FLOOD HAZARD MITIGATION HANDBOOK

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FLOOD HAZARD MITIGATION HANDBOOK

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Land & Water Management Division

August 1988

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PART I

FLOOD HAZARD MITIGATION

INTRODUCTION

Floods are a persistent and serious problem throughout the state and nation, causing more property damage than any other type of natural disaster. Approximately six percent of Michigan's land area, encompassing more than 200,000 buildings, is considered prone to flooding. Although the flood hazard areas are spread throughout the state, the highest risk zones are in the populated areas of the southern two-thirds of the Lower Peninsula, including the glacial lake bed areas along Lake Erie, Lake St. Clair and the Saginaw Bay of Lake Huron. Currently, average annual flood damages in Michigan are estimated to be between $60 and $100 million. Contributing to the high level of annual damages, Michigan has experienced three federally declared flood disasters in the last six years. These floods and associated damages are:

1. March 1982--flood disaster in Berrien and Monroe Counties, with estimated damages of $12 million.

2. September 1985--flood disaster in Alcona, Saginaw, Genessee and Lapeer Counties with estimated damages of $63 million.

3. September 1986--flood disaster covering 30 central Michigan counties, with estimated damages exceeding $500 million.

Flooding, for the most part, is not a problem until flood waters encroach upon developed areas. Since it has been our history to live and build around water, it is not surprising that flood waters threaten homes and other structures. What is surprising is that floodplain development continues to increase--resulting in increases in potential flood related damages. Although there are state and local programs to regulate new development or substantial improvements in flood prone areas, there is very little being done to minimize the impact of flooding on existing flood prone structures. Federal and state programs that affect existing structures usually come into play after a disaster and emphasize quick recovery. Because of this emphasis, most opportunities for effecting long-term flood hazard mitigation measures, such as removing or floodproofing damaged buildings, are missed.

The flood of September 1986, for example, damaged an estimated 30,000 buildings. Both Federal and state emergency programs tried to get people back to normal living conditions in these homes as quickly as possible, without looking at possibilities for either moving the structure out of the floodplain or floodproofing the structure. Thus, citizens are placed into the damage-rebuild-damage-rebuild cycle experienced with many existing floodprone structures.

The impetus to remove floodprone structures from the floodplain has to come from the local level. State and Federal governments can provide technical support and help define funding, but the decision to floodproof or remove floodprone structures is primarily a local responsibility.

Since the community is in a poor position to develop a comprehensive flood mitigation plan during the process of recovering from a flood, it is important to address the flooding issues before the flood occurs.

The purpose of this handbook is to provide information on flood hazard mitigation that will aid local units of government in developing a plan of action that will reduce the damage and threat to life caused by floods.

PROBLEM IDENTIFICATION

RECOGNIZING THAT A PROBLEM EXISTS

The first step in developing a flood hazard mitigation plan for a community is to recognize that potentially severe flood hazards do exist in many areas. The term "100-year flood" is misleading; the flood seems like a remote threat--a dimly feared disaster that only happens once every one hundred years But such a flood follows no time schedule. It has a 1% chance of occurring in any given year, regardless of the date of the last occurrence. Looking at it from another perspective, it is a flood that has a 26% chance of occurring during a 30-year mortgage. It is equally important to recognize that flood hazard mitigation planning can help break the flood-rebuild-flood-rebuild cycle that often results from the short-term management of post-flood recovery programs in frequently flooded areas.

The process of problem identification is extremely important since the way the question is framed influences the answer--the problem definition influences the shape, scope, and character of the possible solutions. Therefore the problem should be defined in terms of the needs, goals, and the economic and social concerns of the community, as well as in terms of the physical aspects of the community and the flooding source.

PROBLEM DEFINITION

The first step in arriving at a solution to any problem is to begin with a good understanding of what the problem is. In the case of flood hazards, the process must begin with an evaluation of 1) the extent to which a flood hazard exists and 2) how those hazards affect the community. Then, 3) a thorough environmental impact assessment should be carried out by your community addressing the physical, economic, social, biological, and cultural issues associated with the flood plain and the flooding itself. To accomplish, this it is necessary to:

1. Determine the flooding source and its characteristics.

2. Develop a flood stage damage forecast map.

3. Determine the overall needs of the community and how they can be coordinated with the need for flood hazard mitigation.

DETERMINE THE FLOODING SOURCE AND ITS CHARACTERISTICS

To understand the extent of the flood hazard in an area, it is necessary to determine 1) what is causing the flooding, 2) how high the water will get, 3) how long it will last, and 4) how much warning time there will be. Information should also be gathered concering the conditions of any protective works such as sea walls along the Great Lakes or flood walls or dikes along a stream system. It is also important to note the condition of upstream dams if they exist. The most common source of information about flooding is from the Federal Flood Insurance Study for the community. Other sources include: Michigan Department of Natural Resources (MDNR) Land and Water Management Division; Soil Conservation Service; the U.S. Army Corps of Engineers; U.S. Geological Survey; county drain commissioner; building inspector; or the city/township engineer.

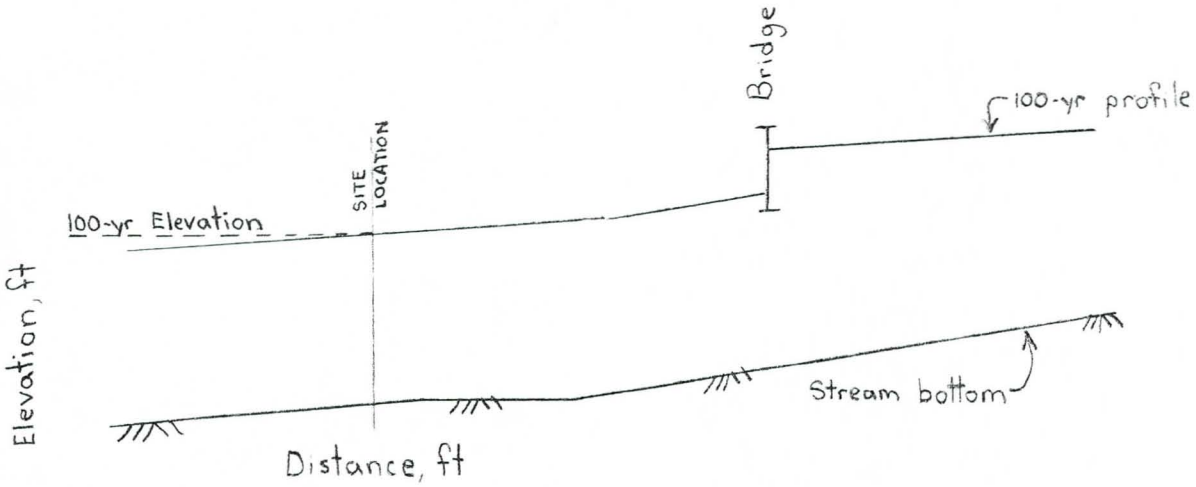
The information that is available in the published Flood Insurance Studies includes:

1. Flood Elevations - Typical Flood Insurance Studies contain elevations for floods which will occur on the average of once in 10-, 50-, 100-, and 500-years. The base flood level used for regulation is the 100-year flood. (A 100-year flood refers to the flood stage that has a 1% chance of occurring during any given year.)

2. Flood Velocity - For riverine flooding the velocity of floodwaters (in feet per second) is listed in the Floodway Data Table of the Flood Insurance Study (FIS).

3. Flood Depth - The depth of the flood cannot be obtained directly from the FIS. However, if the ground elevations are known, the depth of flooding is the difference between the flood elevation and ground elevation at any specific point.

Figures 1 and 2 illustrate the information that is available in a Flood Insurance Study.

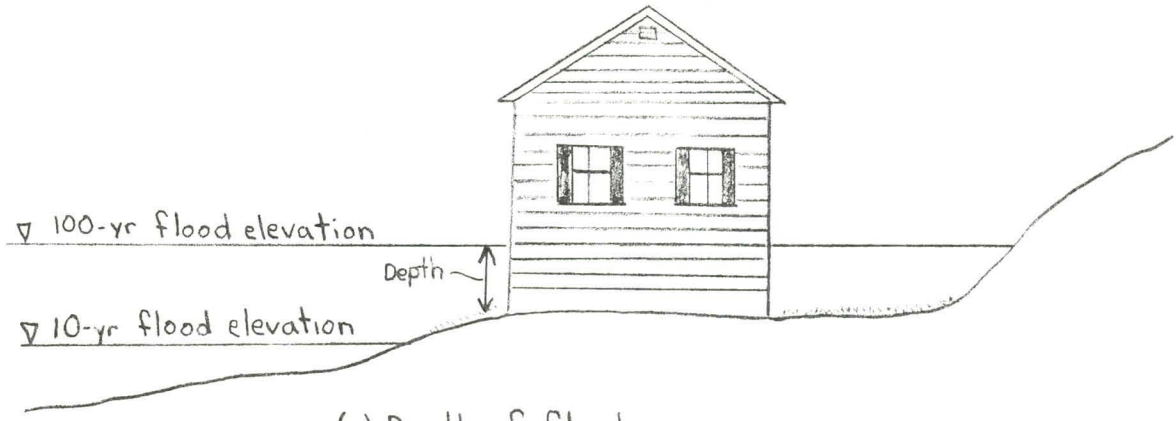


(a) 100-yr flood profile

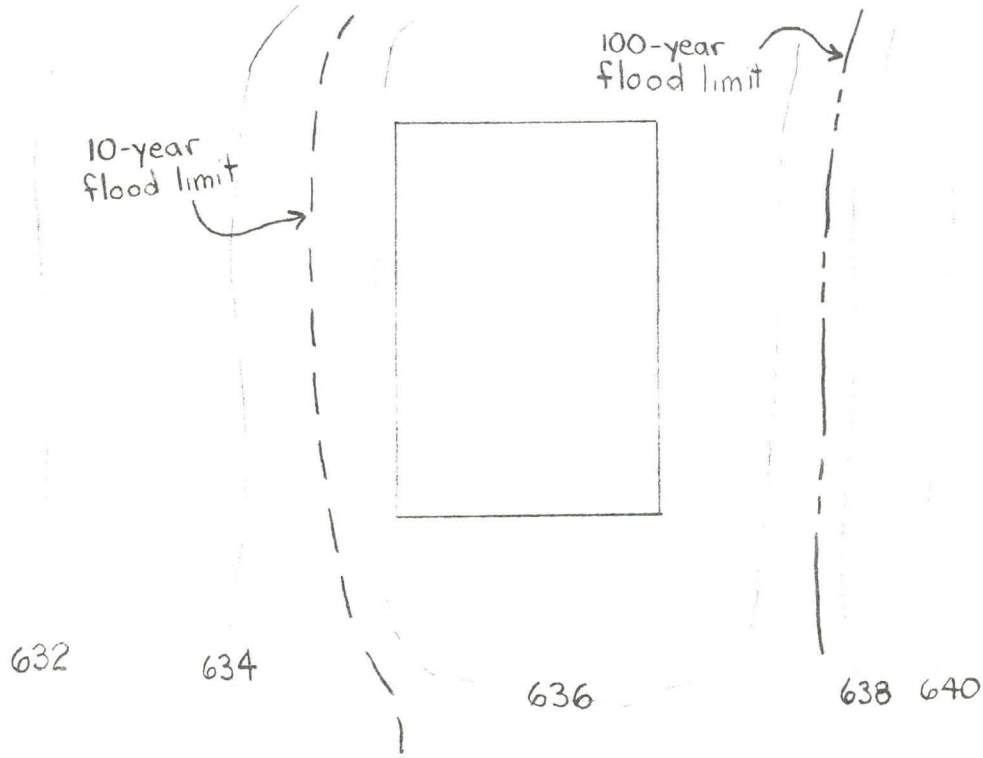
STATION	FLOODWAY WIDTH (FT)	FLOODWAY SECTION AREA (SQ FT)	FLOODWAY MEAN VELOCITY (FT/SEC)	WATER SURFACE ELEVATION WITH FLOODWAY (NGVD)	WATER SURFACE ELEVATION WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT)
8300.000	1023.	9665.	2.2	634.6	634.5	.1
9500.000	397.	6481.	3.2	634.8	634.7	.1
10000.000	236.	4619.	4.5	634.9	634.8	.1
10095.000	190.	3771.	5.6	635.0	634.9	.1
10100.000	197.	3848.	5.5	635.0	634.9	.1
10115.000	197.	3849.	5.5	635.0	634.9	.1
10120.000	200.	3827.	5.5	634.9	634.8	.1
10600.000	600.	8090.	2.6	635.8	635.7	.1
11000.000	650.	9466.	2.2	635.9	635.8	.1
11450.000	650.	9189.	2.3	636.0	635.9	.1
11900.000	750.	11900.	1.8	636.0	635.9	.1
12100.000	750.	7747.	2.7	636.0	635.9	.1

