costs of actually executing a preparedness plan. However, they can be expected to be substantial. Whether they ought to be included in economic analysis of a warning and preparedness alternative is not clear. A good basis may exist for saying that costs for carrying out emergency measures are a normal part of fire, police, public works and other governmental agencies' expected expenditures and that they were not incurred just because a plan of action was adopted. On the other hand, identification of all costs may be important with respect to implementation of Section 73(b) of Public Law 93-251.

INTERGOVERNMENTAL NATURE OF WARNING AND PREPAREDNESS ALTERNATIVES

No single agency or governmental level regularly carries out a complete and comprehensive program of flood warning and flood preparedness planning nor does it seem likely that any might do so in the foreseeable future. Federal and state agencies lack local operating capability and so are prevented from unilaterally carrying out certain portions of a warning and preparedness alternative except in the case of public lands and reservations. Communities come closest to being able to develop and implement all parts of a warning system and preparedness plan, especially in the case of fairly simple plans for small watersheds. However, in most cases, even the smallest communities' warning systems

place some reliance on the weather information regularly made available from the National Weather Service and preparedness plans usually depend on county assistance and on the participation of various volunteer organizations and assistance from regional, state, or federal entities. An appreciation of the major reasons which compel the distribution of functions among several parties is important in considering what entities ought to be involved in planning and ought to be assigned implementing and operating responsibilities.

One important key to the intergovernmental nature of warning and preparedness alternatives is that, unlike most other programs, their operation is intermittent. Capability to be fully functional at any time and on short notice must be maintained. However, for all but relatively brief and often infrequent periods, there may be little need in some areas for more than simply monitoring weather conditions. Thus the system is largely in stand-by status. This means that reliance must be placed on performance of operational responsibilities by agencies which have other missions that produce or can be adapted to the capabilities and resources required for the warning-preparedness system.

For example, reference has been made to the need to maintain a twenty-four hours a day capability to receive flood related information. This task could be performed by a special office and communications system. However, if such an approach were taken, those resources would be idle or nearly so most of the time. Yet it would be necessary to bear their cost on a full-time basis.

The more practical method and the one normally chosen is to lodge the responsibility for the communications function with police, public works, fire or another department which normally maintains a twenty-four hours a day operational status for the performance of its principal mission. While emergency service agencies (formally civil defense and disaster agencies) have established some communications systems entirely to serve their own purposes, it is more common, and in most instances more effective, for flood warning and preparedness systems to rely to the greatest extent possible on equipment, facilities and personnel already

maintained for other regularly established and financed functions. In that way, the benefits of an organization in being can be obtained.

Dissemination of flood information and of warnings is also characteristically more than a single agency activity. The National Weather Service regularly informs community and county officials and news media of severe weather, flood watches and flood warnings with the expectation that each recipient will in turn spread the word to others including the general public. Development of a warning and preparedness alternative normally has as one of its principal objectives the improvement of this warning dissemination process to ensure all potentially affected parties are provided important information on a timely basis. Means of dissemination may include use of civil defense siren systems and other mass warning devices, announcements by public address systems of police and fire vehicles or helicopters, ringing of church bells, use of ham and citizens band radios and others. More complete plans may include several of these techniques to provide redundency as a guard against incomplete warning and to provide the repetitive reinforcement of warnings which stimulates response. Introduction of each of these means increases the number of governmental and private interests involved in the process of warning dissemination.

The design, implementation and execution of the preparedness plan component of a warning and preparedness alternative likewise involves multiple interests from two or even all three levels of government and can include the private sector as well. Funds for preparedness planning and some technical assistance have been available from the federal government and, in some cases, from states. Funding for personnel and equipment can come in varying proportions from local governments, but also from the federal government, the states and sometimes from the private sector. Well rounded preparedness plans will include provisions for such things as hospital and utility services, traffic control, protection of vital records and other actions. Schools or other public and private buildings may be used to house evacuees and volunteer organizations are usually enlisted to provide at least minimal services.

Aid in recovery is normally sought from a variety of federal, state and local governmental sources. Depending on the details of state and local government organization, public or private ownership of such things as utilities and hospitals, and proliferation of special purpose districts, plans with such features require the coordinated participation of many public and private entities.

The upshot of the matter is that none but the most rudimentary warning system, and no thorough community level preparedness plan can be developed or operated without the cooperative and coordinated activities of several governmental agencies and levels and at least some kinds of private entities. This entails an obvious problem since the necessary coalescing of efforts in planning and actual performance is not achieved spontaneously or even by informal means alone. It requires negotiations among the participants, agreement on the roles of each, development of a program for the coordinated participation of all, operational coordination, and commitments binding enough so that each participant and the general public may rely on the pieces fitting together to afford the desired protection.

CHAPTER 3

EXAMPLES OF PAST PRACTICE

Analyzing the legal, financial and other managerial aspects of implementing flood warning and preparedness alternatives would be eased considerably if large numbers of such systems had been implemented alone or as part of some overall strategy and some record of experience was thereby available. Even if the alternatives demonstrated a variety of conflicting approaches, the experiences associated with each could be examined to appraise what advantages one or another approach might have and to identify particularly good examples for emulation. Unfortunately, there is no instance of a comprehensive flood warning and preparedness system which has been planned and implemented as a federal project measure, at least so far as is known to the investigators. The closest examples include the ongoing program of the NWS to assist communities in establishing flood warning systems, a flood emergency evacuation plan developed by the Corps for Barbourville, Kentucky, and a warning and preparedness system being developed by TVA and the city of Gatlinburg, Tennessee.

The intent of this chapter is to describe the approaches taken by the NWS, Corps and TVA to date with regard to the matters of planning, finance, implementation, operation and other topics discussed in succeeding chapters.

NWS PROGRAMS

The NWS has for many years encouraged the establishment of flood warning systems by communities located in areas subject to flash flooding. Their activities along this line are performed under continuing program authorities and include distribution of promotional literature, consultation with non-federal officials, participation in framework and river basin planning programs, conduct of demonstrations, and

assistance to communities.[1,2] NWS also maintains an international system for collecting meteorological data and is the principal source of weather forecasts in the United States.

Planning

NWS does not usually provide a full range of services related to planning of flood warning and preparedness systems. Its mission is generally viewed as encompassing flood recognition, ending at the point of receipt of the warning at some central site within the threatened community. Development of a response plan for issuance of warnings and their dissemination to the public is left to the community aside from what announcements NWS may provide by weather radio or release to public radio and television stations serving the affected area. Development of a preparedness plan is an optional local activity.[3,4]

For the portions of a flood warning and preparedness system with which it customarily concerns itself, NWS planning is of the more detailed variety with respect to analysis of the flood hazard and techniques for interpretation of data. Planning of non-technical aspects is usually done in close coordination with local interests.

Financing

Financial assistance provided by NWS to communities is limited and usually consists of provision of inexpensive items such as plastic rain gages for observers and furnishing of certain specialized services.

[1] 15 USC 313.

[2] 7 USC 450b

[3] WS Form E-42 Memorandum of Understanding for Flash Flood Alarm System.

[4] WS Form E-43 Memorandum of Understanding for Flash Flood Warning System.

The services rendered such as installation and calibration of equipment and training probably exceed the value of equipment donated by NWS in most cases. Agency policy requires expensive pieces of equipment such as flash flood alarms to be paid for by non-federal interests. It should be noted, however, that the types of systems generally installed by communities with assistance by NWS are relatively inexpensive and thus do not raise many questions of financial capability or distribution of costs.

Efforts to date by the NWS to encourage and facilitate the implementation of flood warning systems and preparedness plans have not included consideration of the 20 percent limit on the cost to non-federal participants for nonstructural measures which is established by Section 73. There has been no contribution of federal funds to non-federal interests to offset higher local costs and hence no problem of calculating or apportioning a federal reimbursement. Non-federal interests have been required to bear whatever costs were associated with the preparedness plan and allowed to do so in whatever way they wished.

Implementation

Implementation of the types of flood recognition systems the NWS is involved with in most communities is fairly uncomplicated. If a self-help system is to be installed, the principal implementation steps are to employ or obtain the volunteered services of observers in suitable locations, train the observers, and train the person(s) designated to perform the interpretation of data and issue warnings. NWS normally performs the parts of implementation related to training. If a flash flood alarm is employed in the warning system, implementation involves procuring and installing the alarm, connecting it to a signaling device at the desired location and providing suitable connections to power and telephone lines if long distance transmission of the signal is required. NWS assists in procurement and installation of equipment. Non-federal interests must provide for all other implementation requirements including furnishing of any necessary lands, easements and rights-of-way.

Operation

Flood warning systems established by the NWS in conjunction with local governments depend almost exclusively on non-federal operation. In most such systems, the only federal role is provision by NWS of their regular weather forecasts and flood predictions. Monitoring of flash flood alarms or collection of precipitation and/or stream stage data, interpretation of data, and issuance or dissemination of warnings are all carried out by non-federal interests. There are a few exceptions to this pattern. One is the NWS role in dissemination of flood warnings through mass media. Another is the operation of some highly sophisticated computerized systems such as one being planned for Stevens Creek Watershed in Santa Clara County, California, in cooperation with the California-Nevada River Forecast Center of the NWS.[5] The Stevens Creek flood warning system will provide automatic forwarding of local data to the River Forecast Center for entry into the national data processing system and for interpretation by NWS through use of rainfall-runoff models for the Stevens Creek Watershed. However, even though the federal government participates much more closely in operation of that warning system and in other similar systems, decision-making, issuance of warnings and warning dissemination largely remain a non-federal responsibility.

Assurances

Local governments participating with NWS in establishment of flash flood warning systems must agree to recruit and manage a network of volunteer observers, develop the local procedures for issuing warnings, designate a person to be trained in forecasting and establish a community communication and action center for receiving and disseminating information.[6] For systems built around flash flood alarms, the local

[5] Owen, H. James. Stevens Creek Flood Warning and Preparedness Plan Prepared for the Santa Clara Valley Water District. San Jose, CA. 1979.

[6] WS Form E-43 Ibid.

government must also agree to arrange and pay for necessary power and telephone lines, provide for continuous monitoring of the alarm on a 24 hour basis, develop a response plan, and implement the response plan when needed.[7]

TENNESSEE VALLEY AUTHORITY AT GATLINBURG, TENNESSEE

An agreement exists between TVA and the city of Gatlinburg, Tennessee, to develop and implement a flood warning and preparedness system.[8] This effort is of particular interest because it is somewhat more like a "project" than is the ongoing program of the NWS. It should be recognized, however, that TVA water resources development and flood control programs allow great flexibility. In the case of Gatlinburg, TVA's participation resembles that which might be provided by the Corps under it's Flood Plain Management Services program.

The city of Gatlinburg, Tennessee, is the gateway city to the western side of the Smokey Mountains National Park, one of the most heavily used facilities in the National Park System. The population of the city is only a few thousand, but tourists swell the population to upwards of 20,000 on many summer weekends. The principal economic activity of the community is housing, feeding, and providing other services to park visitors.

The city sits astride the channel of the West Fork of the Little Pigeon River. Several large structures, including multi- story motels, have outer walls which form one side of the channel. At least one motel is located on a low lying island in the channel. Throughout the length of the city, the stream is narrow and frequently spanned by small slabs of concrete at low elevations which serve as footbridges. The valley is also narrow and defined in some places by almost vertical rock walls.

[7] WS Form E-42 Ibid.

[8] Agreement between Gatlinburg, Tennessee and Tennessee Valley Authority for Development of Flood Warning and Evacuation System. 24 June 1976.

Flash flooding is a serious problem in the Gatlinburg area. A relatively minor flood in 1935 rose 10 feet in 15 minutes as the result of a thunderstorm over only about a third of the drainage area above the city. The only warning of the impending flood was a roaring noise from the direction of the park. Higher floods are reported to have occurred in the past[9] and far more severe floods are certainly possible.

The high concentration of persons in Gatlinburg and the potential for flash flooding poses a severe problem. The problem is worsened by the large number of visitors usually in the community who are unfamiliar with the flood potential, the difficulties of disseminating warnings and obtaining a positive response among overnight guests, limited routes for escape, and the quickness with which floods can occur. According to TVA, "A 100 year frequency flood at Gatlinburg could be expected to rise 4 feet over the level reached by the 1966 flood and could cause over 100 deaths.[10] A 500 year frequency flood would rise an additional 2 feet[11] and could result in the loss of over 500 lives."

TVA has investigated the situation at Gatlinburg for a number of years. Attention has been given to a variety of structural and nonstructural measures. Upstream impoundments have been ruled out because of the environmental impact of their location within the park. Flood walls were considered undesirable because the extreme height required would effectively partition the city and because of their adverse environmental impact. Permanent relocation of flood plain developments was unacceptable to local interests. Faced with these several constraints, TVA undertook consideration of whether a warning and evacuation plan could be developed successfully for the area.[12] Further discussion with Gatlinburg officials led to execution of the

[9] Tennessee Valley Authority. Floods on West Fork, Little Pigeon River: Gatlinburg, Tennessee. June 1958.

[10] Tennessee Valley Authority. Flood Forecasting and Evacuation Plan for Gatlinburg, Tennessee (undated).

[11] Tennessee Valley Authority. Ibid.

[12] Owen, H. J. Evaluation of Warning and Evacuation Planning for Gatlinburg, Tennessee. Prepared for the Tennessee Valley Authority. September 1975.

agreement between the city and TVA to develop a demonstration project to test the effectiveness of using advanced flood warning devices and evacuation procedures. The agreement was executed on June 24, 1976.

The warning component of the system to be implemented at Gatlinburg includes a number of radio operated, self-reporting rain gages located in the park area and a data processing and runoff prediction system using a mini-computer to be located in Gatlinburg. The evacuation plan is to consist of both an overall plan for the city's actions in preparing for and during flood emergencies and site-specific plans for each commercial establishment located in the flood plain. The site-specific plans are to deal with arrangements for receipt of flood warnings and issuance of specific evacuation instructions to occupants. The agreement also provides for certain training and practice and for maintenance of the equipment.

Planning

Responsibility for planning of the Gatlinburg system is divided between TVA, the city and private interests. TVA is providing detailed design of the flood recognition system including specification of equipment. However, the preparedness planning portion of the alternative was investigated by TVA only to the point of determining that a useful flood preparedness plan could be developed. Actual development of the preparedness plan was left entirely to non-federal interests. The agreement between the city and TVA does not spell out any required level of detail or content for the overall preparedness plan and only names the subject matter which site-specific warning and preparedness plans are to address. However, TVA reserves the right to terminate the agreement and recover certain equipment if a satisfactory system is not developed.

Financing

The agreement for the Gatlinburg system spells out cost sharing arrangements. Non-federal interests are to bear 10 percent of the first cost of obtaining and

installing equipment and software required for the flood recognition system, 100 percent of the cost of developing an overall community-wide evacuation plan and site-specific systems for warning and evacuation, 50 percent of the major costs for operation and maintenance of the system in the first 10 years, and 100 percent of operation and maintenance costs after the tenth year of operation.

In one respect, TVA's approach to distribution of costs for the Gatlinburg system is specific. The agreement between the city and TVA specifies that the city of Gatlinburg, not just non-federal interests, will bear particular costs. Also worth note, the Gatlinburg approach provides reimbursement of costs only to governmental participants. However, in another respect the agreement is not specific. For example, TVA did not concern itself with the distribution of the non-federal costs for the site-specific warning and preparedness systems. The city is only to "require" those things of "...commercial establishments located wholly or partially within flood hazard areas..." It is left to non-federal interests whether the city or another non-federal agency shall assist financially in private parties' compliance with the requirement.

Two points with regard to the Gatlinburg situation should be noted. First, the cost sharing arrangements finally evolved were part of the agreement for joint implementation of the project. As such, the specific arrangements perhaps reflect more what worked out in one particular case than a general policy approach. TVA might have been equally suited if the State of Tennessee, the County or a special purpose district had assumed the costs which the city agreed to bear. Second, it is not evident that the apportionment of costs produces the 80-20 split of costs specified for nonstructural measures by Section 73 nor that the apportionment was based on the land-related costs of an alternative structural project.

Implementation

The agreement between the city of Gatlinburg and TVA provides a fairly crisp division of responsibility for implementation. TVA is to provide plans and specifications of gages and data processing devices. The

city is to carry out the actual purchase and installation of equipment, obtain all necessary permits and approvals such as assignment of radio frequencies, establish an operator training program, develop an overall prepparedness plan, and require the development of site-specific warning and evacuation plans. The basis for division of implementation responsibility appears to have been allocation to the city of primary responsibility for all parts of the plan except the planning and specification of hardware. If specification of hardware is considered planning rather than implementation, TVA's approach in Gatlinburg is to assign all implementation responsibility to non-federal interests excepting general review and approval of the system which finally evolves.

Operation

Operation of the flood warning system is specified in the implementation agreement as a city responsibility. In particular, the city is obligated to provide qualified operators to staff the forecast center, to issue and disseminate flood forecasts, and to issue evacuation notices. The city is also required to provide space and utilities for continuing operation of the forecasting center. The only ongoing operational role specified in the agreement for TVA is provision of assistance to the city in maintaining liaison with National Park Service, National Weather Service, other federal agencies and civil defense agencies.

Assurances

The agreement between TVA and Gatlinburg seeks to assure the performance of the city through a "carrot and stick" approach. Expensive equipment is to remain the property of the city after a period of ten years. However, during the ten year period, TVA has the privilege of retrieving the equipment if a system satisfactory to both the city and TVA is not achieved on a timely basis and satisfactorily maintained.

CORPS OF ENGINEERS AT BARBOURVILLE, KENTUCKY

The city of Barbourville is located in southwest Kentucky at the confluence of the Cumberland River and Richland Creek. The population of the city is about 3,500. Economic activity in the community is primarily retail trade and manufacturing of apparel, textiles, leather, lumber, machinery, and metal products. Union College, located at Barbourville, has about 900 students and is also an important part of the city's economy.

Floods in the area are frequent and floods far larger than any known of in the past can occur. A local flood protection project was authorized by the 1950 Flood Control Act. The project, consisting of a 3.5 mile long levee, was constructed in 1959 by the Nashville District, Corps of Engineers. The levee provides protection against floods up to approximately the 100 year event. Several floods which have occurred between 1946 and 1974 either would have or did come close to overtopping the levee, some by a matter of inches. A standard project flood would overtop the levee by about 8 feet. In the event of overtopping, the leveed area will fill rapidly with water, creating a very hazardous situation for anyone remaining within the area.

Pursuant to a request by the city of Barbourville, the Corps participated in development of a flood emergency evacuation plan. Planning began in 1975. The Corps' participation was provided under the Flood Plain Management Services program and Emergency Services program. The completed plan was approved by the city in January 1976.[13]

The plan provides for evacuation, when flooding appears likely, of approximately 2,500 persons who reside within the leveed area of the city. Leadership of the evacuation effort is to be furnished by a trained volunteer group serving on the Emergency Operating Center Staff. The plan is staged with defined sets of actions to be taken at each of several degrees of

[13] U.S. Army Corps of Engineers, Nashville District, et al. A Report on Flood Emergency Evacuation for Barbourville, Kentucky. September 1976.

threat. It also divides the city into zones, each with designated evacuation routes and assigned destinations. Hospital and nursing home patients are accorded special assistance. With regard to warning, the Barbourville plan only notes the existing self-help system operated in conjunction with the NWS and areas of possible improvement.

Planning

Development of the Barbourville plan was a cooperative effort between the Corps, city and numerous other agencies. However, the Corps provided the bulk of the effort to formulate the basic concepts and prepare the plan document. The city furnished financial support for a portion of the planning performed under contract. For those topics which the plan addresses, considerable detail is provided. Evacuation routes are identified, shelters specified, duties for individual staff of the Emergency Operating Center are stated and stages of the plan are well defined. The plan considers traffic density, traffic control, evacuation rules, and security arrangements. Shelter information included in the plan addresses accommodations, administration, food and health services and other aspects. The plan also treats public education, dissemination of warnings, general operating procedures and updating of the plan. Parts of the plan are specific to the point of identifying which street closures are to be barricaded and which controlled by police, number of police to be stationed at each traffic control point, etc. The plan does not contain any disclaimer concerning variation in its execution from the details presented.

Financing

First costs associated with implementation of the Barbourville plan were estimated to be $4,000, all of which were to be borne by non-federal interests. Annual costs were estimated to be $1,000, also to be borne by non-federal interests.

The evacuation plan does not specify distribution of non- federal costs but rather provides a "suggested cost sharing plan" for distribution of the financial

burden among the city of Barbourville, Knox County and the Commonwealth of Kentucky. It should be noted in this regard that the evacuation plan was developed under the Flood Plain Management Services program where emphasis is on non-federal implementation. Development of the same plan as part of a survey investigation might have resulted in more attention to the specifics of cost sharing. In particular, since the plan was only offered to the city for whatever use it saw fit, no formal implementing agreement like that between TVA and Gatlinburg was necessary. As with many of the flood warning systems developed by communities in conjunction with the National Weather Service, overall costs were too small to raise any significant concern over implementation policy.

Implementation

Implementation steps for the Barbourville evacuation plan included furnishing and equipping an emergency operating center, conduct of a public relations effort, purchase of various badges, signs and decals, and completion of steps to formalize and adopt the plan. The latter included adoption by the city of Barbourville of an ordinance providing a legal framework for the plan and providing necessary authorities for designated personnel, action by Knox County to make facilities and equipment available for execution of the plan, approval of parts or all of the plan by various federal and state agencies, and establishment of mutual aid agreements with various entities. Accomplishment of all these implementing actions was primarily the responsibility of the city of Barbourville. While the plan did not require very complex or difficult implementing actions, the approach taken in a more complex case or one that arose from an authorized study might well differ.

Assurances

The Barbourville evacuation plan resulted from technical assistance rendered to the city by the Corps under the Flood Plain Management Services program. Therefore, no assurances were required of the community.

INCONSISTENCY IN APPROACHES

These instances do not show a consistent federal approach to participation in flood warning and preparedness system development and operation. One explanation may be that each agency and each program has its own capabilities and constraints. Probably even more indicative of the actual reasons is the fact already noted that comprehensive warning and preparedness systems have not really been extensively used as major tools for flood loss reduction. It has not been customary to consider them as a standard method like the construction of impoundments nor even zoning restrictions. Consequently, there has been little thinking through of roles and functions.

CHAPTER 4

POLICY CONSIDERATIONS

Congress directed in Section 73 of Public Law 93-251 that planning for purposes of flood loss reduction should consider a broad array of measures. Warning and preparedness alternatives fit this context. However, it is not to be expected that warning and preparedness will play a large role in every case or that it will even be suitable for use in all situations. Planners must decide the applicability and potential usefulness of warning and preparedness systems in each case based on consideration of economic, hydrologic, engineering, environmental and social factors; preferences of the concerned non-federal interests; and prospects for successful implementation.

Consideration of these and other matters in a fashion which is sufficiently realistic and thorough to support selection of warning and preparedness as a part of the preferred alternative requires an understanding of the types of issues which will arise and have to be solved in putting that measure into use. Appraisal of those issues and their intricacies and formulation of judgements on whether and under what conditions flood warning systems and preparedness plans could or should be developed and operated at particular sites requires the planner to have a body of relevant legal and institutional knowledge.

This chapter deals generically with some important policy considerations pertinent to planning, implementation and operation of warning and preparedness alternatives. Chapter 5 provides similar treatment of important legal considerations. Together, they are intended to provide certain background information useful both for reviewing the analysis of issues presented in Chapter 6 and for analyzing other issues which may arise in practice.

The policy related matters dealt with in this chapter include:

1. Interest of federal, state and local governments and the private sector in the implementation and operation of warning and preparedness systems;

2. Financial capability of governmental levels and the private sector to support planning, implementation and operation of warning and preparedness alternatives;

3. Relative technical capabilities of governmental and private sectors to plan, implement and operate warning and preparedness alternatives;

4. Unresolved problems of a technical nature which have policy implications;

5. Motivation of governments and the private sector to create and maintain interest in warning and preparedness alternatives.

GOVERNMENTAL AND PRIVATE INTEREST

Each governmental entity will ascertain the support which it will give to a proposed flood warning and preparedness alternative based, in part, on how that measure would serve its interests. Differences in the degree of support are to be expected. What is vitally important to one level of government may be of only minimal interest to another. Variations in interest are also to be expected between state governments and between local governments. Each state and each community comprises a unique context for determination of how and to what extent its interests will be benefitted by a flood warning and preparedness program. The private sector, including individuals and various types of business and other organizations will also support or contest proposals for flood warning and preparedness systems in part according to how each party perceives the systems' effect on furthering its interest.

While all of the variations attendant to the diverse interests of the public and private sectors cannot be addressed, some bases for a general interest on the part of each level of government and the private sector can be identified. This insight can be helpful as background information in identifying a pattern for allocating the responsibilities associated with implementation and operation of a warning and preparedness alternative. This is important because the assignment of a role to a particular level of government or to an entity of the private sector which requires more cost and effort than is warrented by its perceived interest in the results is likely to be a serious error. Successful use of warning and preparedness measures rests upon each participant carrying out its assigned role.

Governmental Interest

There are at least four reasons for governmental interest in warning and preparedness alternatives including:

1. The relationship to overall resource management;
2. Reduction of flood losses;
3. Avoidance of future costs for flood control works; and
4. Complementarity with various goals other than flood loss reduction.

A governmental interest exists with respect to warning and preparedness alternatives if only because they involve the Nation's water and land resources. Water and land, particularly the fertile lands of the flood plains, are two of the important resources from which our national wealth is derived. However, interest on this account at the federal level is of the most general sort and might be satisfied by simply assuring that warning and preparedness alternatives did not permanently diminish either the resources or their productivity. States could reasonably be expected to have a somewhat similar interest although reduced in

geographic scope and oriented to more immediate concerns. On the other hand, local governments might be expected to have an acute interest in the way water resources are managed in their vicinity. Whether flood problems are addressed with a warning and preparedness alternative, multi-purpose dam and reservoir, levee, land acquisition program or another technique may make a great difference in future community development, the type and extent of damages prevented and the availability of water supply, recreation and other water related goods and services.

Warning and preparedness alternatives are also of interest to all governmental levels because they offer a way to reduce flood damages. This is of obvious importance to local governments. To the extent that warning and preparedness alternatives would prevent damages in excess of their costs, there is also a national benefit in their use since the federal government eventually bears a significant share of flood losses through programs for repair, rehabilitation, disaster assistance and other purposes. States also maintain such programs and would similarly benefit by reduced flood losses. The exact degree of interest which exists on the part of each governmental level for this reason depends somewhat on the size of flood loss being considered. The general practice in governments' absorption of flood losses is for each governmental level, beginning with the lowest, to deal with the problem to the limit of its resources. State aid is provided only when local resources are exceeded and federal aid only after state resources are depleted. Therefore, local governments would have an interest in all cases while the state and federal interest in reduction of losses becomes progressively greater for floods of more serious proportions.

Reduction of flood losses by warning and preparedness alternatives may also stave off or delay the need for costly flood control works, thus increasing the economic reasons for an interest on the part of federal and local governments since those entities provide most of the financing for structural measures. While this is probably the strongest reason for the federal interest, local interest on this account might be mitigated due to preference for the more comprehensive prevention of damages that can be achieved with large flood control works.

Each level of government has goals other than the reduction of flood losses. The federal government, for example, is concerned with long range management of resources with a view toward combining optimum development with protection of the environment, social well-being and other purposes.[1,2] State and local governments are likewise concerned with a variety of goals which, while perhaps of progressively shorter range, lesser scope and more specificity than those of the federal government, nevertheless are broader than just reduction of flood losses. The salient characteristics of flood warning and preparedness alternatives such as absence of environmental impact, low financial cost and protection against catastrophic flooding may sometimes fit better with those other goals than do dams or other traditional approaches to flood loss reduction. Some situations probably exist in which each level of government has an interesst in warning and preparedness alternatives for this reason.

For all of the foregoing and other reasons which could be set forth, an interest of varying degrees exists at all levels of government in the use of flood warning and preparedness alternatives. However, these types of arguments provide no insight as to what lengths each government's agencies could or should go to see such alternatives employed on a widespread basis. Some further information pertinent to this point can be gleaned from examination of activities already underway by various federal agencies and relevant legislation and policies.

Prediction and warning of floods has been a statutory responsibility of the NWS and its predecessors since 1871. Warnings include both announcements of river stages at over 2,300 points and wide distribution of meteorological forecasts. NWS has also actively promoted the development of community level flood warning systems and has recently begun to encourage community development of flood and flash flood preparedness plans to take full advantage of early warnings.[3]

[1] U.S. Water Resources Council. A Unified National Program for Flood Plain Management. Washington, DC. July 1976.

[2] U.S. Water Resources Council. Principles and Standards for Planning Water and Related Land Resources. F.R. September 10, 1973.

[3] National Weather Service, U.S. Department of Commerce. Operations of the National Weather Service. January 1977.

Sizable appropriations for these purposes indicate a substantial federal interest and evidence the view of the legislative and executive branches that the federal government can or should encourage at least the warning system portion of warning and preparedness alternatives.

Two other federal agencies have been actively engaged in encouraging and supporting warning and preparedness planning including that for floods. The Defense Civil Preparedness Agency has for several years provided technical leadership and financial support for preparedness planning at the community level. While the agency is oriented heavily toward war related disasters, flood and other types of natural hazards can be dealt with through the mechanism of "all purpose" disaster plans if communities elect to do so.

The Federal Disaster Assistance Administration has been specifically directed to encourage state and local preparedness planning for disasters, including floods. The Disaster Relief Act of 1974, Public Law 93-288, declares that:

> It is the intent of the Congress, by this Act, to provide an orderly and continuing means of assistance by the Federal Government to State and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from (disasters) by...encouraging the development of comprehensive disaster preparedness and assistance plans, programs, capabilities, and organizations by the States and by local governments...

The Act also establishes a grant program without matching requirements to support state and local disaster preparedness planning. Importantly, the President is required by the Act to:

> ...provide technical assistance to the States in developing comprehensive plans and practicable programs for preparation against disasters, including hazard reduction, avoidance, and mitigation;...and direct appropriate Federal agencies to provide technical assistance to State and local governments to insure that timely and effective disaster warning is provided.

These programs and directives demonstrate that the interest of the federal government is served by doing many of the types of things which would be involved in planning and carrying out warning and preparedness alternatives for flood loss reduction.

The notion that a federal and state interest exists in use of flood warning and preparedness alternatives is reinforced and refined by A Unified National Program for Flood Plain Management. That policy statement sets forth a conceptual framework for a national effort including flood loss reduction and recommends federal and state actions for a continuing program of coordination, education, technical leadership, forecasting and provision of cost sharing which would "facilitate a desirable mix of structural and nonstructural approaches to flood hazard adjustments." It also states as general principles that flood loss reduction must be viewed within the larger context of flood plain management and that flood plain management is an area in which the federal government has a fundamental interest.

Somewhat less can be said about state governments' interest in warning and preparedness alternatives through examination of ongoing programs and legislation. Warning and preparedness planning concepts have been considered mostly at the federal and local levels and state programs are not well developed. However, all states have an agency or office assigned responsibility for disaster planning, provision of emergency services and like responsibilities. In most cases, these agencies view the encouragement of local preparedness planning and provision of technical assistance for that purpose as one of their key objectives. Some states, California as an example, also invest considerable funds in providing forecasting of floods and dissemination of flood warnings to supplement services available from the NWS.

Private Interest

Individuals and organizations in the private sector have an interest in the use of warning and preparedness alternatives for at least two reasons, including provision of personal security and reduction of economic losses.

Concern for death or injury of one's self and family is, of course, a basic interest of individuals. To the extent that warning and preparedness alternatives can provide for safety from floods, that alone is ample reason for persons in flood prone areas to favor such systems and provide a measure of support for their implementation. This reason is less valid for business and other organizations which may have an abstract concern for life and health but which lack any personal involvement.

Reduction of economic losses from floods is a far broader basis for interest in warning and preparedness systems by both individuals and many types of private organizations. In addition to those living in the flood plain, individuals and organizations owning property there, providing services to floodplain residents or involved in other ways have a stake in minimizing damage and disruption of commerce. In some cases, this interest may be spurred by concern for more than just the immediate losses of a single flood. A record of repeated flood losses may lower property values, discourage visitors at resorts, result in increased taxes to provide relief or protection, or in other ways cause long-term adverse economic effects.

FINANCIAL CAPABILITY

Implementation and operation of warning and preparedness alternatives entail certain costs. The nature and general range of those costs were summarized in the preceeding chapter. While the aggregate costs for implementing and operating a warning and preparedness alternative are generally less than those for alternatives employing dams, levees, land acquisition and most other flood loss reduction techniques, they are nevertheless significant. The capability of proposed participants in such alternatives to bear the associated costs is therefore important if a realistic assignment of responsibilities is to be made.

The adequacy of a participant's financial capability is obviously related to the amount of dollars which are available or can be made available either in

ready funds or in the form of services. Financial capability also depends to an extent on the manner in which funds can be raised and the authority to expend funds for the needed purposes. It may also depend in certain cases on the degree to which the means available for raising funds can distribute the financial burden in an equitable way, usually considered to mean to the direct beneficiaries in a manner related to their relative degrees of benefit.

It is worth note that the costs associated with implementation and operation of a flood warning and preparedness alternative are of a variety of types. Costs for equipment require cash, are basically one-time costs, and must be available at the time of implementation. Some other costs, such as those for maintenance of equipment, do not occur until the warning and preparedness system has been in use for some time and can be met either through services or an outlay of funds when they do arise. Still others, such as the cost for practice of the preparedness plan can be met only through services and, moreover, the services must be provided by certain participants. The costs for each element of a warning and preparedness alternative such as flood recognition or warning dissemination also vary in size, adding considerably to the complexity and flexibility of cost apportionment.

Federal Government

It must be recognized that the extent of federal costs will always be of concern to the Congress and the Executive Branch. However, the federal government is in a position to shoulder the federal share of warning and preparedness project costs in instances where it believes the approach to be an appropriate one. The 80-20 formula was apparently included in Section 73 on the ground that it represents an approximation of the cost sharing proportions for structural works. If a warning and preparedness system is relatively less expensive than a construction alternative, the federal government should find it financially attractive in many instances.

Making funds available in particular instances should not present any special problems. For projects,

the well established authorization and appropriation procedures can be used. If the federal participation is to be managed from program funds such as those of the Corps' Flood Plain Management Services program or the operating programs of the Weather Service, the only questions would appear to be whether, in the particular instance, the proposed undertaking is something for which the intended source of funding can provide money.

However, the Congress is not insensitive regarding the type of costs assigned to the federal government. The past policy of the Congress with regard to the traditional types of flood loss reduction projects has been to emphasize the federal role in the initial steps of implementation and leave to non-federal interests the continuing and future costs of operation and maintenance and of bearing such liabilities as might arise.

The federal government is somewhat constrained in the means by which assistance can be provided in implementation and operation of warning and preparedness alternatives. While ample authority may exist or be created to provide many types of help, practical considerations of efficiency and effectiveness often have a limiting effect. The seat of federal government and even the regional and other field offices are geographically remote from many areas for which warning and preparedness systems may be needed and recommended. This remoteness makes it undesirable for the federal government to assume responsibilities which require staff to be on-site, especially for anything less than extended full-time duty. Remoteness also deprives the federal government of the detailed knowledge of the local situation which is necessary for effective operation of a warning system and preparedness plan.

State Governments

State governments vary widely in their financial capabilities in terms of gross revenues, operating budgets, reserves, borrowing authorities and limitations. present indebtedness and in other ways. However, states generally have relatively large financial capabilities and most can create debt by either ordinary or extra-ordinary legislation. There are probably no states which could not afford a fair share

of the cost of implementing and operating a particular flood warning and preparedness system or even a number of such systems if they chose to do so.

While it is unlikely that any state would have to resort to debt to finance its share of costs for a particular warning and preparedness alternative, that prospect does raise a point of interest with regard to both state and local government. One means of circumventing constitutional limitations on debt used in many states is issuance of revenue bonds. Courts in many states have found debts so created to be outside the meaning of constitutional provisions controlling debt.[4] This raises a question whether the warnings and other outputs of a warning and preparedness system could be construed as vendible goods which might support repayment of borrowing based on future revenue. Pursuit of this question entails a large and complex set of legal and policy questions. However, where lifesaving is concerned, policy would clearly be in favor of serving all beneficiaries on an equal basis without any charges for those who could not afford them.