(b) Typical Floodway Data Table

Figure 1 Information available in published Flood Insurance Studies



(a) Depth of flooding



(b) Topographic Map

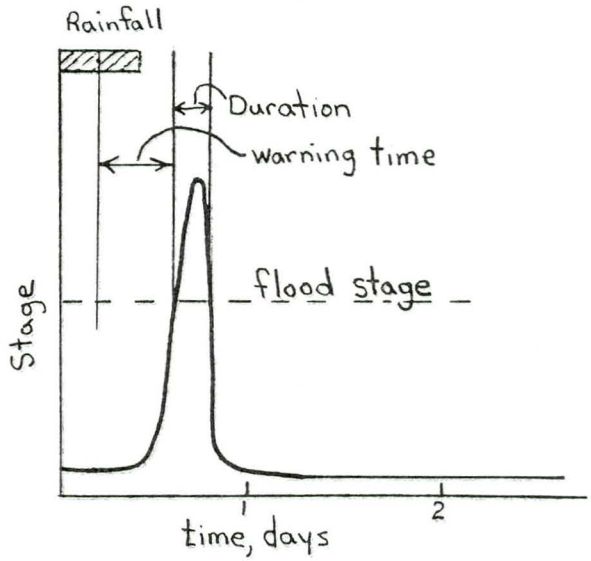
Figure 2 Flooding Characteristics

The following information may be available from the data used to prepare the Flood Insurance Study, or from a nearby U. S. Geological Survey Gaging Station:

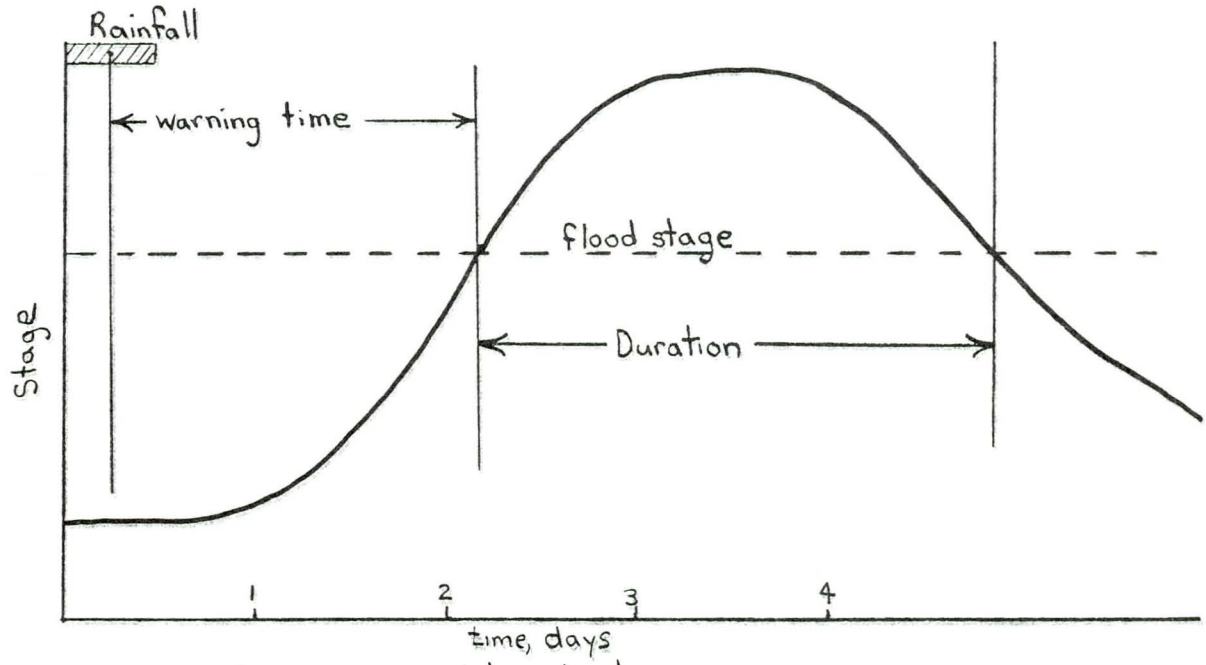
1. Duration - The length of time that a flood lasts can be critical when it is necessary to feed and shelter evacuees, and to determine the types of flood mitigation techniques to be used. The majority of the rivers and streams within Michigan usually have flood durations that range from several hours to several days.

   To obtain assistance in estimating the duration of the flooding contact the MDNR, Land and Water Management Division; the U. S. Geological Survey, Water Resources Division; the Federal Emergency Management Agency (FEMA); or the U. S. Army Corps of Engineers, Detroit District.

2. Warning Time - the time between the first indications that a flood is probable and the time when water levels exceed flood stage in the community. In urban areas that have sewers and gutters or in small drainage basins that are very hilly, the flood stages may occur in the community within a couple of hours. On the Grand River or the Saginaw River, however, the warning time may be several days. The MDNR, Land and Water Management Division; the U. S. Geological Survey Division; or the National Weather Service may be very helpful in determining the warning time.



(a) Small Urbanized Watershed



(b) Large Watershed

Figure 3 Graph of Stage versus time for a small and a large watershed

DEVELOP A FLOOD STAGE DAMAGE FORECAST MAP

Once the flooding source is identified, the next step is to determine how the flood hazard affects the community. The most useful and concise way to combine information about the flooding source with information about the community is to develop a Flood Stage Damage Forecast Map. (See Figure 4). A Flood Stage Damage Forecast Map is, essentially, the flood plain information from the Flood Insurance Rate Map superimposed over a detailed topographical map of the community. This combined with an elevation survey of all buildings within the hazard area that will show elevations of floors and openings will clearly indicate which buildings in the community are at risk from flood damage.

Ideally, the base map used in the preparation of the Flood Stage Damage Forecast Map should be a topographic map obtained by aerial photographs. The Flood Stage Damage Forecast Map should meet the following guidelines:

1. Be drawn at a scale large enough so it is possible to locate buildings, homes, streets, bridges, and railroad tracks. A scale of 1" = 400' or larger is recommended.

2. Contain contour lines (lines connecting points of equal elevation) at 1, 2 or 4 foot intervals. If contour information is not available, it would be advisable to measure elevations at various sites throughout the community. These spot elevations could be obtained under the supervision of a land surveyor or engineer.

3. Show the areas that will be flooded for various flood stages. If the community has a Flood Insurance Study, elevations should be available for the 10-, 50-, 100-, and 500-year floods--the 100- and 500-year floodplain is delineated on the Flood Insurance Rate Map.

4. Indicate elevations of floors and openings of affected buildings.

5. Indicate critical areas such as hospitals, police and fire departments, nursing homes, schools, waste water treatment plants, etc.

6. Show evacuation routes and routes that should be barricaded.

7. Show areas that must be evacuated.

8. Show the location of the Emergency Operations Centers and Evacuation Centers.

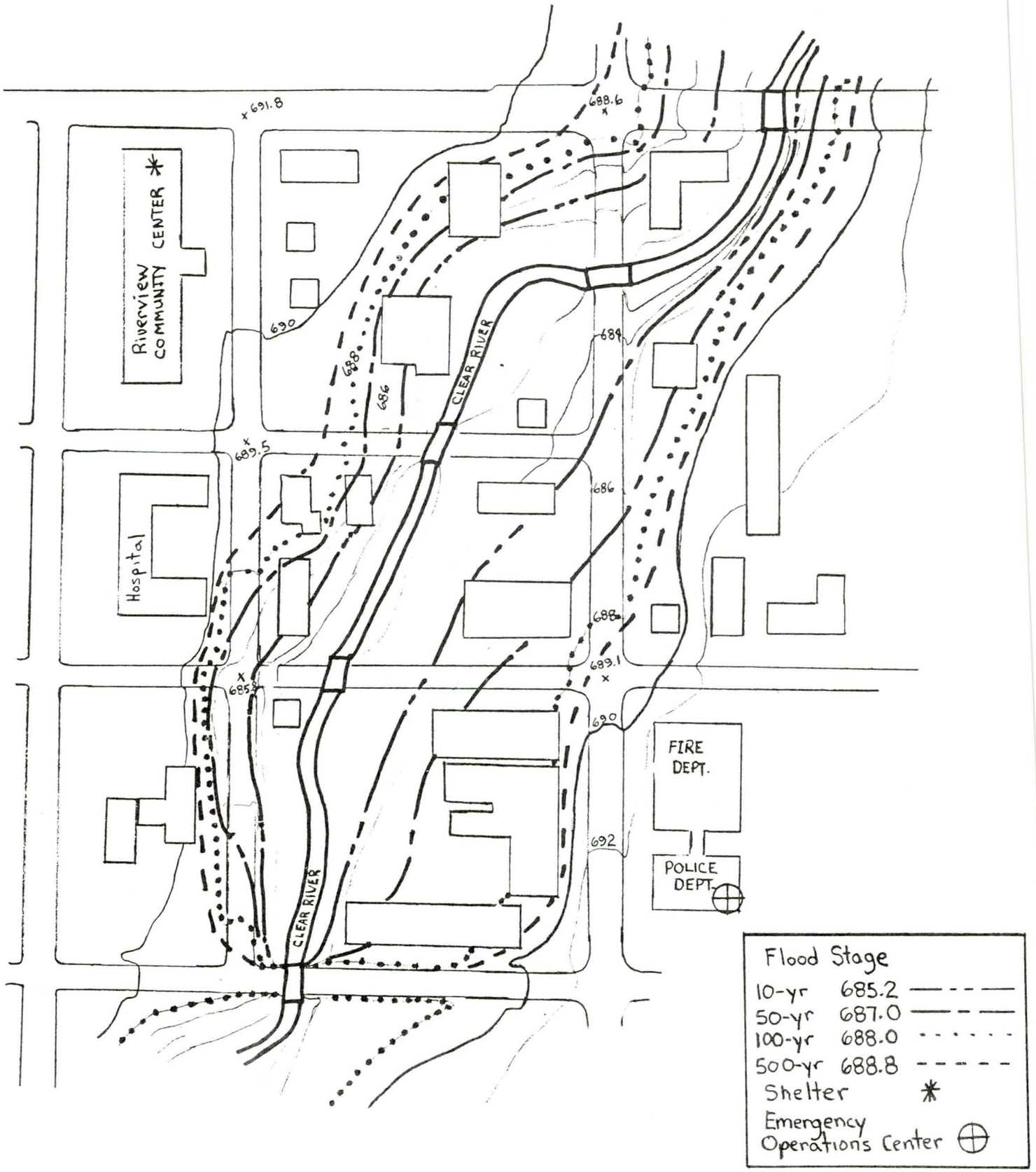


Figure 4 Flood Stage Damage Forecast Map

DEFINITION OF NEEDS

In order to represent the interests of every sector of the community in the problem definition, it is important to convince citizens, businesses, and community leaders that a problem does exist and that it is in their best interests to contribute ideas, information, time, money, and effort to the flood mitigation planning process. Local businesses can be an important source of funding and support for public information campaigns and the early stages of planning as well as in the implementation of mitigation measures. Many people may not realize that feasible and effective flood mitigation measures exist. The local media can be very helpful by publicizing the flood hazard mitigation effort in a positive and informative way--encouraging community members to consider the flooding problem and what can be done about it.

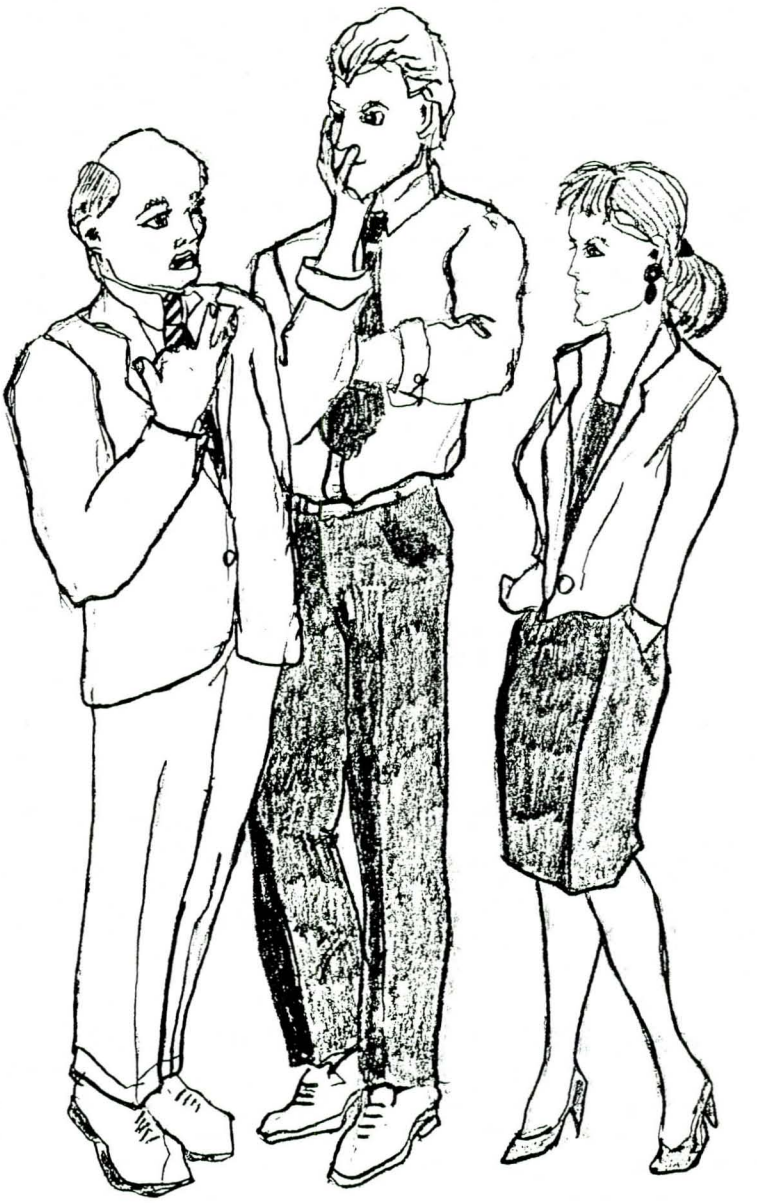
It is important to recognize that flood hazard mitigation does not have to be a negatively perceived or an isolated process. Flood hazard mitigation can be incorporated into long-term community development needs such as expanding recreational areas and open spaces or revitilizing business districts and rehabilitating substandard housing. Through community involvement and support, the flood hazard mitigation planning effort has been made a positive tool for community development in many areas. The community benefits both from the minimized flood losses and from the new community development that may result.

The following are suggestions for obtaining a broad-based understanding of the community's needs:

1. The legislative body should appoint a Flood Hazard Mitigation Committee that represents the community as a whole. It should include floodplain residents, zoning administrators, local officials and business people. The committee will need the help and input from engineers, hydrologists, planners, economists, and attorneys.

2. Hold public meetings to solicit input from citizens. In addition to educating citizens about the benefits of flood mitigation programs, public meetings provide the community members with an opportunity to express their ideas, opinions, and reservations concerning flood hazard mitigation planning. Such information may provide some insight on the current flood mitigation program (or lack of it), could help identify problem areas, and would help stimulate the community's interest in supporting and participating in the flood hazard mitigation planning process.

3. Obtain input from the local government or community council on the location of recent flood damages and areas where future development may take place. Determining the direction that future development is likely to take is very important since a good flood hazard mitigation plan takes long-term as well as short-term concerns into account.



4. Obtain estimates of previous flood damages from the County Emergency Services Director, the Emergency Management Division of the Michigan State Police and Federal government agencies as well as from businesses and private individuals. At the Federal level FEMA is a good starting point.

5. Obtain input from state agencies concerning hazard mitigation techniques that may be applicable to your community; the Emergency Management Division of the Michigan State Police and the Michigan Department of Natural Resources, Land and Water Management Division, can provide assistance and information.

FLOOD HAZARD MITIGATION ALTERNATIVES

Floods will continue to occur with or without man's intervention. The Great Lakes Basin Framework Study published in 1970 projected average annual flood damages would continue to increase at the rate of $1.4 million per year ($4.1 million /year in 1987). We need to minimize this increase in flood damages while decreasing the impact of floods on existing flood prone buildings. Many methods do exist which have proven effective in minimizing flood damages under varied conditions. These efforts to reduce losses due to flooding are of three basic forms:

1. Keeping the flood waters away from the people.

2. Keeping the people away from the flood waters.

3. Flood fighting--flood warning and emergency response measures.

KEEPING THE FLOOD AWAY FROM THE PEOPLE

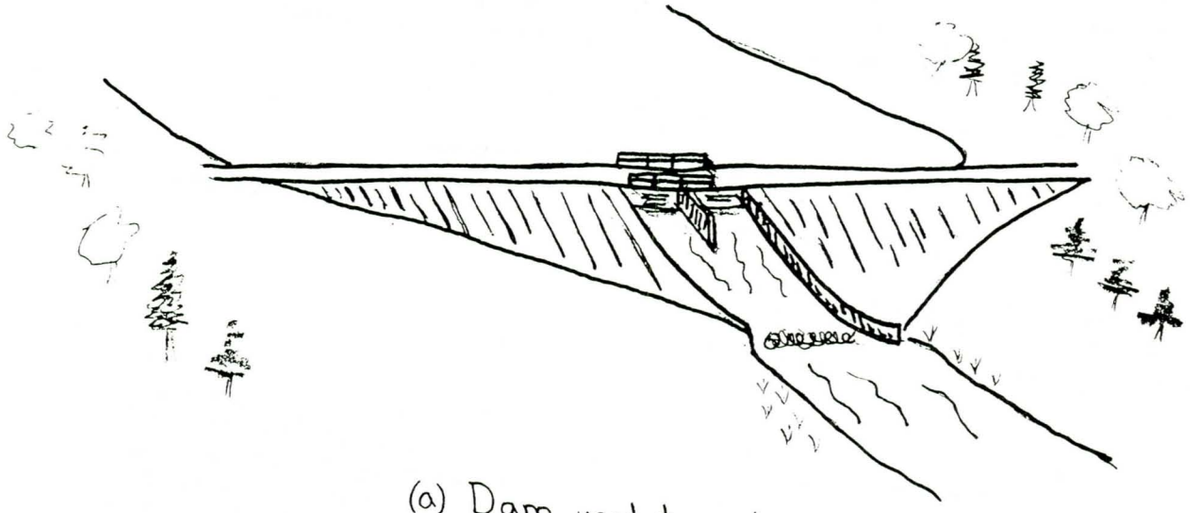
Modification of the Flooding Problem

This approach attempts to keep the flood waters from reaching existing developed areas by reducing flood flows, increasing the flow carrying capacity of a stream, or by containing the flood with permanent structures such as dams, channel alterations, or levees. This approach is seldom the most economical or physically feasible in Michigan's floodprone areas.

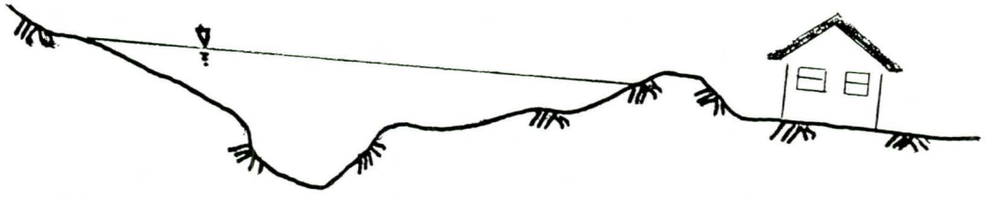
The City of Flint, for example, built a flood control project that consisted of improvements on the Flint River, Swartz Creek, and Thread Creek. The improvements on the Flint River consisted primarily of channel straightening, enlargment, paving, and beautification. The work on Swartz Creek and Thread Creeks included straightening, enlarging, and changing channel configuration to a trapezoidal cross-section. Also, three single-purpose flood water retarding structures , 40 miles of single-purpose channel work and 5.7 mies of levees provde for an 89% reduction in flooding and improved drainage in the area. These structures greatly reduced damages from the 1986 flood disaster.

In a very dramatic example of how effective flood control works can be, the City of Frankenmuth constructed a flood control project in 1982 which significantly reduced flood damage to the City in the 1986 flood disaster. Vassar, a town further upstream, did not construct a recommended flood control project and subsequently experienced the worst flood damages in their history during the 1986 flood disaster.

Although the construction of flood control works can provide protection from flooding, this approach is not often taken in Michigan because of environmental concerns and lack of economic feasibility.



(a) Dam used to reduce flood flows



(b) Levee to keep flood water from structure

Figure 5 Modification of the Flooding Problem

Floodproofing (Retrofitting)

While dams and other flood control projects attempt to protect large areas, or long reaches of a watercourse, floodproofing is used to protect individual structures. The protection is provided by modifying the structure or the building site to prevent the entrance of damaging floodwaters. "Retrofitting" is used to describe floodproofing techniques that are applied to an existing floodprone structure. The general categories of floodproofing measures are:

1) Elevation of the structure above the flood level (at existing site).

2) Relocation of the structure to a less hazardous site.

3) The construction of levees to divert flood waters from the structure.

4) The construction of floodwalls to block flood waters from entering the structure.

5) The use of special closures (such as flood shutters over openings) or sealants to seal out flood waters.

6) The installation of sewer shutoff devices to forestall basement flooding due to overloaded sanitary sewer and runoff drainage systems.

Such methods are well established and most can be accomplished economically in a short time.

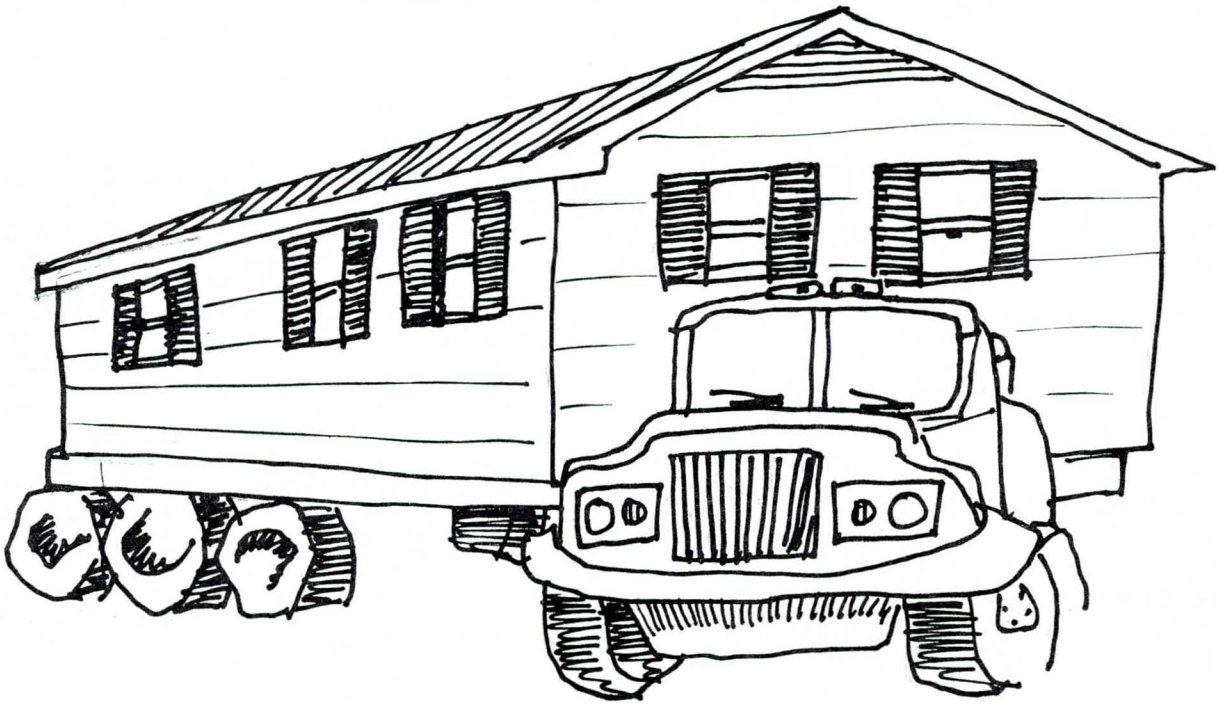
For some structures which are located in areas with especially deep flooding (over 6 feet) or floods of high velocity (greater than 5 fps) many of the floodproofing methods would be inadequate. Determining whether or not floodproofing is the best course of action and deciding which type of floodproofing would be the most efficient and effective requires examination of the characteristics of the structure, its location, and the expected flood. The Federal Emergency Management Agency has published a Design Manual for Retrofitting Flood-prone Residential Structures (FEMA 114) which provides an in-depth discussion of the various retrofitting methods, technical advice, and aides for decision making. The manual may be ordered from:

FEMA Publications
P. O. Box 70274, S.W.
Washington, D.C. 20024

1. Elevation

Raising or elevating a structure above the 100-year flood elevation reduces the flood damage potential significantly. With proper foundation design, this technique can be used in areas of deep flooding.

The elevated house can be placed on several types of foundations, including earth-fill, piers, pilings, or vertical walls. Since the elevation of the lowest floor is above the 100-year flood elevation, the flood insurance premiums will be reduced.