State legislatures have considerable capability to facilitate the apportionment of costs for programs in desired patterns by earmarking parts or all of specific revenues for particular purposes, enacting legislation assigning responsibility for certain costs among existing or newly created sub-state units of government or individually authorizing expenditures from general revenues for selected programs and projects. States have employed this capability in various ways in furthering traditional flood loss reduction measures. Some have ongoing programs to share costs of particular types with other non-federal interests, others provide loan programs to help local governments meet non-federal costs and still others provide funds to assist in projects on a case by case basis. The most prevalent approaches are probably those which either establish a revolving loan fund against which local project sponsors can draw or which furnish assistance in purchase of lands required of non-federal interests.

[4] Hoggan, Daniel H. State and Local Capability to Share Financial Responsibility of Water Development with the Federal Government. Washington, DC. 1971.

In any event, state legislatures have seldom made commitments to assume all of the non-federal responsibilities and have usually followed a policy similar to that of Congress with regard to bearing costs of a continuing nature.

Local Governments

Local governments differ greatly from federal and state governments and from one another in several aspects of their financial capability. Obviously some communities are wealthier than others if one compares their tax base, reserves and sources of revenue to their extant obligations. They also differ in the means which the parent state has furnished them for raising revenue and the purposes for which expenditures can be made.

Some communities, especially the very small, may have difficulty in raising substantial amounts of money. Those which do have funds available may be reluctant to place priority on spending for flood warning and preparedness systems. The fact that the benefits of warning and preparedness systems, as with most other flood loss reduction measures, are expected to occur sometime in the future detracts from the urgency with which they are viewed by local governments with severely limited resources.

Local governments have perhaps the greatest flexibility of all levels of government in tailoring the distribution of a financial burden in desired ways. The possibilities exist for taxation on a county-wide or city-wide basis, creation of various special purpose districts, and other techniques not so readily available to federal and state governments and agencies. The major impediment in local financial capability may well be the authority to expend funds in some of the ways needed to implement and operate warning and preparedness alternatives. Among others, these may include expenditures for securing land outside the government entity's jurisdiction, contribution toward systems to be operated by one entity for the service of several, and assumption of the risk for liability.

Local governments are generally able from a practical standpoint to promise and provide much more in the way of services than in cash outlays. Similarly, it is usually easier in a political sense for local governments to participate in multi-governmental projects if the state and federal governments make initial investments, thus deferring local input of funds or services until some future time. These two tendencies fit well with the need identified earlier for local participants to provide certain services connected with operation and maintenance.

Private Sector

Flood warning and preparedness alternatives developed as part of authorized flood loss reduction projects are usually conceived as public systems for the benefit of both the public and private sectors. Nevertheless, a portion of the cost can fall on private parties. Major private costs are probably limited to the development of any site-specific warning and preparedness plans which might be required for certain structures. However they could also include costs associated with floodproofing if that were integral to the response plan, modification of structures and utility or other systems to facilitate proper emergency operation, and changes in operational procedures. Publicly provided services from a warning system could also terminate at the point of making a suitable announcement, leaving to interested parties the costs of providing whatever equipment and arrangements are necessary for assuring receipt of the announcement. This latter approach is the one generally followed by the NWS with respect to its warning program. Radio and television stations, local governments, schools, businesses and individuals must either subscribe to the weather teletype, purchase radios or otherwise arrange to receive warnings. Where public warning systems go further and provide warnings to individuals, it is usually through some type of mass warning system.

The financial capability of private sector entities runs the gamut from large corporations to poverty stricken individuals. Presumably, the individual with little resources has as much right to share in the benefits of a public warning system as does the rich

individual or the wealthy corporation. The apportionment of costs either made deliberately or inherent in the design of the warning system and preparedness plan can cause a de facto discrimination in the distribution of benefits if differences in financial capability are not considered.

The problem of distributing costs among the private sector is eased to an extent by the fact that major costs tend to be related to the ownership of property. Less economically well-off individuals do not own the types of structures for which site-specific warning and evacuation plans might be required. Neither are they generally concerned with the costs of interfering with existing operating procedures of businesses or factories. For purposes of life saving, purchase of an inexpensive radio may be adequate or dependence may be placed wholly on the use of publicly provided mass warning systems.

TECHNICAL CAPABILITIES

Whatever pattern evolves in allocation of responsibility for planning, implementing and operating flood warning and preparedness alternatives must take into consideration the relative technical capability of participants. Assignments of responsibility which require particular capabilities not readily available to the assignee are likely to be inefficient at best and may result in complete or incorrect performance, leading to possible failure of the warning system and preparedness plan to realize its intended purpose.

Technical capability to carry out some part of planning, implementing or operating a warning and preparedness plan implies the need for both the expertise or skills to do whatever task is assigned and the organizational resources and ability to carry it out. A meteorologist in private practice may, for example, be expert in interpretation of meteorological information to predict precipitation from storms but lack the radar, communications and other equipment necessary to gather the data on which such predictions are based. Similarly, a community public works department may have

all of the equipment and personnel necessary to carry out a flood fighting effort but lack knowledge on how it should be done.

No one level of government can be said in a generic sense to be inherently more technically capable than another to plan, implement and operate a warning and preparedness system. Far too many types of expertise and capabilities are required in a system of even moderate complexity and the variation between the capabilities of various governmental entities is too great. Some special purpose districts or cities, for example, have technical capabilities in some aspects of water resources planning which exceed those of some states while others are literally devoid of independent expertise. The same type of variation exists in the private sector between various organizations and individuals with respect to technical capability to carry out parts of the system for which they might be left responsible.

In any given situation, it might be relatively easy to identify the respective technical capabilities of potential governmental participants in a warning and preparedness scheme and to determine which could best perform each part of the required work if other considerations were ignored. However, there are things to be taken into account which complicate the matter such as compliance with cost sharing arrangements and the need for development of a uniform federal role.

Planning

Planning of warning and preparedness systems requires analysis of the flood hazard in relevant terms, understanding of the various types of approaches which might be employed, familiarity with available equipment and knowledge of pertinent engineering, social, legal and other aspects. These types of requirements suggest that planning could be done best by those specializing in such matters. It would be relatively clear if those were the only significant aspects of planning that, from the standpoint of technical capability, federal and/or state agencies ought to perform the planning since they could support and justify maintaining such specialists on staff far better than could local governments. But planning

embodies additional requirements as well. Among others, these include a need for detailed knowledge of the area at risk, familiarity with existing procedures and preparedness plans of various local agencies and organizations, and information on the availability of local resources of equipment and personnel. Numerous questions may also arise in planning for which local preference is the deciding factor, such as whether one type or another of a mass warning system is most desirable, or for which local guidance is essential, such as procedures for adoption of the completed plan. All of these latter requirements suggest that local governments ought to be deeply involved in planning because they have the needed expertise for certain aspects of the effort.

Planning also requires information from the private sector. Design of warning systems should proceed with some awareness of those who have special needs of some type and evacuation planning should take into consideration any needs for assistance on the part of invalids, the elderly and others. Privately owned heavy equipment is frequently depended on in planning rescue or damage reduction activities and non-governmental organizations are generally assigned responsibility for feeding, clothing and other care of evacuees. Provision of information about or planning of such services all fall within the special technical capability of the private sector.

Implementation

Implementation of a warning and preparedness system may be fairly simple if a watch/warn type of flood recognition system is used and if the preparedness plan provides only for evacuation. The action required to implement an alternative of that type may only amount to purchase of some suitable radios, subscription to the NWS weather teletype service, distribution of some general information to the public on how evacuation is to be carried out when a flood threatens, and adoption of the plan by appropriate local authorities. Implementation poses no great problems in this type of situation and the respective roles of federal and local governments and the private sector can be visualized in a number of ways which might be effective.

More complex warning systems and more complete preparedness plans present a different case. They may involve large amounts of expensive equipment, require more extensive actions on the part of private parties, call for stockpiling of equipment and supplies, and depend on numerous intra-and inter-governmental agreements for operation. Implementation becomes a much more complex matter in this event with concern for property acquisition procedures, adoption of incentives or ordinances to influence private party actions, and interagency negotiation. More complex warning and preparedness systems also require the same implementation steps as do simpler plans such as equipment installation, distribution of information to the public and formal adoption of the plan.

The federal government has or can effectively develop some types of expertise in those types of things which are common to many warning systems such as specification, acquisition and installation of equipment; specification and acquisition of certain types of supplies; and development of model ordinances. These technical capabilities may overlap to various extents with those of state and local government but are generally beyond what is really available in the private sector. The special technical capabilities of local governments lie in adoption of the plan, negotiation of intra-and inter-governmental agreements and like activities which again are largely beyond the private sector. Special capabilities of the private sector include making any required modifications of building or systems and acquiring such equipment as may be necessary for receiving warnings and carrying out the planned response. Combination of the technical capabilities of the private and governmental sectors may be required for such things as development of site-specific warning and preparedness arrangements for private properties.

Operation and Maintenance

Operation of a warning and preparedness system requires monitoring of weather messages or conditions, periodic distribution of information to the public if that is a part of the plan, and execution of the warning and preparedness steps if a flood occurs. Maintenance involves testing and care of equipment,

periodic checking of stockpiled equipment and supplies, updating of various agreements and lists, periodic review of the plan to insure its viability, and practice or training in carrying out selected parts of the plan.

The federal government has only a limited technical ability to assist in operation and maintenance activities. It cannot act for the local government in renewing agreements and, of course, cannot practice the plan for local participants. While its performance might not be efficient, the federal government could assume responsibility for monitoring local weather conditions, checking stockpiles and testing equipment. However, these types of activities could best be performed by local agencies. Perhaps an appropriate federal role in operation and maintenance from the standpoint of technical capability is to serve as a supervisor to see that operation and maintenance is properly carried out and to act as a technical resource in the event updating of the plan requires its modification.

Local governments have most or all of the technical capabilities necessary to conduct operation and maintenance of a warning and preparedness system. Once the system is installed, little is required in the way of expertise except for repair of complex equipment and design of practice activities. The primary requirement is for 24 hour availability and periodic attention to routine testing, information distribution and like matters which can be easily provided or performed by local governments.

TECHNICAL PROBLEMS

The state-of-the-art of flood warning and preparedness has advanced considerably but numerous technical problems still exist. Some of them have implications for policy related to planning, implementation and operation of warning and preparedness systems. Two important problems of this type are the unreliability of meteorological forecasting and prediction of the social response to warnings.

Unreliability of Meteorological Forecasting

Advance warning of floods and execution of protective actions would be simple matters if precipitation could be accurately predicted many hours before its occurrence. However, this capability does not exist and predictions have a prospect for being in error, even on a short term basis.

The normal means of reflecting this uncertainty is to use staging of warnings and response actions, based to the extent possible on rainfall actually received. Where watersheds are sufficiently large and travel times sufficiently long, this approach may prove wholly adequate. However, in some cases, travel times may be so short or necessary response actions so time consuming that such an approach is not fully effective. In those cases, it is necessary to begin warning and response actions based on expected rainfall as determined from long range forecasting, synoptic data, satellite imagery and other predictive or analytical devices. Warnings issued and actions taken on that type of information may prove to have been unneeded if the expected rainfall does not occur. Aside from the expense and inconvenience of a false alarm, erroneously putting a preparedness plan into action may incur damages of one type or another. Business enterprises might be closed, basements flooded to stabilize the structure, or hospitals evacuated. All of these and a multitude of other types of actions could result in economic losses, injury or death, giving rise to liabilities.

The NWS has available to it an extensive system for data collection and sophisticated equipment and procedures for interpreting that data in terms of weather forecasts. For states and local governments to attempt duplication of such a system would be wasteful and to ignore it would be foolish. From a policy standpoint, it appears that the NWS system ought to be relied on to some extent by almost every flood warning system.

Uncertainty of Social Response

It would be highly desirable for all parties in areas subject to flooding to be knowledgeable of the

risk, maintain an awareness of weather conditions, understand fully all warnings and be prepared to take appropriate action. Unfortunately, this is not generally the case. Many persons in areas subject to dangerous levels of flooding are either totally unaware of the possibility of flooding, or refuse to believe historical levels could be exceeded. Even with a significant public information effort, it is to be expected that many persons will not fully comprehend warnings or heed them or know the types of action to be taken in various circumstances.

Much of the literature concerning flood warning and preparedness is authored by sociologists and a large part of that deals with the matter of response to warnings. Researchers and writers on this topic seem agreed that reaching the general public with warnings and generating the desired response is difficult. The principal suggestions which they make are to provide reinforcement of warnings and specific instructions on the proper response.[5]

AUTHORIZATION VS. APPROPRIATION

A situation which should be borne in mind is that Section 73 is not an appropriation measure. Some federal agencies have taken the position that they have no funds available for various aspects of work on nonstructural measures. For example, the Soil Conservation Service currently indicates recognition of the Section 73 policy but feels itself able to do planning in connection with a warning and preparedness system only if the undertaking is financed by a non-federal sponsor. Purchase of equipment is not an eligible project cost.

On the other hand, the National Weather Service has interpreted its funded program obligations so that

[5] McLuckie, Benjamin F. The Warning System in Disaster Situations: A Selective Analysis. Disaster Research Center Report Series No. 9. Department of Sociology, Disaster Research Center. The Ohio State University. Columbus, OH. July 1970.

they can include making both technical assistance and some equipment available. In addition, NWS provides much of the data on which warnings are based.

The Corps is in a less uncertain situation, at least so far as its authorized projects are concerned. If study of warning and preparedness is expressly included in a study or project authorization, funds clearly can be spent on such an activity as well as on any other constituting part of the project. Further, if the mandate of Section 73 is construed to require examination of nonstructural alternatives in the development of flood control and loss reduction projects generally, it follows that funds made available for the project should be spent in part for this purpose.

MOTIVATION

A warning and preparedness system is not like a piece of machinery. Some of the components are gages and other pieces of mechanical equipment for which reliability and effectiveness can be assessed on a technological basis. However, the human ingredient in warning and preparedness is crucial. Whether officials, private individuals and the general public will make the commitments identified in the plan and carry them out with diligence and skill is an essential inquiry. Resolving this question in specific situations is vital. Good plans are prescriptions of how flood hazards can be reduced by issuance of timely warnings and the taking of appropriately responsive actions. It may seem overly lacking in confidence to ask how people can be motivated to do what the plan says, but experience shows this to be a real step in the development and maintenance process and fully as important as the acquisition of equipment, the drawing of an organization chart, and the commitment of such funds as may be necessary.

Of course, it also is true that desire and determination must be present in order to produce a dam or flood wall. Technically justified projects have floundered because of lack of enthusiasm and staying power to initiate or persevere in the study, authorization and appropriations process. Normally, the

necessary drive must come largely from the local interests which are to be directly benefitted. However, it is not generally thought to be a major concern whether, once a sound structure is built, it will be permitted to receive the flood flows it was designed to hold. Perhaps failure to give explicit consideration to questions such as this is an error. Particularly in multipurpose projects, maintenance of proper reservoir levels is not a cut and dried affair. It can be affected by judgments and by interest conflicts among recreationists, environmentalists, proponents of increased water supply and irrigation reserves, power interests, and others. Nevertheless, flood control works are continuously visible objects with highly tangible contributions to the daily lives and activities of important groups of people. Consequently, it is a fairly safe presumption that they will not be ignored. As rising concern over dam safety demonstrates, impoundments may or may not be adequately maintained, but they are almost certain to be used, once brought into being.

Warning and preparedness systems present motivational issues in a different and more readily apparent form. Some of the key problems can be briefly identified.

The need for twenty-four hour a day, seven day a week surveillance and availability to receive and transmit data and information has been noted earlier as well as the need for constant readiness to respond. A number of organizations maintain such capacity and perform realistically. For example, fire departments keep crews on duty around the clock. Major transportation terminals maintain essential services continuously. They do so because the regular functions they perform are understood to require such attention and the consequences of leaving posts unmanned becomes rapidly apparent. Management may have increased difficulties in keeping workers attentive to duty during the wee hours when activity is slack and there are long dead periods. But things happen often enough to keep people convinced of the need for maintenance of continuous operationaal capability, even if the chores are not always pleasant or immediately fulfilling in achievement.

Floods happen only at widely separated and generally irregular intervals. Even in fairly vulnerable areas, years can go by without any actual occurrences. Although danger can come suddenly and sometimes as a surprise, it is known that against all reason many people choose to act as though it will not happen next time. At any given time, they prefer to think and ac as though today and this week will surely be safe, and most of the time they are right in the sense that next week they can look back and observe that no catastrophe came.

In the many years since the end of World War II, and with only brief exceptions for the intense concern over hydrogen bomb danger circa 1950 and the Cuban Missile Crisis of 1962, civil defense programs have had great difficulty keeping themselves in viable condition because the overwhelming majority of the people, including most governmental and private sector leaders, have preferred to suppress consciousness of danger from direct military attack on the United States. Whether reasonable or not, the feeling that catastrophe will not strike--at any rate not soon--has led to atrophy of true civil defense capabilities in many places, even where plans exist. It also has let plans become out of date, unknown to those who must operate them, and entirely unreal to the general public whom they are supposed to protect.

Natural disasters such as floods are also distasteful to contemplate and so invite repression from consciousness. They have been more visible than domestic military vulnerability, but genuine preparation for them tends to encounter similar apathy and avoidance.

Consequently, it cannot be merely assumed that a plan which calls for volunteers to go out and read rain gages in the dead of night or when inconvenient for other reasons will be faithfully performed. Even regularly functioning twenty-four hour a day installations may be reluctant to take on the additional responsibility of a flood watch, unless they see compensation for the extra responsibility and possible exposure to criticism or liability if they do not perform adequately.

These reasons for possible failure of a warning and preparedness system to function properly in time of need must be expressly recognized and ways found to forestall or counteract them. Because the problems are psychological, they cannot be approached in the same ways as the procurement of mechanical equipment. However, development and application of incentives are problems faced in the process of making many programs viable. Accordingly, they should not be regarded as unique or insurmountable in flood hazard management situations.

CHAPTER 5

LEGAL CONSIDERATIONS

Flood warning and preparedness is acknowledged as a useful and practicable approach to flood loss reduction. A few actual instances already exist in which the federal government has recommended or employed this approach and Section 73 of Public Law 93-251 directs federal agencies to give consideration to such measures in projects involving flood control. It is relatively certain that numerous situations will be found in the future for which warning and preparedness alternatives will be recommended for implementation either alone or as part of some overall strategy. If warning and preparedness alternatives are to be used on a widespread basis and if the recommendations for their use are to be affirmative, it becomes necessary to consider the legal aspects related to their planning, implementation and operation.

This chapter treats three such matters dealing with authority to undertake programs, commitments to participate in flood warning and preparedness systems, and liability. These are not all of the legal considerations which might become important in formulation of warning and preparedness alternatives and planners should be alert to the need for consideration of the legal aspects of the specifications on which they are to develop warning and preparedness systems. However, the three considerations named are likely to be of importance in every case.

AUTHORITY TO UNDERTAKE PROGRAMS

Implementation, operation and maintenance of flood warning and preparedness alternatives requires carrying out some set of actions. The steps to be taken vary in number, type and complexity according to the nature and sophistication of the plan which has been developed and diverse other circumstances. In any event, the responsibility for each step must be assigned to a particular party for accomplishment. This distribution of responsibility must be with due regard for the legal authority which each party has at its disposal.

Federal Agencies

Federal agencies can act only on the basis of sufficient delegations of authority, generally contained in statutes. Thus, if the Corps, the National Weather Service or the Soil Conservation Service wishes to establish a program that will enable it to observe actual and potential flood conditions, to disseminate warnings, to make and assist in evacuation or other preparedness plans, or to engage in disaster response and recovery work, it must find a basis in some law enacted by Congress that can be construed as authorization to undertake the projected activity. The congressional directive may be pointed and specific such as the statutory provision mandating the NWS to operate a hurricane watch program. Or it may be more general such as the provisions authorizing several agencies to undertake warning and preparedness activities. (33 U.S.C. Sec. 7da-1; 16 (U.S.C. 590g(a); 42 U.S.C. 4101; 82 Stat. 983). The more general types of authorizations can also be interpreted to include participation in flood warning and preparedness activities if these are related to a broader responsibility of the agency. For example, the general authority to undertake flood plain management including flood control or flood loss reduction programs could well be construed to authorize the planning of a flood warning and preparedness system or the provision of technical assistance to communities in such planning. Especially if a broad authorization is matched with appropriations which are either specifically for some aspects of flood warning and preparedness activity or susceptible of use for the purpose, a sufficient legal basis can be said to exist. This is the case since Section 73 of the Water Resources Development Act of 1974 directs federal agencies to consider nonstructural measures for flood loss reduction equally with construction of physical works. Given this congressional enactment, it can be argued that a federal agency which can undertake a structural flood loss reduction program would be remiss if it did not analyze a given situation carefully enough to determine whether and how a nonstructural program such as a flood warning and preparedness system could be used as an alternative or a supplement.

Nevertheless, it should be cautioned that where authorizations are not reasonably clear, it may be necessary to secure the opinion of appropriate counsel as to whether a statutory basis exists for a particular agency to engage in flood warning and preparedness activities.

Of course, the Corps is quite well endowed with legal bases for engaging in flood warning and preparedness activities. Its studies of particular geographic locations and project sites are generally specifically authorized by Congress and so can include references to nonstructural alternatives when thought advantageous. In addition, however, Section 73 provides ample justification for the Corps' consideration of flood warning and preparedness as a method for loss reduction in any area and for any project including adjustment to floods with which it is concerned. Further, the Corps' Flood Plain Management Services program provides flexible avenues for considering local means of dealing with flood hazards and for furnishing technical assistance to communities.

Thus, it may be said that authorizations for federal planning activities relating to warning and preparedness are reasonably specific. Implementation and operation of systems present somewhat different situations, although particular agencies may have fairly wide lattitude in these matters.

The core programs of the National Weather Service inevitably give it an operational role in flood warning. It's forecasts and analyses of conditions are expected to be made available for guidance to the general public and to a variety of special interests. On the other hand, NWS has not considered that it has much authority to participate in preparedness planning or activities and, in view of the fact that other federal agencies do engage in such work, it may be that NWS funds would not readily be committed in this direction.

The elements of the Federal Emergency Management Agency have specific mandates with respect to response and recovery, as well as for disaster planning. Also, it might be found from time to time that other federal agencies because of their specific responsibilities in

areas such as housing or transportation could conceivably become involved in some aspect of implementation or operations.

On the whole, however, implementation and operations as a federal set of activities is most likely to be attached to a specific project or program for which the agency in question has responsibility. For example, the general responsibility of the Corps for the management and safety of it's own impoundments and other properties necessarily give the agency by implication the power to ascertain whether there is danger to them from flood and to take reasonable actions to forestall or minimize the danger and to recover from the damage which inundation may cause. Similarly, all agencies managing federal lands and properties have general administrative responsibility for them from which could be deduced the ability to take appropriate measures designed to protect them from flood loss.

If the information or other measures developed in pursuit of these federal responsibilities can be of benefit to the nearby populations or governmental units, there would seem to be no reason why administrative action should refrain from arranging affairs so that the federal efforts yield broad dividends. On the other hand, the actual justification for the activities just categorized is the protection of federal property or the promotion of federal programs specifically authorized.

In some instances, federal agencies may loan or grant equipment useful in implementing flood warning and preparedness systems. Congress has the constitutional power to dispose of federal property, spend money and make grants in aid of a federal purpose. When such can be clearly established as the basis of a federal action to operate or participate in a cooperative flood warning and preparedness system, authorization probably can be found. However, in each specific instance, the particulars should be examined and an appropriate determination made.

Non-Federal Agencies

Authorizations to state agencies must be sought in the statutes of the state concerned. Just as the

Congress provides the delegations of power on the basis of which federal agencies conduct their program activities, so the state legislatures enact laws which govern the conduct of state agency programs.

The local agencies belonging to general purpose units of local government such as cities, counties and towns derive their powers from their charters and frequently from acts of the state legislatures as well. However, in the operational sense, they are subject to the legislative direction of the local governing board of the unit involved: e.g. the city council or county board of supervisors.

Finally, it should be noted that there are some special districts, authorities or public corporations which are technically legal entities independent of the general purpose governments. These operate under special statutes or charters of their own. Their powers are drawn from laws which may either directly authorize certain activities or may provide for action of the agency's governing authority to do so. Whether or not these special purpose units have powers specifically useful in flood warning and preparedness or powers of a broad nature from which may be deduced authority to engage in some aspects of the operation of warning and preparedness systems needs to be a specific inquiry conducted through examination of the statutes or other authorizations under which the agency in question functions.

General purpose units of local government such as cities, counties, towns, villages, etc. normally have a basic legal asset in dealing with protection against disasters. They usually have broad responsibility for protective services including those derived from the state's constitutional power to promote and safeguard health, safety and general welfare. Accordingly, it is probably true as a generalization that local governments can engage in the operational aspects of warning and preparedness if they wish to do so. The most important legislation to be considered may be the resolutions of the local governing boards appropriating money for the particular activities. If these are forthcoming, the authorization is a practical one; otherwise it may lead to little concrete action.

In time past, the foundation of state-local relationships was Dillon's Rule. This traditional doctrine held that local governments had only those powers expressly conferred upon them by the state constitutions or enactments of the state legislature. All other powers were denied. In recent times however, there has been a shift away from Dillon's Rule in an increasing number of jurisdictions. Accordingly, it is increasingly found that general purpose units of local government may engage in those activities normally within the sphere of local government, unless their charters or state statutes restrict their freedom to act.

The state itself is a constitutional unit having broad powers. Undoubtedly, state governments have the basic authority to develop and administer warning and preparedness systems as implementing action under the Police Power. However, specific programs require some sufficient basis in enactments of the state legislature.

Because of the central role of local governments and agencies in warning and preparedness, it is important to ascertain whether they have the authority to acquire and operate lands and installations for the monitoring of stream and related conditions. The difficulty in such activities is that the locations in mind are outside their boundaries and so beyond their normal jurisdiction. It is beyond the scope of this report to deal with this question specifically for individual locations. However, it may be said in general that local governments either have or can be given authority of the type useful for the operation of warning systems irvolving extraterritorial activities. Generally speaking, municipal corporations can acquire real property ouside their corporate limits and can administer it by virtue of their status as owners. Further, they can be authorized by the state legislature to acquire land for specific purposes and exercise governmental powers over it. This type of authority has most frequently been conferred for park holdings and for municipal water supply installations. If a state legislature decided that flood warning activities were similarly meritorious and required this kind of special legislative recognition, it could be provided.

Private Sector Entities

Private organizations and individuals can undertake virtually any activities they wish merely by deciding to do so. Of course, they must have the ability, and for many things the training or education. If a professional or occupational license is a legal requirement (such a license to practice medicine or professional engineering), that to must be obtained. But on the whole, any of the private entities which might participate in implementation, operation or maintenance of a flood warning and preparedness system can make their contributions without specific legal authorization.

COMMITMENTS TO PARTICIPATE IN FLOOD WARNING AND PREPAREDNESS SYSTEMS

If a single agency is to undertake a unilateral program for development and use of a flood warning and preparedness system or for another activity that is conceived to be self contained, a proper legal basis may consist of only sufficient authorization in law and the availability of funds for the intended performance of functions. However, it has been emphasized that most warning and preparedness systems depend for their effectiveness on the participation of several entities, each contributing a different ingredient to the whole. Consequently, it is necessary where several participants are to be involved to be assured that each of the activities important to the functioning of the system will be performed in a timely and appropriate fashion. Commitments of personnel and equipment and assurances that the several elements of a warning and preparedness plan will be performed in accordance with its terms must exist before it can be said that a system is actually in being.

For the provision of technical assistance in developing a plan, it may be enough that some federal or state agency is authorized to perform the tasks intended for it. In fact, the usual way of obtaining such help is by applying for it to the agency having the capability to provide whatever assistance is desired. Generally speaking, the agency from which

help is requested is not obligated to respond favorably in every instance. It may, for example, not have sufficient resources to honor all requests. Moreover, the agency may be expected to use discretion in extending what aid is available to those applicants which, in its judgement, are best able to benefit from it or which are most likely to be stimulated in their own activities by the infusion of outside help. However, technical assistance, or even the complete preparation of a plan by federal agencies for a community, comes before the operational phase. It is in implementation, operation and maintenance of a plan and in the conduct of disaster operations pursuant to the plan that failure of agreement or nonperformance of a commitment is most prejudicial. Weaknesses at that point may rob an area and its people of the protection from the system on which they have been led to rely.

Formal agreements in the nature of contracts among the participants, or some of them, are frequently entered into to fix the obligations of each to perform and to specify any procedures which need to be clearly understood. In an operational sense, these should be embodied in the flood warning and preparedness plan, but the purpose of the contractual agreement is to signify the acceptance of the parties of their particular rights and obligations as a binding commitment.

The character and some of the possible content of such contracts will be discussed in Chapter 6. However, one kind of authorization which could prove particularly useful in establishing and operating cooperative warning and preparedness programs should be mentioned.

Almost all the states have enacted interlocal cooperation statutes--sometimes known as "joint powers laws." Although they vary in scope and detail, the general concept is similar in almost all cases. Units of local government are empowered to undertake cooperative projects or programs and to provide interjurisdictional administration for them, where necessary. In some of the states, it is further provided that the local governments may cooperate in this fashion with local governments both within and without the state. Since a warning and preparedness system often needs to

function on a regional basis to be effective, interlocal cooperation is very important. Also it should be noted that the interlocal cooperation statutes usually permit state agencies and even federal agencies to be parties to the undertakings thus authorized.

An even more familiar type of local governmental contract is that in which one municipality or county purchases services from another. Thus it is conceivable that one community could purchase flood warning protection from another and merely make a pro rata contribution to the cost of the activity. However, it should be emphasized that for the most part, active participation is advantageous because the success of the warning and preparedness approach presumes broad involvement.

The question of enforcement of agreements is a difficult one. If a local government which has agreed to maintain the equipment components of a warning system in good working order does not do so, what practical remedy is there? A textbook legal answer is that the provider of the equipment might sue to reclaim it and might conceivably even ask money damages for its deteriorated condition. But the success of such a suit would not lead to the strengthening of the warning apparatus. It more likely would constitute a confirmation of the demise of the system.

Whether the threat of such a suit might have a salutary effect, especially if the defendant thought it possible that it would be required to pay a money penalty, is an open question for which the Investigators know of no actual experience to supply an answer.

Since a money judgment of a court may be an inappropriate means of obtaining the objective that a breached contract of this kind was meant to secure, an enforcement suit might be for specific performance: i.e., to order the defendant to maintain the equipment or do such other things as the agreement bound it to do. In many situations, individuals and organizations (including governmental agencies) will respond favorably to court orders simply because they are recognized instruments of legal authority which our social customs and pressures teach us should be obeyed. If

there is disobedience of its order, a court can declare the malefactor in contempt and can impose money penalties or even confinement until the contempt is purged by performance. In fact, the jailing of public officials for failure to perform their official duties is rare, but it can occur.

Grants are often viewed as good devices for stimulating performance. The recipient organization or community sometimes accepts obligations that it would not otherwise undertake in order to obtain the valuable services or funds offered by the grantor federal or state agency. So far, the limitation on this technique in connection with performance of flood warning and preparedness system obligations is that the aid is generally given in order to establish the flood recognition portion of the system. The laggard or absent performance is most likely to develop at a subsequent stage when receipt or even keeping of the granted items is no longer sufficiently prized by the recipient.

This does not mean that contracts should be ignored or denigrated as a means of spelling out binding obligations and pinpointing them. Nevertheless, it should not be considered that the mere conclusion of such agreements among the participants in a warning and preparedness system solves the problem of motivation.

Of course, contracts can be used to good effect in dealing with private participants in a warning and preparedness system. Such private entities will normally be expected to furnish manpower or equipment or to perform particular functions for which they have resources or which fit in with their business activities and capabilities. For example, a private firm might be made responsible for and paid to maintain data gathering and processing equipment or to furnish trucks in time of flood hazard. Companies whose properties are of particular importance to community protection against flood loss might undertake to integrate their warning and preparedness activities with the community plan or to provide certain kinds of information to the community disaster authorities on a regular basis. Their failure to do so could be made to bring the normal range of consequences for breach of contract, including liability for the payment of money damages for any losses or injuries caused or contributed to by the failure or inadequacy of performance.

As the coming discussion of liability will show, there is a so far relatively little considered aspect of legal obligation which may be useful in assuring responsiblity for performance if a warning and preparedness plan is developed and put into effect in binding form.

LIABILITY

The conduct of almost any activity can result in injury to persons or damage to property. For example, even office work can be attended by accidents. This susceptibility to loss from negligence, incompetence, miscalculation and other mishaps should be an expected incident of any program of flood protection. However, the hazardous character of floods and the stressful conditions which accompany their occurrences make these considerations of more than ordinary importance in dealing with flood warning and preparedness alternatives.

Liability is closely associated with responsibility. However, the latter is broader in meaning and can connote moral obligation or political accountability as well as enforceable legal exposure to pay or otherwise make good for damage or injury.

The length at which problems of liability are discussed in the ensuing pages is not meant to imply that flood warning and preparedness alternatives present particularly onerous liability features. There is little reason to believe that the method creates greater risks for those instituting or operating such alternatives than do other means of meeting flood hazards. However, the limited use of warning and preparedness systems has given relatively little opportunity for the development of specific law and precedent. When situations are being newly considered, there is always a possibility that the decisions of courts and legislatures will be less than ordinarily predictable.

Because of the lack of specific law and precedent, it is therefore necessary at the present stage to examine many liability questions in terms of analogies

and by characterizing the nature of activities associated with the development and operation of such systems. Accordingly, this discussion attempts to set forth the nature of the problem, and to explain the legal principles which are or will be applied. Where the law is reasonably clear, footnote or other references are offered as authority. If a question is as yet open to uncertainty, this is indicated and suggestions made as to what its resolution might be.

There are legal means of providing parties with some protection against the dangers of uncertainty. Advice is given in Chapter 6 concerning the means of obtaining such safeguards in the planning, implementation and operation of flood warning and preparedness systems.

Elements of Liability

The person suffering an injury or property damage often bears the hurt or loss without the possibility of securing compensation or other redress. In many situations, the blow can be softened or the harm entirely cured by insurance. But in such cases it is almost always the party sustaining the loss who has borne the economic consequences through payment of an insurance premium.

When the injury or damage is due to the fault of someone else, our legal system generally fastens liability on the person who is at fault or on the organization in whose name the perpetrator acted. However, not every fault gives rise to liability. There are several basic elements of the relationship between the cause of the harm and the injured or damaged party that must exist in order to shift the burden of the mishap from the victim to someone else.

The first element essential to liability is that there be a duty. Unless the person or organization alleged to be at fault owes a duty of performance, forebearance or protection, there is no responsibility for what may occur and so no fault even though an injury or loss has occurred. Thus, where there is a flood hazard, the failure of a particular agency or individual to issue a warning of impending inundation

results in no liability if there was no legal duty to give warnings. As subsequent discussion indicates, a question exists as to whether and when federal, state or local governments and private parties have a duty to issue flood warnings or otherwise do the types of things which make up a flood warning and preparedness system. Even if a duty does exist, a plaintiff endeavoring to enforce liability must show that the duty was owed to him or to a class of which he is a member.

Another ingredient necessary for liability is that the conduct omitted or improperly performed was the proximate cause of the injury or loss. If the flood warning was not given but the injured party had the information and any instructions that a warning would have conveyed, he in fact knew everything that he would have been told. In such circumstances, it cannot properly be said that failure or fault in giving the warning caused the injury.

There may frequently be several causes which contribute to a particular injury or damage. Where this is the case, the plaintiff must prove that the defendant's act or omission was closely and substantially enough associated as a reason for the harm to merit liability being assessed against him. In this connection, it may be noted that even a defendant who is at fault can, according to the law of most jurisdictions, escape liability if the plaintiff was himself negligent and if the contributory negligence was a significant factor in causing the harm.

Finally, the aggrieved party must have relied on the performance of the duty. If the injured party did not take measures to safeguard himself and his property because he expected or had a right to expect that a warning would be issued in time of danger, failure to issue the warning or its improper issuance can give rise to liability.

In dealing with preparedness activities, the element of reliance is likely to become much more complex and problematical. For reasons which are elaborated in the following discussion, faulty performance in the giving of assistance (such as rescue) can give rise to liability even if the aiding party had no initial duty to come to the aid of the victim.

However, it may be more difficult to establish that any governmental or private party has a duty to come to the assistance of an endangered person or to assist in protecting particular property. In any given instance, assessment of the existence of a duty such as will produce liability depends on the nature of the parties involved. For example, police department have fairly wide ranging responsibilities to protect lives and property. Thus, the existence of a duty on the part of such an agency is to be differently determined than is the responsibility of a private citizen who acts, if at all, strictly as a volunteer. Similarly, it will be relevant to inquire whether the party had any contractual obligation to perform the service on account of which there is a complaint. For example, if a trucking company enters into a contract to provide vehicles in time of emergency, there is a different basis for assessing liability than if the trucker merely had vehicles available which he could have put at the disposal of evacuation authorities.