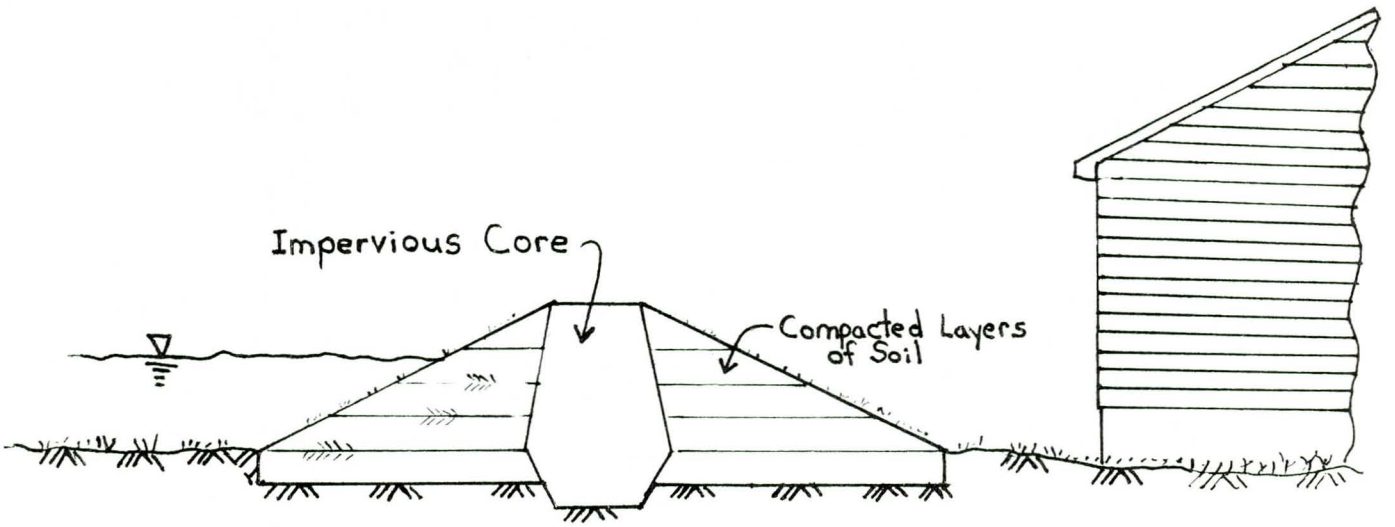


2. Relocation

As a retrofitting technique, relocation minimizes the flooding potential by moving the structure out of the floodplain. Another benefit to the owner would be a significant reduction, or the elimination of the flood insurance premium.

Relocation may be expensive since it requires raising the house, loading it unto a trailer, moving the house out of the floodplain and placing the house on a new foundation. Because of the complexity involved in moving a house, the job will have to be done by a professional.

3. Construction of Levees



Levees are constructed of compacted soil with the purpose of preventing flood waters from damaging structure or property.

As a retrofitting (floodproofing) technique the construction of levees has several advantages.

a) May be less costly to construct than other techniques.

b) Using landscaping it may be possible to blend the levee in with the existing ground features.

c) Pressures due to water and impacts from debris are kept away from the structure. (Providing the levee is not over-topped or does not fail).

However, there are several drawbacks to the construction of a levee.

a) State Law (Floodplain Regulatory Authority, Act 245, PA of 1929, as amended) along with local ordinances may limit the use of levees. Under State Law, it is unlawful for a person to occupy the floodplain in such a manner that it causes a harmful interference to the flood carrying capacity of the watercourse. The construction of a levee within the floodway of a watercourse would result in upstream flood stages being increased and the possibility of flow being shifted onto adjacent property owners. It is unlikely that a levee would be permitted within the floodway. (See Figure 6)

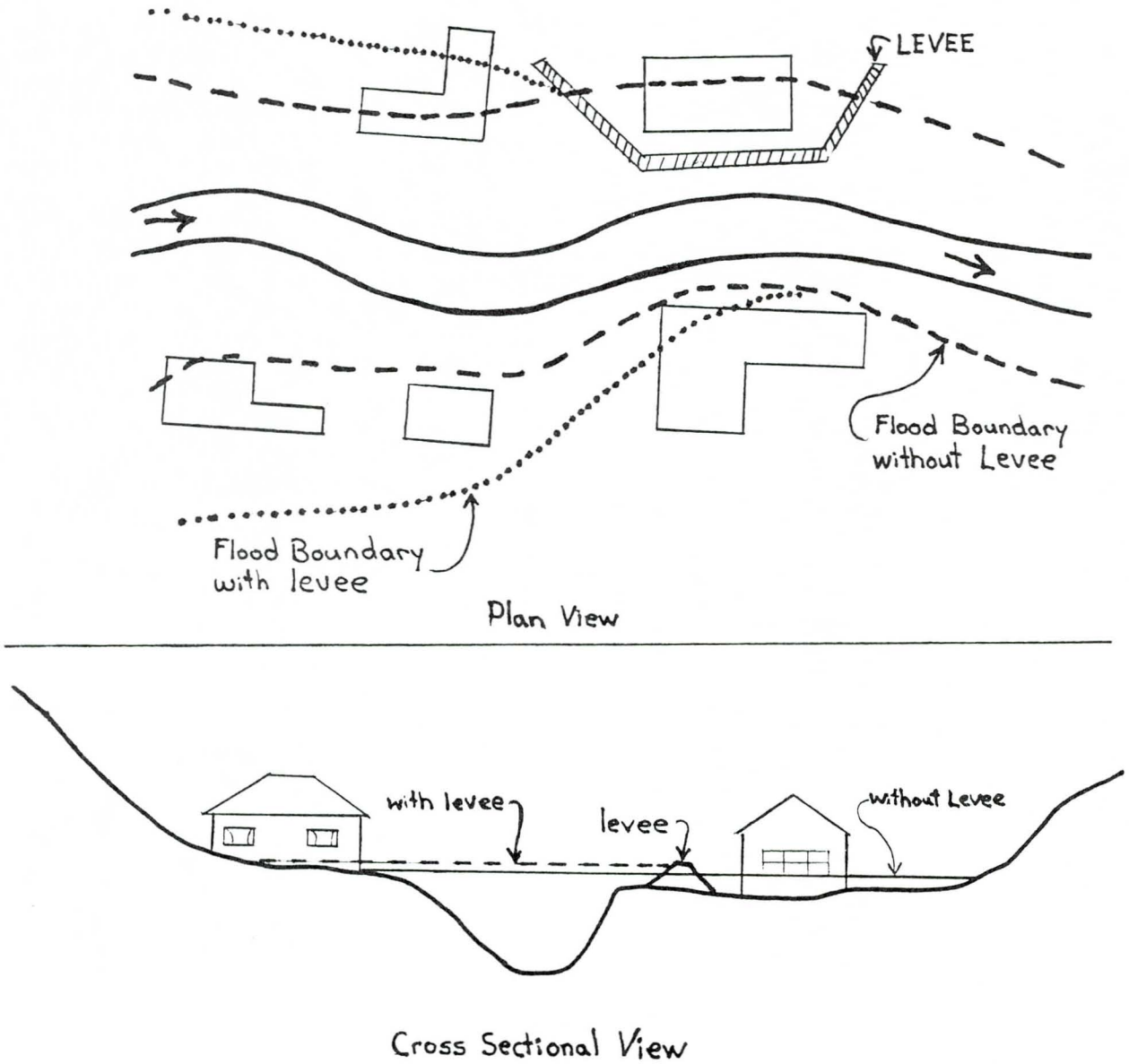


Figure 6 The construction of a levee may increase upstream flood stages, and damage adjacent property owners

b) Levees may provide a false sense of security to the homeowners. There is always the potential that the levee may be overtopped or fail. Should failure occur, the damage may be more severe than what would have normally occurred. Even though a structure may be protected by a levee, it should be evacuated during a flood.

c) The levees will eliminate natural drainage within the perimeter of the levee. As a result, it would be necessary to provide for interior drainage through the use of sump pumps or drains with back-up valves (See Figure 7). If the sewer system will become surcharged, it will be necessary to install a backwater valve on the sanitary sewer system, to prevent sewage from "backing" into basements.

d) Levees will require a considerable amount of room to be constructed. To provide stability to the levee, the side-slopes of the levee are usually about 1 foot vertical to 2 or 3 feet horizontal. As a result, the width of the base of the levee may be 4 to 6 times the height of the levee.

e) Construction of a levee on permeable material (such as sand) will require expensive techniques to reduce the amount of seepage. Excessive seepage beneath (or through) the levee can result in failure of the levee.

f) A levee must be maintained so that trees or burrowing animals do not weaken the embankment. The owner must also be aware of any settlement or erosion so that repair can be made immediately.

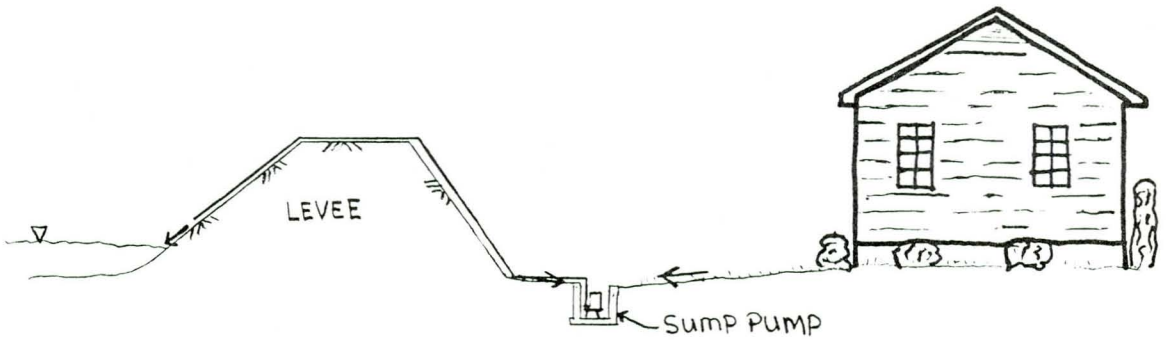


Figure 7 Levee with Sump Pump to provide interior drainage. Pump located at low point inside the levee.

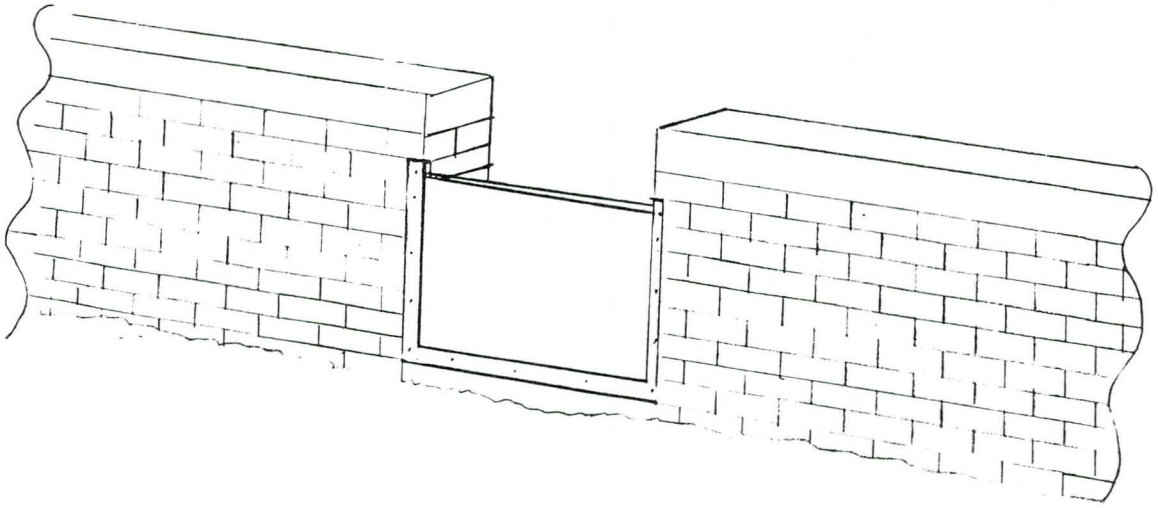


Figure 8 Brick Floodwall with Closure panel

4. Construction of Floodwalls

A floodwall is similar to a levee, in that it can provide protection from flood waters to a structure or property through the use of man-made materials. (Such as concrete).

The main advantages that a floodwall has over a levee include:

a) Requires less space to construct

b) Requires less maintenance.

As with levees, there would still be the drawbacks of no construction in the floodway, a potential false sense of security, the need to provide interior drainage and special foundation techniques on permeable soils. In addition, it may be necessary to provide entrances for driveways and sidewalks, which would have to be sealed during a flood.

5. Special Closures

As noted in the floodwall section, special closures may be needed to prevent water from entering through openings in the floodwalls for sidewalks or driveways. For buildings that have been floodproofed, closures may be needed on doors or windows.

The closures may be permanent (such as a brick wall around a window opening), hinged, or portable (such as a drop-in panel).

The hinged or portable closures require action from someone to install them during a flood. This can create a problem if the flood occurs when no one is home, or if there is very little warning time. An improperly designed or installed closure can defeat an otherwise adequate flood protection system.

6. Dry Floodproofing

Some structures can be protected from flooding by making the structure watertight. It is important that the building be in good structural condition and that the depth of flooding does not exceed 2 to 3 feet.

Due to the amount of pressure exerted by water on a structure, dry floodproofing requires input from a structural engineer. Improperly designed dry floodproofed structures can result in collapsed walls, buckled basement floors, or damage due to uplift. The damage from such failures would typically be greater than if the structure had been allowed to flood.

Detailed publications are available for the design of dry floodproofed structures (see references 9 and 10). However, the best advise is to consult a structural engineer.