These principles are part of the law of torts (the law of injury to persons and property) and are well settled. However, the manner of their specific application to a particular field of activity is affected by the characteristics and circumstances involved in the subject area of concern. Accordingly, it is necessary to consider questions of duty, cause of injury or loss, and reliance as they may occur in the use of flood warning and preparedness systems. Because such systems are so heavily involved with public sector activities, it is also necessary to consider some matters relating to the liability of federal, state and local governments.

Sovereign Immunity

So far as Anglo-American law is concerned, the doctrine of sovereign immunity has its origin in the centuries old axiom that "the King can do no wrong." Translated into modern American terms, this means that even though the federal government or a state and its officers acting within the scope of their governmental authority may inflict injury or damage, no adversely affected party can obtain payment or other restitution

by the normal processes of suit and enforcement of a judgment thus obtained. Without a remedy that persons suffering injury or damage are entitled to invoke, it can be said that the federal government or the state has no liability.

Of course, aggrieved persons, to the extent allowed by the procedures and practices of the appropriate legislature, have been able to have special bills enacted to compensate them for losses that they cannot claim in the courts, but the success of such redress comes through political means, is uncertain, and depends on the generosity of the governmental unit rather than on any legal obligation.

In modern times only a minority of the states have continued to adhere to the doctrine of sovereign immunity in practice.[1] The federal government and most states have "consent statutes" such as the Federal Tort Claims Act[2] under which immunity is waived and suits for the wrongful acts or omissions of a governmental agency and its personnel are allowed. However, these consents to suit are not total. They generally remove much of the sovereign immunity but not all of it. To what extent a governmental body is liable on the same terms as a private entity must be determined by consulting the relevant federal or state statutes and the court decisions interpreting them.

Cities, counties, special districts and other local governments or instrumentalities are not sovereign in their own right. Except to the extent that the statutes of the parent state specifically provide otherwise, local governments are creatures of the state and legally part of the state government.[3] Consequently, their immunity status is the same as that of the state itself. However, state statutes have made local

[1] McQuillen, Municipal Corporations, Vol. 1., Sec. 3.01 (1977).

[2] Federal Torts Claim Act, 28 USC 2671 et seq..

[3] Supra Note 1.

governments subject to suit on virtually the same basis as private entities in most jurisdictions.

Tests for the Existance of a Duty

As was discussed, earlier, the first essential element to liability is that there be a duty which is not properly discharged. It is therefore necessary to consider whether or not a duty exists on the part of government with regard to flood warning and preparedness. One way of approaching the determination of whether a duty exists is to ask if conduct of the activity in question is obligatory or permissive.

An obligation of federal, state or local government to provide a service can arise either from a constitutional charge that it be done or from establishment by traditional practice and belief that there is a settled responsibility to perform it. The latter rationale must develop over some period of time through usage. Accordingly, with respect to each such category of service, it may be assumed that there was a time when it was only becoming traditionally established and when the obligation of public agencies to provide it may even have been the subject of conflicting views.

Whether there is an obligation to provide a program or whether it is permissive is an important factor in determining whether and to whom liability may attach. If provision of a program were to be considered a basic governmental responsibility in the same sense as functions such as education or national defense, failure of the obligated level of government to furnish it or faulty performance would give rise to liability.

A second test of governments' susceptibility to liability is to inquire whether the activity in question is governmental or proprietary in character. The former are those which governments traditionally perform and which are not readily susceptible of performance by private enterprise. Proprietary functions are those which are or, in some cases, were performed by private business but which may also be engaged in by

government.[4] Some common examples are the production and distribution of electrical energy, mass transit, operation of public recreational facilities and provision of housing.

The question of whether a warning and preparedness activity is governmental or proprietary is likely to be significant. The distinction has been viewed by the courts[5] as an important one for at least one hundred years.

As applied to the question of liability for fault, it is a highly relevant classification. Since it is well established that private persons and organizations are liable for acts and omissions which do not come up to accepted standards of care and competence, determination of whether a function is or is not governmental is likely to be conclusive on the point of applying such immunity as the laws of the state may provide.

The rule is that if the function is proprietary in character, there is liability for fault in performance because private entities would be liable and because, even though undertaken by a government agency, the activity is akin to that occurring in the private sector.[6] If classified as governmental, no liability attaches, except to the extent that the jurisdiction involved has statutorily removed or modified its sovereign immunity.

Governmental Duty

Floods and the storms which often cause them have been considered as "Acts of God" for which no one is responsible. This is the traditional view developed in

[4] City of High Point Vs. Duke Power Co. CCANC. 120 F2d 866 (1950).

[5] 40 ALR2d 927 (1957); Sho Sato and Arvo Van Alstyne, State and Local Government Liability, P. 740 (1977); Kenneth Culp Davis, Administrative Law and Government, P. 97 (1975).

[6] Indian Towing Co. Vs. United States 350 US61 (1955).

case law over many centuries.[7] Seasonal melting of accumulated snow and ice jams are also natural phenomena for which the law has customarily considered no one to be responsible. If persons and property owners suffer death, injury or loss on account of inundation, the burden is theirs. Even insurance protection has been limited and, for flood as such, not available on any widespread basis until the federally subsidized insurance became available in the late 1960's or more recently in many communities.[8]

Some cities and towns in low lying areas have undertaken to build levees and other protective works--as early as the nineteenth century in particular instances. But large numbers of other communities have never done so and have therefore remained exposed to whatever storms and other natural conditions may bring.

Creation of Duty by Traditional Practice - The federal government did not undertake to provide flood protection until the Congressional enactment of 1917 did so on the Mississippi and Sacramento rivers, 1933 on the Tennessee river and at various other times for other streams and areas, depending on the dates of the relevant project authorizations and implementing appropriations.[9] Along with these developing commitments on the part of Congress came some statutory delegations of power to the Corps of Engineers, U.S. Geological Survey, Department of Agriculture and others to undertake a variety of measures bearing on flood control and flood loss reduction.[10] No one has definitively determined whether, in the years since Congress began

[7] I Am Jur 2d Acts of God Sec. 5 (1952).

[8] National Flood Insurance Act of 1968, 82 Stat. 572; 42 USC Sec. 4001 et seq.

[9] Tennessee Valley Authority, 48 Stat. 58 (flood control provisions: 48 Stat. 60); Mississippi River Flood Control Act 45 Stat. 534.

[10] See 39 Stat. 950; 33 USC Sec. 701a-1; 16 USC 590 g(a); 42 USC 4101; 82 Stat. 983.

authorizing flood control projects and other flood related measures, any or all of these services have passed from the pioneering and permissive to the traditionally accepted and obligatory. Certainly they are not so because they grew up from the early days of the Republic.

Similarly, no authoritative conclusions have ever been reached as to whether state or local undertakings to construct and maintain flood protection works have ripened into traditional activities of those levels of government. It could be that they have come to be expected functions in those jurisdictions which have become most active along these lines, but that in others which have not recognized such responsibility by their actions, the older view should still prevail.

Of course, it must also be borne in mind that the Sovereign can assert either its immunity or consent to be sued by enacting legislation specifically designed for the purpose. For example, Congress has enacted a provision in its flood control statutes reading: "No liability of any kind shall attach to the United States for any damage from floods or flood waters at any place." (33 U.S.C. Sec. 702C) But from the project orientation of the context of this enactment, it is probably the sound interpretation to assume that this declaration of immunity applies only to damage or injury caused by federal flood control project works. In the case of warning and preparedness activities, the damage or injury would likely be attributable to failure to give warning or to take some other action such as proper conduct of an evacuation. In general, the states have not enacted similarly specific statutes. However, in considering the liability situation for a particular jurisdiction, an examination of its laws would need to be undertaken.

Creation of Duty by Constitutional Charge - There is no federal constitutional mandate for flood damage reduction activities. The constitutional justification for federal involvement in flood control was originally, and to this day largely is, the congressional power over interstate and foreign commerce. Navigation is an aspect of such commerce and the prevention or control of flooding is desirable to maintain streams in

a safe condition for navigation. Of course, other benefits also come from the control of floods and the reduction of flood losses, but, from the legal point of view, these have been regarded as incidental benefits which it has been constitutionally possible for the federal government to provide because of its authority over interstate and foreign commerce.[11]

The so called "Police Power" of the states to protect health, safety, morals and the general welfare is certainly broad enough to support state and local activities relating to flood control. However, as with the federal commerce power, this constitutional basis for state and local governmental action is merely an authorization. In general, neither flood control nor warning and preparedness has been mandated by state constitutions. Whether anywhere in the country there are any provisions of state constitutions which could be construed as placing such obligations on the jurisdictions concerned could be determined for certain only by specific study and analysis of an intensive and thorough kind.

Creation of Duty by Statute - The several statutes authorizing and providing the wherewithall for flood control and loss reduction programs constitute congressional decisions in favor of instituting and carrying out the services. While they either direct or empower various federal agencies to undertake specific flood loss reduction activities, they do not necessarily embody determinations that it is obligatory for the federal government to have such programs or to provide the enumerated kinds of flood related services. To the contrary, Congress can establish such programs and provide for their implementation because they are viewed as essential or because it is decided that it would be nice or convenient for groups or the population as a whole to have them.

Similarly, the statutes and local laws of particular states and counties or municipalities can contain

[11] Gibbons V Ogden 9 Wheat 1 (1824); Wilson V. Blackbird Creek Marsh Co. 2 Pet 245 (1829); Black's Annotated Constitution Sec. 8 Cl.3 Art. I p. 157 (1972).

mandates for the conduct of flood programs of various kinds. In the instance of the states themselves, the obligations can be created either by laws of general application or by specific project legislation.

It should be further noted that the activities in question are sometimes conducted by general purpose units of government and sometimes by public corporations or special districts. Thus, the authority and obligations of the Tennessee Valley Authority are normally to be found in the acts of Congress specifically relating to TVA rather than in those generally applicable to all federal agencies. At the state and local levels, many water resources and flood control districts or authorities exist. When, as is frequently the case, these are organized as independent bodies, their statutory responsibilities and prerogatives must be ascertained from their organic acts and other legislation expressly including them rather than from the general laws of the jurisdiction.

Application of Tests for Duty - A conclusion that flood warning and preparedness is a mandatory function of government would tend to support the fixing of responsibility for a reasonable quality and amount of service on the level of government so mandated. The argument would be that a duty to furnish the service makes sense only because it is expected that people need to rely on it. Further, the existence of a duty implies an obligation to perform it adequately. A consequence of such reasoning would be that improper or insufficient performance would give rise to liability for losses attributable thereto.

If the activities are permissive, it may be contended that failure or faulty performance gives rise to no liability.[12] There is some judicial authority for this conclusion.[12] The reasoning is that no one has a right to flood control, warning of inundation or assistance in coping with the danger.

If a governmental entity provides a flood warning it is a nonobligatory benefit so far as the situation of any particular individual is concerned. If the

[12] Ades V. Mayor of Deal Borough 69NJ86, 351 A2d 14 (1976).

recipient refuses or ignores it, he is no worse off than he would be in the absence of the program. If he accepts the service, he is using it for whatever it may be worth and cannot complain of inadequacies when he is not entitled to anything in the first place.

The difficulty with this line of reasoning is that it can be applied equitably only to some of the possible instances. Where warning and preparedness activities offer some help, but not as much as one might like, it may be fair to say that the beneficiaries are better off than they had an enforceable legal right to be. Similarly, if people were not previously given warnings and one is omitted, it may be that no one is worse off than before, although admittedly the potential flood victims will not be as well off as they would be with a properly functioning program.

In a report largely devoted to expositions of decided cases dealing with rules of liability under the federal Tort Claims Act, the unsatisfactory and indefinite condition of the law is made clearly evident.[13] A variety of distinctions appear which seem more to reflect uncertainties of policy than any clear views concerning the obligations of the United States Government to provide disaster services. The problem is that a variety of tests have been used, each proceeding on an independent principle. As a result, the several measures advanced for determining whether federal liability exists are not mutually exclusive, nor do they operate from the same set of premises. Consequently there is a random collection of precedents, no one of which can be predicted with certainty to be controlling in a particular case.

Application of the "obligatory-permissive" and "governmental-proprietary" approaches could yield opposite results. If flood warning services are not susceptible of operation by private enterprise (they have not been so operated until now), they must be

[13] "Legal Constraints on the Planning and Development of Disaster Home Warning Systems", Report to the National Science Foundation, Lewis and Clark, December, 1977.

governmental and so free from liability risks to whatever extent sovereign immunity has not been waived. On the other hand, if the function is "permissive" because it is not a well entrenched and mandatory governmental function, then liability risks accompany public agency performance to the same extent as if administered by private enterprise.

Not logically connected to any of the foregoing propositions is a consideration familiar in the law of torts. A good samaritan may have had no obligation to start with, but when he undertakes to perform his good deed, he must also do it with reasonable care.[14] If a person who is not under an initial obligation is negligent and so causes or contributes to injury or loss, he is liable for the damage attributable to his intervention. Application of this rule would argue for governmental liability in cases of faulty performance of the warning and preparedness function.

On the other side, there is a holding in a case specifically dealing with a warning system. One court has held that the government is liable for negligent or improper operation of a warning system if the benefits are directed at specific individuals. However, if the warnings are addressed to the general public, there is no liability even where there is negligence damage resulting from reliance on the information.[15]

While such a result may seem strange, it is understandable on technical legal grounds. In order to collect damages in a lawsuit, the plaintiff must usually prove that the defendant owed a specific obligation to him and that a breach of it caused the harm. A warning addressed to the world in general is not necessarily given in response to an obligation to anyone in particular. On the other hand, a disaster warning program should not be intended as a secret, only for the ears of a few. It is true that under a home

[14] James Dooley, Modern Tort Law, Vol. I Sec. 3.41 (1977).

[15] National Manufacturing Company et al V. United States 210 F2d 263 (1954).

receiver program, the National Oceanic and Atmospheric Administration has encouraged private persons to purchase special radios over which they can receive disaster warnings not transmitted over ordinary broadcast channels. Nevertheless, the whole public is urged to secure such radios and warnings of flood peril are usually meant to alert everyone. Certainly they do the most good if they are widely received and acted upon. To suggest that there is government liability if one has purchased a special radio but none if a warning is received over an ordinary radio or television would seem to be advocacy of perverse public policy.

The "obligatory-permissive" classification will often overlap with the "governmental-proprietary" test. In most instances it is probably true that obligatory functions will be found to consist of those activities which are traditionally viewed as proper for performance by government whereas those classified as "permissive" will be among the undertakings which could be done either by public or private entities. However, these two types of classification are not entirely coincident and synonomous.

Since a key distinction between governmental and proprietary functions is whether they have been or could reasonably be performed by private enterprise, warning and preparedness probably fall into the governmental class. The difficulty--perhaps even impossibility--of conducting such activities for profit is very likely enough to foreclose their being considered proprietary in character. Nevertheless, it may be relevant to consider whether it is obligatory on any level of government to perform them. There are some things which neither government nor private enterprise do and which either go undone or which are for each individual to provide for himself. As the earlier discussion of the point indicates, it was not so long ago that flood warnings were simply not provided on an organized basis and there are many places where they are still not furnished by an agency or person. To date, no court has decided that for a federal, state or local government not to have a warning program in operation and a preparedness system in being is a negligent or culpable omission. Accordingly, it may be that flood warning and preparedness would be found to fall into a class of governmental functions which are permissive.

Perhaps the operation of a flood warning service should be classified as governmental because it is not readily susceptible of performance for profit, but it should be noted that there are private enterprise weather services. On the other hand, preparedness programs are probably open to little or no controversy concerning their status in the governmental function category.

When considering local governments, it may be sufficient to inquire whether state law has stripped municipal corporations and other local governments of sovereign immunity altogether. If so, other distinctions become unimportant and local governmenal participation in or conduct of a warning and preparedness program will subject the involved city, county or other unit to liability on the same basis as for any of its other activities.

It seems appropriate to conclude that populations will increasingly demand warning of flood conditions and that as response techniques become more effective, the value of such measures will be more widely appreciated. Accordingly, the fact that local governments enjoy very little sovereign immunity and most states have severely modified or abandoned the general immunity principle make it clear that state and local governments will increasingly be liable for failure to provide good programs. This argues for the undertaking of warning and preparedness on a serious and sufficient basis where it is found to be a suitable protective or loss reduction technique. Half hearted measures may turn out to be not enough to achieve their objectives, may mislead the public, and may create liability.

Private Liability

Private individuals and businesses can become involved in flood warning and preparedness programs as suppliers of equipment. They might also perform a number of services on a contract basis rather than by becoming employees of the governmental bodies having primary responsibility for the activities. Private involvement can be on either a compensated or volunteer basis.

If private participation in a flood warning and preparedness system is on a business basis, it is only to be expected that responsibility will be the same as in any other private activities. If warning devices or other items of equipment are furnished for some use in warning and preparedness programs, the manufacturers and sellers will have the same contractual and implied responsibilities as manufacturers and sellers do toward purchasers of merchandise generally. On the whole, manufacturers and suppliers are responsible for providing equipment and materials to a workmanlike standard of quality.[16] They are responsible for the exercise of due care in making installations and servicing equipment. If the equipment or services are represented to be of an expert character or if their nature is properly understood to require more than ordinary care and skill, the providers are responsible for meeting whatever standard the context reasonably requires to make the goods and services suitable for their intended purposes.[17] If injury or damage results from failure of the private provider to meet the applicable standards of care and proficiency, they are liable for losses incurred.

It might be supposed that volunteers ought to be less vulnerable than others because they are contributing their services and normally stand to gain nothing but the satisfaction of doing good deeds. But such is not the law. Under the good samaritan rule discussed earlier, volunteers, although under no obligation to participate, must perform with reasonable care once they undertake a mission. They are liable for any loss caused by their negligence or other fault. In fact, unless covered by express statutory provisions, they are not protected against injury to themselves or damage to their property. This is because workers compensation insurance generally applies only to employees.[18] By definition, volunteers do not have employment status.

[16] 77 CJS Sales, Sec. 305 (1952).

[17] Supra note 13 at Sec. 32.10.

[18] 99 CJS Workmen's Compensation, Sec. 1 (1952).

Installation and Maintenance

If a manufacturer or a builder produces a piece of equipment or a structure that is defective and becomes the cause of injury to persons or damage to property, he incurs liability. The method of enforcement is a lawsuit by the party who has suffered the injury or damage.

In determining the risks and cost attendant upon the development and operation of a flood warning and preparedness system, it is necessary to inquire whether those who install such systems and operate them can be held to any standard of quality and suitability for the system itself. This is a different question from that of adequacy or care in performance. At issue is whether the instrument or tool with which performance takes place has been suitably constructed and maintained in proper working order.

To make this question clear, it is necessary to establish the meaning of proper installation and maintenance. To the extent that hardware is involved, the ordinary concepts of manufacture and construction can apply. A gage is either delivered and installed in good working order and with parts of proper quality or it is defective. A computer which assists in the transmission and processing of data is either sound or it is defective. In the latter event, its failure to perform its intended function can put the warning system out of commission.

In cases where physical installations are faulty or where equipment is defective because of poor quality manufacture, the ordinary rules of manufacturer's liability can apply. To the extent that a warning and preparedness system is a collection of equipment, it may be viewed just as any other mechanical thing. But a warning and preparedness system is partly hardware and partly an institutional structure composed of plans, agreements and administration. How the concept of effectiveness due to fault is or should be applied to the partially or entirely nonmechanical elements of the system also needs consideration.

It is important to remember that reliance is a vital part of liability relating to a warning and

preparedness system. Only if an injured or damaged party relied or had a right to rely on receipt of a warning or on some attendant service and it was either faulty or not provided will possible liability arise. Accordingly, the question is what kinds of inadequacies other than defects in equipment components of the system may give rise to liability.

Since human failures are just as much grounds for establishment of fault as mechanical failure, they must be judged in particular cases to see whether they fall below the standard of reasonable performance.

A warning-preparedness plan could be defective in a variety of ways. It could simply lack one of the institutional features required to make the system yield the data of which it is capable or to turn information into reasonable and implemented decisions about warnings and response measures. It could fail to include essential agreements concerning the parts which vital agencies or other players are to assume. The plan might contain an unworkable system for delivery of the warnings and directions that need to be transmitted. There might be insufficient or no provision for training of personnel in the tasks they need to perform in order to make the system work. Many other things could be ill designed or prove impracticable when put to the test of an actual occurrence.

As a conceptual proposition, it is just as possible that a defective plan can cause loss as it is that an inoperable rain gage or alarm can bring on a harm producing failure to warn. However, the evidenciary problems involved in establishing inadequacy to the point of fault and resultant liability may be more difficult or less tangible than in the case of equipment.

How good and complete a plan must be in order to pass the test of workmanlike quality has not been authoritatively established. It is probably possible to apply some of the criteria used for equipment sufficiency--at least on the verbal level. But the judgmental factor, and so the margin for difference of opinion, is greater. A gage is faulty if it does not register the measurements it is supposed to take.

Whether it did so or not is a matter of fact. Whether a plan failed to function in a particular instance because of an intrinsic inadequacy or because of some insufficiency or weakness in the actions of the people carrying it out could be a subject of dispute. Except in the clearest cases, it is conceivable that the quality or character of a plan, if put in issue by a litigant, might be left to the judgment of a jury.[19]

Once a warning and preparedness system is installed, its effectiveness depends on maintenance to a degree that becomes progressively more important as the system grows older. Good original equipment will deteriorate if not properly cared for and repaired. Sooner or later it will wear out and timely decisions must be made concerning replacement. If there is a duty to maintain the system, there is also a duty to keep it in good working order so that it can be used for its intended purposes.[20]

If this concept is also viable for the organizational elements of a system, there may be a duty to see that the interagency and intergovernmental elements of the preparedness plan remain in force and sufficiently in the consciousness of present personnel so that there is a reasonable expectation that the plan will be followed when an impending flood is to be monitored, warnings issued, and response activities brought into play.

It may be asked whether a duty to maintain a warning system also includes or should include the obligation to update a system. It is unrealistic to suggest that every time a more advanced communications system or a better sensing device comes on the market, the operators of a warning system are legally compelled to acquire the new equipment on pain of being held accountable for negligence or other fault. The making of improvements, no matter how desirable from the policy point of view, should probably be considered as discretionary from the legal standpoint. However, there might be circumstances under which a long standing failure to modernize a system could be culpable as lack of reasonable care.

[19] Supra note 13 at Sec. 32.10.

[20] Supra note 13 at Sec. 32.12

Updating or improving the plan can have meanings quite apart from or dissimilar to modernizing hardware. A plan can become outdated for any number of reasons. An administrative or organization or statutory change could inhibit or make ineffective the participation of an agency or other entity which was originally a suitable vehicle for performance of some task. Such an occurrence, as well as new physical or technological conditions, could render a plan and its set of institutional arrangements useless. Consequently, it would seem necessary to view a warning and preparedness system as an integrated mechanism consisting of hardware, software and capabilities, all of which must be kept in good working order. Otherwise, the interests of persons and communities having a right to rely on the system in meeting flood hazards may be prejudiced to the point where those having the obligation for maintaining and operating the protective mechanism incur liability for any resultant damage or loss.

False Alarms

The value of flood warnings depends on people taking seriously the information concerning an approaching flood. It is expected that public authorities such as police departments, and private persons such as homeowners, plant managers and operators of public accommodations act on the basis of what they are told about the impending danger.

If the flood materializes in accord with the warning, such action is likely to be beneficial and assist in saving life and property. If the warning is of a probable occurrence and the flood does not come or is much less severe than predicted, any unnecessary action can still be laid at the door of sensible precaution and prevention of risk.

Response to a flood can be expensive. The business establishment that closes and sends its work force home, the auto dealer who moves stock off the lot to a place of safety several miles away, and the owners of buildings who take protective measures all incur some cost or loss which is unjustifiable if the warning proves to be a false alarm. There may even be injury or damage resulting from the haste that the warning generates.

To turn in a false alarm has been made a crime by statute.[21] If injury or damage results to persons or property, the perpetrator is also civilly liable.[22] There is little doubt as to the policy behind the imposition of such responsibility. Of course, there are some cases in which a false fire alarm is the result of a genuine and excusable mistake, but the summoning of aid on account of fire is a call for help because of a condition already said to exist. Moreover, it is already established firmly in common understanding that to cry "fire" falsely is malicious and irresponsible.

While the actions constituting a false fire alarm are fairly well understood, the concept of a false or incorrect flood warning needs analysis. Owing to the nature of the observations which must provide the background facts for such a warning and the state of the forecasting art or science, there could be some disagreement in the circumstances of a particular case as to whether a warning was false or simply incorrect. Further, the flood context is unlike the fire danger in that it is uncharacteristic of the latter that failure to sound an alarm would be equally culpable with a negligent or malicious affirmative act. It is not customarily conceived that anyone has a positive duty to give a fire alarm, except perhaps for those public employees employed to watch for forest fires and even they are not generally supposed to have any liability producing obligation to the public at large.[23] On the other hand, there may be a legal obligation to give a flood warning when a warning and preparedness plan has been developed and put into effect. If so, omission resulting either from negligence or other inadequacy as well as from maliciousness could be just as culpable as the giving of a false alarm. Indeed, it might be even more damaging because the most likely consequence of a false warning would be to cause unnecessary expense of moderate proportions whereas an omitted warning could cause catastrophy.

[21] For example see: D.C. Code 29-1119 (1973).

[22] James Dooley, Modern Tort Law, Vol. I Sec. 2.03 (1977).

[23] 36 ACJS Fires, Sec. 15 (1961).

It makes a substantial difference whether the anticipated flooding is from spring snow melt, prolonged precipitation, or a storm that impacts the local area where the high water occurs. An unsettling factor in any effort to assess fault for an erroneous flood warning is the peculiar mixture of observation and prediction that gives rise to identification of a flood threat. When the danger comes from an accumulated snow pack, the data on which an alarm rests is largely gathered by simple observation of melting snow and rising water. It can be watched hour by hour. Depths, rate of rise and speed of crest movement can be reported as facts. It may be possible to color the results maliciously or by honest mistake, but false reports are unlikely, except through gross incompetence or neglect.

Prolonged precipitation which gradually brings streams to the point of overflow presents a similar situation. Even if the onset of heavy rain stretching over days or weeks may not initially give rise to a belief that flooding is imminent, as the condition persists, observation of stream flows and reporting of readily ascertainable facts is the key to whether a warning should be issued.

In both of the foregoing types of circumstances, uncertain prediction can play some part. How rapidly the temperature will fluctuate, and whether runoff from snow melt will be augmented by a storm can spell the difference between a justified alarm, none at all, and a false or erroneous one. Similarly, whether or not resultant high water will be aggravated by a new rainfall from a concentrated and severe storm during the next few hours is sometimes an important question for the forecaster.

However, danger from storms presents the variables of prediction in their clearest form. In this connection, it is necessary to appreciate the character of a forecast as a prediction rather than as a report of a coming certain fact and to distinguish between an alarm which is false and one which is merely incorrect.

Weather forecasts used to be given in absolute terms: "Rain tomorrow"; "Fair and cold tonight;" etc. This conveyed the impresion of certainty as though actual information were being presented. Of course, it

did not take much experience, even on the part of a layman, to know that there was a margin for error in these predictions. But how great the error might be was either unknown or not stated.

In recent years, the precipitation element in weather forecasts has characteristically been stated as a degree of probability. Some other meteorological factors such as the direction and speed of movement of a storm system have also been hedged to some extent or accompanied by explanations of the circumstances that could cause the predicted conditions to be altered or not to materialize at all. Forecasts announcing a probability rather than a certain fact cannot of themselves give rise to liability, unless it can be proven that they were disseminated maliciously and deliberately to mislead and that a plaintiff was damaged thereby.

While precipitation or runoff is the prime ingredient of a riverine flood, it is only one of several factors which must coincide or coalesce to produce a dangerous occurrence. Consequently, a properly given warning of impending danger from flooding requires analylsis of existing and coming meteorological conditions as they will combine with stream flow regimen, runoff characteristics and a variety of flood plain and floodway conditions to produce, accelerate, impede or forestall flooding of some given severity in a particular location. Also of great importance is evaluation of the rate at which flood levels will increase and when depths will reach certain stages.

A flood warning system that incorporates all of these elements is a complex mechanism. Its functioning must be examined carefully in order to determine what possibilities exist for the operator or participants to incur liability.

It should be remembered that the plaintiff who would succeed must show that a culpable error or misrepresentation was made and that it was the cause of or contributed to the injury or loss for which damages are claimed. A warning stated in terms of probability that flooding will occur is a difficult basis on which to establish liability. Only if the information conveyed is grossly incorrect in circumstanaes where the issuer

of the warning should have done better or should have explained the likelihood of mistake, is there real chance that the kind of fault which would support liability could be established.

The attitudinal problem underlying the success of warning systems is perhaps of more practical significance. If the warning authorities cry wolf too often, their credibility is almost certain to suffer. If this happens, the recipients of the information and directions to take precautionary measures may take to ignoring the warnings and so make the system ineffective. Further, a system with a poor record may fail to sustain the community support that is essential to its success. If this factor is in the consciousness of the administering agency, it may tend to be conservative on the side of disseminating alarms sparingly. Under such circumstances, as well as where negligence or incompetence is involved, omission may raise a more serious liability problem than affirmative error.

Where a warning system has been made a regular part of an area's flood management program, failure to give a warning in circumstances that call for one can make the administering agency liable for resulting injury or loss. Persons probably have a right to rely on the issuance of warnings where publicity has been given to the existence of a warning system. In fact, an accompanying preparedness program, especially if including drills or the involvement of members of the public, will probably increase exposure to liability by encouraging reliance on the mechanisms that are designed to trigger activation of the preparedness plan.

Places of Work and Public Accommodation

Many major installations are located on flood plains. Despite increasing efforts to dissuade or even prohibit the presence of many kinds of development on flood prone lands, existing establishments and even new growth bring congregations of people to areas of substantial flood threat.

It is well established that owners and operators of facilities frequented by groups of people or by the

general public owe their patrons or employees reasonable care aimed at protecting their safety.[24]

Among the protective and precautionary measures that factories, hotels, schools and other places serving business, recreational and educational clienteles must take are the standard range of protections against the ravages of fire,[25] avoidance and remedying of structural defects and other hazardous conditions, and warnings against a variety of perils such as slippery passages, unavoidably dark areas, and temporary safety risks caused by such things as construction in progress or wear and tear that has not yet been repaired. It is also familiar law that property owners are liable for injury to persons who are attracted to the premises by conditions maintained there by the owners or operators.[26] The underlying policy is that owners and operators of premises have an obligation to anticipate hazards which invitees and even trespassers will encounter and to offer reasonable protection against them.[27]

It is an interesting question whether owners and operators of facilities in the path of floods have similar duties to protect against that danger and just what they must do to avoid or minimize their liability. This is not the place to examine such a question in all of its many ramifications. However, the possible duty to respond to flood warnings, to pass them on to employees or patrons, and whether development and implementation of preparedness plans is a legal obligation are relevant inquiries.

The actual existance and extent of a particular property owner's duty cannot be discussed fully in general terms because individual situations are bound to vary in material respects. Nevertheless, it is both

[24] 40 Am Jur 2d Hotels, Motels, etc. Sec. 54 (1972).

[25] 40 Am Jur 2d Fire Sec. 115 (1972).

[26] Supra note 22 at Sec. 12.01.

[27] Supra note 22 at Sec. 19.01 - 19.03.

accurate and important to emphasize that the presence of a good and functional flood warning system can do much to relieve the obligation of owners of property and business enterprises. Often the patrons or others frequenting the premises have the responsibility to take their own protective action and can do so, if only they are made aware of the need. At the very least, persons who know of imminent danger and do nothing to save themselves and their personal effects are chargeable with negligence. As previously pointed out, a plaintiff who has thus contributed to his own hurt or damage cannot recover.

In policy terms, the operation of a good warning system gives everyone the opportunity to avoid or reduce his own injury or loss. In legal terms, such a system will often discharge enough of the duty owed to potential victims so that the responsibility is partially or wholly decentralized to the affected property owners and individuals. What is useful to do to forearm the community at large and its inhabitants to meet effectively the dangers pointed out by a warning is a matter for the preparedness part of the system.

There are any number of entities which may be affected by flood warning and preparedness systems. Obviously, if no such system is in operation, they will neither derive any benefits from it nor will they be under any obligation to respond to warnings in particular ways or to maintain preparedness plans for the use of information that a warning system might provide. It is also clear that while liability generally attaches to the business firm or other organization as well as to its agents, it is almost invariably an employee whose performance or failure to act must be considered in assessing responsibilities and liabilities. Accordingly, the following discussion proceeds by invoking the concept of the management representative or directing administrative unit. To illustrate the kinds of problems that can most readily be anticipated, hotel managers and plant managers are used as examples.

The Hotel Manager - Years will certainly pass during which a hotel or motel situated on flood prone land is not imperiled by flood. If the location is such that the thaw every spring covers the parking lot

with an inch of water, business goodwill may be damaged. Failure of the manager to inform guests that their feet may get wet tomorrow morning can lead to disgruntled customers, but not usually to lawsuits. However, when an established warning system gives the hotel manager information on the basis of which he should reasonably conclude that serious flooding may occur at or near his location, the issue of duty and of what kind of actions will sufficiently discharge it or avoid liability can be a significant one.

The provision of safe facilities is a hotel keeper's legal obligation.[28] In specific terms, this means whatever the law of the jurisdiction requires, both in equipment and in standards of care. The mandates of building and other codes, local ordinances and state laws are the most common types of obligation involved.

To the extent that these sources must be implemented by structural design of premises or by other measures taken well in advance of the appearance of a particular flood threat, they have little bearing on obligations connected with response to word of imminent probability of high water. However, readiness to make appropriate and timely response to a warning of danger and conduct in doing so are relevant. Unless they are part of a preparedness plan having the force of law, there are probably no specific requirements for hotel keeper action directly and solely applicable to flood hazard. However, some of the precautions against loss and injury from fire have value for flood and failure to have them ready and to use them when a flood warning is given could occasion liability.

One of the types of response expected to a flood warning is evacuation of the threatened area. Since some fire protection safeguards also call for evacuation, they may provide analogies for the development of a body of law and practice that relates a hotel keeper's readiness and actual employment of evacuation of guests with susceptibility to liability when a flood warning or direction to quit a flood plain is received.

[28] 40 Am Jur 2d Hotels, Motels, etc. Sec. 86 (1972).

In extreme cases of shortness of time between receipt of a warning and the arrival of a life imperiling flood, the actual alarm equipment and procedures required for fire occurrences may be those to be used. However, it is more typical of a flood warning situation that longer periods of time are available. The hotel keeper's course of conduct should be suited more specifically to the likely flood conditions and methods of giving present and would-be guests opportunity to act prudently themselves. He may also have a duty to assist them.

A practical question is whether a hotel keeper has or should have an obligation to send patrons away or to deny them accommodations during periods when flood warnings are in effect. He must be presumed to know much better than members of the general public whether the conditions foretold in the warning carry any danger of affecting his premises or of denying safe egress from them.

Such action may not be taken lightly by operators of a business because it entails loss of revenue which is unlikely to be recouped. If the warning announces only a probability, or common experience teaches that a flood producing storm may veer off at the last moment, the temptation may be to withhold information or to understate it. If flooding is less than certain, it is a question whether and when the management must act as though the event will occur.

There is no definitive precedent or policy fixing the point or accurately describing the circumstances under which the hotel keeper has an obligation to shift the risk or loss from the patron to himself. However, well established case law provides principles for application to the problem. For example, it can be said that an operator of accomodations who solicits members of the public to use them must exercise reasonable diligence to make them safe for the intended use.[29] It is also settled that such an operator may not withhold information that the patron should have for his own safety or to permit him to evaluate the risks he takes by using the facilities.[30]

[29] Supra note 28.

[30] Supra note 28.

Affirmatively misleading statements minimizing or denying the presence of danger may lead to liability. Silence when there is a duty to convey information can also subject the operator to liability for any resulting injury or loss.

On the other hand, the patron is chargeable with exercising ordinary care and discretion on his own behalf.[31] If a flood warning has been publicly disseminated, the litigants in a specific situation may argue over whether the patron could have evaluated the warning for himself. Factual issues such as whether the patron heard or otherwise received the warning may enter into the dispute. Also, it may be asked whether the operator does not owe a duty of disclosure of probable perils in any event and whether the duty can be made to apply specifically to flood warnings and what they may mean in specific circumstances. It also may be appropriate to inqure if it makes a difference whether the patron is familiar with the local area and knows the character of the stream and its environs or is a stranger with little understanding of the danger.