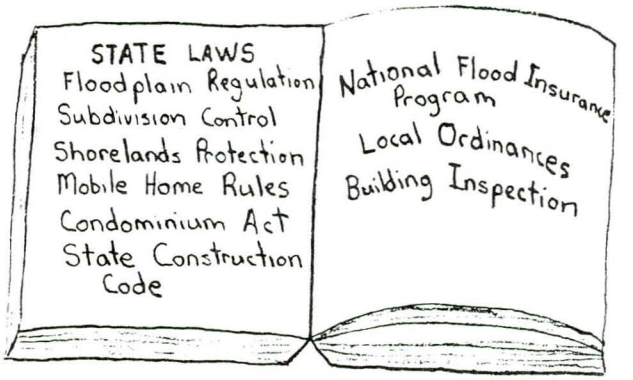
The following figure provides some guidance on what retrofitting methods are feasible for different flooding situations.

FIGURE 9 RETROFITTING DECISION MATRIX

RETROFITTING FACTORS		RETROFITTING METHODS									
		ELEVATION ON FOUNDATION WALL	ELEVATION ON PIERS	ELEVATION ON POSTS OR COLUMNS	ELEVATION ON PILES	RELOCATION	(CHAPTER 4) LEVEES	FLOODWALLS	FLOODWALLS	SEALANTS AND	CLOSURES
FLOODING CHARACTERISTICS	1. **Flood Depth**										
	Shallow (less than 3 feet)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Moderate (3 to 6 feet)	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
	Deep (greater than 6 feet)	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO
	2. **Flood Velocity**										
	Slow (less than 3 fps)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Moderate (3 to 5 fps)	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
	Fast (greater than 5 fps)	NO	NO	YES	YES	YES	NO	NO	NO	NO	NO
	3. **Flash Flood Potential**										
	Yes	NO	YES	YES	YES	YES	YES	YES	NO	NO	NO
	No	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	4. **Long Duration Flooding**										
	Yes	YES	YES	YES	YES	YES	NO	NO	NO	NO	NO
	No	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	5. **Debris/Ice Floe Potential**										
	Yes	NO	YES	YES	YES	YES	YES	YES	NO	NO	NO
	No	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
SITE CHARACTERISTICS	6. **Site Location**										
	Floodway or Coastal V-Zone	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
	Riverine Floodplain	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	7. **Soil Type**										
	Permeable	NO	YES	YES	YES	YES	NO	NO	NO	NO	NO
	Impermeable	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
BUILDING CHARACTERISTICS	8. **Building Foundation**										
	Slab on Grade	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES
	Crawl Space or Basement	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	9. **Building Construction Type**										
	Concrete or Masonry	YES	YES	YES	NO	YES	YES	YES	YES	YES	YES
	Wood	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
	10. **Building Condition**										
	Excellent to Good	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Fair to Poor	NO	NO	NO	NO	NO	YES	YES	YES	NO	NO

Source: Design Manual for Retrofitting Flood-prone Residential Structures (Reference 9)

KEEPING THE PEOPLE AWAY FROM THE FLOOD



1. Floodplain Management - Regulation of Land Use

The regulation of the use of flood hazard areas can reduce the potential for future flood problems. Regulation can take the form of local ordinances, building codes, or state law. For these methods to work, local ordinances must be enforced. Government agencies can also effectively restrict development in flood hazard areas through acquisition of such land. Over the past decade, these approaches have become more widely used, since it is more cost effective to avoid flooding problems than it is to construct remedial protective works to solve flooding problems.

2. National Flood Insurance Program

The National Flood Insurance Program (NFIP) was passed by Congress in 1968 to prevent flood damage of new developments by requiring local regulation of floodprone areas in return for making flood insurance available for existing floodprone buildings.

Although the flood insurance program provides invaluable relief for flood-stricken communities in the short term, it is not an automatic solution to the long term problem of repeated flooding. Other forms of flood hazard mitigation must be implemented in addition to ensure that flood-related damages will be minimized in the long run.

The Michigan Department of Natural Resources, Land and Water Management Division has an informative slide presentation on floodplain management and the National Flood Insurance Program. This presentation is available, free of charge, to community officials.

3. Acquisition and Relocation

One of the best ways to guarantee that homes and businesses will not continue to be repeatedly damaged by cyclical flooding, is to acquire these structures and relocate them outside of the floodplain. The City of Owosso used this approach very successfully by taking advantage of a variety of funding sources (such as a small cities block grant, federal funds, and private investments) to not only clear the floodplain, but also revitalize downtown development. The project has created 40 jobs and the downtown area tax base has gone up by $2 million.

The City of Midland rejected U.S. Corps of Engineer's proposals for dikes and channel improvements as too expensive and visually unfavorable. Instead, the city used Dow Foundation grants and matching general revenue funds to begin a program to move undesirable flood prone structures, returning the floodplain to its natural state. In this voluntary program property owners who are interested are offered a fair market appraisal. If agreement is reached, the properties are then cleared by the city, ground cover is added and the resulting unoccupied floodplain can be used for hiking trails, picnic areas, river access, golf course expansion, and ball diamonds.

The City of Burton used Section 1362 funding to eliminate several buildings repeatedly damaged by flooding. If a structure meets the following criteria it may qualify to be purchased by the Federal Emergency Management Agency under its Section 1362 program.

-The structure must be insured under the National Flood Insurance Program.

-It must have been damaged by at least three previous floods over a 5-year period, with an average damage of 25% or more of the value of the structure; or beyond repair; or;

-It must have been damaged by a single flood and determined irreparable by local ordinance or because of significantly increased building costs.

The program allows for two different methods of transaction. The land and structure may be purchased, the building demolished and the land turned over to the local unit of government. Or, only the land may be purchased and the building owner is allowed to move the structure to another location. Again, the property would be deeded to the local government. Either way, the local unit of government must agree to maintain the land for open space use only.

The rationale behind the 1362 program is that it is often cheaper for the Federal Government to buy certain properties than to pay repetitive flood insurance claims.

4. Storm Water Management

Today across the nation, problems from land drainage in urban areas are the major cause of water-related property damage. Stormwater management encompasses the measures used by property owners and local governments to limit the amount of runoff from new development and to control the water flow through the municipal drainage system. Historically, curbs, gutters, and underground pipes have been used to remove water as quickly as possible to minimize localized flooding. The result of these practices often was increased flooding downstream. Costly public drains were then constructed which simply transferred the problems to downstream communities.

The degree to which stormwater runoff contributes to flooding problems is related to the degree of development. Roads, buildings, and other paved surfaces block the infiltration of stormwater into the soil. Over a period of time, the ground water table is depleted while overland runoff is greatly increased, resulting in flooding and erosion problems. (See Figure 11).

With a better understanding of the failures of the traditional approach, stormwater management methods have been developed for the purpose of maintaining the natural predevelopment runoff characteristics on development sites. These methods can incorporate water quality control and temporary storage of stormwater to reduce the levels of sediment and pollutants in addition to minimizing the increase in the rate of stormwater runoff. Case studies using modeling techniques indicate that preserving critical stormwater storage areas such as floodplains and wetlands can be the most important element in a comprehensive stormwater management program. Developing or filling in these areas increases local flooding and allows the flood peak to be transmitted downstream. Stormwater management policies that limit runoff from individual developments but allow critical storage areas to be filled are often not effective in controlling increases in downstream flooding.

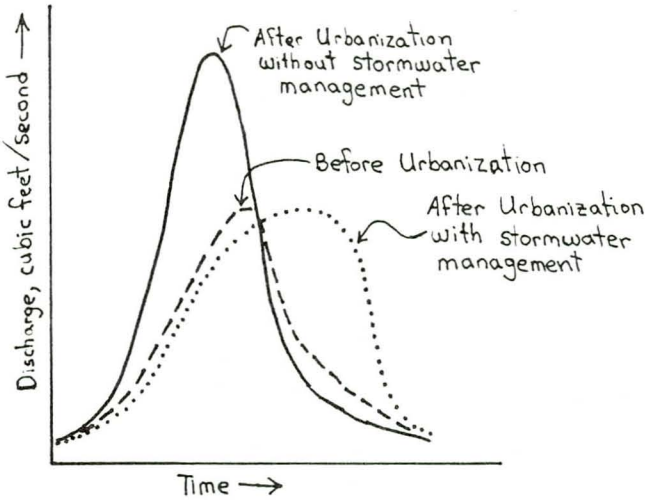
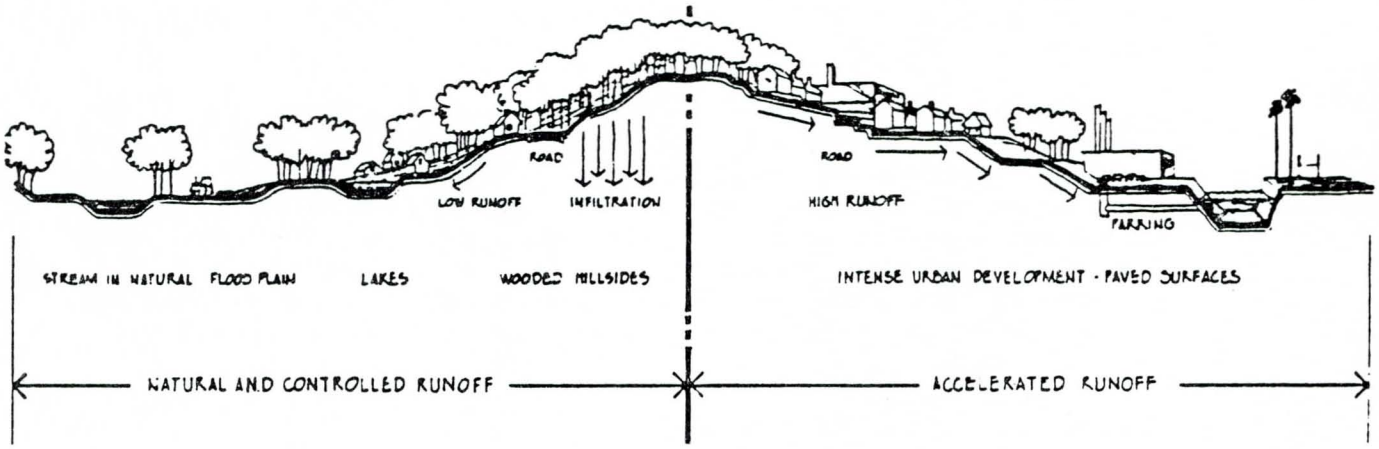


Figure 10 Impact of Stormwater Management on Flood Peaks

Urbanization Accelerates Stormwater Runoff



Source: *Ohio Stormwater Control Guidebook,*
Ohio Department of Natural Resources, 1980, p. 11.

Typical Changes in Runoff Flows Resulting from Paved Surfaces

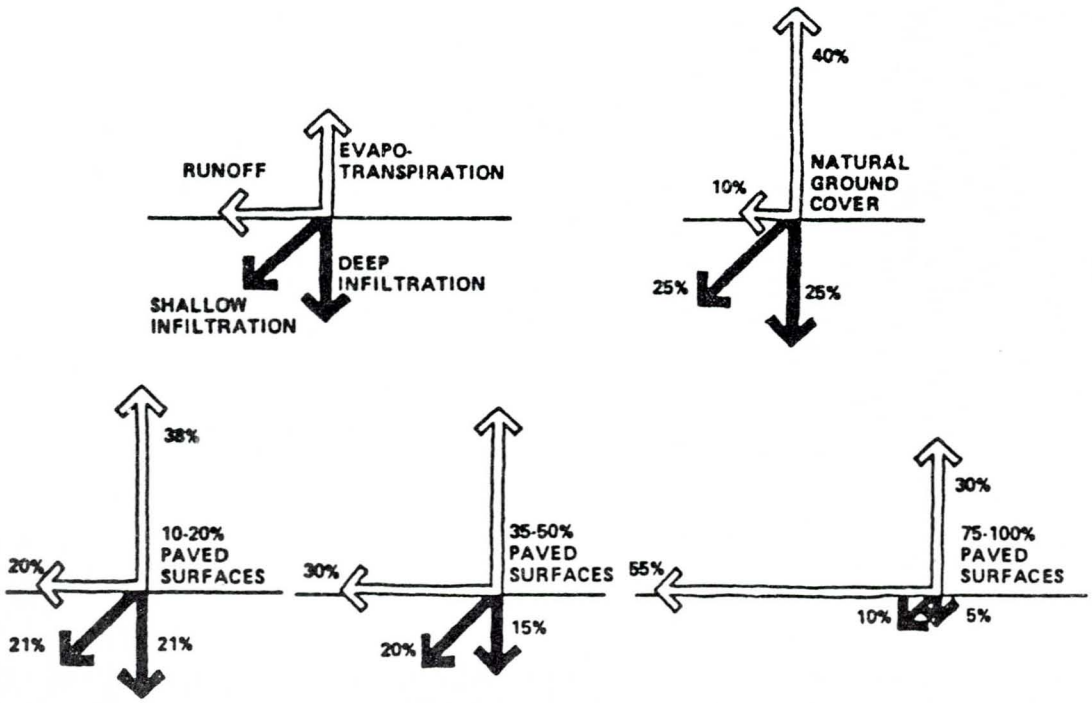


FIGURE 11

Source: L.B. Leopold. *Hydrology for Urban Land Planning*. U.S. Geological Survey Circular 544. 1968

In many areas, the stormwater problems of individual communities can be best managed by a comprehensive drainage plan for the entire watershed. Whether or not a plan for the entire watershed has been developed, effective stormwater management is an important part of the comprehensive flood hazard mitigation programs of many communities.