The courts could be called upon to decide such questions from time to time in the future. On the other hand, both the hotel business and the public safety might be advantaged by a single definite rule that did not seek to distinguish between knowledgable and ignorant guests but placed an obligation on the management to follow uniform procedures thoroughly.

Of course, in the absence of a warning system, these questions can be avoided. The operator may still have a better idea than his guests that, given enough concentrated precipitation, his premises will flood dangerously and the guest may be unaware of the situation. But this would not be an instance of "what you don't know won't hurt you." Consequently, the issue of who should bear the risks when there is a warning system and of how this responsibility is brought into play needs to be clearly resolved. While the manner of doing so is a matter for policy decision, the effects

[31] Supra note 28 at Sec. 85.

on this issue of particular legal forms such as official plan adoption and negotiation of contractual obligations is discussed in Chapter 6.

Plant Managers - Many of the considerations discussed with reference to hotel keepers are also relevant for the conduct of other kinds of commercial establishments, including manufacturing plants. However, such places merit separate discussion because workers are required to be on the premises during stated times in order to fulfill the terms of their employment. Accordingly, the members of the work force do not have the same degree of freedom in deciding whether to enter, stay or leave. Of course, they are not restricted in the same sense that members of an armed forces unit are subject to military discipline. However, the employer-employee relationship may place even greater responsibilities on management.

Shutdown of facilities or excusing of certain groups of workers is a recognized part of work regimens. However, such occurrences related to natural hazards are more likely to involve impossibility or extreme difficulty in reaching the workplace rather than danger of staying there. Of course, plant closings at the discretion of management are known to occur when severe weather has begun, but these have generally been motivated by concern for workers reaching home or travelling under adverse conditions.

If workers are injured while at their workplace and engaged on the employer's business, the employer is clearly liable. Normally, it may be expected that workers compensation insurance which the employer is required by law to carry will cover injury to workers caused by flooding of the premises.

However, it may also be wondered whether the concept of the employer's obligation to provide a safe workplace embodied in the Federal Occupational Safety and Health Act[32] is or should be applicable to proper

[32] 29 USC 654.

response to warnings of an impending flood. A similar question could be asked with reference to state laws dealing with the safety of factories and other business premises.

If such laws were made applicable, it is conceivable that they might extend not only to making proper response to warnings but to preparedness programs. For flood prone business premises, it would seem just as appropriate to require flood drills as fire drills, and to expect management to have a flood injury and damage minimization plan. In some circumstances, this could be justified as prudent business practice, without concern for any liability to outsiders that might arise.

Hospitals, Schools and Public Utilities

There are a variety of institutions which provide essential public services. When located in a flood prone area, each of them can raise special problems of a kind relevant for warning and preparedness. For example, prisons contain populations which are not allowed to make their own decisions concerning personal safety and general conduct. Consequently, it may be asked to what degree these caretaker agencies must assume responsibility for injuries resulting from questionable judgments and actions involving exposure to flood hazards. Public works agencies may be assigned special responsibilities in preparedness plans because they possess equipment, supplies and manpower which, although not primarily intended for the purpose, are both useful and subject to immediate governmental control in combating flood hazards.

No effort is made here to catalog all of the institutions which could present uncommon or acute liability problems. But hospitals, schools and public utilities are considered to give some concrete indications of what is involved and to offer some assistance with a few of the most likely areas of concern.

Hospitals - Well developed preparedness plans will provide for the furnishing of hospital services in times of flood emergencies and also for the services of medical, nursing and ambulance personnel from hospitals for use off the premises as needed. In addition, hospitals in areas subject to inundation present

special problems and responsibilities because their patient populations are not all mobile and so must have special protection on-site and/or unique provision for evacuation. Accordingly, protection through warning and preparedness presents an unusually large and varied set of responsibility and liability questions.

Many hospitals are privately owned and operated; numerous others are institutions of local governments or states, and some are federal. The discussion earlier in this chapter of sovereign immunity and distinctions between governmental and proprietary functions should be borne in mind. For purposes of this presentation, it will be assumed that the hospitals involved and their employees are not immune from suit.

Where flood plain zoning and other controls specifically directed at elimination or minimization of flood risks are in effect and diligently administered, it is unlikely that many new hospitals will be built on vulnerable terrain. However, buildings have long lives and many existing hospital facilities are in flood plains and have not been sufficiently protected by design or other measures to the point where they can be considered immune from the hazards of inundation.

It is submitted that the mere placing of a hospital in a location where it is subject to inundation, if done at a time when it was not unlawful to so situate the facility, cannot be considered legal fault which will subject the institution to liability in the case of a flood occurrence. Many other structures of all kinds have been similarly located and, either wisely or not, the attendant risks have been regarded as normal. Consequently, the taking of them cannot properly be viewed as an absence of adherence to those ordinary standards of care required to defeat claims of negligence. Of course, if the facility was built in violation of laws relating to flood hazards, the situation could be otherwise because noncompliance with a relevant statute is evidence of fault such as can establish liability for resultant injury or damage.[33] However, in view of the fact that permits must be

[33] James Dooley, Modern Tort Law Vol. I Sec. 34.139 (1977).

obtained and a variety of other procedures satisfied in order to construct a hospital, it seems unlikely that many of them now standing were placed on their prsent sites contrary to flood plain management laws in force at the time of their construction and original occupancy.

Existance and active status of adequate plans and arrangements to keep the hospital functioning, or if necessary to evacuate it and provide alternative care facilities on an emergency basis for patients, is quite another matter. Pursuant to the civil defense and emergency services legislation in force in virtually all of the states, it is possible to have disaster plans which have the force of law. When such a plan, including hospital services and functions, has been adopted, implementation of its provisions becomes a legal obligation. Failure to make reasonable provisions along these lines could be considered fault giving rise to liability in case injury or damage that could have been prevented by such implementation occurs.

The specifics of a preparedness plan could also be determinative as to whether a hospital has to furnish ambulance services or medical and nursing assistance outside of its own premises in time of flood. It is a reasonable part of mobilization of community resources to plan for and rely upon the concentrations of medical and related skills, personnel and equipment generally most readily available from hospitals. However, aside from the general obligation of such institutions to receive and treat patients in time of disaster, the affirmative duty to provide medical and health resources should not be inferred. Consequently, the development and proper maintenance of a preparedness plan is of great importance from the legal point of view as well as for administrative reasons.

Even though hospitals avoid some responsibilities by declining to participate in certain aspects of flood preparedness plans, such a policy position could lay these institutions open to serious loss of goodwill and support in the community. In any event, the peculiar nature of the hospital and its services carries special obligations to promote and protect safety. Institutions which must provide environments especially conducive to protection of weak and ailing persons may

well be expected to guard patients against as many dangers to their physical well-being as possible. Moreover, the interruption of medical and related procedures likely to be occasioned by unexpected flooding poses a serious risk that organizations caring for debilitated or incapacitated persons must take into account. Thus warning and preparedness programs can be of special value to hospitals in assisting them to avoid and when necessary to cope with flood dangers more effectively. An auxiliary but important benefit of such programs can be to provide concrete performance of the safety obligation and thereby to minimize possible risks of liability.

Schools - As with hospitals, the locating of schools in flood prone areas is a questionable practice and may, or may not in the future, be restricted by zoning or other laws. However, many of them are already there and will remain for a long time.

It is also true that schools are administered both by governmental and private agencies. In considering questions of liability for public schools it should be recognized that their function is governmental rather than proprietary. Whether any elements of sovereign immunity from suit are to be considered will depend on the relevant state statutes and court decisions in the particular jurisdiction. For purposes of this discussion, it will be assumed that the local school district or administering general purpose unit of local government does not have sovereign immunity.

As with any other institutions having premises intended to be regularly frequented by many members of the public, schools need to be cognizant of the duties of reasonable care and safety owed to employees, all persons regularly in attendance and the relatively large number of invitees who may be expected to come upon the premises virtually at any time. In addition, there are some features of school facilities and operations that need especially to be considered in terms of preparedness.

The school receives children who, because of their youth and inexperience, are in need of supervision and direction to an extent not to be anticipated for

adults. It is generally the law that while in attendance, children are in the care of the school system.[34] Moreover, compulsory school attendance laws require the presence of the children on the school premises.

These circumstances give special importance to the decision and actions of the school authorities in determining whether or not to respond to warnings of impending flood dangers. The implementation measures they take must also be viewed in the light of the quasi-parental responsibilitites they bear and the presumed inability of the children to protect themselves by independent exercise of judgment and minimization of risk.

In general, it cannot be expected that school authorities will have any responsibilities in interpreting data or in determining whether issuance of a flood warning is justified. However, once the agency whose function it is to issue and disseminate such warnings has given them, or if it has supplied any instructions concerning implementation and response, schools may reasonably be held to a standard of more than ordinary care in putting the information to use. For example, they are probably chargeable with making evacuation plans and putting them into operation earlier and more conscientiously than institutions catering to adults might be.

Schools are also prime resources for sheltering flood victims in time of emergency. On the whole, no special structural or maintenance features or programs are obligatory in outfitting school buildings for such use. Nevertheless, experience is abundant to demonstrate that schools do serve such purposes when they are located in or reasonably near flood prone areas.

In the absence of specific laws mandating the use of school premises as disaster care centers and prescribing express requirements in that conncection, schools do not have any extra legal obligations on this account. However, in assessing the need to keep school premises in good repair and safe to accommodations large

[34] 79 CJS School Sec. 445 (1961).

numbers of the general public, possible use as a flood shelter is an additional element to consider.

The provisions of any pertinent preparedness plan will be of great significance in determining the responsibilities and liabilities of schools. Since educational institutions are already under special obligation to care for the safety of their pupils during school hours, the development of any community preparedness plans should consider including them. The provisions of such plans cannot excuse the schools from the exercise of a measure of care commensurate with the protection of children, but it may add specifics especially relevant for evacuation and other actions likely to be appropriate in time of flood emergency. Disregard of or inadequate implementation of a preparedness plan (especially one having the force of law) may provide evidence of fault such as will generate or intensify liability. Consequently, for reasons similar to those which apply in the case of hospitals, schools can benefit substantially from the existence of and participation in warning and preparedness systems.

Public Utilities - The utilities having a particular bearing on preparedness plans and their implementation during times of disaster are those providing electricity, gas, water, and transportation. Each of these can be either publicly or privately owned and operated. If the former, the function is proprietary because it can be and historically has been conducted in many instances as a private business and paid for by user charges. The comments made here are on the assumption that applicable law in the jurisdidction does not restrict or eliminate liability on grounds of sovereign immunity.

The services and products provided by the aforementioned utilities are all essential to safe and normal community and individual living. In time of imminent or occurring flood, one or more of them may suffer interruption with resultant injury or damage to persons, property or business interests.

Since flood is an "Act of God", the failure of a utility service by reason of interference from the flood itself in most instances will not occasion any liability on the part of the utility agency or company.

Only if the failure is due to the clearest kind of neglect to take reasonable measures to protect utility facilities and equipment against foreseeable and probable perils might the situation be otherwise.

Transportation service may be halted either because physical conditions make it impossible for the vehicles to move or because the dangers of imminent or occurring high water are judged to present too great a risk to the operators, the user public, other persons or the equipment. If these judgments are made unilaterally by the utility, there may be liability for resultant injury or damage if a court later finds the judgment to have been unreasonable or to have been made without authority. If made in accordance with a preparedness plan having the force of law, it is probable that no liability will be incurred by the utility because it was merely following procedures established as being appropriate to the public interest and safety.

The same may be said for power and water utilities. The services they furnish are essential. Interruption of them is very likely to cause peril and to be a direct or indirect cause of loss. On the other hand, imprudent continuance of service may cause explosions, escape of toxic substances, fires, disease or electrocutions. If shutoffs or curtailments of service are in accordance with a preparedness plan having the force of law, resultant damages can likely be regarded as the necessary and justifiable balancing of risks in the public interest and pursuant to authority and procedures emanating from proper exercise of the governmental power to protect public health and safety. If so, those who incur loss must bear it themselves (either directly or through such insurance protection as they may have secured). There is no liability producing fault when the injury or damage is attributable to an Act of God.

Communications - Privately owned communications industries are also important to flood emergency planning and operations. The telephone is a public utility medium. Television, radio and newspapers are not strictly speaking in the same category, but for present purposes they have some similar features.

These communications media provide some of the means through which the general public can receive flood warnings and instructions concerning the action which it is desirable for them to take. Some of them also are used by disaster workers for operational purposes.

Aside from maintaining service to the maximum extent possible, the main assistance that can be rendered by telephone systems is to cooperate in programming restoration of interrupted service. There is not likely to be any requirement of general law that this be done in any particular way. It may be assumed that the order in which individual locations or facilities receive attention from emergency crews is a management decision made in the course of operations by the utility.

A preparedness plan may well designate priorities for the maintenance and restoration of service because telephone communication is important to the conduct of emergency operations as a whole. If telephone companies become parties to preparedness plans or otherwise accept them, they do become responsible for following their provisions. Depending on the circumstances of individual instances, this could include exposure to liability for disregard of the plan or for negligence. There are two existing sources of governmental authority under which the position of telephone and other utilities might further be affected. State public utility regulatory agencies have substantial authority over the quality and conditions of service which utilities must provide. The specifics vary from jurisdiction to jurisdiction, but it is probable that if affirmatively undertaken by these agencies, they could establish obligations and priorities for restoration of service and other aspects of flood disaster situations that would need to be carried out on pain of incurring liability.

The other avenue is the ill defined emergency powers of the Governor. In time of emergency, the principal executive authority of the jurisdiction, and sometimes even lesser officials, issue proclamations and other orders which purport to have the force of law or which are customarily obeyed as though they do. Whether, absent the commitment assumed under a preparedness plan, a telephone or other utility could be held

liable for knowingly or inadvertently disregarding a direction issued on such a basis or for misperforming under it is an interesting question that does not now have a definitive answer.

Radio and television stations generally disseminate weather reports, flood warnings and related information as part of the news or on a public service basis. Except in the unusual circumstances where they have developed the content themselves, these stations are not responsible for the reports or instructions, nor can they reasonably be expected to check for correctness or to make an independent judgment as to the wisdom of the advice given by disaster agencies, public safety officials or similar sources.

The most important questions relating to the broadcast media are the extent and nature of coverage which they are or should be obligated to provide. Should an acceptable standard of service for them include obligatory displacement of revenue producing time or program content and appropriate arrangements designed to disseminate warnings and instructions?

Radio and television are not public utilities in the traditional sense. Their relationship to warning and preparedness is not the furnishing of their normal services or products alike to all customers. Rather, it is the provision of information not originating with them and dissemination on a priority basis. Such obligations could arise from the fact that they are licensed industries using the public airways by government permission. If radio and television undertake contractual obligations to provide warnings and related dissemination services, their liabilities will be determined on bases similar to those applicable to other furnishers of service pursuant to agreements. The scope of the present work does not allow for special examination of what obligations might be imposed pursuant to the Federal Communications Act or any other legislation such as Congress or the states might enact.

Perhaps apropos but in a somewhat different vein, it may be noted that civil defense and disaster statutes frequently provide for mobilization and requisition of resources, as necessary during an emergency.

Experience shows that such extreme action as requisition is rarely if ever taken in connection with natural disasters and it is probably realistic to assume that flood warning and preparedness situations will contemplate radio and television facilities being left in the hands of the regular operators.

In the absence of specific law or license provision, and without an agreement governing the emergency conduct of these media, it may be asked whether the failure or refusal of a radio or television station to carry flood warnings creates liability. Without specific precedents as a guide, one would be thrown back on the general principal of tort law. Analysis would need to examine whether any of the attendant circumstances were sufficient to establish a duty on the part of stations to disseminate warnings as part of the general obligation to operate in the public interest; whether the failure or inadequacy of dissemination by a particular radio or TV defendant caused or materially contributed to injury or loss, and whether a particular plaintiff relied or had a right to rely on dissemination from the defendant.

Newspapers are not as much involved in the dissemination situations likely to give rise to liability questions of the kind being pursued here. Their methods of composition, production and distribution make the time and coverage needs of many warning and preparedness systems unsuitable for reliance on the printed word. But, in some communities, they may be important avenues of access to the wire services which do carry flood data and information of value for disaster operations. However, newspapers are not licensed to disseminate the news. Consequently, it is probable that their only obligations to make any of their property or contracted services available in connection with flood warning and preparedness would come from participation by agreement in preparedness plans, through voluntary action at the time of an emergency, or through temporary requisition under emergency laws. Assessments of exposure to liability would require application of tort principles to specific situations.

CHAPTER 6

IMPLEMENTATION APPROACHES

Many steps must be accomplished between the decision as to the proper means of protecting an area against the dangers and losses of flooding and the realization of that protection. They include the planning of the system, financing of the project or program, actually creating it, and successfully putting in place the organization and arrangements for impoundments and other physical works. Experience has combined with technical and scientific knowledge to show how the job is to be done; to make clear what is better and what is worse; to illuminate the choices that need to be made and the consequences that are likely to attend selection of each alternative.

Warning and preparedness systems do not have this full record of successful and not so successful instances from which to draw the "how to do it" lessons. Nor has the federal government participated in enough full warning and preparedness systems to have identified and argued out the policy questions concerning the extent of its desirable involvement and the nature of its relationship to the local interests seeking protection.

This may be thought strange because surely to warn people of approaching inundation and for them to plan and execute the measures they will take to get out of harm's way or make it safe for them to remain in the midst of the risen water seems an obvious course of action. But the lag in developing truly professional and comprehensive warning and preparedness systems is a fact. Perhaps it can be partially explained by the long standing preference for building physical works to keep flood waters away and to permit occupiers of the land to go about their business as though serious flooding would not occur.

The procedures by which structural measures move from their inception to operational status and by which they are thereafter sustained have become familiar. Congress, the Executive Branch, the state governments and local interests have argued their merits and inequities long and thoroughly. The institutional framework for flood warning and preparedness is only beginning to be developed.

The few instances of significant federal involvement with warning and preparedness specifically directed at flood protection need to be used for what guidance or other information they can provide. For that reason they are described in Chapter 3. However, so long as the experience record is thin and even major policy questions are still largely unexplored, analytical methods must be relied on heavily to show how the job can be done and to identify alternatives to be considered.

Chapters 4 and 5 have developed the major items of substantive law and policy information presently available. Much of this material might be cast as issues because, as the discussion has shown, there are often no clear and definitive resolutions of such matters as liability and responsibility for furnishing protection. However, it has seemed best to regard the items in Chapters 4 and 5 as informational background against which the several issues central to the creation of a warning and preparedness system can be examined by the planners and policy- makers faced with the concrete task of developing systems in particular geographic locations.

Throughout this chapter, questions are raised as to the proper distribution of functions and responsibilities between the federal government and non-federal participants.

PLANNING

There are two significant areas of uncertainty with respect to planning of flood warning and preparedness systems. They concern distribution of the responsibility for planning between the federal government and non-federal interests and the level of detail to which plans should be developed.

Responsibility for Planning

The threshhold legal question is whether the Corps or any other federal agency is required to plan warning systems for particular locations or project areas,

whether it must develop preparedness plans, and whether it must plan warning-preparedness systems.

One way to look at the problem is to note that warning and preparedness is only one from among a number of possible nonstructural measures. Section 73 merely requires that structural and nonstructural measures be considered. Depending on the circumstances of each individual project or study area, it is probable that some nonstructural measures will prove more relevant than others and that reasonable consideration of the category as a whole will not make equal development or analysis of all of the conceivable nonstructural techniques essential. Nevertheless, it would seem that to meet the intent of Section 73, the possibility of employing each of the known nonstructural approaches should be raised and either pursued further or discarded as preliminary analysis might indicate in the specific situation.

Instances of Corps involvement may be differently viewed depending on whether they go forward under authorizing action of Congress for the study of a particular area or project, or whether they come about under the Flood Plain Management Services program. Where there is a specific authorization, it is possible to argue that the words of the authorization govern and that only the types of measures directed to be investigated need be considered. Congress can specifically direct that a particular kind of nonstructural measure be employed. For example, relocation was expressly provided for in the Prairie du Chein instance.

On the other hand, the mandate of Section 73 would be a nullity if it applied only to cases in which study or project authorizations specifically directed consideration or use of flood warning and preparedness or nonstructural measures generally. The language of Section 73 would then never apply unless specifically triggered by wording in the authorizing action. In such instances it would be surplusage because the authorization would be sufficient of itself.

Since it must be assumed that Congress did not intend to place a meaningless statute on the books in enacting Section 73, it is appropriate to conclude that each area or project being studied or planned for flood

protection should receive analysis to determine whether each of the known nonstructural measures could contribute to loss reduction, either if used alone or in conjunction with other flood control or loss reduction techniques. In those instances where warning and preparedness is determined to merit development, the Corps may prepare a flood warning and preparedness plan. It may also participate in a multi-party effort to produce such a plan, or it may recognize the action of non-federal interests in developing such a plan and may consider it in lieu of its own action.

Planning of a flood warning and preparedness alternative is a complex effort requiring considerable time and effort and necessitates certain technical capabilities on the part of the planning organization. Among the tasks to be performed are analysis of the flood hazard in terms relevant to warning and preparedness, identification of the characteristics and needs of the area which is to be protected, and development of subplans for warning issuance, warning dissemination, evacuation, property damage reduction, public information, maintenance and perhaps other objectives. All of this must be done so as to be consistant with established emergency procedures, existing commitments of equipment and personnel and availability of resources for carrying out the plan. Moreover, all of the subplans must be closely coordinated and their contents considered in trade-offs between timeliness, reliability and cost as part of deciding the main features of the system.

This type of planning requires collection of a sizable mass of background information, various types of technical analyses and both subjective and objective decisions. It also requires development of assignments of responsibility for agencies and some specified personnel, writing of inter-and intra-agency agreements and creation of procedures for adoption and implementation of the warning system and preparedness plan at the local level.

Many of the planning activities could be performed equally well in most cases by either federal or non-federal planners. Some could perhaps be performed better by one than another. The question of what part the federal government should expect non-federal

interests to perform is as yet unsettled. As in the case of other authorized flood control and water resources studies, the recommendation eventually made to Congress comes from a federal entity. However, that does not prevent the recommendation of a federal agency from being based at least in part on planning performed by non-federal interests. Legislation authorizing flood control studies usually is worded as a directive to the Chief of Engineers or another federal official but, again, that is not generally taken to mean that the specified official and the staff of the agency so designated must perform every aspect of the planning.

Lack of authority provides no impediment to non-federal participation in planning of flood warning and preparedness alternatives. Local governments and special purpose districts are normally endowed generously with authority to participate in planning for topics related to their interests. Individuals, of course, may participate with the exception perhaps of corporations with extremely limited charters. The question is whether they should be required to be a part to planning.

The responsibility assigned non-federal interests in planning of local flood protection works has usually been small. Once the federal investigation has begun, a two way communication process is set in motion to promote public understanding, keep the public informed on the status of the study and solicit information. However, the public does not participate much in deciding scale, level of protection, technical specifications and like matters. The first significant input asked of non-federal interests is participation at a public meeting to review the assessment which has been made of the nature and extent of the problem and to be informed concerning the details of the plan of study. The next significant input is at the time when a broad range of alternative solutions have been identified to eliminate those which are impractical or clearly infeasible. Non-federal input is asked at that time to help select those remaining alternatives to be studied in detail. The next and most important non-federal input is at the conclusion of planning to review the recommended plan. If this process is applied to a situation from which a warning and preparedness alternative emerges, non-federal interests will have been involved primarily in selecting that alternative for

detailed investigation and in approving or rejecting its finally recommended form.

Flood warning and preparedness alternatives are different from traditional types of projects in ways important to assessing the value of any analogy of one to the other with respect to the assignment of planning responsibilities. The minimal day-to-day participation of non-federal interests in technical design of dams, levees and other flood control measures makes some sense in view of the fact that design of those types of projects is based primarily on physical circumstances which can be assessed as well by federal planners as by local participants and on relatively well developed federal policy. In addition, federal agencies continually involved in such projects can develop expertise in various design disciplines which non-federal participants cannot often match. However, flood warning and preparedness plans are not creations of concrete and steel. While they depend in part on physical conditions, much of their design depends on understanding existing organizational and institutional arrangements, past experience in emergency operations in the locale, desired patterns of assigning responsibilities, and local preference for making various trade-offs. Because of its character, planning of flood warning and preparedness alternatives requires some capabilities which are either not available in federal agencies or for which they can claim no unique expertise. Local input to the technical aspects of the planning process on a day-to-day basis therefore becomes a much more important matter than for most structural measures.

Participation of non-federal interests in federal planning is variously encouraged or required by the Principles and Standards for Planning Water and Related Land Resources, The Unified National Program for Flood Plain Management and other policy documents which have the force of law so far as federal agency procedures are concerned. For the most part, the requirements of these types of directives are meant to insure opportunity for non-federal review of federal planning and are adequately discharged through a public involvement process. According to the Corps' directive on public involvement, for example, the public is to be involved in early planning stages and not just involved reviewing plans after the fact. However, these documents do

not take account of a significant difference between plans for structural and nonstructural measures. Dams and other structural works either remain within the ownership and operational control of the federal government for the long term or are turned over to non-federal interests only after construction is completed. Nonstructural measures, especially in the case of warning and preparedness systems, are usually intended to be implemented, operated and maintained wholly or in major part by local governments or other non-federal interests.

There is no legal or theoretical impediment to the Corps or some other federal agency having proper authorization to deliver a complete blueprint for a flood warning and preparedness system to a local or state government. However, if the agencies and organizations which will thereafter be responsible for administering it and for bearing the costs and liabilities have not intimately participated in the formulation of the plan, there is a great likelihood that they will not accept its provision or that they will give it only lip service. It follows that cooperative planning of some kind will normally be essential to promote the acceptance and practical implementation of the operational plans, if not of the system design.

Another factor favoring non-federal participation is the nature of flood warning and preparedness alternatives with regard to their vital need to mesh with ongoing non-federal activities. It would be exceptionally difficult, time consuming and expensive for federal planners to develop fully adequate detailed plans without significant input of at least information and, in many if not most instances, of experience and views as well from local officials and local business communities.

For the several reasons described, a substantive day-to-day participation in planning of flood warning and preparedness alternatives is plainly preferable and quite possibly necessary for best results. Joint planning is the most desirable approach since the actual functioning of warning and preparedness systems is almost certain to involve activities by more than one agency and level of government and all those who must contribute to success should have a part in decisions concerning the policies, study methodologies,

plan content and assignment of responsibilities. However, where the several parties are likely to differ greatly in technical and financial capabilities, such equality may not be realistically attainable in practice. Moreover, there are few existing institutional arrangements of an intergovernmental character through which truly joint planning of warning and preparedness can be achieved. Perhaps the Susquehanna and Delaware River Basin Commissions with their representation of states and the federal government, and the several interstate planning bodies having both state and federal representation come closest. Unless such intergovernmental machinery is successfully further elaborated and its use becomes more widespread, the nearest practicable approach available in most instances will probably be coordinated planning in which certain tasks are assigned to federal and non-federal interests for performance.

Non-federal planning responsibilities might include provision of readily available information, conduct of certain inventories, and participation in decision-making. Some of the types of readily available information which would commonly be needed are those concerning existing emergency plans and procedures, existing hydrologic and other data collection systems operated by non-federal interests, available resources of equipment and personnel, existing mass warning systems, existing communications capabilities, and utility and transportation systems. Inventories which might be useful include those to identify demographic and socioeconomic characteristics of the area to be protected, to locate and describe vital facilities, to identify special warning participants and to ascertain the availability and suitability of such things as evacuation destinations. The non-federal decision-making role would likely include participation with the federal government in selecting the general type of flood recognition system and means of warning and almost unilateral decision as to procedures for plan adoption and such things as selection of the local party to be in charge of operations.

This type of division would then leave to the federal planners the hydrologic, hydraulic and other

analyses of the flood hazard, identification and coordination of federal agency assistance, formulation of alternative concepts for warning and preparedness, leadership in detailed development of the various subplans and cooperation with non-federal interests in the development of implementing arrangements.

This approach has the added benefit of providing non-federal officials the detailed familiarity with the plan necessary for its operation.

Two other considerations might affect the extent of non-federal participation in planning, depending on how it was desired to handle them. First, it may make a difference as to who is to adopt the plan and assume responsibility for it. If the warning and preparedness system is in conjunction with a project operated by a federal agency, it is likely that the United States Government will have all of the responsibility for planning or at least a significant share of it. If a completed project is to be transferred to non-federal ownership or if the warning and preparedness system is a separate program for which local or state government undertakes most or all of the responsibility, determination as to how far the federal agency should go with planning will be a matter of policy rather than law.

Second, liability can result from faulty planning as previously described. If it is desired to assure a uniform approach to bearing that liability, planning could be done without any substantive non-federal assistance. On the other hand, non- federal participation in planning could spread that burden and assure some non-federal interests had a stake in the adequacy of the plan. A policy determination on how liability is to be distributed may influence policy concerning non-federal participation in planning to a considerable extent.

Level of Detail

Federal flood control projects are planned in explicit detail. The planning process usually begins with development of a plan of study which identifies issues, defines planning objectives, formulates alternative measures for meeting objectives, and estimates the

time and funds necessary for completion of the study. Intermediate stages of planning provide for gathering the data and information needed to improve the formulation and evaluation of the most promising alternatives and evaluate their costs, benefits and other impacts. Alternatives finally selected for implementation are studied further to determine appropriate sizing of projects, determine the degree of protection to be afforded, consider aesthetic and environmental aspects and to prepare detailed engineering specifications for construction.

Before construction is undertaken, extensive work is done to assure foundation conditions are suitable, investigate the availability of borrow and spoil sites, plan routes for construction traffic and to settle numerous other points. Specifications for structures and means of construction are similarly detailed. Materials, procedures for placement, compaction and other aspects are all thoroughly planned. In short, every reasonable effort is made to assure the project will perform exactly as expected. There is good reason why such care is taken in planning flood control works. Failure or improper functioning can prevent obtaining whatever protection is intended to be provided by the structure. In some cases, failure could cause catastrophic damages aside from whatever losses might have occurred from a flood. Also, of course, flood control works cannot be tested before they are installed and their workability is assured only through competent planning.

The appropriate level of detail for planning flood warning and preparedness systems is open to some conjecture. Because such measures have not been used extensively, no long and well developed body of experience exists on which to base an answer with many specifics.

Design of a flood warning and preparedness alternative can be pursued in levels of detail varying from limited planning which only ascertains that such an alternative is needed and could be developed through explicit planning for every conceivable contingency. The first extreme is obviously not very helpful and the second is extraordinarily complex. Between the extremes are a very large number of alternatives from which an appropriate policy can be selected. For

example, plans for issuance of a warning could proceed only to the point of identifying who should make the decisions on release of it. To provide more detail, plans could be carried to the point of specifying the criteria on which warning messages of various types are to be based or even through actual writing of the messages to be used under various conditions of rainfall and river stage. Similarly, plans for the dissemination of flood warnings could stop at assigning responsibility to non-federal interests, be so specific as to assign responsibility for warning dissemination to a particular entity, or even pursued to the point of spelling out how the dissemination of warnings is to be carried out, the resources required for the job and the priority of warning various areas. In the case of traffic control, planning of routes could or could not be supplemented by identification of the number of personnel, barricades, signs, lights and other equipment necessary to effect the desired control. The same types of choices occur throughout the planning process with regard to the level of detail of each part of the plan.

Some policy regarding the appropriate level of detail of planning flood warning and preparedness systems is essential as guidance to the planner in laying out time schedules and budgets for the planning process. It is also necessary as a basis for describing to non-federal interests the nature of the final product which they will be provided if a warning and preparedness alternative is chosen as the preferred alternative. This latter point is particularly important since warning and preparedness alternatives have not been widely employed and their nature and benefits are consequently not as well known as are those of structural flood loss reduction measures.

Consideration of flood warning and preparedness alternatives is only encouraged or required by Section 73 of Public Law 93-251, The Unified National Program for Flood Plain Management and other federal government policy documents. These documents do not specify or provide for any specific guidance as to the form or substance of recommended alternatives. However, Section 73 does require consideration of such measures and its legislative history makes it clear that Congress

intended that the consideration given be comparable to that for flood control measures. It can be inferred from this that Congress expected warning and preparedness alternatives to be developed to a level of detail equivalent to that commonly employed for flood control measures so as to facilitate their comparison with one another. The Principles and Standards for Planning Water and Related Land Resources also requires various displays and comparisons of alternative measures. Compliance with those requirements necessitates relatively complete investigations of each alternative considered for recommendation.

The extent to which the detail of a flood warning and preparedness alternative should be developed needs to be at least considered in terms of possible liability. While most risks of suit over injury to persons or damage to property are likely to arise out of faulty operations in executing a plan rather than from its content, the quality of a plan for warning and preparedness could become the basis of a claim of negligence or incompetence resulting in liability. If such a plan were deficient or inept enough, and if a community were given reason to suppose that it could rely upon the plan as an element of its protection against the consequences of flood, the agency which produced only half a plan or one so sketchy that it belied appearance of sufficiency or completeness might be held responsible for injuries or losses. Abbreviated planning supported by only skimpy investigations requires greater numbers of assumptions and increases the prospect for unforeseen conflicts or other inadequacies which may only become apparent when the plan is executed under emergency conditions. Detailed planning offers a far better opportunity for each intended participant to assess pertinent portions of the overall plan while it is in draft stage and identify erroneous assumptions concerning capability, conflicts with duties assigned under other operating procedures or shortcomings of the plan.

The Corps' Flood Plain Management Services program presents a different set of circumstances in this regard than does planning of authorized projects. The assistance which the Corps provides in the Flood Plain Management Services program is discretionary in the sense that it is rendered in response to applications

from state or local governments. In the final analysis, it is up to the Corps to decide whether it will respond to any such application and to what extent it should devote resources to a particular undertaking. The quality of any work which is performed could still be an issue, but it is unlikely that there could be any legal fault for not preparing a nonstructural plan or for contributing too little technical assistance.

The need also exists for detailed planning of flood warning and preparedness systems for the same reasons noted earlier for flood control works. Failure of the system to work properly, especially in the case of the warning component, may leave those depending on its benefits in worse condition than if the system did not exist. As with structures, not all of the parts of a warning and preparedness plan can be tested other than by actual use. Assuring all of the pieces of the system fit together and will function satisfctorily under emergency conditions requires detailed planning.

The detail of planning may also affect the prospects for approval of a proposed flood warning and preparedness alternative by non-federal interests. Too little planning may result in a plan which does not generate confidence that it will, in fact, protect lives and reduce property damage.

As noted in the discussion of legal considerations in Chapter 5, some liability may be associated with a flood warning and preparedness alternative in the event it is given the force of law and is then carried out improperly. Few of the local governments which lack sovereign immunity would seek that risk and might therefore prefer that the plan not be detailed on the basis that they cannot be held responsible for what went unsaid. A policy reflecting that concern would limit plans to saying that, for example, traffic should be controlled at certain intersections to prevent entry into a flooded area, without describing whether or what equipment was required, whether it was a police, public works or other responsibility, and how many personnel were required for the task. Concern over a detailed plan springs, of course, from the fact tht all of the conditions which may exist at the time of an emergency cannot be foreseen. Police assigned traffic control or

warning dissemination tasks may be engaged elsewhere, planned routes may become impassible, or specified equipment may be temporarily unavailable. Yet, if a detailed flood preparedness plan has been formally incorporated in the community's emergency operations procedures, managers directing emergency activities may be faced with either acting contrary to the approved plan or following a plan which has become untenable. Neither course is entirely satisfactory because each involves risk of liability.

Fortuntely, a relatively simple way exists to reconcile the opposing problems of too much or too little detail which stem from liability considerations. The need to do competent planning can be met through detailed analysis and specification of the warning system and preparedness plan. The problems of having such detail as a formal part of the plan can then be avoided by presenting non-critical details such as lists of materials, personnel requirements and the specifics of operational procedures as desirable levels of performance to be provided at the discretion of those managing the emergency response. This would leave only the crucial parts of the alternative as specifically required performance for which participants would be responsible. Application of this approach would, of course, need to include ample explanation in the body of the plan and in information concerning the plan which is distributed to the public and to other governmental parties.

The shortcomings in reconciling this problem in the manner suggested is the lack of any requirement for non-federal interests responsible for operation to take the discretionary parts of the plan seriously and attempt to operate in accord with them so far as possible. Care also needs to be taken in deciding which parts of the plan are essential and cannot be left to discretion.

FINANCING

Division of costs for flood warning and preparedness alternatives involves the amounts or proportions

assigned to the federal government and to non-federal interests, the types of activities or functions for which each is to bear the expenses and the mechanics for implementing the division of financial responsibilities. These several aspects are closely related and therefore must be considered together in establishing any overall policy.

Cost Apportionment

The most important of the three financial aspects is probably division of the amount of costs. In many cases, the size of the non-federal share of costs may be the largest single factor in non-federal decisions to prefer one or another type of warning and preparedness alternative from among those which are practical or to prefer a warning and preparedness system over other types of flood damage reduction measures which are proposed. Given a choice of two plans accomplishing somewhat the same purpose, non-federal interests will often choose the one which requires the least financial imput on their part. Some departures from this expectation are likely to occur. They will be influenced by such considerations as how much of the non-federal cost share for each type of alternative is to be in the form of an immediate cash contribution or expenditure, how much can be provided as matching services and how much can be deferred or involves only a potential cost such as assumption of liability.

Some specific direction concerning apportionment of costs for flood warning and preparedness alternatives which are developed as part of a project involving flood loss reduction is provided by Section 73(b). According to that statute, non-federal participation shall be:

> ...comparable to the value of lands, easements and rights-of-way which would have been required of non-federal interests under Section 3 of the Act of June 27, 1936 (Public Law numbered 738, Seventy-fourth Congress), for structural protection measures, but in no event shall exceed 20 percentum of project costs.

The law seems on its face to be clear. Non-federal participants are required to bear a cost equivalent to that for lands, easements and rights-of-way for an alternative structural project.

A definitive prescription is lacking as to what constitutes a "project" as used in Section 73(b). Considerably different interpretations can be made depending on whether "project" is taken to mean a single measure, two or more nonstructural measures or a plan combining structural measures with one or more nonstructural measures. Even if the simplest case of a project including only a flood warning and preparedness system, a problem arises as to what type of "structural protection measures" should form the alternative on which the cost allocation is to be based. Warning and preparedness systems are seldom if ever true alternatives to dams, levees or channelization projects in terms of the type and extent of protection they provide or the way in which benefits are produced. Certainly, the methods of accomplishing damage reduction are not parallel--there is no obvious way of translating the land or rights-of-way components of a flood control project directly into components of a flood warning and preparedness system.

If Section 73 said non-federal participation should be only comparable or similar to that required for structural measures, one alternative would be to assign to non-federal interests some fixed set of responsibilities which would comprise 20 percent or less of costs in most warning systems. However, the requirement of being comparable to the value of those things demands individual treatment of each case unless it can be correctly assumed that the value of lands, easements and rights-of-way for any structural protection alternative would in every case exceed 20 percent of the cost of a warning and preparedness alternative. If that assumption is true, the problem of cost allocation reduces to a simple 80-20 split of overall costs between the federal government and non-federal interests. Project planning presumably will include the investigation of alternative structural projects so no great burden is put on the planner by this requirement even if the assumption is not true.

Division of the Types of Costs

Division of the types of costs raises questions of whether the federal government or non-federal interests should bear the financial burden for purchase of equipment for flood recognition systems and communications, installation of equipment, modification of utility systems or structures, acquisition of land, purchase of supplies to be stockpiled, execution of the plan, conduct of public information programs, performance of continuing monitoring and maintenance activities and each of the other specific items that go into making up a flood warning and preparedness system. Even aside from their cost amounts, some of these types of activities are of a nature to be more easily financed by a particular participant.

Section 73 is silent with regard to the types of costs to be borne by the federal government and non-federal interests. It is worth particular note in this respect that Congress omitted mention of maintenance and operation and holding the United States free from damages which were other requirements of the 1936 Flood Control Act. As has been pointed out, these items may be a larger component of overall costs for flood warning and preparedness than for most structural measures. Division of the types of costs for flood control works is generally guided by Section 3 of the 1936 Flood Control Act which provides that non-federal interests should: a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project; b) hold and save the United States free from damage due to the constuction works; and c) maintain and operate all of the works after completion in accordance with regulations prescribed by the Secretary of Army. Subsequent legislation has added other requirements for non-federal interests which are variously applied including relocation or alteration of bridges, roads and pipelines, regulation of flood plain areas; provision of public facilities related to project operation; and conduct of public information programs related to the project.

One major difference between the structural measures addressed by the 1936 Act and flood warning and preparedness alternatives is the absence of any

significant requirement for land in the case of the latter. Small plots for location of precipitation and river stage gages and/or antennas and radio relay stations, easements for access to such sites, and perhaps easements for location of buried communications cables are about the extent of land related requirements for most systems. Additional requirements might arise for provision of space for emergency operating centers, evacuation care facilities and storage of materials but this is not comparable in difficulty or cost to acquiring land for construction projects.

A second notable difference between structural projects and flood warning and preparedness systems is the share of the overall project cost expended at the planning, implementation and operation stages. In the case of a dam or levee of any significant size, planning costs are a relatively small part of overall project costs and their share of overall costs usually decreases as project size increases. For flood warning and preparedness systems, planning costs are more nearly equal to and may even exceed implementation costs in some instances. In addition, the share of overall costs devoted to planning of warning and preparedness systems tends to rise as project size increases. Annual operation and maintenance costs for flood control works also tend to be relatively small in comparison to the implementation cost whereas operation and maintenance costs may be nearly as large or larger than first costs for some flood warning and preparedness systems.

Within the statutory requirement of Section 73(b), the matter of workability needs to be considered in apportioning costs. Local governments and some state governments may be particularly sensitive to the types of costs they are asked to bear and the period of time in which the costs are incurred. Smaller communities, rural counties and others may have difficulty in providing funds for equipment purchase on short notice. Assignment to these types of non-federal interests of costs for testing and maintenance of equipment, public information and other continuing activities is likely to be preferable. Similarly, there are constraints on what responsibilities and costs the federal government can best assume. For example, the federal government cannot very well provide services to coordinate local

operations, develop detailed assignments of responsibility or carry out day-to-day monitoring of local weather conditions. Local governments and, to an extent, state governments, are better equipped for these types of activities.

Mechanism for Sharing Costs

The mechanics for dividing costs between the federal government and non-federal interests pertain to how the appropriate apportionment can be effected. It is obviously desirable for whatever means is selected to be generally applicable to most or all warning and preparedness alternatives notwithstanding their differences in composition and overall cost.

The mechanism for sharing costs in the case of flood control works is non-federal provision of lands, easements and rights-of-way and such other items as are specified in law or may be decided to be appropriate for the particular project. For nonstructural measures, Section 73 leaves the proposing federal agency with flexibility to recommend whatever cost sharing mechanism it chooses. The discretion can either be passed on to field offices for their exercise on a project by project basis or some internal guidance can be provided from headquarters to insure a uniform approach in all warning and preparedness alternatives developed by the agency.

Assuming a uniform policy is desired, there are two major approaches which might be taken to cost sharing:

A. Assignment to non-federal interests of the costs associated with a fixed set of the major implementation, operation and maintenance actions selected on the basis of typical non-federal technical capabilities and authorities, federal limitations and other considerations, supplemented by payment one direction or another to achieve proper sharing of costs.

B. Assignment to non-federal participants of full responsibility for the costs of carrying out all implementation, operation and maintenance actions, offset by a payment from the federal government to non-federal interests.

Distribution of costs and distribution of responsibility are clearly different. However, an approach to cost sharing would be more effective and more easily administered if they paralleled one another. Some attention therefore needs to be given to the implications of the cost sharing mechanism with respect to the division of responsibilities for implementation, operation and maintenance.

Alternative A (fixed division of costs) is most like traditional practice and would facilitate maintaining past policy with respect to responsibility for operation, maintenance and liability by simply assigning those things as non-federal costs when the cost sharing pattern is established. Since it is likely that any significant assignment of continuing responsibilities to non-federal interests would entail costs in excess of 20 percent of overall project costs, a question arises as to how the equalizing payment of funds should be shared among state and local governments, private organizations and individuals which participate in implementation of the alternative or are expected to take part in its future operation and maintenance. This alternative would not foreclose the possibility of recommending more than the minimum with regard to non-federal responsibilities if warranted by the situation and needed to produce an appropriate cost share.

Alternative B (local cost with federal reimbursement) would probably work in the case of communities or counties with a fair amount of financial resources and technical capability and it would be a simple mechanism for cost apportionment. However, some non-federal participants might have considerable difficulties, especially in selection, purchase and installation of sophisticated equipment for some types of flood recognition systems. The approach would work as well as

alternative A in facilitating continuation of the past policy of leaving operation, maintenance and liability to non-federal interests. One drawback to the approach is that it does not facilitate retaining responsibility at the federal level as conveniently as alternative A and such retention may be found to be desirable in some situations.

IMPLEMENTATION AND OPERATION

Responsibility for implementation and operation of levees, floodwalls and other types of local flood control measures is distributed between the federal government and non-federal interests in accord with Section 3 of the 1936 Flood Control Act. The federal government usually provides for all implementation excepting provision of land rights, bridge adjustments and a few other matters spelled out in the 1936 Act and subsequent legislation or required because they are thought to be particularly important for the project at hand. Non-federal interests then operate and maintain the completed project. The federal government only makes periodic inspections and reviews reports made to it. One of the basic questions concerning use of flood warning and preparedness alternatives is whether the same or some different pattern of assigning implementation and operation responsibilities should prevail.

Implementation

Warning and preparedness alternatives are like traditional measures in that they require some implementation effort. However, the types of actions which are necessary differ greatly. In the case of most traditional types of measures, the principal parts of implementation are related to acquisition of land rights and to construction. These are generally minor parts of implementing a flood warning and preparedness system.

The major steps toward implementation of a flood warning and preparedness alternative include establishment of the flood recognition system, purchase of materials and equipment needed for execution of the

plan, modification of utility systems and structures as may be necessary, development of any site-specific warning systems and preparedness plans which are required, adoption of the plan, assignment of responsibilities for the execution, operation and maintenance of the plan and consumation of whatever inter-and intra-governmental and governmental-private agreements are necessary. Each of these steps may have several parts. For example, establishment of the flood recognition system may involve purchase, installation and calibration of measuring and communications equipment; recruitment and training of observers and/or other staff; and development of any detailed procedures not provided as part of the project plan. Development of site-specific warning systems may include preparation and adoption of local ordinances requiring them, establishment of criteria for the level of performance to be provided, analysis of requirements at each site involved, design and installation of the needed system, inspection and training. Other major parts of implementation could be similarly disaggregated but the result is obvious without doing so. Implementation of flood warning and preparedness alternatives having any complexity at all requires a large and diverse set of actions which are quite different from those associated with structural measures.

Continuation of past policy regarding the division of implementation responsibilities would result in almost totally federal implementation. Regardless of whether that approach would be desirable from a policy standpoint, it is not likely to be possible because of a lack of authority on the part of the federal government to do all of the types of things which would be required. For example, it would be difficult under present legal arrangements for the federal government to act directly in requiring private property owners to install site-specific warning systems and preparedness plans. Although the authority and mechanism for that might conceivably be provided by legislation adding safety from floods as an objective of the Occupational Safety and Health Act as discussed in the previous chapter, the same objectives might be more easily accomplished by state and local ordinances and codes similar to those which require installation of fire alarms and fire equipment in public buildings. Similar limitations in legal authority exist for other aspects of implementation.

Another consideration in allocating responsibility for implementing actions is the affect which differing patterns for doing so have on liability. Improper installation of a warning system or faulty implementation of some part of a preparednesss plan could result in liability. In the absence of any legally binding commitment for one party or another to hold the others free from such losses, liability might be assigned to whichever party carried out implementation. Achieving the desired distribution of liability may govern the assignment of responsibility for implementation if liability is not handled through a specific agreement.

Implementation responsibility could be entirely delegated to non-federal interests, reserving to the federal government only the role of inspector to assure it was carried out properly. This is the approach taken in some other programs such as that for construction of sewage treatment plants financed in part by federal grants. However, this approach would depart significantly from the past policy of extensive federal involvement in implementation which has prevailed in the area of flood control.

Assignment of all implementation responsibilities to non- federal interests could produce a bias against selection of warning and preparedness systems. Whereas the types of responsibilities associated with construction of sewage treatment plants are relatively well known because they are widely used, local officials and staff members of local agencies are largely unfamiliar with what is required to implement a flood warning and preparedness system. The result of this lack of familiarity is likely to be adoption of a wait-and-see position, reserving support until the plan is fully detailed and all implementation actions spelled out. Many local sponsors would doubtless back away from approval of the plan once that stage is reached if implementation requires action beyond the available technical capability or if it involves overly controversial actions.

An intermediate approach to the division of implementation responsibilities is to operate on the basis of some uniform assignment of tasks to both the federal government and non-federal interests. This would facilitate continuing past policy in the respects that

non-federal interests could be made responsible for provision of land-related items and a significant federal role could be maintained. The approach would also enable making best use of both federal and non-federal authorities and capabilities. Another advantage is that the pattern of responsibilities could be at least matched in part to the pattern for dividing types of costs, thereby tending to minimize the size of any balancing payments between the federal government and non-federal interests as well as complications attendant to the distribution of such payments among non-federal parties.

Operation of Warning Systems

Operation of the warning system component of a warning and preparedness plan is more complicated than simply providing administrative supervision and waiting for the alarm signal. It includes whatever is required for the functioning of the flood recognition system, maintaining a high state of readiness on the part of equipment and personnel needed for issuance and dissemination of warning, assuring the continued effectiveness of pertinent intra-organizational arrangements, and other like actions. These responsibilities can range in nature from involving little effort to time consuming and complex tasks. For example, operation of a flood recognition system may vary from simply maintaining awareness of general weather conditions to management of sophisticated computerized equipment systems for collection and processing of various data. Operation of a warning system also includes interpretation of whatever data or information is provided through the flood recognition system and in other ways, and the making of decisions regarding whether or not a warning should be issued, to whom, and the message that should be conveyed. The warning component also includes the dissemination of warnings, so operation entails carrying out the distribution of warnings to officials, special warning recipients and the general public. If site-specific warning systems are a part of the plan, the warning component may also include their operation.

The warning system is apparently considered the most important component of a warning and preparedness

program as indicated by the large number of communities which have warning systems but only poorly developed or no preparedness plan. One reason, of course, is that warning is far more vital in most cases to protection of life than is the availability of a response plan. Another equally valid reason is that preparedness plans are usually not very practicable unless some time for putting them to use is provided through early warning of impending floods. For these several reasons, it is important that assignment of responsiblity for operation of the warning system component assures its proper performance to the greatest extent possible.

There is some basis for assigning federal agencies a part of the operational responsibilities for at least the flood warning component of warning and preparedness systems. The Disaster Relief Act of 1974, Public Law 93-251, directs federal agencies to:

> Provide technical assistance to state and local governments to insure that timely and effective disaster warning is provided.

The law is also clear that whoever undertakes to provide warning and thereby generates reliance on the availability of timely and reasonably accurate information must take reasonable care. A question could be raised concerning the reasonableness of any system which did not make some provision to take advantage of the nationwide weather forecasting system of the NWS. Therefore it may be appropriate to view the NWS as having at least partial responsibility for operation of almost all flood warning systems.

One major and obvious constraint on an extensive participation by the federal government in operation of the warning component of flood warning and preparedness systems is the inefficient use of large numbers of federal staff if duties require being on-site continuously. As described in Chapter 2, such systems are on standby status much of the time and can be most effectively operated as part of other activities. This problem of ready availability of federal staff on a 24 hour basis might be overcome in certain locations where a suitable federal installation exists. However, that prospec is limited and insufficient as a basis for

general policy. The problem might also be overcome by attempts to operate the warning system from a federal office at a remote location such as the offices of the National Weather Service and Corps of Engineers which are normally staffed on a 24 hour basis during times of anticipated heavy rainfall. But that introduces problems of reliability in communication and timeliness.

Policy considerations favor turning local flood protection projects over to non-federal interests for operation. There are no legal impediments to that approach which affect flood warning and preparedness systems. In fact, in view of the role which warning may play in avoiding certain liabilities, there is good reason to think that the cooperation of non-federal interests would be forthcoming for operation. The only major obstacle to local operation of warning and preparedness systems is likely to be the lack of technical capability in some communities to operate and service complex equipment associated with advanced types of flood recognition systems. However, assistance in those cases can probably be provided by NWS under its regular program authorities or by the Corps under its Flood Plain Management Services program.

Operation of Preparedness Plans

Operation of the preparedness plan component of a warning and preparedness system, aside from maintenance, updating and testing activities, occurs mostly when the plan is executed upon occurrence of a flood threat or actual inundation. The specific actions involved in executing a preparedness plan vary from case to case depending on what has been thought to be productive to include in the plan. Among others, they may include activities directed toward evacuation, property damage reduction, maintenance of law and order, and provision of various types of assistance.

Several steps may be involved in evacuation activities including distribution of notices or announcements suggesting voluntary evacuation, ordering of evacuation or forcing removal of persons from dangerous areas. Evacuation efforts may range from community-wide to those concerned with only specific buildings and from simply sending persons home from work or school to

difficult relocations of hospital patients or jail inmates. Other aspects of evacuation may include direction of outgoing traffic and closure of roads to incoming traffic.

Property damage reduction activities can likewise take many forms including ordering and carrying out the curtailment of gas and electric services or of modification in their operation, institution of floodproofing measures for public and private facilities, relocation of property and records, and changes in operational procedures.

Both evacuation and relocation of persons and property may call for unusual security precautions to prevent vandalism and theft. Execution of a community preparedness plan may also entail provision of various resources and manpower on short notice and solicitation of assistance from adjacent jurisdictions to provide emergency medical services, rescue, care of evacuees, and immediate post-flood restoration of services.

The potential federal role in execution of the preparedness plan portion of warning and preparedness systems is even more constrained than in the case of operating warning systems. Responding to floods, particularly flash floods, requires immediate action by persons and organizations on the spot. Time is not usually available to wait hours for outside assistance to arrive and, in many caes, flooding disrupts normal transportation systems to the point where outside help may even be days in arriving. It follows that, wherever possible, execution by local interests of the emergency phase of flood preparedness plans is to be preferred and may, in many instances, be essential.

COMMITMENTS TO IMPLEMENT AND OPERATE

Study of a flood plain can determine what means are best employed for its protection or what the merits and disadvantages of particular measures may be. However, the ultimate test is the functioning of a completed system in time of need. An impoundment may break in time of stress and disappoint the people who took confidence in it during the long days before the

flood came. A plan to warn all who may be in danger and setting forth the actions that will be taken in response may satisfy from the time it is presented to local, state and federal authorities and to the public at large until the first real occasion on which it should be used. But part of any good system is the assurance that it will work. How can it be made certain that a flood loss reduction measure will be effective?

In the absolute sense, it is impossible to be assured that anything will live up to expectations in a given instance. Operating personnel vary in their capabilities and competence, mistakes are made, equipment can malfunction, structures can collapse, and promises can go unfulfilled. While there is no sure preventive for any of these risks, organizational and other measures can be taken to reduce the likelihood that something will go wrong. One of the key elements is the strength and clarity of the commitments which implementors and operators have to the system and to the performance of their specific roles in it.

A structural flood control system centers on the physical works. Once construction is complete, the commitments required to make the system valuable are those to operate and maintain the facilities and equipment. The Corps, a flood control district, a city or a state owns the impoundment. Of course, the owner can abandon it, but it is fairly obvious that someone needs to be hired to tend the gates and even to manicure the recreational buffer that often surrounds the pool. If, as is frequently the case, the project is a multipurpose one, a regular budget and assigned revenue sources, personnel, and a program of operations are produced by the motivation created by the investment in facilities and nurtured by the interest groups which receive or expect to receive continuous benefits from the project. Even though not an automatic assurance, the important commitments to operational flood control exist because the project exists and must be continuously tended to satisfy the demands of regular customers and beneficiaries of the project's services.

By contrast, equipment, although important, is likely to be a minor part of the warning and preparedness system. The rain gages do not have customers who

daily wait to receive the readings so that they may use the information in a productive process or who pay fees for the service. The essence of a warning and preparedness system is the commitment of persons to keep themselves available and to act in certain ways when danger threatens. Waiting and watching is a vital part of the system, but in the long months and even years when nothing worth reporting may be happening, it may be difficult to tell whether the participants are still committed in the sense that they remain conscious of their obligations and are truly prepared to perform them.

The Plan as a Commitment

There can be no real warning and preparedness system for a particular area unless there is a plan. It needs to be known who will give the warnings, when they can be expected, who will transmit and disseminate them and what actions are supposed to be taken or decisions made when the information is at hand. There are inevitably many actors in a warning and preparedness system for a community or larger region and no one of them can function in isolation. For any of them to derive actual benefits from the system or make a meaningful contribution to it, actions must be coordinated and predictable. This is the foundation of reliance on the system and the only way to assure that both participants and beneficiaries will know what their roles are.

It is theoretically possible for the plan according to which these interrelated commitments and actions occur to be loose and informal. The National Weather Service, Corps, Soil Conservation Service, state, community, utility companies, hospitals, police departments, public works agencies, school systems, business organizations, radio and television stations, and householders--or as many of them as might be involved in a particular project--could conceivably tell each other that they would coordinate their plans and activities to help each other protect against flood hazards. Each might simply do what it thought appropriate in surveillance, in practicing emergency procedures, and in making responses to actual flood situations. But merely to postulate such a state of affairs carries an air of unreality. A warning and preparedness system has too many parts and too many actors to be viable without a script.

A written flood warning and preparedness plan is obviously a description of how the operations of such a system are intended to proceed. Like many other kinds of plans, it can be only a paper representation of how the system might function. The purpose can be for the guidance of the participants and the recipients of the warnings. On the other hand, the plan can be made obligatory.

Having a clearly written plan properly disseminated makes it possible for all participants with specific duties in the warning and preparedness system to know what they are supposed to do and how their activities fit in with those of the others concerned. But no matter who has produced the plan, its mere existence neither compels anyone to follow it nor brings on any legal consequences for failure to observe its provisions.

It would be bizarre to suggest that a warning and preparedness plan should not be made or that it should not clearly specify duties for each of the participants in order to avoid fixing liability for faulty performance. Nevertheless, it should be remembered that the discussion in Chapter 5 showed that the question of responsibility for giving warnings, developing a capability for response and taking proper response measures is not now focused as a matter of law. Consequently, all governmental entities may presently be able to escape the legal consequences that might be expected to flow from failure to provide proper protection to the community.

On the other hand, the very preparation and adoption of a plan is testimony on the part of those who develop and adopt it that they believe it possible to prevent or reduce damage and loss of life through institution of a warning and preparedness system--more particularly the system for which they have produced the plan. Thus, the actions here described may move flood damage and destruction from the legal consequences of an Act of God to the unsheltered arena of mortal responsibility.

If one chooses to indulge the idea that federal, state or local governments might prefer to refrain from development of a plan on the ground that the liability risks could prove too costly, it may be said that the

alternative is to forego the protection of a warning and preparedness system in order to leave the financial burdens of flood losses where they presently fall. It is submitted that since the public safety is involved, the decision is to be made on other grounds than that of liability. Also it should be pointed out that in deciding for the construction of impoundments and other structural measures, the burden is shifted from the individuals and other entities which suffer the flood losses resulting from a lack of protection to the governments which build and operate the works and which provide the land, easements and rights-of-way.

To the extent that the plan describes the conduct of persons in the agency which has produced it, some impetus toward proceeding in accordance with it may be created. However, even in such a case, much can depend on how the agency treats the plan and how seriously it is devoted to warning and preparedness as an approach to flood loss reduction. If the plan is issued as agency guidance to all of its staff in the area concerned, the document will have more standing than if it is merely a product of a work group within the agency attempting to provide technical assistance to a community.

If the plan has been federally produced, and especially if there had been little or no substantial participation in its development by the other parties, no premises of the kind just offered should be indulged. Since the federal government cannot be expected to play a major operational role apart from the flood warning functions of NWS, the fact that the Corps, TVA or some other federal agency is the author of the plan for the community makes it an outsider's document. It is likely to have a hard time even winning serious attention from the non-federal participants in a warning and preparedness program. If it is a very good and well written plan, its merits may induce the actors to accept its guidance. But the process by which the governmental and private entities in the area make the plan their own is important to its actual effectiveness.

Making the Plan Into Law

Another limitation from the point of view of federal action is that the Police Power (the power to protect health, safety, morals and general welfare) is constitutionally a state power rather than one of the federal government. While there are a number of other constitutional sources of authority that the federal government may use, their employment is legally not as direct as what can be done by the states and their municipal or county subdivisions. Accordingly, a next logical step--giving the flood warning and preparedness plan some kind of enforceable standing--is best viewed as a possible course of action for one or more of the non-federal governmental participants.

A flood warning and preparedness plan can be officially adopted by a county board of supervisors or a city council. This gives it standing, at least so far as the local governmental employees are concerned. If adopted either as a local law or as an administrative regulation having the force of law, the binding character of the plan would be enhanced.

Precisely what the effect of giving the plan the force of law is likely to be in a particular instance will depend on the content of the plan in question. If it lays down police, traffic or emergency regulations of the kind that the adopting authority can legally make, the results can be binding on both public employees and private persons. However, it is important to caution that state and local governing bodies have greater lattitude in imposing obligations on private interests and individuals for actual periods of disaster emergency than for ordinary times. Consequently, official adoption of the plan, although generally advantageous in giving it standing with all concerned, may be more useful as a means of providing a legal basis for response activities than for the developmental aspects of warning and preparedness such as ordering that watches be kept, assuring that equipment and supplies be stockpiled and maintained in readiness for use when a flood is imminent, or obtaining the design or modification of public utility facilities.

Participation in Plan Development

Developing a good flood warning and preparedness plan involves professional and technical skills and experience that are not freely available in many of the communities where there is a need. For this reason and because some federal and state agencies have relevant interests, the tendency is to rely heavily on such federal and state assistance as is available. In fact, it is sometimes considered an advantage if the Corps or some other non-local agency can be secured to produce the entire plan. Some cost and time of local personnel is saved if this route is taken, but employment of this alternative frequently makes it difficult for local, public and private interests and individuals to identify with the product and develop a high degree of enthusiasm for implementation and operation of the system.

Cooperative development of a plan by all of the intended participants in the resulting system is likely to take longer and may appear more troublesome, but it stands a better chance of success in actually securing a plan that will achieve general acceptance and that will sustain itself through the long and continuing operational phase that must become a reality if there is to be real flood protection. A police chief who goes to some of the meetings and sees his concerns discussed and has seen adjustment in the plan to take account of them; a factory manager who learns for himself from helping to develop the plan how important measures taken on his premises can be, and the county supervisor who can tell his colleagues on the Board the importance of the small appropriation needed to keep the information reception center fully effective can make the difference between a truly operational system and a paper plan.

Because even highly vulnerable areas may go for some years without serious flooding, generating and keeping both official and citizen support for the warning and preparedness system is an especially important problem. Personal identification of key community figures with the plan, and if possible with continuing aspects of system operation, is one of the more effective ways of promoting support.

Public hearings during the development of a plan, or when it is finished and ready to be exposed to citizen view, is a standard method of attempting to generate a feeling of community participation and of making the local residents aware of the problem and its intended solution. However, such proceedings can seldom be relied upon as an effective means of stirring public interest. Very often hearings are poorly attended. Coverage of them by the news media may be only perfunctory or may not materialize. Moreover, those who do come are not likely to be infused with enthusiasm or commitment from a format that is often dull and which may not seem to have an discernable effect on the ensuing product.

This is not to say that hearings should not be held. Often they are mandated by law. With all of their limitations, they are sometimes among the few means of gaining public attention for a subject that has a hard time competing with family and other concerns. Nevertheless, the point is that the regular means of making a flood warning and preparedness plan known to those who are expected to participate or benefit from it are not likely substitutes for local involvement in development of the plan.

Contracts and Memoranda of Understanding

Where many entities must cooperate to make a system work, the most effective means of assuring that the parts will come together is a formal agreement. If it has the attributes of a contract, the agreement can be enforced and violators either made to perform or subjected to penalties. Of course, enforcement in the courts is more suitable for certain kinds of obligations than for others. Since the judicial process takes time, it may not be entirely satisfactory to command compliance when the flood is imminent or already occurring. However, the incurring of liability attendant upon breach of contract may cause participants to perform. Moreover, some aspects of a warning and preparedness system lend themselves quite easily to a contractual approach. For example, an obligation to service a monitoring system so as to keep it in good working order, whether this is to be done by a county public works department or by a private company, can be arranged by contract. Indeed, it should not be left to informal understanding or to the mere chance that someone will undertake the task.

Performance of the plan itself can be made the subject of a contract. Since there are likely to be several necessary participants in order to make the system function, the contract could well be a multilateral one with all of those entities having significant roles subscribing to the document. By doing so they would accept the obligations ascribed to them in the plan and would acquire express rights to have the other participants provide their parts of the performance.

It is likely that not all of those who should bind themselves to carry out the plan will be involved to the same degree. For example, a local trucker may be concerned only to make his vehicles available for emergency duty on prescribed short notice, while the city has a wide range of duties of a continuous character in addition to its responsibilities at the time an emergency occurs. Consequently, those who accept the plan as a contractual obligation may be few in number. Other participants may be involved only in subsidiary contracts of a more limited content dealing only with their specific relationship to the warning and preparedness program.

It might be best for the warning and preparedness system if all participants could be brought into a contractual framework in the strict sense. However, there are a variety of circumstances in which governmental agencies, especially those considered to be independent or of superior authority, will not readily enter into contracts that might subject their normal operations to increased judicial control. Enforcement of performance by them is frequently viewed as an administrative matter to be worked out by the agency heads or staffs, and in case of conflict or other difficulty, by the chief executive of the governmental unit--e.g., the president, governor, mayor or county manager.

Where there are legal or administrative inhibitions to the use of full fledged contracts, the memorandum of understanding is a customarily available device. It is a written instrument in which the procedures, obligations or methods of joint or cooperative action

are spelled out and formally accepted by the parties. The arrangement is akin to a contract, but its means of enforcement are administrative and political rather than judicial.

If the Corps and the National Weather Service are both to participate in the same warning and preparedness system along with a community, they may find it inappropriate to sign a contract and might prefer the memorandum of understanding. On the other hand, a contract between a municipality and a federal agency is not unusual. Thus, there is a possible choice of instruments to be made, certainly in arranging obligations between local governments and federal or state governments or agencies and even where a more varied group of participants is involved. There is nothing that prevents any types of parties from using the less binding memoranda of understanding in preference to contracts if they elect to do so.

Among the comparative advantages and disadvantages to be considered in the use of each of these forms is the function that it can serve in distributing the operational and financial risks of liability.

By contract, the parties can shift the burdens and incidence of liability among themselves. In prescribing the arrangements which must be made for structural projects, federal statute presently provides that the non-federal sponsors must save the United States harmless from any claims which may arise out of the development of the project. This is done by the agreement (contract) which the local sponsor enters into with the Corps when it undertakes to furnish land and rights-of-way. If the parties to a contract covering a flood warning and preparedness project desired, they could settle, as among themselves, any of the now uncertain questions of liability. Thus they could minimize prospects of litigation and could make their own policies for the particular instance on the distribution of risks. However, such a contract would be binding only on the parties to it. It could not cut off the rights of third parties such as members of the general public who might have claims on account of occurrences involving the administration of the warning and preparedness system. Where flood loss or other damage ensues, such

non-party individuals could still seek redress against the agency which was alleged to be at fault. However, the contract could provide that the party assuming the liability under its terms could indemnify the party against whom the claim was brought and even that the agency assuming the liability would defend the suit.

A memorandum of understanding is not an appropriate vehicle for the settlement or redirection of liability. While it can be effective to commit the parties to administrative actions, it cannot normally alter financial obligations when the law places them elsewhere.

ASSURANCES

When a federal agency cooperates with non-federal interests within the framework of a single project, the reason is sometimes that each participant can achieve its separate objective better than if it acted alone. For example, sale of water supply storage space in a reservoir to a municipality allows the Corps to obtain the features in a multi-purpose impoundment in which it is directly interested at a lower cost than if the undertaking did not include provision for water supply, while the local government secures the benefits of a reservoir without having to support the entire expense of building and operating one. The combination of purposes is often the factor which makes it possible for a project to have a favorable cost-benefit ratio.

Other federal programs are intended to advance a purpose shared by the federal and non-federal participants. A flood warning and preparedness system is an undertaking of this kind.

While it is in the public interest to see that projects of both types are prosecuted efficiently and achieve their objectives, success from the strict federal agency point of view can be measured in different ways in the two instances. A project involving local purchase of storage does not necessarily give the Corps or other agency of the federal government any ongoing responsiblity for the effective realization of the community's water supply purpose. It may be

irksome to any right minded person if the local government thereafter does not utilize what it has bought, and it may even be that the federal government could put to good use any capacity left idle. But the non-federal interest has paid for what it now possesses and any failure to realize the full benefits does not necessarily intefere with attainment of the federal objectives for the project.

On the other hand, if a flood warning and preparedness system to which the federal government has contributed funds, technical assistance, equipment or some other valuable consideration is subsequently rendered ineffective by failure of another participant to perform as envisioned, the entire undertaking is subverted. Accordingly, from the very inception of such a project, the participating federal agency has a legitimate interest and concern to see that its own investments and efforts are protected against loss through the non-performance or other inadequacy of its cooperating entities.

Grant programs present this same problem. Congress has made many decisions to support specified state and local activities with federal funds. In order to increase the likelihood that the results intended for the aided projects will be achieved, the administering federal agencies, either pursuant to specific statutory direction or to general authority, attach conditions to receipt and retention of the money. These constitute varying degrees of federal control in order to assure that the undertakings will be prosecuted diligently and successfully. On the whole, the system works because the recipients of the aid want the flow of funds to continue and certainly seek to avoid having to return aid already given.

Flood warning and preparedness systems carry the same dangers of inadequate implementation as do most other projects and programs. Loss of interest, changes in local policies and priorities, or any of an almost infinite number of shortcomings can abort a project or result in its providing a lesser amount or lower level of service than it should afford. Unfortunately, the spur supplied by threatened or actual withdrawal of the aid will be an appropriate control mechanism only where the non-federal participants continue to have serious

interest in the project and would consider its discontinuance a loss. With this in mind, it may be inquired whether the federal government can require performance up to a standard or whether, at any stage of an episode, it can secure suitable commitments from its partners to make the system a working reality.

The matter of what assurances are to be given by the local sponsor to the federal government is relatively well defined in the case of structural measures and there are numerous precedents as to the words which should be used for the purpose. It is not so straightforward in the case of flood warning and preparedness systems because there are few precedents to follow and experience has not taught either which parts of operation and maintenance should be addressed or the means by which assurances enforced.

Matters to be Assured

It is not to be expected that the federal agency providing assistance in the planning and operation of a flood warning and preparedness system could prescribe every detail of operation and maintenance. Neither would that necessarily be desirable. Operation of even the best prepared plans and projects is liable to require some flexibility to deal with the exigencies which arise from time to time. Detailed specification of every aspect of operation and maintenance would, among other things, presuppose perfect planning. Moreover, if the party to be responsible for operation and maintenance cannot be accorded some trust in performance of its duties, implementation arrangements may need a thorough revision.

One basic type of assurance which deserves consideration is that which, while unrelated directly to warning and preparedness activities, affects the comprehensiveness of the overall approach to flood loss reduction and its continued viability. In the case of structural projects, communities have sometimes been required to regulate flood plain land uses and/or publicize flood plain information in return for federal cost sharing. This serves the twofold purpose of limiting development which would erode project benefits and furthers an important national program. The same sort of requirements might be applied in the case of warning and preparedness systems.

A second type of assurance which might be of value is one relating to control of land use in upstream areas. This requirement has seldom been used in conjunction with structural projects. However, it is possible in the case of dams and levees to anticipate and provide for whatever additional volumes of runoff may be produced by upstream development. Timing of runoff is only occasionally a critical matter in design of structures. But the situations in which warning and preparedness systems are likely to find their greatest use are different. Warning and response time will often be short and therefore critical to successful execution of the plan. Since warning and preparedness plans can only provide for limited movement of personal property, heightened flood stages from upstream development will generally cause increased damages.

Public information is accorded some attention in assurances related to structural projects. Local sponsors are commonly required to advise residents living in areas behind levees providing only a low degree of protection that danger of flooding still exists. But in most cases, floods do not exceed the level of protection provided and the full benefits of the structure are obtained without any action on the part of residents. Public information is much more vital to securing the benefits of a warning and preparedness plan since persons and agencies in the affected area are expected to respond to warnings in specific ways to safeguard lives and property.