The Stormwater Management Guidebook for Michigan Communities published by the Clinton River Watershed Council, has been prepared with the concerns of local officials in mind and "reflects the experience of Michigan experts and state-of-the-art stormwater management practice throughout the United States. The what, why, and how of stormwater management practices and programs at the local governmental level are presented." This publication can be obtained by writing to the Clinton River Watershed Council, 8215 Hall Road, Utica, MI 48087.

5. Information and Public Education

Since a successfully developed flood hazard mitigation plan entails a large measure of public support, it is important to make sure that the public is aware of flood hazards and understands how to protect themselves and their property from flood damage. A good public awareness program can take advantage of local media resources such as newspapers, radio, and television to provide accurate and complete information to as many community members as possible. Further suggestions for public information campaigns concerning evacuation and emergency response measures are discussed in the Flood Fighting Appendix in this Guidebook.

FLOOD FIGHTING MEASURES

For detailed guidance in developing a flood fighting plan for your community, see Part II - A Guide to Flood Fighting.

The term "flood fighting" is used to describe the various flood damage reduction and safety measures that can be initiated as soon as a flood warning is received. The construction of sandbag dikes to protect evacuation routes or other critical areas, such as hospitals, is a good example of a flood fighting plan in action. During the 1986 flood, the City of Zilwaukee used a volunteer sandbagging effort to reduce the flood damages from the Saginaw River. The decision on when to sandbag was based on the National Weather Service's River Forecast Center flood forecast.

The Federal Emergency Management Agency has repeatedly emphasized that advance planning is the key to effectively managing any natural disaster crisis--flooding is no exception. The investment of time and effort in developing a flood fighting plan can yield many benefits. An effective and well-rehearsed plan will not only guide the management of the crisis, but also coordinate key flood fighting factors to ensure that the most appropriate emergency measures are implemented in time.

Flood Forecast Warning

A flood forecast warning system consists of flood detection devices (river gages and rain gages) and a communications network that brings this information to the attention of authorities. A reliable flood forecast warning system coupled with a well planned emergency response effort can substantially reduce property damage and loss of life. After severe flooding from the St. Joseph River in 1982, the City of Niles, with the assistance of the Michigan Department of Natural Resources, developed a flood hazard mitigation plan that consisted of a flood fighting effort. The plan was implemented for a 1985 flood which was similar in magnitude to the 1982 flood, but resulted in virtually no damage. In 1982, a City block was inundated and several hundred thousand dollars in damage resulted.

Emergency Response

How a community reacts to a flood warning can be defined as emergency response. Activities that can mitigate flood losses may include sandbagging, construction of temporary levees, or evacuation. A flood forecast warning is of little use if the community does not implement a planned response.

Before establishing objectives it is very important to carefully scrutinize, debate, and revise the proposed objectives because they will form the basis for a plan that will guide the implementation of flood hazard reduction measures. Care should be given to ensure that all affected interests have had an opportunity to be heard, and that any conflicts between flood mitigation objectives and those of other authorities or community programs are reconciled. For example, if your community chooses objectives that do not meet the minimum floodplain development criteria as required by the Federal Emergency Management Agency, then there is a conflict that must be resolved. Similarly, a conflict could develop if your community chooses to adopt an objective to promote recreational activities in the floodplain without first consulting the local Parks and Recreation Department.

If well thought out, each objective chosen for the Flood Hazard Mitigation Plan will balance the needs of the community and those of nature to achieve the goal of reducing flood damages.

ESTABLISHING LOCAL OBJECTIVES FOR FLOOD HAZARD MITIGATION

Once the flooding problems of your community have been assessed and well-defined with due consideration given to the physical, economic, social, biological, and cultural issues and after the tools available have been determined, your community can take the next step--establishing objectives.

The objectives that a community may establish can be broken down into five major categories, although often these categories are established in combination:

1. Protect new and existing development from flood damage.
2. Preserve or restore natural floodplain values.
3. Prevent loss of life and reduce the impact of damage from flooding where flooding problems cannot be eliminated.
4. Combine flood loss reduction with the community's environmental, social, and economic needs.
5. Promote public awareness of flood hazards and mitigation measures and encourage public participation in the establishment of these objectives.

These general objectives must be further refined to reflect the specific needs and desires of your community. For instance, a community with undeveloped floodplains may tailor its objectives toward acquiring the floodplain land for open space use or for protecting new development. A community with a highly devloped floodplain may desire to establish objectives that protect existing development such as buildings or begin extending an existing levee system. Or, it might want to set an objective to try to regain some of the lost environmental values of the floodplain through an aggressive acquisition/relocation program.

Before any objectives are selected, the costs and benefits of each must be understood. Individuals within your community should have the opportunity to voice their opinions and concerns, as the final objectives are intended to reflect the needs and desires of the community as a whole.

A strong public participation program provides a means to gather input from citizens in identifying objectives and needs. It also provides a forum to inform the pubic of flooding problems and the planning process, and to evaluate the acceptability of various solutions identified to reduce future flood damage.

SELECTING ALTERNATIVES

After the potential flooding problems have been determined within your community, a survey of all the possible mitigation methods have been completed, and the local objectives have been established, it is then appropriate to select alternatives that will help mitigate the local problems and meet your established objectives.

This section discusses the considerations in matching solutions to problems and suggests implementing short- and long-term strategies.

Matching solutions to problems

Before a flood hazard mitigation plan will work, the plan must be implementable, the benefits received should equal or exceed the cost of implementation, and the measures implemented must satisfy the objectives set early in the planning process. In matching solutions to problems, a community must be keenly aware of these conditions and proceed accordingly.

The public input acquired in identifying problems, establishing objectives, and reviewing flood hazard reduction measures, becomes very helpful in matching solutions to problems. Therefore, it is strongly advised that a flood hazard mitigation committee be established very early in the process. This committee should broadly represent the community, and include floodplain residents, zoning commisionsers, local officials, and business people. In addition, it would be beneficial to get input from civil engineers, hydrologists, land use planners, economists, and attorneys. These professionals will be able to aid your community in developing the most feasible and economical projects. The flood hazard mitigation committee will be able to judge the acceptability of the projects proposed that have been determined to be feasible and economical.

The process of matching problems and solutions is a complex one requiring careful evaluation of all alternatives. Compromises may be necessary and, in nearly all cases, a combination of approaches will work best. The decision on how to make the compromises can be recommended by the flood hazard mitigation committee.

Short and Long-term Strategies

Once alternatives for reducing flood damage are selected, a community should plan for their implementation by developing short-term and long-term strategies. Each measure in both the short- and long-term strategies should be well described. It is also necessary to identify the person or agency responsible for carrying out the measure, indicate the time frame for implementation, and explain how the project will be financed.

Short-term Strategies

If a reliable delineation of the floodplain is made, short-term measures such as floodplain regulations, emergency preparedness plans, and public information programs can be easily implemented.

Long-term Strategies

Long-term measures are those which generally have to be implemented in phases, over a period of years. Examples of these include major U.S. Army Corps of Engineers' flood control projects and acquisition/relocation programs.

Putting long-term flood hazard reduction measures into effect usually requires reevaluating the selected alternative (or combination of alternatives). This evaluation should eliminate any impractical or uneconomical measures and develop cost-effective designs for those remaining. The process must address the following key issues.

- Potential for funding, including assistance from state and federal sources.
- Whether the measure can be implemented successfully within the physical, legal, financial, and other existing constraints.
- Acceptance by the public.
- Compatibility of the measure with community goals other than floodplain management.

Determining which measures to include in a flood hazard mitigation program can be approached by developing and comparing alternative programs.

Comparing the alternatives may make it apparent that some combinations of measures are clearly inferior to others and ought to be dropped from future consideration. Others may be found reasonably satisfactory or even superior, except for some particular problem which can be corrected through a small adjustment.

IMPLEMENTATION

The first step in implementing the flood hazard mitigation plan is to have it formally adopted by a local governing body, such as the City Council. The plan, as recommended by the Flood Hazard Mitigation Committee, is presented for final review to the local officials. With adequate public participation and coordination throughout the process, formal adoption should not be a problem.

Secondly, the various measures identified in the plan must be implemented. Without public support and full community commitment, no plan will work. This support and commitment requires both financial and human resources to bring about the selected alternatives recommended by the Flood Hazard Mitigation Committee.

Lastly, after implementation, these measures must be enforced and periodically updated as necessary to maintain their effectiveness and continued improvement. An annual review of the overall program is strongly recommended.

PART II

A GUIDE TO FLOOD FIGHTING

INTRODUCTION

As noted earlier, the term "flood fighting" is used to describe the various mitigation measures that can be implemented just before, or even during a flood situation. Although these measures are implemented at the time of the flood crisis, advance planning is necessary to ensure that the flood hazard warning notification, materials (such as sand, bags, hauling equipment), and volunteer workers are effectively coordinated. If the warning time is only a couple of hours, there is very little time to be wasted trying to find suitable equipment or looking for volunteers to help in a crisis situation. The Federal Emergency Management Agency has repeatedly emphasized that advance planning is the key to effectively managing any natural disaster crisis--flooding is no exception. The investment of time and effort in developing a flood fighting plan can yield many benefits. An effective and well-rehearsed plan can not only guide the management of the crisis, but also coordinate key flood fighting factors to ensure that the most appropriate emergency measures are implemented in time.

The flood fighting plan must coordinate the following factors:

1) Flood Stage Damage Forecast information from the community's Flood Stage Damage Forecast Map.

2) Warning time.

3) Emergency flood containment measures--temporary structures

To produce a comprehensive sequence of actions to be taken as flooding conditions arise, the plan should specificy who is responsible for each step in the sequence, and should define an overall hierarchy of who is in charge. A reliable flood forecast warning system coupled with a well planned flood fighting effort can substantially reduce property damage and loss of life.

OVERVIEW OF THE PLANNING PROCESS

I. Problem Identification

II. Flood Warning Systems

III. Emergency Response Measures

IV. Developing a Flood Fighting Plan

V. Implementation of the Plan

PURPOSE

The object of this portion of the handbook is to provide guidance to the communities of Michigan on how to prepare and implement a successful flood fighting plan.

Because of the wide variety of community needs and capabilities, this manual is only a guide to be used for developing a plan tailored to your community. The Michigan Department of Natural Resources (MDNR), Land and Water Management Division, or the Emergency Management Division of the Michigan State Police can provide further assistance and guidance in developing your flood fighting plan.

PROBLEM IDENTIFICATION

Before a flood fighting plan can be developed, it is necessary to review the sections on the Problem Definition (Page 4), Flooding Sources and Its Characteristics, (Page 5) and, Develop A Flood Stage Damage Forecast Map (Page 7). Following is a summary of the information required to define the problem.

DEFINITION OF NEEDS

1. Establish a local Flood Hazard Mitigation Committee.

2. Hold public meetings to solicit input from citizens.

3. Obtain input from the local government or community council.

4. Obtain estimates of previous flood damages.

5. Obtain input from federal and state agencies concerning flood fighting techniques.

DETERMINE THE RESOURCES AND INFORMATION AVAILABLE

1. Flood elevation information: this information may be available in the community's Flood Insurance Study or other flood studies prepared for the community. If you do not already have this information contact the Michigan Department of Natural Resources, Land and Water Management Division, (517) 373-3930.

2. Topographic (ground elevation) information and mapping: for a flood fighting plan or a warning system to be as effective as possible it is necessary to have a quality map, preferably with contour elevation information.

3. Technical assistance: local volunteer engineers, surveyors, planners, and builders are important sources for technical assistance in both the planning and conducting of a flood fight.

4. Detailed technical information is available from the following agencies: the Michigan Department of Natural Resources, Land and Water Management Division; the National Weather Service; the U.S. Army Corps of Engineers; the Michigan Department of State Police, Emergency Management Division; FEMA; and USGS.

5. Community Engineer or other consultants. If the technical information is not available from the agencies listed above, it may be necessary to have the community engineer develop it, or to hire a private consultant.

6. Sources of funding: both private and government support may be available. In some communities businesses have provided funding to develop a flood warning system since it would be as beneficial to the business as to the community.

Figure 12 on the following page provides a Summary of Sources of Information and Assistance.