The types of information which are of particular importance are a) general education of the public concerning the need for and existance of the warning and preparedness system, warnings to be given and their meaning, actions to be taken when a warning is given, and the consequences of not acting in response to a warning; b) education of public officials concerning their responsibilities for activation and execution of the plan; and c) provision of emergency information at the time the plan is executed. Not all of these types of informational needs lend themselves to treatment by specific assurances. Particularly, education of public officials can be part of the practice activities described in the plan maintenance arrangements and emergency information procedures can be combined or allied

with the warning process as an integral part of the plan. This leaves conduct of an initial and continuing program to educate and inform the public as the principal activity of that type suitable for treatment through assurances.

Operation and maintenance of equipment are activities to which assurances seem clearly suitable. In this case, the assurance could specify maintaining equipment in accord with the plan if the plan includes prescribed schedules and procedures for testing and maintenance. For stockpiled supplies and materials, maintenance could consist of periodic inspections and/or inventories to ascertain whether items are available and ready for use. Assurances might also be used to require the party responsible for operation of the system to provide training of a suitable type for personnel who are actually to perform the monitoring, forecasting and warning functions. Additionally, since NWS information on weather conditions would be a helpful adjunct to most programs, an assurance might be required that the system operator would subscribe to the weather teletype service or make other suitable arrangements for obtaining NWS forecasts.

The aforementioned matters are easy enough to identify and make the subject of commitments in drafting agreements. Monitoring the situation also may be relatively simple, especially if a federal agency is to continue to be associated with flood control and related activities in the area. Problems of enforcement will be discussed shortly.

Implementation presents varied problems. Since some of them are likely to be site-specific, the most useful thing to do at the present juncture is to illustrate the kinds of circumstances that can arise.

Providing assurances that commitments will be made and that performance will follow needs special attention in the case of entities which are not involved in a major way in the overall preparedness function but which have important, although limited, parts to play. The added feature is that such participants are likely to have less feeling for the overall preparedness objective. This can be the circumstance with both public

and private entities, although a business enterprise concerned solely with the furnishing of its product or service may need a more persuasive or perhaps even a regulatory approach to a greater degree than a public agency which is either part of the participating local government or at least in a general way responsible for promoting public safety and welfare.

For example, execution of a preparedness plan could call for curtailment of gas service to an area in time of emergency. This may require modification of the gas delivery system by installing valves or interrupting loops to create dead ends. The question is how to secure the addition or modification of equipment and facilities which the utility may or may not consider necessary or even desirable for its own primary purposes. Further, it may not be enough merely to assume that if the modifications are made, valves will in fact be closed at the times called for in the preparedness plan.

Some cities contract with county sheriff's departments for provision of law enforcement. If warning requires use of mobile loudspeakers, the city might well wish the sheriff's department to take on that responsibility. Still another illustration of the situation would be assigning to a special purpose district some particular responsibility such as data collection. In each of these situations, the activity may be vital and its performance needs to be assured. From the federal standpoint, it is not particularly important how performance of subordinate players is secured so long as it is accomplished. Moreover, there is considerable merit in avoiding the need to negotiate separate agreements with each player. A better way is probably to look at the agreement with the principal local sponsor as a master agreement and make completion of such further agreements as may be necessary a non-federal responsibility, the completion of which is a requisite to any federal investment for plan implementation.

Direct Federal Regulation

Direct federal regulation of a kind that could require others to maintain effective flood warning and

preparedness systems would need a constitutional basis, especially since protection of safety and health is basically a state power. Merely to aid local governments in establishing and funding or equipping their own systems does not encounter any such legal problem because Congress can always provide for financial assistance simply by exercising its clearly granted power to appropriate money. If more is to be done at the federal level, the most apt and perhaps the only satisfactory legal basis would be the congressional authority over interstate and foreign commerce. It will be recalled that this has been the primary constitutional peg on which to hang federal flood control programs. It can also provide any necessary justification for the forecasting and data dissemination activities of NWS. The argument is that floods and adverse weather conditions endanger navigation and so are perils to interstate and foreign commerce with which the national government may deal directly. But to use the commerce power to order states, municipalities and private entities to maintain warning and preparedness systems would be a novel and dubious approach. While states and their local subdivisions have a constitutional duty not to burden interstate commerce unreasonably or in a discriminatory fashion, they do not have an affirmative duty to promote such commerce.

Since far reaching federal regulation of working conditions has been sustained, it might be suggested that warning and preparedness might be included within the Occupational Safety and Health Act obligation to provide a safe working place. But this is an obligation of employers toward their employees and relates to conditions created or maintained by the employer such as properly guarded machinery, properly lighted, heated and ventilated premises, or good repair and maintenance of sanitation in factory or office. It would be straining to say that a state or local government was answerable to the Federal Department of Labor for maintaining a system that would warn the entire community against possible floods which those governments do not create and specifically provide for response actions which the warned individuals should take in their homes as well as their workplaces.

If this reasoning is correct, one must return to contemplation of the leverage that a federal agency might gain from the assistance it offers communities and their non-federal sponsors of flood warning and preparedness systems.

Contract Enforcement

In turning over equipment or structures to non-federal entities, the Corps, the Soil Conservation Service and other federal agencies have frequently included provisions by which the recipients pledge themselves to maintain what they receive in good order. Undoubtedly, a federal agency could insist upon a contractual agreement with participants in a flood warning and preparedness system committing some or all of them to a specific course of action in operating the system and keeping it functional. In legal form, these would be perfectly valid and enforceable contract obligations. The consideration for them would be the federal contribution to the warning and preparedness plan, the grant or other federal funding, the loan or grant of equipment, or the provision of services by the NWS. It is a reasonable proposition that placing such provisions requiring maintenance or continued performance in agreements covering federal participation in or assistance to warning and preparedness projects can create a helpful sense of obligation on the part of local interests. However, one should not rely too heavily on such assurances.

One needs to ask what, for example, the Corps would do if a local government were to let the ranks of its volunteer observers of stream flow grow thin, or to become lax in impressing upon its 24 hour a day fire department that its communications officers were also supposed to service the reports from these observers and from NWS.

Almost surely, a first step would be the calling of the unsatisfactory situation to the attention of the local government and reminding it of its written commitment. Such reminders can sometimes cue an agency which has let it's responsibilities slide unintentionally or with little thought. They may even shame a nonperformer into picking up neglected duties.

But if the local participant has really lost interest or acquired a different set of priorities, more positive enforcement measures may need to be considered.

It appears to be the general view of federal personnel administering the relevant programs that realistically there is little such action that they can take. Suits have not been filed for the specific performance of contract obligations to maintain flood warning and related systems nor even to compel maintenance of structural works turned over to non-federal sponsors.

Most states have laws requiring the owners of dams to keep them in safe condition and it has been brought to our attention that on relatively infrequent occasions, federal agencies have requested state authorities to take action in particular cases involving impoundments originally built by the federal government but subsequently turned over to the non-federal sponsors. As Table 1 indicates, the coercive character of these state statutes varies. In some instances, the state can do the repair or maintenance work and require the dam owner to pay, but in others the approach is something less. However, the interviews undertaken in the course of the work on this study did not bring to light any direct suggestions that judicial interventions should be sought to compel the observance of agreements for maintenance made when the projects were undertaken. It does not appear that under present circumstances views would be any different respecting agreements pledging non-federal interests to maintain warning and preparedness systems.

Recovery of Investment

Perhaps another course applicable to some cases would be to demand return of equipment provided by the United States Government in order that it might be used elsewhere in the flood loss reduction effort. With a properly drawn initial contract, the federal right to reclaim property not being used in accordance with the agreement would certainly be enforceable. The difficulty is that the objective is not for the United States to recapture rain gages or automatic data equipment, and removing it is likely to be a final recognition of project failure rather than a step toward getting the system back into effective operation.

TABLE 1

DAM REPAIR AUTHORITIES

State	Citation	Who Bears Cost
Arizona	Revised Statutes, Title 45 (water), Chap. 3 Article 1	Dam repair made with approval of state engineer; no mention as to who pays the costs.
Arkansas	Statute 21-1301 through 21-1315	No specific mention of repairs or cost allocation.
California	Water Code Division 3, Part 1, Chap. 4, Article 3.	Owners pay for repairs but state has authority to demand it.
Colorado	Chap. 148-5-6 revised Statutes 1973	Owners pay for state inspection; nothing specific on repairs.
Connecticut	Pending ammendment to General Statutes 25-110 to 25-119	Commissioner of State may require owner to repair at own expense and within a certain period of time.
Idaho	Title 42, Chap. 17	The state, under Police Power has control of construction and maintenance of dams but the owner may be obligated to pay the cost.
Kentucky	Revised Statutes, Chap. 151	The owners of dams, levees and enbankments are liable for the cost of repairs.
Minnesota	Chap. 105	Nothing stipulated in the chapter on repairs.

DAM REPAIR AUTHORITIES (cont'd)

State	Citation	Who Bears Cost
Nebraska	Statutes 46-277, 46-278	The state has the authority to make the owners pay for repairs and can impose penalties if the owners do not pay.
Nevada	Revised Statutes 535.030	State inspects dams; owners repair at their own expense.
New Hampshire	Revised Statutes 1968 Chap. 4 482-35 and 48-36	The state owns and pays for the repair costs.
New Jersey	Laws of NJ, Title 58.4 Sec. 1 through 10	The state has the authority to inspect the dams but owners must pay repair costs.
New York	McKiney's Consolidated Law of NY Book 17-½, Sec. 15.	The state will pay the cost of repairs but it has the option of submitting the bill to the local jurisdiction for reimbursement.
N. Carolina	State Statute No. 143.211	No mention of dam repair costs.
N. Dakota	Century Code Statute 21-04-11, 61-04-12, 61-04-09, 61-16-15	It is a misdemeanor not to repair dams but the code does not specify who pays the costs.
Ohio	Sec. 1521.062 of Ohio Revised Code.	Dams are repaired at the expense of the owners.
Oklahoma	Oklahoma Statutes, Title 82, Paragraph 105.27	The owner of the dam pays for repairs.

DAM REPAIR AUTHORITIES (cont'd)

State	Citation	Who Bears Cost
Oregon	Water Laws 540.350 Dams, Dikes, & Hydraulic works	Repairs are made at the owners expense.
Rhode Island	General Statute 46-19	Repairs are made at the owners expense.
Tennessee	Safe Dams Act of 1973, Chap. 25.1 CA 70-2501 to 70-2530	Owner must pay for repairs to all waterways, drainage, levees and dams.
Texas	Water Code, Sec. 12.052	Repairs are made at the owners expense.
Utah	Water Laws 1965, Title 73, Chap. 5 Sec. 5,6,7,9,12,13	Repairs are made at the owners expense.

Another tack might be to claim as damages the money and value of personnel time or other contributions in kind made by th federal government for warning and preparedness systems. The theory would be that these expenditures were made by the federal government on condition that the system would be implemented and kept operational. Culpable failure of one or more of the non-federal participants to perform in accordance with their contract obligations to this end might make them liable to make reimbursement for the value of the resources which the United States was induced to expend. It should be emphasized that since no determined efforts appear to have been made so far to enforce operations and maintenance commitments of the kind under consideration, the suggestion made here is not at this time a proven remedy. The most that can be claimed is that it is an approach supportable on the basis of general contract principles.

In the spirit of the Flood Disaster Protection Act of 1973, consideration might also be given to withholding of federal loans, grants, guarantees, and insurance to effect local cooperation.

Dependence on Local Interest

Another kind of advice is that the best assurance which a federal agency may have is the careful appraisal of the intensity of the interest exhibited by the non-federal participants. If they are strongly enough motivated to look upon warning and preparedness as a real protector of community lives and property, federal assistance may be a good risk. Strong emphasis may need to be placed on a public education and information program as part of the initial effort and the ongoing warning and preparedness system. The best guarantee of the staying power of a program is the support that it can continue to generate.

Readings of the depth and staying power of commitment of officialdom and citizenry are certain to be far from infallible. But so long as the number of places at which the Corps and other federal agencies can give help with warning and preparedness is larger than the resources that can be made available, administrators of the federal programs should be able to choose instances where chances of obtaining strong local participation are reasonably high.

CHAPTER 7
CASE STUDY OF IMPLEMENTATION ARRANGEMENTS

INTRODUCTION

This chapter employs a case study to illustrate some of the aspects of implementing a flood warning and preparedness alternative which were discussed in preceeding chapters. The area selected for study is in the vicinity of Phoenix, Arizona. The location and principal features of the case study area are shown in Figure 7-1.

Selection of the case study area was based on a number of factors. Among others, these included the existence of a multi-jurisdictional setting, need for fairly sophisticated warning and preparedness arrangements, ready availability of information concerning the physical setting, and willingness of federal and non-federal agencies in the area to provide information and assistance.

The identification of costs and other types of implementation requirements associated with the alternative postulated in the case study are only gross estimates. Since the primary purpose of the case study is to illustrate implementation arrangements, it was only important to identify the types, purposes, and general magnitudes of costs and other implementation requirements. Knowledge of their exact amount and nature would have added little or nothing to the illustration. The requirements identified, particularly the costs assumed for implementation and operation, should not be viewed as specifically representative of what might actually be incurred for a flood warning and preparedness alternative for the study area or elsewhere.

Likewise, any real situation is bound to be a unique combination of physical setting, pattern of development, and institutional structure. Nevertheless, Phoenix and its environs offer a variety and number of circumstances relevant to flood warning and preparedness which have similar counterparts in many other places. Accordingly, it is possible to learn a great deal from an analysis of this case study in conjunction with the less site specific discussions and analyses presented in the earlier chapters.

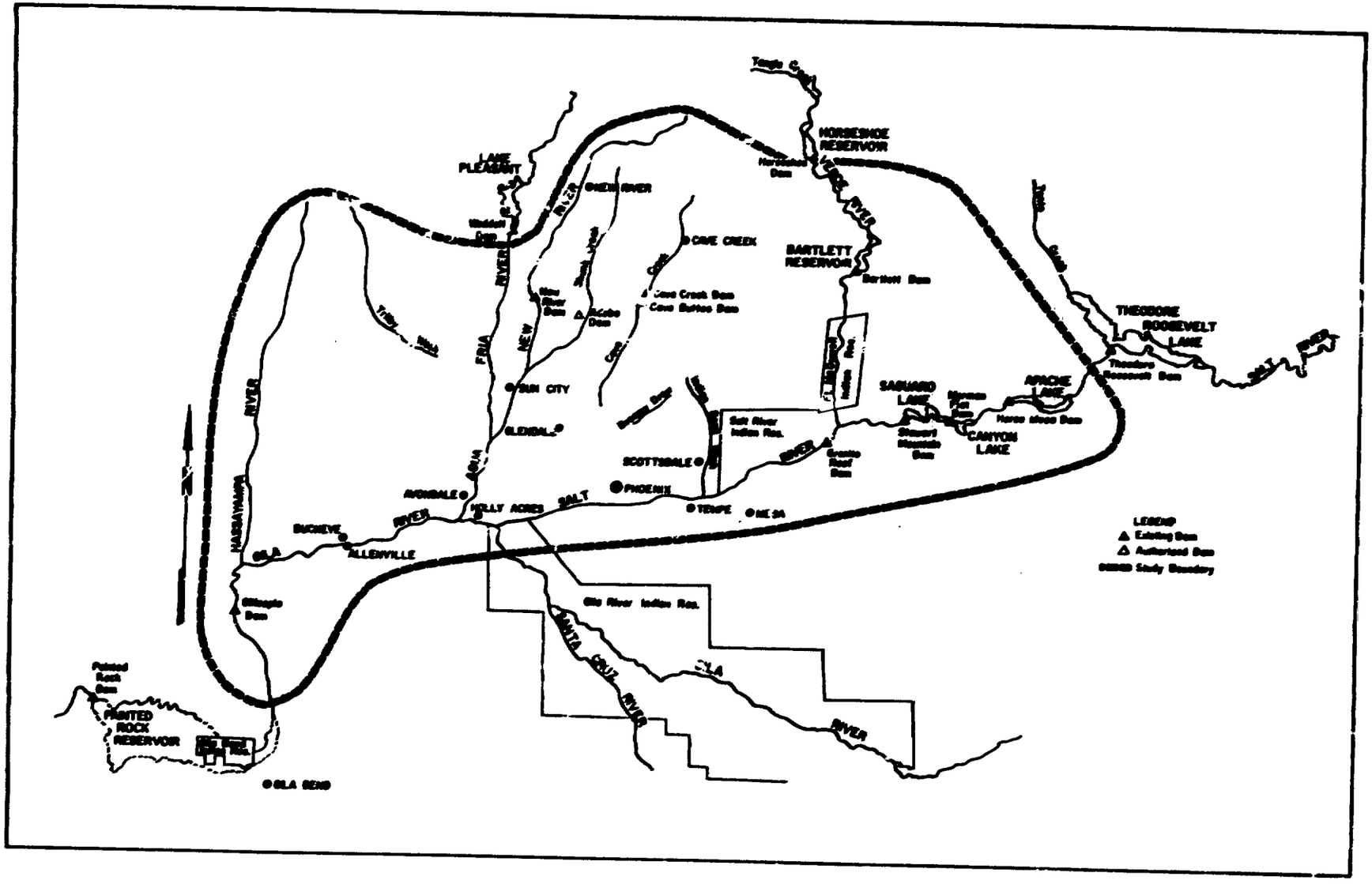

FIGURE 7-1 CASE STUDY AREA

For example, many stream systems and their drainage areas contain highly urbanized developments and sparsely settled agricultural subregions. And all areas susceptable to inundation present risks of flash flooding, seasonal or gradual flooding, or both. Accordingly, examination of the case study area is useful in applying general knowledge to actual conditions involved in flood warning and preparedness for both kinds of flood danger.

Further, the area contains strong units of general purpose government, at least two water oriented special districts with a long history and experience, and other less well developed and financed local institutions. A range of capabilities (both present and potential) may therefore be assessed in an actual setting.

DESCRIPTION OF THE AREA

Social and Economic Setting

Non-Indian settlements in the case study area began in the mid-1860's based on irrigation from the Salt River. Phoenix was established early in the period of settlement and, by the 1870's, became the leading commercial center in the area. Construction of the Arizona Canal and other canals and arrival of branch-line railroads connected to transcontinental routes resulted in the growth of Phoenix and development of a number of neighboring communities in the 1880's and 1890's.

Construction of the Salt River Project, the first multipurpose project authorized under the Federal Reclamation Act of 1902, was an important event for the area. The project, consisting of several reservoirs and an extensive canal system, provides irrigation service and supplies electricity to the area. Construction was begun in 1904 and proceeded almost continuously up through World War II. At present, the project provides water for irrigation of 250,000 acres of land and sells power to approximately 280,000 accounts which serve nearly a million people.

During World War II, the Salt River Valley was the site of a number of military airfields and defense

plants. After the war, the area entered into a sustained period of urbanization and industrialization which still continues.

Population

The majority of the case study area lies in Maricopa County with the remainder in Yavapai county. Maricopa is the most populous of Arizona's 14 counties and the Phoenix metropolitan complex is its major urban center. Most of the population in the case study area resides in Phoenix or other parts of the Salt River Valley, leaving the remainder of the area sparsely settled or uninhabited.

Phoenix had a 1977 population of 682,000. Other incorporated cities in the case study area and their approximate populations include Scottsdale (82,000), Tempe (103,000), Mesa (115,000), Glendale (75,175), Avondale (6,900), Buckeye (3,525), Gila Bend (2,000) and Florence (2,173). Unincorporated urban places in the case study area and their approximate populations include Cave Creek/Carefree (2,245), New River (1,500), Sun City (45,125), Holly Acres (3,000), and Allenville (200). There are also parts or all of four Indian reservations in the case study area including Fort McDowell (348), Salt River (2,950), Gila River (8,600) and Gila Bend (357).

Economy

The case study area is a major center for economic activity in the Southwestern United States. Leading factors in the area's economy are manufacturing (principally high technology products), retirement, tourism, retail trade and services, and government. Industrial development is centered in metropolitan Phoenix, with agricultural districts extending to the west, southwest, and southeast of the urban area. Within the past 20 years, manufacturing has replaced agriculture as the main source of income in Maricopa County, although the county still leads the state in agricultural production. Agriculture in the case study area is expected to continue to decline (both absolutely and comparatively) as the urbanization of the Phoenix metropolitan complex increases.

Physical Setting

The Gila River Basin is an irregular area of 58,200 square miles extending from the Continental Divide in southwestern New Mexico to the Colorado River at Yuma, Arizona. It includes practically all of the southern half of the state of Arizona. The river rises in an area of high mountains and plateaus and flows westward over a course 654 miles in length. The major tributary to the Gila River in the northern portion of the basin is the Salt River, which joins the Gila River near Phoenix. The Salt River has a drainage basin of approximately 13,000 square miles.

The case study area encompasses the northern and western portion of the Gila River Basin. The boundaries of the case study area are shown in Figure 7-1. Its downstream boundary is at the Gila River's point of inflow into Painted Rock Reservoir, located near the town of Gila Bend. The upstream boundary along the northern portion of the case study area is irregular, including all of the drainage areas of the Hassayampa and New Rivers, the Agua Fria River below Lake Pleasant (Waddell Dam), and the Verde River below Horseshoe Reservoir (Horseshoe Dam). The upstream boundary on the eastern edge of the study area is Theodore Roosevelt Lake (Theodore Roosevelt Dam) on the Salt River. On the south, the study area includes the flood plains along the Salt River and the portions of the Gila River downstream of its junction with the Salt River. The case study area also includes several creeks and washes in the vicinity of Phoenix.

Topography

The northern portion of the case study area drained by the Salt River is extremely irregular and rugged. Elevations rise commonly to more than 7,700 feet and, at San Francisco Mountain in the Verde River Basin, to more than 12,000 feet. To the south and east, the study area consists largely of long desert valleys lying between north-south ranges of rugged mountains. In the southwest, the study area consists of broad, flat, low lying desert valleys and isolated mountains of relatively low relief.

In the vicinity of Phoenix, elevations range from about 1,000 feet at the Salt River to about 7,700 feet in the headwaters area of the Agua Fria River. The mountains immediately north of Phoenix rise to an elevation of about 5,000 feet. The area surrounding Phoenix is characterized by short rugged mountains and broad intermountain alluvial plains.

Geology

The area is generally within the Basin and Range physiographic province, which is typified by geologic faulting and tilting. This tectonic activity has formed numerous north-south trending mountain range separated by broad alluvial basins. Despite the prevalence of faults throughout the area, the earthquake hazard in the study area is not considered severe. While several major earthquakes have occurred in California and northern Mexico, few of consequence have centered in central Arizona.

Climate

The climate of the case study area is arid and marked by extreme heat and low rainfall. In summertime, daily high temperatures average over 100^{o}, with lows averaging near 70^{o}. During the winter months, highs average near 60^{o}, with lows about 40^{o}. Temperatures in higher elevations tend to be lower in both summer and winter. Precipitation amounts in the case study area range from less than 6 inches per year in the desert to in excess of 20 inches in the surrounding mountains. Elevations above 3,000 feet experience occasional snowfall. Snow accumulates in the watersheds above 7,000 feet elevation and is a major factor in the hydrology of rivers in the area. Snow rarely occurs in the desert and generally melts upon hitting the ground. Snow that falls on the watershed between 3,000 and 7,000 feet in elevation is ephermeral in nature and subject to very rapid melting. Because of the large portion of the watershed within this range of elevation and the instability of its snowpack, very high runoff volumes have been experienced in short periods of time--major flooding results.

Precipitation in the case study area occurs in two distinct seasons. Winter rains are usually the

result of cyclonic disturbances originating over the Pacific Ocean. These storms bring widespread precipitation. The arrival over Arizona of moist tropical air from the Gulf of California in midsummer signals the start of the summer rainy season. The rainy season extends from July to September and occasionally into October and is marked by scattered, often heavy thunderstorms. Occasional dying topical storms can bring general precipitation over much of Arizona.

Water Resources

The major streams in the case study area are the Salt, Verde, Agua Fria, and Gila Rivers. Their principal tributaries in the case study area include the Hassaympa River, New River, Skunk Creek, Cave Creek, Indian Bend Wash, as well as several smaller arroyos and washes. With the exception of the perennial Salt and Verde Rivers above Granite Reef Diversion Dam, all of the streams are ephemeral.

The Salt and Verde Rivers supply approximately 93 percent of surface water available in the case study area. They are controlled by four dams on the Salt River (Stewart Mountain, Mormon Flat, Horse Mesa, and Theodore Roosevelt) and two dams on the Verde River (Bartlett and Horseshoe). These structures, along with the agency responsible for their operation, are known as the Salt River Project. The reservoirs impound water to provide irrigation and domestic water for the Salt River Project area which encompasses most of the metropolitan Phoenix area. The reservoirs were not designed or authorized for flood control even though they provide significant reduction of peak flows as an incidental benefit of their operation. At Granite Reef Diversion Dam, waters passing through or over the dams into the Salt and Verde Rivers are normally diverted into canals which serve the Greater Phoenix area.

The Agua Fria River is impounded by Waddell Dam, forming Lake Pleasant. The dam and reservoir is owned and operated by the Maricopa County Municipal Water Conservation District No. 1. The amount of surface water available from this system is far less and not as reliable as that from the Salt-Verde Rivers system but its contribution to the overall water supply of the Phoenix metropolitan area is important nonetheless. Waddell Dam does not provide any flood control except as an incidental benefit of its operation for water supply.

Other impounding structures in the case study area include Cave Buttes Dam on Cave Creek and Dreamy Draw Dam on Dreamy Draw. Both structures were built for flood control by the Corps. Several dams are presently under construction or being considered on Cave Creek, Skunk Creek, Agua Fria River, Verde River, Salt River, and numerous small watersheds.

Aside from the dams mentioned, there are numerous retention structures located around the perimeter of the Phoenix urban area.

FLOOD HAZARD

Much of the case study area, including a significant portion of the Phoenix metropolitan area is subject to a severe flood hazard. As an example, it is estimated that occurrence of a standard project flood on only the Salt River would cause about $252,000,000 in property damages. The risk to life is also significant as demonstrated by 12 flood related deaths in 1978.

Both general and flash floods occur in the case study area. General floods are usually caused by winter storms moving into the area from the west between mid-October and late April. Such storms usually produce light to moderate rainfall over large areas. Occasionally, summer storms associated with tropical cyclones or thunderstorms moving up the west coast of Mexico also enter the area and cause widespread rains.

General floods also can result from snowmelt or combinations of snowmelt and rainfall. Floods associated with snowmelt usually occur during winter or spring and only on portions of the basin's rivers with large drainage areas. Some parts of the case study area are also subject to flooding as a result of releases or spillage from upstream reservoirs or canals.

Flash floods occur on the smaller drainages in the case study area as a result of intense local rainstorms. These intense storms normally occur only in summer or early fall months. However, they are common in the study area during that period. Some portions of the study area are subject to flooding within as little as 30 minutes of the onset of intensive rains.

Flood problems which affect the case study area differ greatly from place to place. However, they can generally be categorized as: a) areas subject to flash flooding; b) areas subject to general flooding on uncontrolled streams; c) areas subject to general flooding on partially controlled streams; d) areas subject to flooding from canal breaks; and e) disruptions to transportation.

Area streams subject to flash flooding and the nature of the affected area include:

* Upper reaches of the Hassayampa River, which are largely undeveloped except for isolated farms and ranches and small unincorporated communities;

* Reaches along tributaries to the Hassayampa River in the vicinity of Wickenburg, some of which are developed for mobile homes and permanent residences;

* Upper reaches of the New River and tributaries, which are largely undeveloped except for isolated farms and ranches and small unincorporated communities;

* Skunk Creek, which is largely undeveloped except for isolated farms and ranches, small unincorporated communities, and the cities of Glendale and Peoria;

* Rowler Wash and other tributaries to Cave Creek which run adjacent to the unincorporated communities of Cave Creek and Carefree;

* Indian Bend Wash, which flows through developed areas of Phoenix, Scottsdale and Tempe;

* Various small washes which originate in the mountains and in the urbanized area of the Salt River Valley; and

* Washes in the mountainous areas of the Salt, Verde and Agua Fria River watersheds, which are generallly unoccupied except for campers and other recreational users.

Streams subject to general flooding which are uncontrolled and the nature of the area affected by them include:

* Lower reaches of the Hassayampa River, which are largely undeveloped except for isolated farms and ranches, small unincorporated communities, and the Town of Wickenburg;

* Lower reaches of the New River, which are largely undeveloped except for isolated farms and ranches, small unincorporated communities and the city of Peoria;

* Gila River below Salt River, which is largely undeveloped except for small unincorporated communities including Allenville and Holly Acres and the Town of Buckeye, all of which are primarily residential areas, and the Gila River Indian Reservation.

Streams subject to general flooding but which are partially controlled by upstream storage and the nature of the area they affect include:

* Agua Fria River below Waddell Dam, which is largely undeveloped except for isolated farms and ranches, small unincorporated communities and the cities of Avondale and El Mirage;

* Cave Creek below Cave Buttes Dam, which runs through residential, commercial and downtown business areas of Phoenix;

* Verde River below Bartlett Dam, which runs through small communities on the Fort McDowell Indian Reservation; and

* Salt River below Granite Reef Dam, which runs through the Salt River Indian Reservation and portions of Mesa, Scottsdale, Tempe and Phoenix.

Canal breakout areas include 8,000 acres of Phoenix subject to inundation by floods which enter and then overtop the Arizona Canal. The affected areas are primarily residential and commercial.

Disruptions to transportation include destruction or inundation of bridges and dip crossings. Because of the extensive dependence in the area's transportation network on dip crossings, flooding virtually isolates portions of the area from one another.

EXISTING ARRANGEMENTS FOR WARNING AND PREPAREDNESS

Flood Recognition System

A number of agencies and offices in the case study area collect data and information relevant to identification of impending floods. Figure 7-2 shows the agencies involved, the sources of data and information, and the direction of the flow of data and information. As is evident from Figure 7-2, Salt River Project and the NWS's Phoenix Weather Service Forecast Office (WSFO) are the principal points of data collection and exchange. Others involved are principally suppliers of data and information, such as the Flood Control District of Maricopa County, or recipients of data which has already been assembled, such as the Maricopa County Department of Civil Defense and Emergency Services.

The network of agencies participating in flood recognition activities depends to an extent on the source and type of flooding. The SRP is primarily concerned with floods which pass through its reservoir system or affect its canal network. Their input to information collection and exchange is therefore limited in the case of floods on streams other than the Salt or Verde Rivers.

Phoenix WSFO is well equipped to obtain basic weather data. Means of communication available at the WSFO include telephone, radio, Service C Teletypewriter Circuit, Service A Teletypewriter Circuit, Forest Service Teletypewriter Circuit and RAWARC Teletypewriter System. Means of communication available for distribution of information to others include telephone, radio, NAFAX, DIFAX, NOAA Weather Wire Services, NAWAS, and NOAA Weather Radio. The Phoenix WSFO operates on a 24 hour basis and is responsible for issuing warnings for 7 counties during the day and 11 counties during nighttime hours. The WSFO is equipped with emergency power.

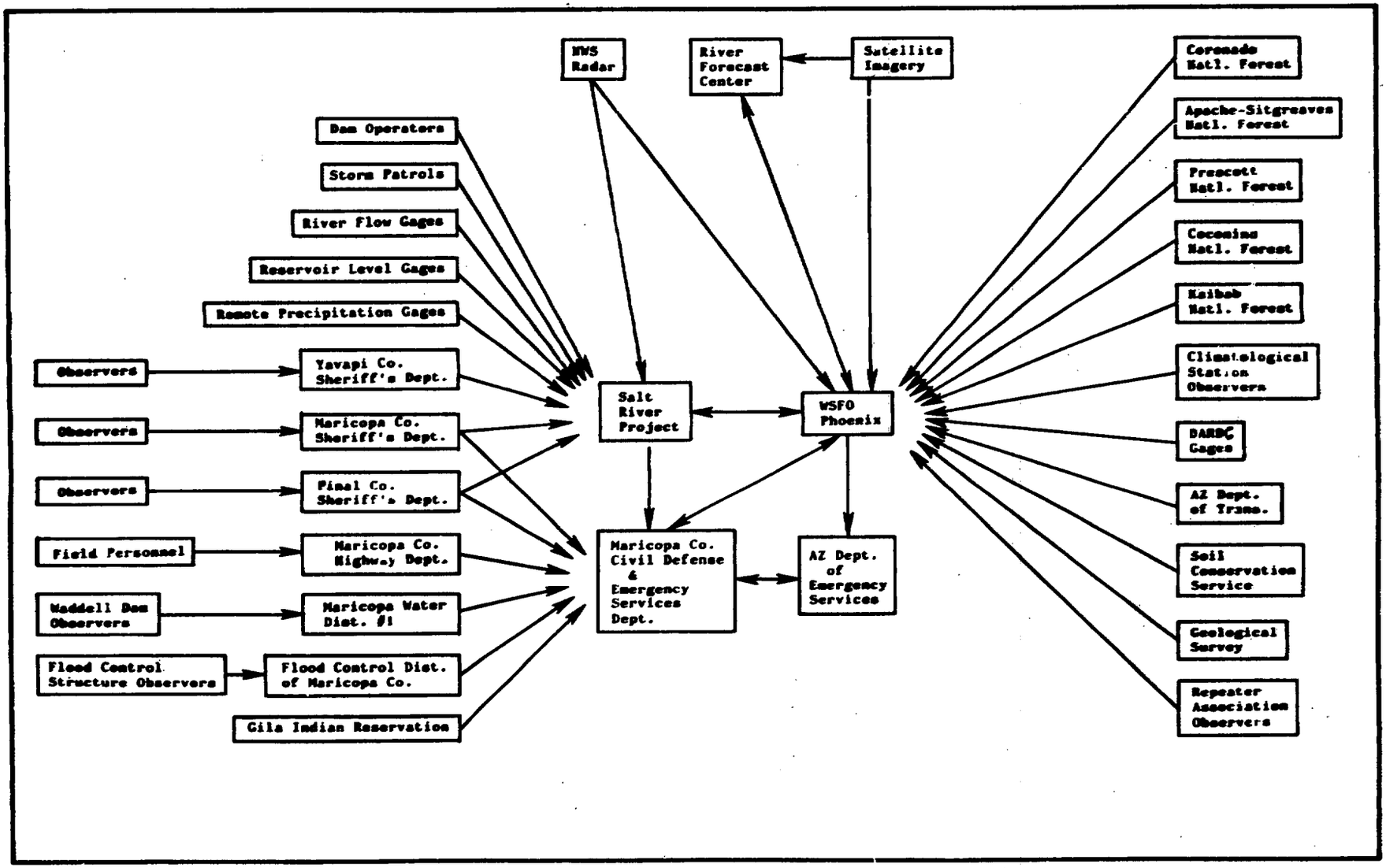

FIGURE 7-2 INFORMATION SOURCES FOR FLOOD RECOGNITION

Salt River Project is also well equipped for the collection and interchange of data and information. SRP offices contain a remote radar display unit which receives output from the NWS weather radar at Phoenix and various communications gear including telephone and radio. SRP's facility also has an emergency power supply and a computer.

Flood Warning Arrangements

The existing arrangements and means for dissemination of flood warnings in the case study area are shown in Figure 7-3.

Decisions to release information on flood situations is made independently by SRP, WSFO Phoenix and the Maricopa County Department of Civil Defense and Emergency Services. There is no formal means of joint decision-making at the present time although informal arrangements exist for coordination through liaison, exchange of information and joint press conferences.

SRP contacts only a limited number of warning recipients including governmental agencies in the area and those persons, organizations and cities which have specifically requested notification of releases or spillage at SRP dams. Notices are given by telephone. Two hours is required to call all listed recipients.

WSFO Phoenix issues flood watches, warnings and other related statements directly to the public via NOAA Weather Radio. It is unknown how many residents have radios capable of receiving such broadcasts. Information is also distributed through the NOAA Weather Wire which is subscribed to by the Arizona Department of Public Safety, Arizona Division of Emergency Services, major radio and television stations, press wire services, and public utilities including Salt River Project. Personnel at radio and television stations decide independently whether to make further dissemination of warning messages.