	Floodplain Information	Floodplain Regulation	Floodproofing Information	Flood Fighting	Flood Warning Systems	Flood Control Projects	National Flood Insurance Program Regulations	Post Flood Relief	Flood Boundary and Flood Insurance Rate Maps	Flood Insurance Study Technical Support Data	Technical Assistance	Flood Records & Stream Flow Data	Topographic Maps	Zoning Ordinance Assistance	Disaster Preparedness
Michigan Department of State Police-Emergency Management Division			x												x
Michigan Department of Natural Resources-Land & Water Management Division	x	x	x				x		x	x	x	x	x	x	
Federal Emergency Management Agency	x		x	x			x	x	x	x	x			x	x
U.S. Army Corps of Engineers	x		x	x	x	x		x			x				
U.S. Department of Agriculture Soil Conservation Service	x		x			x		x			x				
U.S. Geological Survey	x											x	x		
National Oceanic and Atmospheric Administration					x										
Local & County Government	x	x					x		x		x	x	x		
Department of Housing and Urban Development								x							

Figure 12

Sources of Information and Assistance

ESTABLISH A FLOOD WARNING SYSTEM

An emergency response plan and all the preparations and resources to carry it out are of little use if there is no advance flood warning. For a flood warning system to work, it must reliably predict that a flood is coming and how high the water will get (the height of the flood peak.) This information must then reach the authorities quickly so that the warning can be disseminated to the public.

Publications such as "Guidelines on Community Local Flood Warning and Response Systems", Hydrology Subcommittee of the Federal Interagency Advisory Committee on Water Data, August 1985 are available to provide guidance in establishing a Flood Warning System. This section provides a brief overview of the subject to describe what is needed by a community to establish a system.

The key elements in the Warning System are the flood warning device network and the flood warning dissemination system.

FLOOD WARNING DEVICE NETWORKS

1. National Weather Service Flood Warnings

   The National Weather Service provides flood forecasting for major streams where adequate data are available and crest times are greater than 12 hours. In many instances adequate data is not available and the National Weather Service issues a general area-wide flood watch or warning. The accuracy of the predictions is dependent upon the data that is available. Thus, it is necessary that Weather Service have access to as much data as possible (rainfall and river stages).

2. Types of Flood Warning Device Networks (Figure 13)

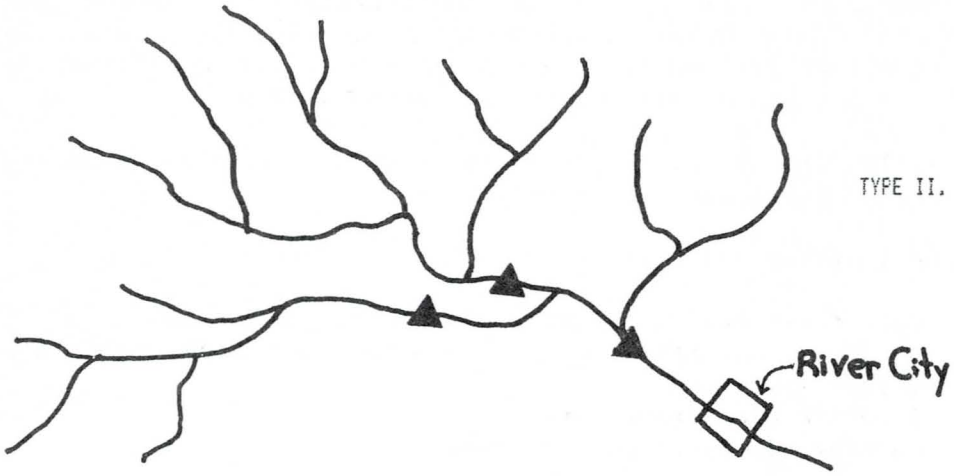
   If the community needs cannot be met by the National Weather Service warnings, it is necessary to establish a local flood warning system. The NWS can help set up loal systems by providing technical assistance including warning systems, rain gage placement and calibration of models. The following are three basic types of warning device networks.

   Type I. One stream gage upstream of town

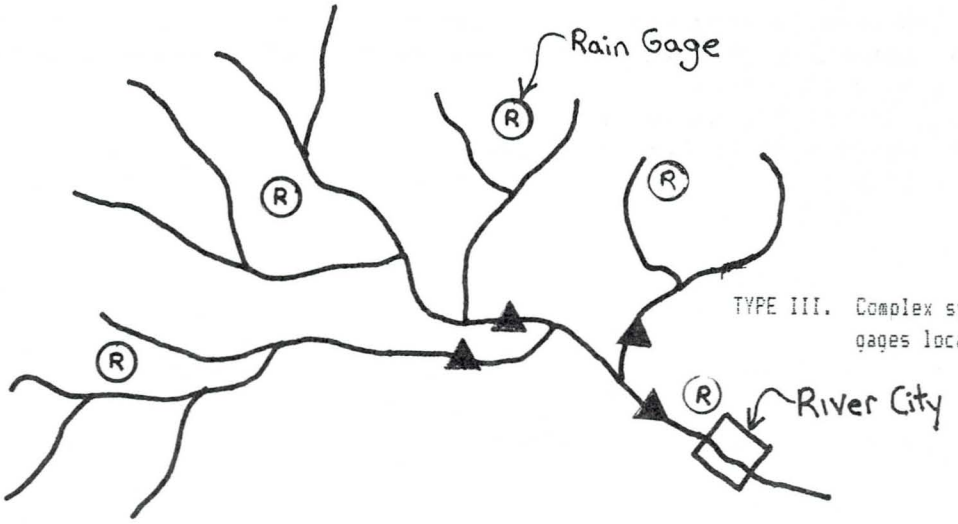
   Advantage: The system is inexpensive to install, maintain, and use. Since the gage is located immediately upstream of the town, the readings will accurately predict the level of flood stages that will reach the town.

   Disadvantage: There is very little warning time between the gage's registering of the critical flood stage and its travel from the gage to the town.

TYPE I. One stream gage located just upstream of the community



TYPE II. Several stream gages located upstream of the community



TYPE III. Complex system of rain gages and stream gages located upstream of the community

FIGURE 13 TYPES OF FLOOD WARNING SYSTEMS

Type II. Gage(s) farther upstream

Advantage: By placing gages farther upstream, more warning time can be achieved without a significant increase in the cost of the system.

Disadvantage: If only one gage is used, and it is placed farther upstream, accuracy will be lost. Having more gages is more accurate, but requires more coordination between the volunteers that read the gages.

Type III. System of Rain and Stream Gages

Advantage: This type of system provides the most warning time and would be the most accurate.

Disadvantage: The system can be expensive to install and maintain since it is quite complex and requires extensive coordination, calibration, and maintenance. It would require either a network of volunteers, or remote sensors.

The system itself can be a "manual" system, a totally automated system, or a mixture of the two.

A manual system would involve:

(a) volunteers reading gages and collecting the data
(b) a flood coordinator to receive the data from the volunteers
(c) flood forecast procedure
(d) warning distribution procedure

An automated system involves:

(a) automatic rain and river gages
(b) automatic collection and processing (radio network linked to a computer)
(c) forecasting software
(d) warning distribution system

FLOOD WARNING DISSEMINATION SYSTEM

Flood Evacuation Standard Operating Procedure (FLEV/SOP), published by the Michigan Department of State Police, Emergency Management Division, provides detailed organizational advice for setting up the structure of such a system. The following checklist gives an outline of the major points that must be covered.

1. Flood Warning Dissemination System Checklist

   1.1 Suitable local warning point (such as a police or fire station)

   (a) Staffed 24-hours a day.
   (b) Adequate communication systems to receive flood information by alternate means.
   (c) Auxiliary power source.
   (d) Not subject to flooding or other common hazards.

   1.2 Procedures required at the warning point

   (a) Must promptly receive flood watches and warnings from the NWS.
   (b) How incoming information is handled and recorded.
   (c) When data will be collected.
   (d) Who or what will activate the collection of data.
   (e) Description for the preparation flood forecasts.
   (f) Conversion of NWS flood forecast information to the Flood Stage Forecast Map.

   1.3 Procedures for the Observers

   (a) Identify information needed.
   (b) Frequency of collection.
   (c) Means of communication, with back-up.

   1.4 Warning Dissemination Procedures

   (a) Prompt attention to flood threat information.
   (b) Coordinate with NWS.
   (c) Warning accurately reflects the anticipated severity of the flood.
   (d) Identify recipients that should receive special warnings (nursing homes, handicapped, schools, police).
   (e) Means of communicating with special recipients.
   (f) Records to assure warnings are given and received.

   1.5 Procedures for Notifying General Public

   (a) All affected persons receive adequate warning, even if telephone and power are not in service.
   (b) Provide warnings that are comparable to the severity of the anticipated flood.

(c) When and how will the warnings begin to take place
(d) Warnings by telephone, radio, TV, in person, sirens, truck-mounted loud speaker, helicopter

1.6 Evaluating and Updating the Warning System

(a) Test the system periodically to determine its effectiveness.

2. Flood Warning Notification

To notify (warn) residents of a flood that has been predicted, the following methods could be employed:

2.1 Radio and Television

Advantages: Reach large numbers of people quickly, can explain the need of the warning and actions to be taken, and relatively inexpensive.

Disadvantage: Need power to transmit/receive, not effective late at night since people are in bed, or if the station is not on, do not know who has been contacted.

2.2 Sirens, other mass warning systems

Advantage: Reach people quickly, apparent urgency

Disadvantage: Depends on power/telephone; cannot explain the reason for warning

2.3 Door-to-Door, telephone

Advantages: Explain reason, persuasive, know who has been contacted, give written instructions

Disadvantage: Slow, need manpower

2.4 Mobile Public Address (cars, trucks, and helicopters)

Advantages: Explain the reason for the warning or excavation; reach a large number of people

Disadvantages: Flooding or bad weather may prevent local travel, do not know who has been contacted, may tie up vehicles that are needed elsewhere

When issuing a flood warning, it is important to:

- Describe the floodprone area as explicitly as possible (a site location map would be useful).
- Indicate who is making the prediction of the flood stage, and as accurately as possible describe the predicted flood stage

(i.e., river is expected to crest at 17 feet on the U.S.G.S. gage)
- Repeat the message using several types of media.

3. Pre-Flood Handout

Prior to flood season residents should be informed of actions that should be taken before and after a flood. This could be done in the form of handouts, before the flood season. The handout would indicate that when a flood warning is issued:

- Listen to the radio or TV for emergency instructions
- Fill large containers with tap water for drinking and cooking
- Keep vehicles ready for evacuation
- Keep a portable radio, flashlights, first aid and medical supplies, and emergency cooking equipment close at hand.
- Move household belongings to upper levels.
- Secure items outdoors that might be washed away.
- Prepare to shut off utilities.

And when flooding starts:

-Shut off the electric, gas, and water utilities.
-If necessary to evacuate, do so quickly and safely. Use the designated evacuation routes. Shelters are available at the locations shown on the attached map.
-Beware of water covered roads and bridges. The roadway or bridge may have been washed away. Do not drive on a flooded road, or walk in water above your knees.
-Beware of fire hazards such as wet hay, feed, or charcoal, gas or oil leaks, and broken electrical wires.
-Do not "sightsee" in the disaster areas.

SUMMARY OF EVACUATION AND NOTIFICATION PROCEDURES FROM FLEV/SOP

1. Evacuation

The flood stage damage forecast map (Figure 14) will identify streets and roads that will be inundated during various flood events. Evacuation routes should not include roads that will be impassable during times of flooding. A map should be prepared showing the principal evacuation routes and routes that would be sand bagged or filled to provide evacuation, and provided to the news media.

When selecting the evacuation routes, the following concerns must be addressed:

(a) Is the route passable in all conditions?
(b) Will local runoff flood the road?
(c) Can the road handle the traffic?
(d) What alternate routes are available?
(e) Which roads should be open only for evacuation?
(f) Which bridges and roads are the most floodprone?

2. Notification

It would be advisable to have several stages of notification/evacuation if the warning time permits.

a. General Warning - Provide information to individuals in the floodplain to prepare for possible evacuation.

b. Oral/written warning to effected people (if river reaches a predetermined height, it will be necessary to begin to evacuate).

c. Evacuation of warned people. This type of notification would generally require a warning time of a day or more.

d. If the warning time is short, it would be necessary to simultaneously provide notification and serve evacuation forms. Such a notification would give the residents a couple of hours to evacuate.

e. No warning with evacuation. Such a notification would result in flash floods (not common in Michigan) or a dam failure. The evacuation must be started immediately.

A detailed description of flood evacuation procedures can be found in FLEV/SOP (Reference 13).