Maricopa County Department of Civil Defense and Emergency Services notifies a few selected individuals in each unincorporated community of flood predictions. Those persons in turn notify other residents. The system reportedly works very well. The agency also

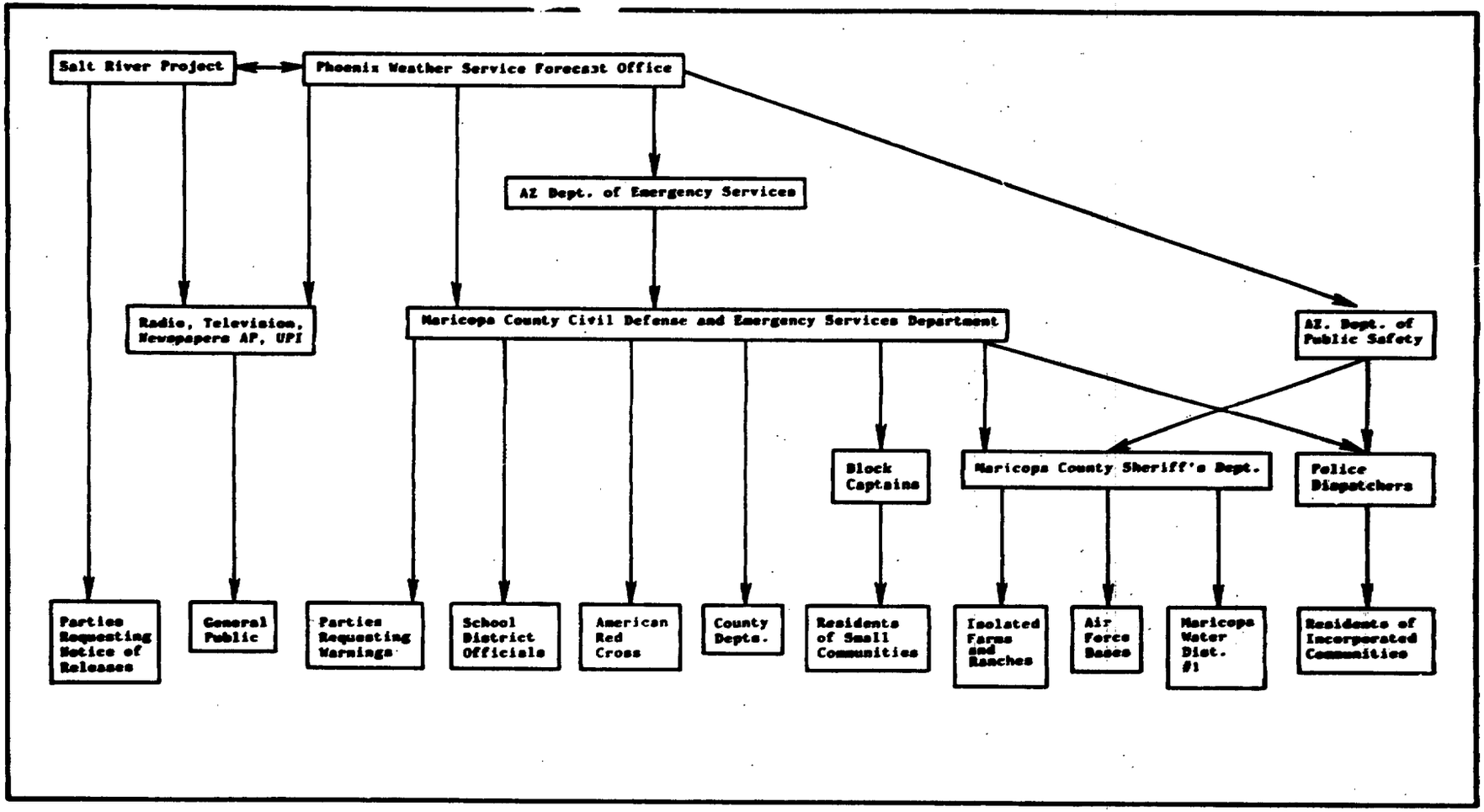

FIGURE 7-3 EXISTING ARRANGEMENTS FOR DISSEMINATION OF FLOOD WARNINGS

notifies the Maricopa County Sheriff's Department and police dispatchers in each incorporated community. Police dispatchers have standard operating procedures for warning dissemination which generally depends on use of mobile public address systems and hailers. Responsibility for warning in rural areas is assigned to the Sheriff's Department. However, the Department lacks adequate personnel and equipment to contact all rural residents on a timely basis.

There is a mass warning system for portions of the Phoenix metropolitan area including the cities of Phoenix, Scottsdale, Mesa and Tempe. However, the system is not designed to allow sounding warnings only for selected areas. The system is powered by the public power supply in the area and activation is through telephone circuits. The siren system is jointly owned and operated by the four cities and the county.

Flood Preparedness Plans

Existing formal preparedness plans for flooding include:

* State of Arizona Emergency Action Plan;

* Maricopa County Natural and Technological Disaster Plan and supporting Standard Operating Procedures of County agencies;

* Standard Operating Procedures for Flood for cities, towns and Air Force bases; and

* Flood Control District of Maricopa County, Standard Operating Procedures for Flood Emergencies.

Both the State and County documents are "all hazards" plans. General preparedness arrangements concerning staff organization, communications, mutual aid and evacuation are applicable to floods as well as to other emergencies. The County plan includes sections dealing with flood warning and evacuation in the Trilby Wash area and the Rittenhouse Dam drainage area.

For the Trilby Wash and Rittenhouse areas, the County's preparedness plan provides a description of

the area subject to inundation and an assignment of responsibility to the Sheriff to provide warnings of floods in "sufficient time for the residents to protect life and property to the maximum extent possible."

An annex to the County's plan deals specifically with storms and floods. It allocates responsibilities to various organizations in the form of tasks. Tasks deal with alerting agencies, initiating evacuation where appropriate, rescue, law enforcement, traffic control, public health, care of evacuees, damage assessment and recovery. Task descriptions are generally divided into groupings of before, during and after the flood.

Maintenance Plan

There are no formal arrangements at present in the case study area for periodic or continuing activities to maintain the viability of the flood warning and preparedness program except:

* Equipment maintenance programs by the NWS and SRP for data collection equipment; and

* Efforts by NWS in cooperation with state, local and other federal agencies to improve forecasting capabilities through development of computerized flood prediction tools.

EVALUATION OF EXISTING ARRANGEMENTS FOR WARNING AND PREPAREDNESS

Flood Recognition

As shown in Figure 7-2, there is no control point or office which has first hand access to all pertinent data, although Phoenix WSFO comes close to being such a place. The need to relay information from one party to another reduces the reliability of the overall system. Such redundency as exists in sources of information does not appear to be specifically designed as a guard against unreliable performance. Some linkages for transmission of data are also limited to telephone. In the case study area, telephone service is vulnerable to

disruption during storms and floods. In addition, automatic transmission of data by telephone, such as from the DARDC gage network, are routed over microwave links which perform poorly during heavy rains.

The data collection system provides information on water levels and releases at all reservoirs in the area. However, the coverage of the flood recognition system is deficient with respect to furnishing detailed information for the following areas:

* Hassaympa River;
* New River;
* Skunk Creek;
* Rowler Wash;
* Indian Bend Wash;
* Gila River below Salt River; and
* Various minor washes.

Problems of flood recognition also exist with respect to timeliness in the case of Dreamy Draw and with respect to identification of the location of points where canals are overtopped.

Accuracy of the flood recognition system is only moderate to poor for those streams which are covered. Little information is available for inflow to the major streams below reservoirs except data on reservoir releases and spills. NWS presently has Antecedent Precipitation Index Models for the Verde and Salt Rivers.' In addition, National Weather Service River Forecast System Model is developed and calibrated for the Verde River but not yet in use. A similar model is being developed for the Salt River. There are few streamflow measurement stations because of the high cost of their establishment given the unstable nature of streambeds in the area. As a result, predictions of floods in the area are generalized.

Flood Warning Arrangements

Arrangements for warning dissemination in the case study area are relatively strong. The general public

has access to information through NOAA Weather Radio on a 24 hour basis if they choose to obtain a radio capable of receiving the broadcast frequency. In addition, there are a variety of special arrangements to warn particular groups of the general public on a geographic basis.

The general weaknesses in the existing flood warning arrangements are:

* Lack of a unified decision-making process concerning the composition and dissemination of warnings which involves both federal and local agencies;

* Lack of capability to deliver warnings to all residents in rural areas on a timely basis;

* Reliance on only telephone to reach "Block Captains" in small communities;

* Lack of timeliness in warning residents of flash flooding;

* Lack of adequate means for disseminating warnings in urban areas; and

* Lack of requirements for site-specific warning arrangements.

Preparedness Plans

The County preparedness plan provides an excellent division of responsibility in terms of major objectives. However, it does not provide any detailed information on what exactly is to be done, how it is to be carried out and requirements for resources. For example, the plan only provides direction to "Initiate evacuation measures where appropriate." The plan does not identify the conditions which require evacuation, means of contacting occupants in affected areas, evacuation routes, evacuation destinations and other relevant points. Some areas subject to flooding are large and the plan fails to address personnel requirements for carrying out the evacuation. Similar problems exist with respect to other functions. Agencies assigned responsibilities for execution of the plan have not developed specific arrangements for meeting their responsibilties.

The major deficiencies in the preparedness arrangements for the case study area include:

* Lack of definition in specific matters to be accomplished;

* Lack of specificity in procedures for carrying out planned actions;

* Lack of identification of manpower and equipment requirements for execution of the plan; and

* Lack of coordination between emergency plans of the State, County, Flood Control District of Maricopa County, SRP and other political subdivisions.

Maintenance Plan

Existing maintenance arrangements are deficient in that they do not provide for:

* Regular continuing education and information of the public with respect to flood hazards;

* Drills, practice or other activities aimed at education of the intended participants in execution of the plan except for NWS training exercises; and

* Regular testing of relevant equipment.

POSTULATED WARNING AND PREPAREDNESS ALTERNATIVE

The warning and preparedness alternative postulated for the case study area to meet the needs described in the preceeding section is discussed in this section with respect to its selection, principal features, general operation and requirements for implementation. The alternative is described in terms of four main parts including flood recognition system, flood warning arrangements, flood preparedness plan, and maintenance plan.

Approaches Considered

Consideration was given by the investigators to a variety of approaches to warning and preparedness which

might be employed to meet the remaining needs of the case study area. The alternatives considered differed with respect to the extent they emphasized performance on an area-wide rather than sub-area basis, the type(s) of data and information used for flood recognition, the sophistication of the flood recognition system, and the role of the National Weather Service. Sub-areas considered included municipalities and unincorporated areas along each stream.

With respect to the extent of area-wide performance of activities, consideration was given to:

* Separate programs for each sub-area subject to flooding including independent flood recognition systems, warning arrangements, preparedness plans and maintenance plans;

* A single area-wide flood recognition system coupled with independent warning arrangements and preparedness plans for each sub-area subject to flooding and both area-wide and sub-area maintenance plans;

* An area-wide flood recognition system and warning arrangement, supplemented by local warning arrangements and coupled with independent preparedness plans for each sub-area subject to flooding, and both area-wide and sub-area maintenance plans; and

* A single area-wide flood recognition system, warning arrangement, preparedness plan and maintenance plan.

With respect to the types of data and information used for flood recognition, consideration was given to:

* Reliance on flood watches, flood warnings, and other informational statements issued by the NWS;

* Use of stream level sensors (Flash Flood Alarms);

* Use of precipitation data collected in the watersheds of streams in the case study area to supplement NWS forecasting;

* Use of stage data for rivers in the case study area to supplement NWS forecasting; and

* Combinations of the above.

With respect to sophistication of the flood recognition system, consideration was given to:

* Manual data collection combined with manual procedures for flood forecasting;

* Automated data collection combined with manual procedures for flood forecasting; and

* Automated data collection combined with computerized flood forecasting procedures.

With respect to the role of the NWS, consideration was given to:

* Operation of the flood recognition system independent of NWS excepting use of regularly available forecasts and information;

* Forwarding of all data to the NWS and reliance on NWS for all flood recognition and forecasting; and

* Establishment of parallel forecasting capability on the part of NWS and local participants.

Selection of Approaches

The foregoing options can be combined into a large number of distinctly different alternatives. The alternative selected for postulation was chosen based on several factors including: nature of anticipated flooding; characteristics of the areas subject to flooding; physical, economic and social setting; existing arrangements for flood warning and preparedness; local resources including technical and financial capabilities; and requirements for timeliness, accuracy and reliability.

All of the consideration given to selection of the features of the postulated alternative was of a general nature, based on readily available data. No detailed studies were conducted.

The approaches selected for use in development of the postulated alternative were:

* Use of a single area-wide flood recognition system, supplemented by both area- wide and sub-area warning arrangements, individual preparedness plans for each sub-area subject to flooding, and a maintenance plan with both area-wide and local components;

* Use of water level sensors and a combined system of precipitation and river stage gages accessable to both the NWS and local participants, supplemented by use of watches, warnings and other statements issued by the NWS to activate the data collection system;

* Use of a combined system of automated and manual collection of data;

* Use of computerized flood forecasting, backed by the availability of manual procedures; and

* Development of parallel or nearly parallel forecasting capabilities on the part of the NWS and local participants with NWS having lead responsibility for preparing and issuing forecasts.

Employment of the selected approach also envisions creation of a "Salt-Gila Flood Forecasting Center" located at Phoenix in close proximity to or sharing space with the Phoenix WSFO. The Center facility would contain communications equipment, a mini-computer and peripheral equipment, and work spaces. There would be multiple communication links between the mini-computer at the Flood Forecasting Center and the central RFC computer at Salt Lake City.

Description of Flood Recognition System

The data collection portion of the postulated flood recognition system would build on that which already exists and is operated by the NWS, USGS, Salt River Project and others.

Major Components

The major components required to supplement the existing data collection portion of flood recognition system include:

1. Purchase, installation, calibration, operation, servicing and repair of self-reporting, radio transmitting precipitation gages including:

   A. Four gages located in the upper Hassayampa River drainage area in Maricopa and Yavapai Counties;

   B. Two gages located in the upper New River and Skunk Creek drainage areas in Maricopa County;

2. Purchase, installation, calibration, operation, servicing and repair of self-reporting, radio transmitting river stage gages including;

   A. One gage located on the New River in Maricopa County above the proposed site of the New River Dam;

   B. One gage located on Skunk Creek in Maricopa County above the proposed site of the Adobe Dam;

   C. One gage located on Rowler Wash upstream of the town of Cave Creek; and

   D. One gage located on Indian Bend Wash near Shea Blvd. in Scottsdale.

3. Purchase, installation, calibration, operation, servicing and repair of self-reporting, radio transmitting reservoir level gages including:

   A. One gage at Lake Pleasant Reservoir; and

   B. One gage at Cave Buttes Dam; and

   C. One gage at Dreamy Draw Dam.

4. Purchase, installation, calibration, operation, servicing and repair of self-reporting, radio transmitting reservoir outflow gages including:

   A. One gage at Waddell Dam; and

   B. One gage at Cave Buttes Dam.

5. Two antenna and radio relay units;

6. Purchase and installation of inexpensive plastic rain gages for use by observers including:

   A. 15 gages for a Hassayampa River precipitation observer network;

   B. 8 gages for a New River precipitation observer network;

   C. 8 gages for a Skunk Creek precipitation observer network; and

   D. 6 gages for an Indian Bend Wash precipitation observer network.

7. Purchase and installation of stream stage gages for use by observers including:

   A. 2 gages on Hassayampa River;

   B. 1 gage on Agua Fria River;

   C. 2 gages on New River; and

   D. 1 gage on Skunk Creek.

8. Establishment of the Salt-Gila Flood Forecasting Center including:

   A. Rental of space;

   B. Purchase, operation, servicing and repair of the local mini-computer and peripheral equipment;

   C. Transmitting and receiving equipment for monitoring of self-reporting radio operated gages;

   D. Purchase of furnishings and supplies; and

   E. Purchase and maintenance of communications equipment.

General Operation

The Flood Forecasting Center's mini-computer would receive the data transmitted from self-reporting precipitation and river stage gages and that supplied from gage and reservoir observers, organize the data into a convenient form, and keep track of rainfall rates at all reporting precipitation stations. The mini-computer would also automatically interrogate telemark gages in the system at a frequency determined by the rate of rainfall at self-reporting precipitation stations (with more frequent interrogation during periods of heavy rainfall).

Data collected and organized by the Flood Forecasting Center's mini-computer would be relayed to the central RFC computer system. The primary means of data transfer would be the NWS's AFOS data communications system. Two alternative means of communication would be provided including satellite relay via the NWS's GOES satellite system and telephone. The frequency of data transfer between the mini-computer at the Flood Forecasting Center and the central RFC computer would increase with increasing rainfall intensity..

The central RFC computer, using data transmitted from the Flood Forecasting Center's mini-computer and Quantitative Precipitation Forecast (QPF) data as input, would compute streamflows for various locations in the case study area and convert stream flow values

to stream stages at the selected locations. Forecasts would be displayed on a monitor at the RFC and reviewed by staff there who could modify forecasts based on any additional information. Forecasts or revised forecasts would then be transmitted to the mini-computer at the Flood Forecasting Center for display or printing.

As a backup measure, the mini-computer at the Flood Forecasting Center would also have the capability to generate flood forecasts, albeit without access to QPF input and with a model simplified to fit the lesser capabilities of a smaller machine. However, additional models would enable use of the mini-computer to address "what if" questions and generate hydrographs for selected points based on assumption of various ensuing rainfall patterns. The mini-computer and its models could also be used to test various reservoir operation schemes. A link between the mini-computer and the computer facilities of the Salt River Project would enable immediate availability of forecasts and projections to the Salt River Project as a basis for river, canal and reservoir regulations. If desired, printers could also be installed at the County's Disaster Defense Center, city offices and other locations to make flood predictions immediately available.

Reliability in the flood forecasting function would be provided by the manually observed gages, means of direct access (rather than through the mini-computer) to self-reported data, and the availability of charts and graphs for manual flood forecasting.

All portions of the case study area which are subject to significant flooding and for which the regular flood forecasting system provides less than 30 minutes warning time at the Salt-Gila Flood Forecasting Center would be protected by upstream water level sensors. Alarms triggered by high water levels at the sensor location would be located at both the Salt-Gila Flood Control Center and, as appropriate, dispatch offices of fire and police departments serving the affected areas, Sheriff's Department substations and the Arizona Department of Public Safety.

The "Normal" status of operation of the flood recognition system in the between-flood periods would consist of routine monitoring of incoming data and information. Data transmitted by self-reporting precipitation and river stage gages would be received at the

Phoenix WSFO and any data of interest forwarded to the RFC.

The flood recognition system would change to "Pre-Emergency" status when meteorologic and other information indicated a significant probability of flood producing conditions occurring in the area. Action taken in the "Pre-Emergency" stage would include:

* Minimal staffing of the Salt-Gila Flood Forecasting Center;

* Alerting of observers; and

* Continual monitoring of general weather conditions and data from self-reporting and telemark gages.

The flood recognition system would shift to "Emergency" status when heavy rains, thunderstorms or other circumstances indicated that potentially flood causing conditions existed in the case study area. The "Emergency" status would be maintained until all threats of flooding had subsided throughout the area. Actions taken during "Emergency" status would include:

* Full staffing of the flood forecasting center;

* Periodic collection of rainfall and stream stage data from observers;

* Continual monitoring of data from self-reporting and telemark gages; and

* Periodic issuance of flood forecasts.

Responsibility for operation of the flood recognition system during "Pre-Emergency" and "Emergency" status would be shared between the RFC and the Salt-Gila Flood Forecasting Center. The RFC would have primary responsibility for preparing forecasts. The Flood Foreceasting Center would have secondary responsibility and take over forecasting responsibilities in the event all means of communications with the RFC were disrupted or if timely forecasts from the RFC were not available for some other reason. Forecasts issued for the area by the RFC would be returned to the Salt-Gila Flood Forecasting Center for release.

Estimated Cost

The estimated first cost of implementing the supplemental portions of the flood recognition system is $122,000. The estimated annual cost for operation and maintenance of that portion of the alternative is $62,000.

Required Technical Capabilities

The principal technical capability required for implementation and operation of the flood recognition portion of the postulated alternative includes an adequate number of staff to man the Salt-Gila Flood Forecasting Center on a 24 hour basis during periods of high flood potential and during floods. Key types of skills required include those for communications, hydrology, engineering and operation of the mini-computer and associated equipment.

Legal Requirements

The most important legal authorities required for implementation and operation of the flood warning and preparedness alternative are those necessary for: a) acquiring and operating gage sites in rural areas of Yavapai County and in both rural and urban areas of Maricopa County; and b) renting space, contributing funds and providing staff for establishing, equipping and staffing the Salt-Gila Flood Forecasting Center.

Description of Flood Warning Arrangements

The warning arrangements would consist of three parts, namely an area-wide part to be executed by the staff of the Salt-Gila Flood Forecasting Center; a set of community level warning arrangements for each sub-area subject to flooding; and site-specific warning arrangements for selected facilities.

Major Components

The principal components of the areawide warning arrangements to be executed by the Salt-Gila Flood Forecasting Center include:

1. Decision criteria for issuance of various types of warnings for each subarea;

2. Procedures for issuance of warnings to local government officials and emergency services agencies responsible for warning and preparedness actions in each subarea;

3. Lists (names, addresses, telephone nunbers) of persons and organizations to be warned; and

4. Radio and other equipment for issuing warnings.

The principal components of the flood warning arrangements for the sub-areas subject to flooding include:

1. Identification of a local official or organization to serve as recipient of flood warnings transmitted to the subarea from the Salt-Gila Flood Forecasting Center;

2. Procedures for relay of warnings to other local officials and organizations;

3. Lists (names, addresses, telephone numbers) of officials and organizations to be warned;

4. Decision criteria for dissemination of warnings to the public;

5. Procedures for dissemination of warnings to the public; and

6. Means (equipment and personnel) for disseminating warnings to the public including:

   A. Modification of the existing mass warning system to enable selective activation of sirens by radio;

   B. Installation of radio activated sirens located at:

      i) Avondale;

      ii) Holly Acres;

iii) Allenville; and

iv) points along the Arizona and Grand Canals which are likely to be overtopped.

7. Purchase of 12 transmitters to activate disaster alert modules;

8. Purchase of disaster alert modules as desired by the public along:

A. Salt River at Phoenix;

B. Gila River at Holly Acres;

C. Gila River at Allenville;

D. Agua Fria River above New River;

E. Agua Fria River below New River;

F. Skunk Creek;

G. New River above Skunk Creek;

H. New River below Skunk Creek;

I. Cave Creek above and at town of Cave Creek;

J. Cave Creek below town of Cave Creek;

K. Dreamy Draw;

L. Indian Bend Wash; and

M. Various small washes in the study area.

The components for site-specific warning arrangements include:

* Means of receiving warnings issued for the sub-area in which the facility is located;

* Procedures for distribution of warnings within each facility; and

* Means for distribution of warnings within each facility.

General Operation

Flood forecasts generated through the flood recognition system would be reviewed by personnel at the Salt-Gila Flood Forecasting Center. Forecasts for each location in the case study area would be compared to decision criteria to identify what action was required. As needed, warnings would be issued to the designated individual or organization in the affected sub-area.

Warnings to the identified official or organization responsible for each sub-area would be issued via telephone and/or radio as appropriate with procedural arrangements for confirmation of warnings to assure messages are received and understood correctly. Designated warning recipients would be selected from persons or organizations available on a 24 hour basis. Designated warning recipients would in turn relay warnings to officials and emergency services agencies responsible for warning dissemination and preparedness actions in each sub-area. Dissemination of warnings to the public would begin if appropriate based on local decision criteria.

The area-wide flood warning arrangements would be staged. The stages would be keyed to those of the flood recognition system and include "Pre-Emergency" and "Emergency." Warning actions taken during the "Pre-Emergency" stage by the Salt-gila Flood Forecasting Center personnel would include:

* Alerting of personnel responsible for execution of the "Emergency" stage of the flood warning arrangements;

* Alerting of personnel and organizations responsible for execution of preparedness plans; and

* Alerting of any special warning recipients requiring extraordinarily long times for response to flood warnings.

Warning actions taken during the "Emergency" stage would include:

* Issuance of general warnings through public media by the Salt-Gila Flood Forecasting Center;

* Issuance of specific flood forecasts by the Salt-Gila Flood Forecasting Center to persons and organizations responsible for sub-area warning arrangements; and

* Dissemination as appropriate of forecasts and warnings to occupants in affected sub-areas.

Issuance of warnings by the Salt-Gila Flood Forecasting Center and local government officials would be complemented by warnings issued over the NOAA Weather Radio station at Phoenix (KEC-94).

Estimated Cost

The estimated first cost of the supplemental items for flood warning is $148,000 not including private expenditures for purchase of disaster alert modules and for establishment of site-specific warning systems. The estimated annual cost for the public portions of operation and maintenance is $27,000.

Required Technical Capabilities

The principal capabilities for carrying out the warning portion of the postulated alternative include those necessary to: a) staff the Salt-Gila flood Forecasting Center on a 24 hour basis during periods of high flood potential and during floods; and b) provide a contact point which is operational on a 24 hour basis in each sub-area.

Legal Requirements

Legal authoritis useful or needed for implementation of the supplemental flood warning arrangements include those for:

1. Modification of the existing mass warning system;

2. Installation and operation of additional siren systems;

3. Dissemination of flood warnings; and

4. Requiring development of site-specific warning systems for selected facilities.

Description of Flood Preparedness Plans

The preparedness plan portion of the postulated alternative would supplement existing arrangements for response to floods. Responsibility for performance would be allocated on a sub-area basis.

Major Components

The major components of the supplemental preparedness arrangements are those providing for:

1. Mandatory evacuation of areas expected to be inundated;

2. Dispersal of fire, police, medical and other emergency services equipment and personnel to assure continuation of essential services;

3. Curtailment of gas and electrical service to areas threatened with inundation;

4. Flood fighting in selected areas; and

5. Mandatory removal of vehicles from streets in areas threatened with inundation to reduce damages and facilitate evacuation.

General Operation

Conduct of preparedness actions would be keyed to flood predictions. In general, each sub-area would be further sub-divided according to the inundation expected at each predicted flow. As flow forecasts were received, preparedness actions would be implemented in affected areas and preparations made for their conduct

in the next higher lying area. Preparations would consist of staging the personnel and equipment necessary for action at a convenient location and alerting residents of the possible need to evacuate.

Estimated Cost

The estimated first cost of implementing the supplemental preparedness arrangements is $34,000 for: a) purchase and stockpiling of equipment and materials for flood fighting and stream patrols; and b) installation of additional valves on gas mains to facilitate curtailment of service. The annual cost for the preparedness arrangements is estimated to be $72,000 for: a) replacement of expended flood fighting equipment and materials; b) equipment rental; and c) labor. These costs do not incude the labor and other costs to utility system operators for curtailing gas and electric service in accord with the plan.

Required Technical Capabilities

Conduct of the postulated preparedness actions require no skills beyond those normally available from emergency services agencies excepting as necessary for: a) curtailment of gas and electric service; and b) technical direction of flood fighting. Other required technical capabilities include: a) equipment and personnel for traffic control and movement of parked or stalled vehicles; b) construction equipment and operators for flood fighting; and c) adequate numbers of people to carry out flood fighting.

Legal Requirements

The major legal requirements for implementation and execution of the preparedness portion of the postulated alternative are the authorities necessary to:

1. Require evacuation of incorporated and unincorporated areas threatened by floods;

2. Conduct flood fighting activities in incorporated and unincorporated areas;

3. Curtail gas and electric service in unincorporated and incorporated areas; and

4. Direct the dispersal of emergency services personnel and equipment.

Description of Maintenance Plan

The maintenance plan would include the activities necessary to maintain the readiness and long term viability of both the existing and supplemental warning and preparedness arrangements.

Major Components

The major components of the maintenance plan include:

1. Servicing, calibration, periodic testing and other maintenance of self-reporting precipitation and stream level gages;

2. Any necessary recruitment and training of observers;

3. Servicing and periodic testing of communications equipment and facilities serving the Salt-Gila Flood Forecasting Center;

4. Conduct of educational and informational programs;

5. Conduct of post-audits of performance of the flood recognition system and execution of the flood warning and preparedness arrangements;

6. Periodic updating of warning lists and procedures;

7. Periodic review to identify needs for improvement or modification of procedures and facilities for flood recognition, flood warning and flood preparedness based on changes affecting runoff or stage-discharge relations, changes in the area at risk or other factors; and

8. Organization and participation in periodic drills and practice.

General Operation

Maintenance activities would be divided into areawide and sub-area programs and separate schedules established for each.

Estimated Cost

Costs for maintenance of equipment used for flood recognition, warning and preparedness were included in the estimates of annual cost for operation. Other maintenance costs are estimated to have a first cost of $24,000 for initial development of educational and informational materials. Average annual costs for non-equipment related maintenance activities are estimated to be $34,000, primarily for labor.

Required Technical Capabilities

Technical capabilities pose few difficulties in relation to maintenance. Only moderate skills are needed for most activities excepting: a) maintenance of equipment; and b) planning type tasks such as post-audits of performance and identification of needs for modification and/or improvement of plans. In general, the technical capabilities required to operate the Salt-Gila Flood Forecasting Center are adequate for this purpose.

Legal Requirements

The authority to carry out some portion of the postulated plan is normally adequate as a basis for related maintenance activities. The only maintenance activities which therefore pose any concern are those such as education and information and planning which are unrelated to specific components of the other portions of the plan. However, these types of authorities are generally available to governmental units.

INSTITUTIONAL CONSIDERATIONS

Design of effective implementation arrangements for the postulated flood warning and preparedness alternative depends on development of a pattern for allocation of responsibilities which is consistent with the legal authorities and the financial and technical capabilities of the participating agencies. Moreover, the distribution of responsibilities should be such that the role to be played by each participant is not inconsistent with its existing policies and normal activities. Existing relationships between agencies should be preserved to the extent possible. And, of course, the allocation of responsibilities should result in a system which makes good political sense in terms of accountability for performance, stability and responsiveness to the public. The following sections describe considerations of this type relevant to governmental agencies in the case study area and potential implementation arrangements.

Federal Agencies

The case study area is served by the full complement of federal agencies. Those with missions particularly relevant to water resources management and/or flood loss reduction include the Corps of Engineers, Water and Power Service, Geological Survey, National Weather Service, and Federal Emergency Management Agency.

Corps of Engineers

The Corps' functions include the investigation, design, construction, operation, and maintenance of works for navigation, flood control, beach erosion control, hydroelectric power generation, municipal and industrial water supply, water quality control, recreation, fish and wildlife conservation, and hurricane protection. In addition, the Corps administers a regulatory program for development and management of water and related land resources, and technical and planning assistance programs such as Flood Plain Management Services.

The study is within the boundaries of the area served by the Los Angeles District of the Corps of

Engineers, headquartered at 300 N. Los Angeles Street, Los Angeles, California. The Corps also has an office at 2721 N. Central Avenue in Phoenix. The Phoenix office was established to facilitate the conduct of the Phoenix Urban Study. The continuation of the Corps' office at Phoenix after completion of the Urban Study is uncertain.

Potential involvement of the Corps in implementation and operation of the postulated flood warning and preparedness alternative for the case study area includes:

* Technical assistance in system design, development of procedures, and other aspects of planning;

* Assistance in floodfighting, rescue and other activities related to execution of flood preparedness plans; and

* Assistance in training and educational activities.

The Corps has considerable technical and financial capability to accompany its legal authorities. District offices are normally staffed on a 24 hour basis when potential flood causing conditions exist. Los Angeles District also has or can obtain the technical expertise to develop and use sophisticated flood forecasting techniques.

Participation of the Corps in day-to-day operation of a flood warning and preparedness alternative is limited by location. The center of the case study area is approximately 400 miles east of Los Angeles. Operation of vital portions of a flood warning system and/or efforts to direct execution of preparedness plans from that distance would raise important questions about reliability and timeliness. In addiion, the Corps lacks legal authority to take many of the types of actions required in execution of preparedness plans.

Water and Power Service

The Water and Power Service administers no programs specifically for flood loss reduction. However,

that purpose can be addressed as one of several in multipurpose projects under the Small Reclamation Projects program and the Federal Reclamation Projects program. The case study area is located within the boundaries of the area served by the Lower Colorado Regional Office, located at Boulder City, Nevada.

Potential involvement of the Water and Power Service in implementation and operation of a flood warning and preparedness alternative for the case study area includes:

* Technical assistance in system design, development of procedures and other aspects of planning;

* Financial assistance (loan or grant) for implementation;

* Operation or assistance in operation of a flood recognition system, particularly in conjunction with provisions for dam safety and dam failure evacuation planning.

The Water and Power Service has considerable technical and financial capability to accompany its legal authorities. The Service would also benefit from the availability of improved predictions of flows through better water management.

Participation of the Water and Power Service in the day-to-day operation of a flood warning and preparedness alternative is limited by location. The center of the case study area is approximately 285 miles southeast of Boulder City, Nevada. Operation of vital parts of the flood warning system from that distance would raise important questions about reliability and timeliness. In addition, the Service lacks legal authority to take many of the sorts of actions required in execution of a flood preparedness plan.

U.S. Geological Survey

The Survey does not administer any programs directly for flood loss reduction purposes. However, it does on occasion prepare and publish a Hydrologic Atlas describing flood problems in a community which includes

stream profiles, maps of inundated areas and other information. Communities and others desiring to do so can use this information as a base for land use regulation and other programs for flood loss reduction. Other water resources investigations carried out cooperatively with states may serve flood loss reduction purposes if designed to do so. The case study area lies within the area served by the Arizona District Office, located at 301 W. Congress Street in Tucson.

Potential involevement of the Survey in implementation and operation of a flood warning and preparedness alternative includes:

* Financial and technical assistance in purchase and installation of equipment for data collection;

* Financial and technical assistance in operation of the flood recognition system;

* Technical assistance in development of flood forecasting procedures;

* Technical and financial assistance in educational and informational activities; and

* Technical and financial assistance in maintenance of equipment for data collection.

The Survey has considerable technical and financial capability to implement its legal authorities. The data on precipitation and stream flows collected through a flood recognition system would be useful to the Survey for its overall water resources activities, thus providing an incentive for participation in implementation and operation of that portion of the postulated flood warning and preparedness alternative.

Participation in day-to-day operation of a flood recognition system by the Survey is limited by location. The center of the study area is approximately 120 miles north of Tucson, Arizona. Operation of vital parts of the flood warning system from that distance would raise important concerns about reliability and timeliness. In addition, the Survey lacks legal authority to take many of the sorts of actions required in execution of a preparedness plan.

National Weather Service

The functions of the NWS include weather forecasting, issuance of storm warnings, display of weather and flood signals, gaging and reporting on rivers, distribution of meteorological information useful for agriculture and commerce, and taking such meteorological observations as may be necessary to establish and record the climatic conditions of the United States. NWS also has authority to establish, operate and maintain a system of precipitation stations in connection with Corps of Engineers surveys or works of improvement for flood control, rivers and harbors and related purposes. The agency operates precipitation stations, stream gages and devices for measuring evaporation rates and it issues flood and water supply forecasts which are used by other agencies in the planning and development of water resources. NWS also operates a geostationary satellite system (GOES) to provide continuous observation of the earth and its atmosphere.

NWS operates a program to plan and develop disaster preparedness programs designed to save lives and mitigate the social and economic impacts of natural disasters. The agency works in cooperation with local officials, volunteer agencies and other federal agencies in this effort. Activities include those to develop preparedness plans, conduct periodic disaster drills, ensure rapid dissemination of warnings, increase public awareness of disaster threats, and encourage proper response to warnings.

The case study area is located within the areas served by the Salt Lake City RFC and the Phoenix WSFO.

Potential involvement of the NWS in implementation and operation of a flood warning and preparedness alternative for the case study area includes:

* Technical assistance in system design, development of procedures and other aspects of planning;

* Operation or assistance in operation of the flood recognition system;

* Preparation and issuance of forecasts and/or development of procedures for flood forecasting by others;

* Maintenance or technical assistance in maintenance of data collection equipment;

* Assistance in development and conduct of informational and educational programs; and

* Assistance in training and plan practice.

The NWS has considerable technical and financial resources to implement its legal authorities. Participation in operation of the warning system and issuance of flood forecasts by the relevant RFC is somewhat limited by its location which is approximately 500 miles north of the case study area. However, the WSFO located in Phoenix offers an excellent potential for timely and reliable participation.

Federal Emergency Management Agency

FEMA administers programs assigned previously to the Defense Civil Preparedness Agency, Federal Disaster Assistance Administration and Federal Insurance Administration. The only program specifically applicable to floods is the National Flood Insurance Program. However, several other programs administerd by the agency apply to floods as one of several types of general emergencies or disasters. FEMA's programs provide for assistance in all phases of dealing with disasters including technical and financial assistance for preparedness planning and coordination of federal assistance for response and recovery.

The case study area is within the boundaries of the area served by FEMA's Region IX office, located at 450 Golden Gate Avenue in San Francisco, CA.

Potential involvement of FEMA in implementation and operation of the postulated flood warning and preparedness alternative for the case study area includes:

* Technical and financial assistance in system design, development of procedures, and other aspects of planning;

* Assistance in training and educational activities; and

* Provision of coordination of federal efforts for assistance in executing the preparedness plan and in post-flood recovery.

FEMA has considerable financial resources to accompany its legal authorities once the president has declared a disaster. However, prior to occurence of a disaster, financial resources of the type which might be useful in implementation and operation of a flood warning and preparedness program are limited to planning grants made to designated state agencies. The agency is also limited with respect to operational personnel.

FEMA is not authorized to provide day-to-day operation of local flood warning and preparedness programs. Even if it were, the distance of the case study area from the agency's regional office at San Francisco, CA, would make such participation questionable.

Federal Role

As explained in a preceding chapter and immediately foregoing sections, the federal government now provides or is authorized to provide some of the components of a flood warning and preparedness alternative like that postulated. Of course it also has the territorial jurisdiction to operate throughout the case study area. However, no single agency of the federal government engages in all of the activities requisite to carrying out the complete alternative postulated. Except where the protection of federal property is involved, it is the underlying philosophy that the role of the federal government in many aspects of warning and preparedness actions is to provide assistance, encouragement and, where appropriate, leadership, but not to take operational charge of a program for a locality.

While the postulated system for prediction of floods in the case study area relies heavily on the services and capabilities of the National Weather Service, what can be provided by that agency is insufficient for a complete system. The need to fill the

gaps in the NWS system is one of the primary reasons for a significant part of the flood recognition portion of the postulated alternative. If the NWS or another agency of the federal government were able in all respects to install the necessary gages and provide the detailed forecasting envisioned, it would have presumably done so in the past.

In addition, the preparedness portion of the postulated alternative includes a considerable number of actions which are to be taken in response to flood predictions. The recently created Federal Emergency Management Agency cannot be expected to be a key participant in such actions. Its services center around disaster planning and response activities related to activation of federal assistance. The agency is not intended to serve as a substitute for local observation and response forces.

Most federal assistance available through FEMA for coping with disasters is only available after local and state resources are exhausted. Since many of the postulated response actions must be taken on the basis of a flood prediction, federal assistance is not likely to be available on a timely basis.

Because of these several constraints, the federal government is not a very strong candidate for a major role in implementing and operating the postulated alternative. Its capabilities and authorities suit it for a strong role in the flood prediction step through NWS and in provision of various types of financial assistance through NWS, the U.S. Geological Survey, FEMA and possibly other agencies.

State of Arizona

The State of Arizona has the territorial jurisdiction necessary to implement and operate the postulated flood warning and preparedness alternative. It also has the financial capability to carry out the alternative if it chooses to do so. However, the State is limited in the role it can be expected to play by its traditional participation in flood loss reduction activities and by its range of legal authorities.

The State government has not engaged very extensively in flood loss reduction activities in the past. State officials have participated in successful efforts to obtain federal projects, but these have emphasized irrigation, hydroelectric power and water supply. Even in these fields long recognized to be important for the growth of the State's economy, the State government has not attempted to become the major administrator or financing instrumentality. Rather, the projects have been developed and operated by some combination of federal and local interests.

Until recently, the image of Arizona as a water deficient area has inhibited the growth of organized concern with inundations as a matter requiring serious governmental attention. Where flood control benefits could be identified as possible features of projects desired for other reasons, they have been counted upon to increase the benefit-cost ratio, thereby making federal construction more likely. It is only as concentrations of population and valuable properties have increased that flood loss reduction is coming into its own as an independent factor.

In Arizona as in almost all other states, the role of the state government has been conceived as that of a regulator or provider of enabling law for local action. Operational aspects have been left to others. For the state to undertake actual administration of a local flood recognition system and warning arrangements would require a sharp break with its traditional role. Perhaps the best precedent that could be cited for such a change would be the established responsibility of the State government for civil defense and disaster protection, but even there it has not been conceived that state employees would be the ones constantly on the spot everywhere throughout Arizona to perform a monitoring function.

With respect to preparedness actions, the state's assistance is not intended to replace local effort. Even if statutes permitted state assistance in disaster response to preceed the exhaustion of local efforts, it is doubtful the State could always provide such services due to limitations in personnel and equipment.

The State's legal tools are also deficient for carrying out some parts of the postulated alternative. It has little operational control, for example, over

local emergency services agencies and private providers of utility services. Exercising such control would require significant new legislation, invoking of the governor's emergency powers or laborious use of the state's licensing and other supervisory authorities. None of these approaches promise effective implementation and operation.

Moreover, if the state government were to provide flood warning and preparedness services of the detail postulated, it probably would need to do so all over Arizona rather than merely for the case study area. The commitment of funds and resources required for effective performance on a statewide basis have not been examined and the policy issues involved have not been seriously considered. But the constraints on State government suggest that its practical role is limited to the provision of technical assistance to local efforts, and the furnishing of such relevant data as it collects in the course of its statewide activities.

Maricopa County

Maricopa County could develop, operate and maintain many parts of the postulated flood warning and preparedness alternative. It has most of the necessary legal authorities and its personnel have many of the necessary types of skills. The County's Department of Civil Defense and Emergency Services is in fact one of the key actors in the existing arrangements for flood warning in the case study area. The County also has the financial capability to implement and operate the plan if it were decided to do so. The County can also enter into agreements with other governmental units and private parties and adopt ordinances formalizing the plan. Furthermore, the County Sheriff's Department and the County Highway Department are two of the important sources of personnel and equipment most likely to be called upon to assist in carrying out emergency actions. The County also has working relationships and close coordination with the private and volunteer organizations providing fire protection in rural areas of the case study area.

The County has territorial jurisdiction over all of the area within its boundaries and is legally

empowered to expend funds and exercise most or all of the functions important to flood warning and preparedness in both incorporated and unincorporated areas. Existing flood preparedness plans for communities were, for example, developed by the County Department of Civil Defense and Emergency Services. However, the County provides few services of an operational nature related to warning and preparedness within the larger incorporated areas. Each major municipality for instance maintains its own police, fire and other emergency services. County services of this type are provided within incorporated areas only for a few of the smaller cities which have little or no resources of their own.

As a result of this traditional division of responsibility between the County and the larger municipalities, County services have not expanded to the point that the staff regularly available could carry out warning and response actions for both rural and incorporated areas. Also, efforts by the County to formalize preparedness plans for incorporated areas, such as adoption of ordinances to control traffic during emergencies, are likely to meet opposition from municipalities which consider such decisions to be within their exclusive domain.

As with the State, the County has not been very deeply involved in flood loss reduction activities. Local efforts along that line have been restricted largely to structural measures built or sponsored by the Flood Control District of Maricopa County. Even in those limited flood related programs the County has carried out, such as land use regulation pursuant to the National Flood Insurance Program, reliance has been put on the Flood Control District to provide the hydrologic, engineering and other technical expertise required. As a result, the County has limited technical capability of its own of the types required for operation of the postulated data collection system and flood prediction procedures.

The County's prime opportunities to participate in the implementation and operation of the postulated alternative include: a) use of its broad authorities and financial capabilities; and b) performance of warning dissemination and preparedness actions in unincorporated areas and in some small incorporated areas.

Municipalities

Municipalities in the case study area have many legal authorities pertinent to implementation and operation of the postulated flood warning and preparedness alternative. They are broadly empowered to make plans for protection against various kinds of threats to safety and welfare. All but a few of the smaller municipalities in the case study area already engage in the distribution of flood warnings under existing arrangements.

Municipalities have no legal impediment to the expenditure of their funds for warning and preparedness. The obstacles which exist are in the realm of competition for too few dollars by too many worthy functions. Education, streets, waste treatment, recreation and other services contend for appropriations. Of course, municipalities' funds could not be used to implement measures which had no benefit for their residents.

Like the County, municipalities in the case study area have relied largely on the Flood Control District for expenditures related to flood loss reduction and for related technical expertise. Only the few largest cities have developed the sorts of specialized technical skills required to operate the flood forecasting center and the data collection network. But most municipalities have considerable technical capability of the types pertinent to warning dissemination and preparedness, evidenced generally by the availability of a relatively full array of fire, police and other emergency services agencies in each community.

Flood Control District of Maricopa County

The Flood Control District encompasses all of Maricopa County and therefore has the territorial jurisdiction necessary to implement and operate the postulated flood warning and preparedness alternative. As described earlier, the District functions generally as the engineering arm of County government for matters related to flood loss reduction and therefore has developed considerable technical capability of that type. This close relationship between the District and

the County stems in part from the fact that the members of the County Board of Supervisors constitute the Board of Directors for the District.

The principal limitation on the role of the District in the flood warning portion of the postulated alternative concerns its legal authority. A strict interpretation of the statutes under which the District is organized suggests that its purpose is limited to the construction and maintenance of structural works for flood control. In any event, the District has always operated as if it were so limited. It would therefore be a considerable departure from past practices for the District to unilaterally undertake implementation and operation of the data collection network or the flood forecasting center. District activities not strictly related to structural measures for flood control are usually only undertaken as a service to the County and for which the District relies on County authorities and funds.

The District is even more limited with respect to the preparedness portion of the postulated alternative. It lacks any significant foundation for legislating requirements concerning evacuation or private action to protect property. About the most it could do along those lines would be to insert appropriate conditions in use permits for future floodplain activities. That approach would be of little value in reducing damages to existing developments. The District also lacks the numbers of staff necessary to carry out a significant share of warning and preparedness actions.

Institutionally, the Flood Control District is best suited by virtue of its countywide coverage and technical capabilities to provide services related to operation of the flood forecasting center through some arrangement which provides the District the necessary legal authority.

Salt River Project

The Salt River Project (SRP) consists of the Salt River Valley Water Users Association and the Salt River Project Agricultural Improvement and Power District. The SRP is one of the largest special districts in the United States.

The bulk of the SRP's area of interest is in the Salt and Verde River Watersheds, outside the case study area. Those portions of the case study area in which SRP operates include the southeastern two thirds in which SRP provides electrical service and the central portion in which it provides water for irrigation. The SRP therefore lacks the territorial jurisdiction to operate in all parts of the case study area except for such things as collection of data relevant to management of project facilities.

SRP's express purpose is to provide irrigation water and electrical power. Flood control is not one of the purposes which the District is authorized to serve. The SRP's efforts related to flood loss reduction are limited largely to giving notice of flows through project reservoirs to parties which have requested such information and to protection of its facilities.

The constraints on SRP involvement in implementation of the postulated alternative are severe and include lack of legal authority and territorial jurisdiction. Given this situation, its principal role is probably limited to provision of data collected in the course of its regular activities, financial participation in installation of new gages in areas useful to SRP and such preparedness actions as are pertinent to protection of its system.

Operation of Flood Forecasting Center

Installation and operation of the postulated Salt-Gila Flood Forecasting Center, including the data collection network and performance of the flood forecasting responsibilities, presents a question with respect to assignment of responsibility. As described in the preceding sections, none of the governments serving parts or all of the case study area combine the legal authorities, technical and financial capabilities, and orientation to do the task unilaterally.

There are three basic approaches which could be taken to creation and operation of the Salt-Gila Flood Forecasting Center. These include:

1. Operation by an existing entity, with proportionate bearing of costs by all benefitted jurisdictions;

2. A cooperative program under some kind of interlocal agreement such as a "joint exercise of powers" arrangement; and

3. Creation of a new special purpose district.

Operation by an Existing Entity

The most populous and well staffed local goverment entities in the case study area are the City of Phoenix and the Flood Control District. Either might undertake to implement and operate the flood recognition system and the Salt-Gila Flood Forecasting Center on behalf of the itself and/or others. However, such an arrangement would require the operator to become involved in matters which are not normally the agency's concern.

Another circumstance which could be considered disadvantageous by the localities purchasing the warning service would be the probable absence of control by them over the system. A contract for services usually involves payment by the purchaser for the service or performance. The providing agency or muncipality expects to administer the operation without interference and does not consider that the purchaser is entitled to any voice in operations. In addition to making services beyond the capability of smaller units of government available to them, the chief merit of the contract for service is its relative simplicity. An existing unit merely expands a function which it is to perform for itself.

Purchasing communities also would need to consider what their dollars would buy. For the life of the contract and any possible renewal periods, they would have a warning system which would probably be better than they could furnish for themselves. However, they would develop no equity in the system and could lose it entirely if the provider should decide for any reason to discontinue providing warning and preparedness for itself. Moreover, the purchasers would acquire little or no experience in operating a system because they would not be participants in its operations, except to the extent that they used the information furnished in times of flood emergency.

Joint Powers Approach

The joint powers approach also involves an agreement among the participating governmental units. Instead of providing for the sale and purchase of the service, it would make some or all of the benefitting local governments participants in operation of the system. This might be done either by assigning duties to each party or by creating a joint agency to operate the warning system on behalf of all. Under the latter procedure, each local government in effect delegates its power to provide for public safety to the joint instrumentality.

The arrangement is attractive in that it gives each participant an equity in the undertaking and a share in the control over its policies and operation. However, successful use of the joint powers approach would require satisfactory provision for important aspects of the undertaking such as funding and representation.

When an established local government embarks upon a warning and preparedness project, it may use its general tax revenues or borrow against its established credit. In the absence of special legislation, a joint powers agreement could not provide for the delegation of taxing power to the joint instrumentality. In the more normal course of events, it would be dependent upon contributions from each of the participating governments. Questions of what to do with communities which at times might not contribute their full shares could be troublesome. If the success of the operating system should be dependent on its completeness, failure of performance or insufficiency in the honoring of its obligations on the part of a participant might impair or even destroy the whole system.

The question of representation on the governing board of the joint instrumentality would require careful consideration. The communities in the region differ widely in their populations, wealth, need for the service, and ability to make contributions. If these inequalities are reflected in differential votes on the representative body, the smaller communities might find themselves with little more effective control than they would have in a purchase of services contract. On the other hand, equality of voting

strength among all participants might strike the larger communities as unfair. Governing boards of such joint agencies most commonly proceed on the principle of equality among the member jurisdictions. At least in the initial willingness to adopt the agreement, success depends on acceptance of this princple.

Special Purpose District

Creation of a special district to operate the flood recognition system and the Salt-Gila Flood Forecasting Center would allow boundaries to be drawn for the purpose which would coincide with the region to be served. Since such a district would be a separate unit of government, there would be no problem of representing existing local governments whose territory lies wholly or partially within the case study area. On the other hand, there would still be disparities in population from one part of the region to another. Consequently, to the extent that there may be significant differences of interest along urban-rural lines or geographically within the area, domination by Phoenix or Maricopa County viewpoints could result. Persons in small watersheds which have relatively little impact on the populous parts of the district might be apprehensive as to the amount of service to be received.

IMPLEMENTATION ARRANGEMENTS

It seems clear that the County should be in charge of warning dissemination and conduct of preparedness activities in unincorporated areas and that municipal governments should be in charge of the corresponding activities within their respective boundaries. Minor variations to that approach may be required in the case of small municipalities without significant resources or may occur through exercise of mutual aid arrangements. However, that general division of responsibility is straightforward, workable, and meets legal and technical requirements. It is also consistent with financial requirements and the traditional division of responsibility between the County and municipalities.

The County and the several municipalities would naturally also need to participate in those maintenance activities relevant to their warning dissemination and preparedness tasks.

With respect to creation and operation of the postulated salt-Gila Flood Forecasting Center, the recommended approach is employment of a purchase of services arrangement in which the County assumes the lead responsibility, collects funds from other participants to support the operation, and employs the Flood Control District to provide necessary technical expertise not already available to the County. The reasons for recommendation of this approach include:

1. The County is one of the few entities in the case study area with sufficient legal authority and territorial jurisdiction to perform the task;

2. The County has well developed working relationships with the Flood Control District through which it can obtain needed technical expertise;

3. Some smaller municipalities in the case study area lack resources to share in financial support of the Center. Costs for their proportionate share of the Center's expenses must be subsidized if their residents are to benefit from the flood warnings to be made available. The County has traditionally provided such assistance and services for small municipalities;

4. The County has an equal interest in all residents and parts of the case study area and therefore has more motivation than other candidates for the task to resolve differences among parties and make the Center's operation useful to all. Leadership by a city could more easily result in negotiations for support of the Center being conducted on a "take it or leave it" basis;

5. The proposed approach makes use of staff and capabilities already available for other purposes; and

6. The proposed approach continues the historic role of the County Department of Civil Defense and Emergency Services and that of

the Flood Control District in serving as the County's technical arm in matters related to flood loss reduction.

Formalizing the Plan

Formalizing the postulated flood warning and preparedness alternative would require:

1. Preparation and execution of contracts including:

   A. Between the County and other parties, including the U.S. Geological Survey, National Weather Service, Water and Power Service and SRP, for installation and operation of data collection equipment;

   B. Between the County and the several municipalities for sharing of the non-federal cost for implementation and operation of data collection equipment and the Flood Forecast Center;

   C. Between the County; Cities of Phoenix, Mesa, Tempe, and Scottsdale; and the Federal Emergency Management Agency for cost-sharing on modification and operation of the existing mass warning system; and

   D. Between the County; municipalities other than Phoenix, Mesa, Tempe, and Scottsdale; and the Federal Emergency Management Agency for cost-sharing on installation and operation of new mass warning devices;

2. Preparation and execution of memoranda of agreement including:

   A. Between the County and Flood Control District, for provision by the District of technical assistance in operation of the Flood Forecast Center;

B. Between the County and the National Weather Service, for cooperation in operation of the Flood Forecast Center;

3. Preparation and adoption by the County of a detailed plan for operation of the Flood Forecast Center;

4. Preparation and adoption of a detailed plan for warning and preparednss, including adoption of ordinances which require evaluation of people, movement of vehicles and management of gas and electrical service systems in accord with the plan by:

   A. Municipalities; and

   B. The County for unincorporated areas and incorporated areas which do not adopt appropriate plans and ordinances.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented here are based on: a) review of the relevant literature; b) review of laws, policies and procedures relating to implementation of traditional flood loss reduction measures; c) review of the past practices of the National Weather Service, Corps of Engineers and Tennessee Valley Authority with respect to the planning, implementation, operation and maintenance of flood warning and preparedness alternatives and flood emergency evacuation plans; d) conduct of one case study; and e) the authors' experiences in dealing with flood warning systems and preparedness plans and other relevant experience.

Literature useful in addressing the implementation aspects of flood warning and preparedness alternatives is limited both in amount and the range of subjects addressed. The most plentiful items are sociologically oriented analyses of disaster response and guidance on the technical aspects of planning. Both statutory and case law concerning flood warning and preparedness are largely absent and require such analyses as are made to depend on general principles. Definition of federal legislation is also lacking, most noticably in the case of Section 73(b) of the Water Resources Development Act of 1974 (Public Law 93-251).

Past efforts to deal with warning and preparedness alternatives in the depth and detail normallly accorded traditional flood control measures are non-existent so far as the authors are aware. The breadth of experience and experimentation which would make analysis of past successes and failures most productive is therefore unavailable. At most, past practice only suggests some implementation arrangements for consideration. Even the use of analogy to discern desirable implementation arrangements for warning and preparedness alternatives based on the laws, policies and procedures applicable to traditional measures is frustrated because of basic differences between the measures and the requirements associated with their implementation and operation.

The result of these and other limitations is that there are few instances in which explicit analysis can

be made of a point and so as to arrive at crisp findings which can be well documented. Most of the conclusions and recommendations presented are rooted in the authors' more general analysis of the information at hand and supposition as to what the facts might eventually turn out to be as existing law is interpreted and new laws and policies are made.

The remainder of this chapter is organized under the following sub-headings:

1. General Findings;

2. General Conclusions and Recommendations;

3. Conclusions and Recommendations on Allocation of Responsibilities;

4. Conclusions and Recommendations on Financial Aspects; and

5. Conclusions and Recommendations on Legal Aspects.

GENERAL FINDINGS

The following seven findings constitute general observations concerning important matters underlying the more specific conclusions and recommendations which follow them.

1. Governmental Interest

A federal, state and local governmental interest exists in flood warning and preparedness alternatives for four reasons, namely:

A, Relationship to overall resource management;

B. Reduction of flood losses;

C. Avoidance of future costs for flood plain management; and

D. Complementarity with other goals.

2. Guarding Against Liability

Schools, hospitals and certain other types of public and private organizations and facilities have

special responsibilities to protect persons in their care or on their premises. Deaths, injuries and property damage which result from flooding can give rise to legal liabilities. Adequate warning of impending floods can be an effective guard against the finding of liability in some cases.

The risk of liability arising in connection with operation of a warning system is small in comparison to the risk of liability in the absence of a system.

3. Implementation Requirements

The actions required for implementation and operation of flood warning and preparedness alternatives can vary greatly because of differences in the areas which they are to serve, their specific objectives, approaches toward achieving those objectives and other factors.

4. Implementation Costs

The principal costs for implementing and operating flood warning and preparedness alternatives are those related to equipment, materials and supplies, modification of utility systems and other facilities, labor associated with monitoring of weather conditions and conduct of public information programs, execution of the preparedness plan, and costs implicit in the assumption of liabilities.

5. Complexity of Implementation Arrangements

Development of arrangements for implementation of flood warning and preparedness alternatives requires the integrated consideration of the technical and financial capabilities and the legal authorities of federal and non-federal participants, relevant law on cost sharing, and factors affecting practical workability. Ideal arrangements which fit all of the constraints and meet all of the requirements in a simple and effective fashion are not readily available. Only major points of such arrangements can be settled for uniform application. The details of implementation arrangements must be individually designed for each case. Successful design will prove challenging.

6. Lack of Analogy to Structural Measures

Flood warning and preparedness alternatives differ from traditional flood control works in several ways

important to the development of implementation arrangements. The distribution of costs between planning, implementation and operation are significantly different as are the lack of need for significant amounts of land acquisition, the important role of interorganizational arrangements, and intermittent nature of operations. These differences make it impossible to follow closely the framework for implementation arrangements set forth in Section 3 of the 1936 Flood Control Act (Public Law 74-738).

7. Non-Federal Participation

The participation of local governments and the private sector is far more important in the planning and implementation of flood warning and preparedness alternatives than is the case for traditional types of flood control measures. Federal agencies lack legal authority to undertake all aspects of implementation and cannot efficiently conduct planning on a unilateral basis. Local governments normally have most or all of the legal authorities required for development and conduct of warning and preparedness programs.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

1. CONSISTENCY IN PAST FEDERAL PRACTICE

Conclusion

Future federal involvement in flood warning and preparedness alternatives on a widespread basis will be limited because federal agencies are presently pursuing divergent paths with respect to the nature and extent of federal participation in the planning, financing, implementation, operation and maintenance of such measures.

Discussion

The National Weather Service provides assistance in planning and sometimes participates in operations but provides little or no financial assistance for implementation except contribution of minor items of equipment. Tennessee Valley Authority provides financial assistance for implemenatation but has declined to participate substantially in planning and operations. Soil Conservation Service authorizes planning assistance but only limited implementation

assistance. The Corps of Engineers provides planning assistance through its Flood Plain Management Services Program but that program does not provide any financial assistance to non-federal interests. For authorized projects of the Corps, cost sharing is provided in accordance with the recommendations which are approved in the authorizing document. This diversity of approach is confusing to professional planners, local officials and the public. It encourages local governments to shop among federal agencies for the most favorable source of assistance and results in plans of differing content, thoroughness and value. None of the agencies have adequate amounts of explicit guidance available to their staff to guide determinations of agency participation in pursuing flood warning and preparedness alternatives.

Recommendation No. 1

The National Weather Service, Corps of Engineers, Soil Conservation Service and Tennessee Valley Authority should each issue guidance describing the nature and extent of assistance to be provided by the agency in planning, implementation and operation of flood warning and preparedness alternatives. Such guidance should describe:

A. Range of planning tasks which will be partially or wholly carried out by agency staff;

B. Purposes and amounts of financial assistance to be provided and cost sharing arrangements;

C. Whether and to what extent implementation responsibilities will be assumed by the agency;

D. Whether and to what extent operational responsibilities will be assumed by the agency; and

E. Assurances to be required of non-federal interests as a condition of federal assistance.

The guidance should recognize that in the absence of a study resolution, at least the Corps of Engineers

has no responsibility except to provide technical assistance in planning to non-federal interests.

Recommendation No. 2

The development and issuance of guidance by the several agencies should be coordinated to avoid the development of conflicting federal roles and policy.

2. LACK OF ATTENTION TO IMPLEMENTATION ARRANGEMENTS

Conclusion

Past federal practice in development of flood warning and preparedness alternatives exhibits little attention to the design of effective implementation arrangements or to the evaluation of those arrangements which have been used.

Discussion

Lack of detailed attention to implementation arrangements in past planning of flood warning and preparedness alternatives appears to stem in part from the lack of significant federal investment in implementation and operation. However, arrangements developed as a condition of implementation funds provided by Tennessee Valley Authority also fail to evidence much explicit consideration of the full range of factors affecting implementation. This suggests that the potential of federal investment is not alone sufficient to stimulate concern about implementation arrangements.

Recommendation No. 3

Regardless of the federal role in implementation and operation, a portion of the effort devoted by federal agencies to planning or evaluation of flood warning and preparedness alternatives should be spent for investigation of implementation arrangements.

Recommendation No. 4

Guidance pursuant to Recommendation No. 1(A) should provide for analysis of the technical and financial capability and legal authority of agencies and organizations expected to participate in planning to assure their ability to do so.

CONCLUSIONS AND RECOMMENDATIONS ON ALLOCATION OF RESPONSIBILITY

3. ALLOCATION OF RESPONSIBILITY FOR PLANNING

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in planning and evaluation of flood warning and preparedness alternatives with due regard for efficiency and their respective technical capabilities. The guidance should recognize that federal participation may not always be essential.

Discussion

Planning of flood warning and preparedness alternatives calls for a variety of types of expertise, not all of which can be easily provided by federal agencies. Among other items, local participants are best able to introduce into planning the consideration of local financial and technical capability to implement and operate, knowledge of past emergency efforts in the locale, awareness of other local ongoing activities with which the plan must mesh, sensitivity to local preferences as to approach, and insight into procedures for adoption and implementation of the alternative.

Recommendation No. 5.

Guidance pursuant to Recommendation No. 1 should stress the need for joint planning by federal and non-federal participants where available institutional arrangements permit that approach. Fully coordinated planning should be required where joint planning is impractical.

Recommendation No. 6.

Guidance pursuant to Recommendation No. 1 should focus federal agency efforts in planning of flood warning and preparedness alternatives on:

A. Hydrologic, hydraulic, economic, environmental, engineering and other technical analyses of the flood hazard and needs of the area to be served;

B. Formulation of alternative concepts for warning and preparedness;

C. Design, evaluation and specification of the technical aspects of data collection systems and equipment, communications systems and equipment, data analysis and flood prediction procedures, and similar component parts of the alternative;

D. Identification of resources needed and other requirements for successful implementation and operation of the alternative; and

E. Provision of assistance to non-federal interests in developing implementation arrangements.

4. ALLOCATION OF RESPONSIBILITY FOR IMPLEMENTATION

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in implementation of flood warning and preparedness alternatives with due regard for their respective legal authorities and their technical and financial capabilities. The guidance should recognize that federal participation is not always essential.

Discussion

Limitation of non-federal responsibilities for implementation of flood warning and preparedness alternatives to the requirements of Section 3 of the 1936 Flood Control Act, Public Law 74-738, and subsequent acts relating primarily to flood control works would result in almost total federal responsibility for implementation in the case of projects for which there was a federal planning authority. However, federal agencies lack authority to perform many of the implementing actions such as adoption of the plan, promulgation of ordinances, and consumation of local intra-and inter-governmental agreements.

Assignment of implementation responsibility affects settlement of cost sharing arrangements and the timing of participants' expenditures. Both precedent and other considerations favor assignments of responsibility that facilitate federal payment of initial costs.

Recommendation No. 7.

Guidance pursuant to Recommendation No. 1 should specify the basic responsibilities to be assumed by federal agencies in implementation of authorized flood warning and preparedness alternatives including but not limited to:

A. Specification, acquisition and installation of equipment and materials for data collection and analysis, warning dissemination, and other related purposes;

B. Initial training of participants;

C. Development and provision of educational and informational materials; and

D. Provision of technical assistance in ordinance preparation, hearings and information meetings.

5. ALLOCATION OF RESPONSIBILITY FOR OPERATION

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in operation of flood warning and preparedness alternatives with due regard for practicality, effectiveness and their respective legal authority. Typically, federal agencies would have no local role.

Discussion

The reliability and timeliness of operation of a flood warning system is enhanced by the day-to-day presence of those in charge of operations. The federal government cannot provide this level of service on a regular basis for all localities for which flood warning systems might eventually be implemented. In addition, day-to-day operation of the flood warning system makes an important contribution to maintaining local interest and readiness.

Execution of flood preparedness plans generally requires the capability for immediate response, detailed knowledge of local circumstances, and use of readily available resources. These requirements can be most dependably met through assigning

responsibility for execution of the preparedness plan to non-federal interests in the immediate area. The federal government also lacks authority to carry out many types of actions likely to be involved in execution of a local flood preparedness plan.

Recommendation No. 8.

Guidance pursuant to Recommendation No. 1 should emphasize assignment of responsibility to local, non-federal interests for operation of the flood warning system and execution of the preparedness plan excepting:

A. Inclusion wherever possible of arrangements for local warning systems to take advantage of the weather forecasting program of the National Weather Service; and

B. Operation by the National Weather Service of data collection and analysis systems where the complexity of the system or other aspects of operation exceed the technical capability of local interests.

6. ALLOCATION OF MAINTENANCE RESPONSIBILITY

Conclusion

Guidance is needed which sets forth the roles of federal and non-federal participants in maintenance of authorized flood warning and preparedness alternatives with due regard for their respective legal authorities and technical capabilities and for protection of the federal government's investment in planning and implementation.

Discussion

The key elements of maintenance include testing, servicing and repair of equipment; updating of plans and procedures; renewal of inter-local agreements; conduct of periodic training and informational activities; and improvement of the plan as necessary based on its use. Non-federal interests generally have the authorities and capabilities necessary to carry out most of these activities. Federal assistance is likely to be needed only in the more technically complex maintenance activities for sophisticated flood warning systems and preparedness plans.

Recommendation No. 9.

Guidance pursuant to Recommendation No. 1 should emphasize assignment to non-federal interests of responsibility for maintenance of flood warning systems and flood preparedness plans excepting:

A. Annual inspections to assure readiness;

B. Provision of technical assistance in modifying the warning system or plan after implementation;

C. Approval of any substantive modifications to the warning system or plan;

D. Participation in and/or observation of drills, training exercises and other periodidc efforts to practice operations pursuant to the plan; and

E. Review and evaluation of post-flood reports on operations of the warning system and preparedness plan for purposes of practice or in response to actual or perceived flood threats.

CONCLUSIONS AND RECOMMENDATIONS ON FINANCIAL ASPECTS

7. POTENTIAL FOR DISCRIMINATORY BENEFITS

Conclusion

Selection of approaches taken in the technical aspects of flood warning and preparedness alternatives and in the design of implementation arrangements may result in inequitable distribution of benefits among intended beneficiaries.

Discussion

Alternatives which place a portion of the implementation cost on individuals by requiring them to purchase radios, subscribe to cable television service or take other actions to receive warnings may result in discrimination against the poor in distribution of benefits. Inequitable distribution of benefits may also result from differences in the thoroughness and reliability of warning arrangements for sub-areas or the extent to which all parties can receive and comprehend the warning.

Recommendation No. 10.

Guidance pursuant to Recommendation No. 1 should stress careful analysis of warning and preparedness alternatives and the arrangements for their implementation and operation to assure all persons intended to be served by the measure receive equitable benefits regardless of economic status, location, physical handicaps or other reasons.

CONCLUSIONS AND RECOMMENDATIONS ON LEGAL ASPECTS

8. LACK OF DEFINITIVE LAW

Conclusion

Little case and statutory law exists to guide consideration of the legal aspects of implementing and operating flood warning and preparedness alternatives; action is needed to establish a foundation for the consistent interpretation of general principles of law which are relevant.

Discussion

Whether or not the warning and preparedness functions are classified as obligatory or permissive, there is a need to make sure that any responsibilities that may be translated into liability are in line with the state-of-the-art in forecasting and properly reflect the difficulties in balancing the consequences of overstating or understating warnings with the economic and safety consequences of mistaken advice to the general public. While it is essential that the public pay attention to warnings and rely on them, it is also important for there to be proper understanding of the imperfections and limitations on warning systems and the scientific knowledge underlying them.

Recommendation No. 11.

In order to resolve some of the uncertainties which now exist, it should be made clear by state law that public agencies with assigned responsibilities are liable for neglect, omission or unprofessional performance in giving warnings, but that considerable latitude is to be accorded in the light of the necessity for them to exercise discretion and judgment in disseminating warnings.

9. NEED FOR DETAILED LEGAL ANALYSIS

Conclusion

Generalized analysis of legal aspects is inadequate as a basis for design of implementation arrangements for flood warning and preparedness alternatives. Each set of arrangements must be tailored to local conditions.

Discussion

Implementation of flood warning and preparedness alternatives involves numerous legal considerations related to duties and authorities of the participants which affect financial capability and susceptibility to liability. States and sometimes lower governmental units within a state differ in the extent to which sovereign immunity has been waived and the basis on which suits can be brought. States also differ in the extent to which they have provided for intergovernmental action of the types necessary for planning, implementation, operation and maintenance of flood warning and preparedness alternatives. Given these differences as well as the wide range of requirements which could exist depending on the sort of alternative developed, it is unlikely that implementation arrangements for any two flood warning and preparedness alternatives will be identical in every respect except for the very simplist and least expensive ones.

Recommendation No. 12.

Design of implementation arrangements for flood warning and preparedness arrangements ought to include detailed review of the proposed arrangements by local legal counsel.

Recommendation No. 13.

An appropriate agency of the federal government ought to prepare a state by state summary which identifies major aspects of law relevant to each state including:

A. Sovereign immunity;

B. Authority of municipal corporations to own property outside their boundaries;

C. Authority to order evacuation pursuant to a preparedness plan.

10. PLACEMENT OF LIABILITY

Conclusion

Concern for liability is likely to be an obstacle to acceptance of flood warning and preparedness alternatives notwithstanding the moderate nature of the risk, in part because the parties to which it attaches may be uncertain.

Discussion

Many flood warning and preparedness alternatives make extensive use of private parties and organizations as volunteers. Given the "good samaritan" rule, volunteers may be reluctant to participate because of the risk of liability. Other agencies and governments may also be hesitant to join into inter-and intra-governmental efforts unless the risk of liability for faulty performance is minimized.

Recommendation No. 14.

Implementation arrangements should make use of contracts as required to specify placement of liability to the detail possible.

11. PLAN ENFORCEMENT

Conclusion

One of the major obstacles to effective operation of a warning system and execution of a preparedness plan is the possibility of parties not acting in accord with the plan.

Discussion

Operation of warning systems and especially the execution of preparedness plans requires the coordinated action of numerous private and public organizations, cooperation of individuals, and sometimes actions requiring extraordinary legal authorities. Simple awareness of the plan or even its formal acknowledgement by community officials is insufficient to assure adequate participation.

Recommendation No. 15.

Implementation arrangements should include provisions for making the plan into law through an appropriate ordinance.

APPENDIX A

BIBLIOGRAPHY

APPENDIX A

BIBLIOGRAPHY

The literature which specifically addresses the managerial aspects of developing and implementing flood warning and preparedness alternatives is limited. As experience is gained in both planning and use of such measures, additional and more specific materials will doubtless become available.

The lack of literature is particularly acute with respect to the legal aspects of flood warning and preparedness for which virtually nothing exists. Under a grant from the National Science Foundation, the Lewis and Clark Law School has prepared a report on liability problems relating to governmental responsibility arising out of the federal program to encourage purchase and use of home receivers specifically designed to receive disaster warnings ("Legal Constraints on the Planning and Development of Disaster Home Warning Systems", December 1977). This report is primarily devoted to an analysis of the Federal Tort Claims Act and cases thereunder. Aside from this publication, the only sources of guidance on legal considerations are the generally applicable tort principles dealing with fault and the statutory and case law respecting sovereign immunity and its limitations. The text and footnotes to the present report contain the authors' formulations based on application of this material to problems of flood warning and preparedness.

This bibliography identifies some of the more useful publications which might warrent review by those engaged in planning of flood loss reduction programs.

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