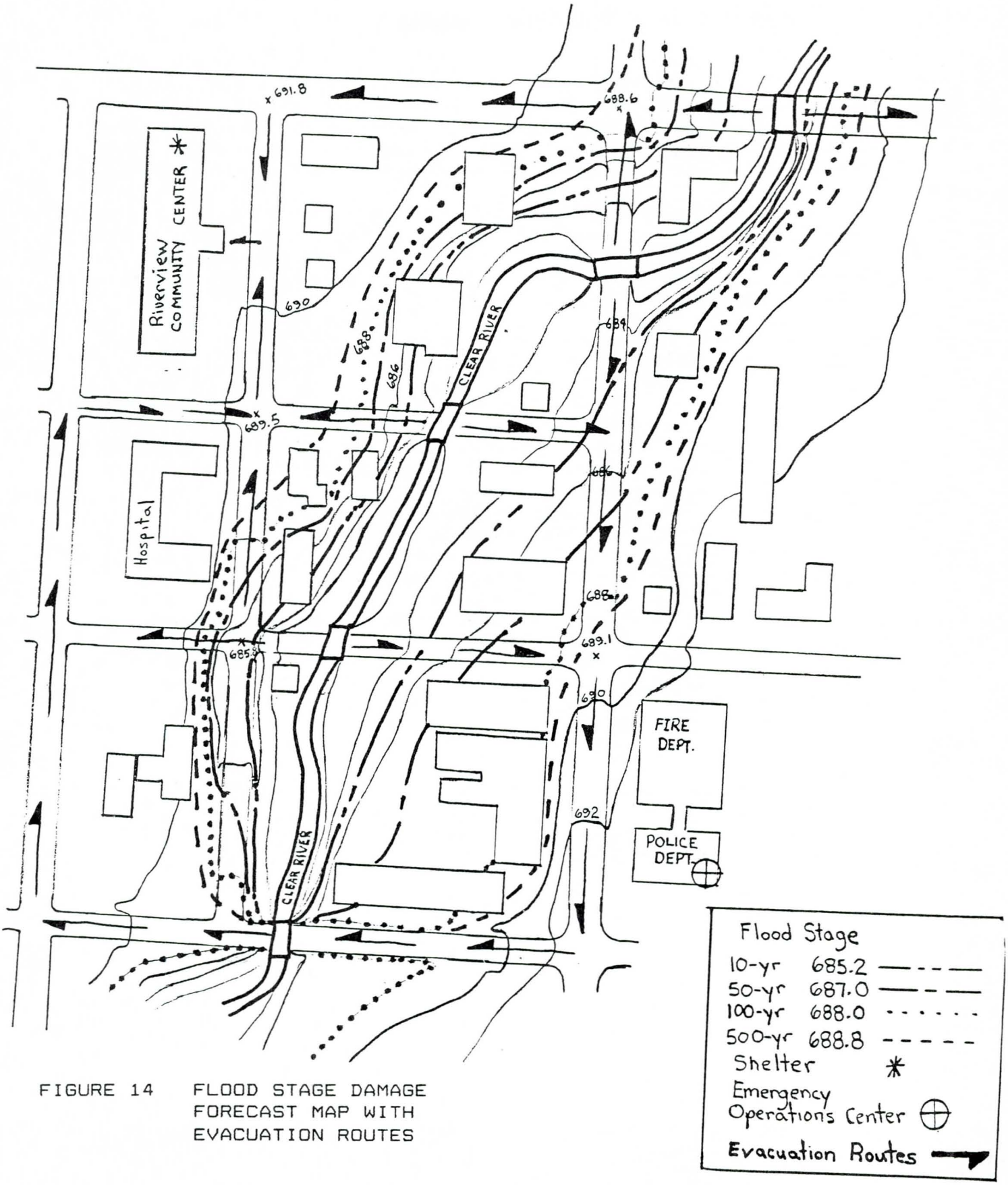


FIGURE 14 FLOOD STAGE DAMAGE FORECAST MAP WITH EVACUATION ROUTES

EMERGENCY RESPONSE MEASURES - FLOOD BARRIER CONSTRUCTION

The term "flood fighting" covers a wide range of activities that are implemented to reduce the damage to property and to save lives. To implement an effective flood fight, it is necessary to have an adequate warning system, organization, planning and resources. An effective flood fighting method is the construction of flood barriers (dikes or levees).

The construction of dikes or levees can provide temporary protection against flooding. As mentioned previously, the construction of the barriers takes time; thus it is necessary to have an accurate flood forecast to prevent unnecessary expenditure of resources and to ensure that the barrier is constructed in time.

To obtain the most effective use of flood barriers, it is best to consider the following factors prior to construction.

1. Select the shortest practical route - saves time and resources.
2. Provide maximum protection. The dike location should offer protection to the greatest number of structures.
3. Take advantage of high ground.
4. Avoid sharp bends, unstable river banks.
5. Utilize the Flood Stage Damage Forecast Map to determine the areas that are threatened, the shortest route, high ground, and the evacuation routes.
6. Keep trees and brush between levee and river. The trees and brush provide protection to the dikes from debris and ice.
7. Leave at least 8 feet between levee and buildings which will allow access to the dikes from the landward side.
8. Keep as far away from the river possible.
9. If possible, discuss alignment with state and local floodplain management officials.

The following poor construction practice may also result in a levee failure: (1) joining a levee with a solid wall; (2) structures, trees or debris projecting from the riverside of the levee; (3) a pipe through the fill.

SANDBAG DIKE CONSTRUCTION

Sandbags may be used where a low short barrier is acceptable and earth fill is not practical. The construction of sandbag dikes are time consuming, expensive, and require a significant amount of manual labor. The following steps are recommended for the construction of a sandbag barrier:

1. Remove all ice and snow, sod, down to bare ground, if possible.

2. Dig a bonding trench 2 sacks wide, 1 sack deep (2' wide, 1' deep). (If on a roadway this may have to be omitted.)

3. Lay a polyethylene seepage barrier across trench, there should be enough to cover the riverside of the sandbag structure (See Figure 15). The riverward slope is covered with the polyethylene seepage barrier, protected with 1 layer of sandbags. Polyethylene should have slack to allow outer side bags to be tamped into place and to avoid puncture. Anchor excess poly at top of dike using sandbags. Poly is not used on landward slope.

4. Fill trench with sandbags perpendicular to flood, bottom of bags toward the flood, unfilled portions toward building. (See Figure 15).

5. The bottom layer of sandbags is layed parallel to flow, with subsequent layers alternating (i.e., perpendicular, parallel, etc.) The base of the barrier should be about three times the height. It is advisable to not exceed three feet high.

When filling and placing the sandbags, the following suggestions should be used:

1. The sandbags should be filled with sand or sand and gravel.
2. Bags should be half (½) full.
3. Overlap unfilled portions with filled bag.
4. Tamp bags into place.
5. Need not tie bags.

Approximate materials needed for the construction of 100 feet of levee:

Height	Bags	Sand Cubic Yards	Polyethylene Sheeting
1 foot	800	8	4 feet
2 feet	2000	21	5 feet
*3 feet	3400	36	6 feet

*Sandbag walls not recommended over 3 feet high.

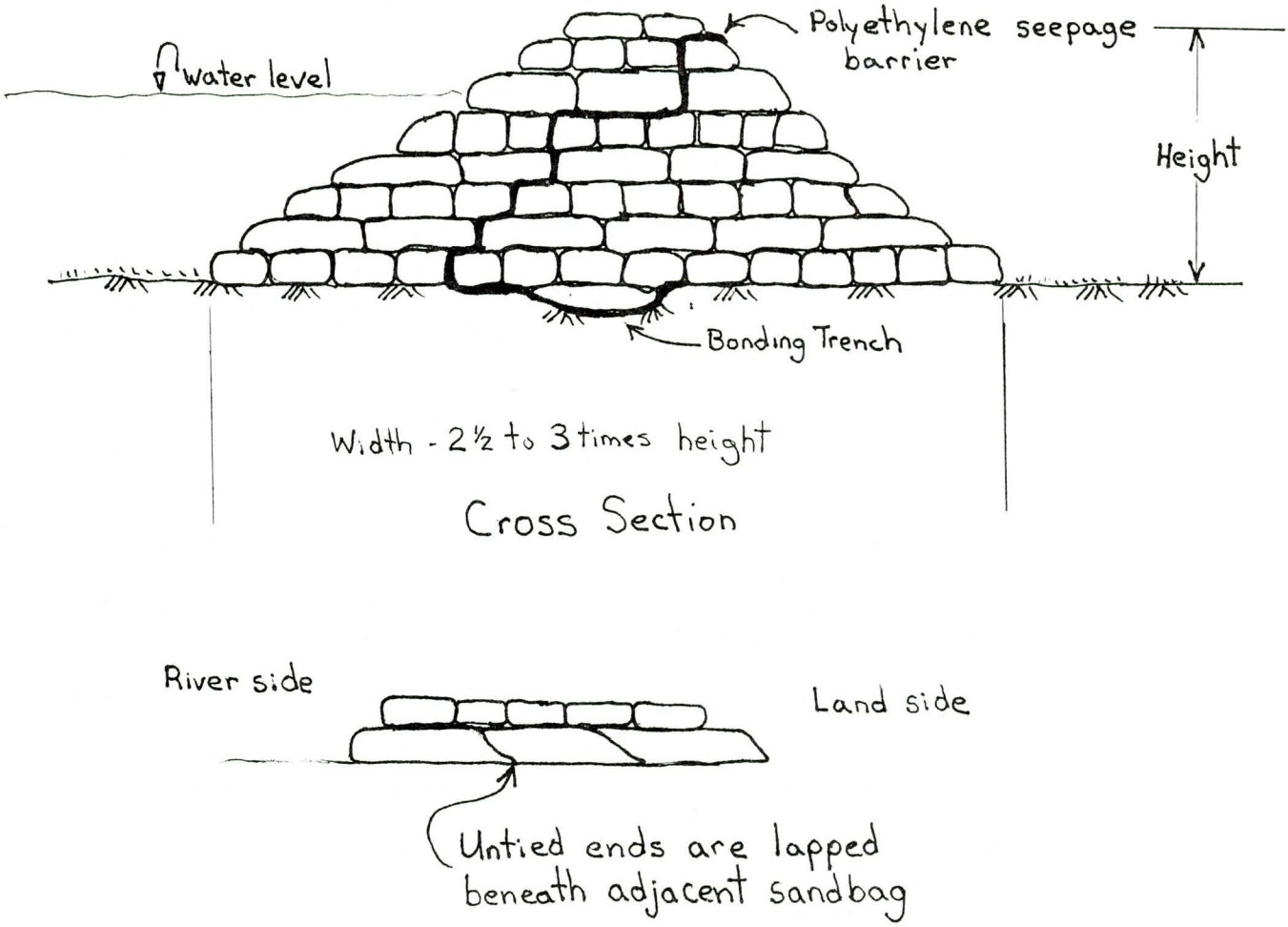


Figure 15

Sandbag Dike Construction

The polyethylene should preferably be black 6 mil; however, clear or 4 mil poly could be used. Two mil should only be used as a last resort.

EARTH FILL LEVEES

While sandbags are a temporary flood barrier, earth fill levees can be more permanent. It is necessary to obtain adequate easement since the construction will require the use of a significant amount of heavy equipment.

1. Foundation Preparation - remove snow, trees, brush, stumps, and if possible strip the topsoil.

2. Fill

   (a) Clay is preferred because water will not readily pass through and steeper side slopes may be used.

   (b) Sand may be used, but would require adequate slope protection and flat side slopes.

   (c) Silt should not be used. If it becomes wet, silt may collapse.

   (d) The fill should <u>not</u> contain large pieces of frozen earth.

   (e) If the material is not homogeneous, the more pervious material should be on the landward side of the embankment.

   (f) Preferable to have the fill and the foundation be the same material.

   (g) Construct top of levee at least 2 feet above the anticipated flood crest.

SLOPE PROTECTION OF EARTH FILL LEVEES

The construction of a levee for flood protection may subject the slopes to scour, debris damage, seepage, and possibly wave action. Thus it is necessary to provide protection to the slope to prevent a failure of the levee. Under emergency conditions it is generally not possible to provide permanent slope protection. The use of a combination of polyethylene and sandbags has proven to be an effective protection method, provided the placement is done correctly.

Anchorage of the Polyethylene (Poly)

For the polyethylene to provide adequate protection of the slope, it must be properly anchored at the toe and on the slope.To anchor the toe of the polyethylene there are several methods that could be used:

1. Excavate a trench and place the poly in the trench and backfill.

2. Poly may be placed away from the toe, and stabilized with fill.

3. Place the poly away from the toe and stabilize with sandbags. Poly is not really necessary on clay embankments if stream velocities are less than two feet per second.

The poly should be started at the downstream end and placed with at least 2 feet of overlap. The poly is held down by sandbags. A solid "blanket" of sandbags should be used when high velocities, heavy debris, or ice may occur; if not anticipated, a grid system can be used. The grid system can include sandbags, 2" x 4" lumber and sandbags, or rope and sandbags.

The critical areas of an embankment should receive priority when placing poly. Poly should <u>not</u> be placed on the landward side of the embankment. If done, seepage may be forced elsewhere and result in failure.

Riprap may be used to control high erosive or impact forces. However, this is a very costly method which requires a large amount of material that may not be readily available.

Other forms of slope protection include groins to deflect the current, log booms to deflect debris, and straw bales to reduce wave action.

CLAY LEVEE (See Figures 16 and 17)

1. Side Slope - On both sides of the levee provide a slope of 1 foot vertical to 2½ feet horizontal.

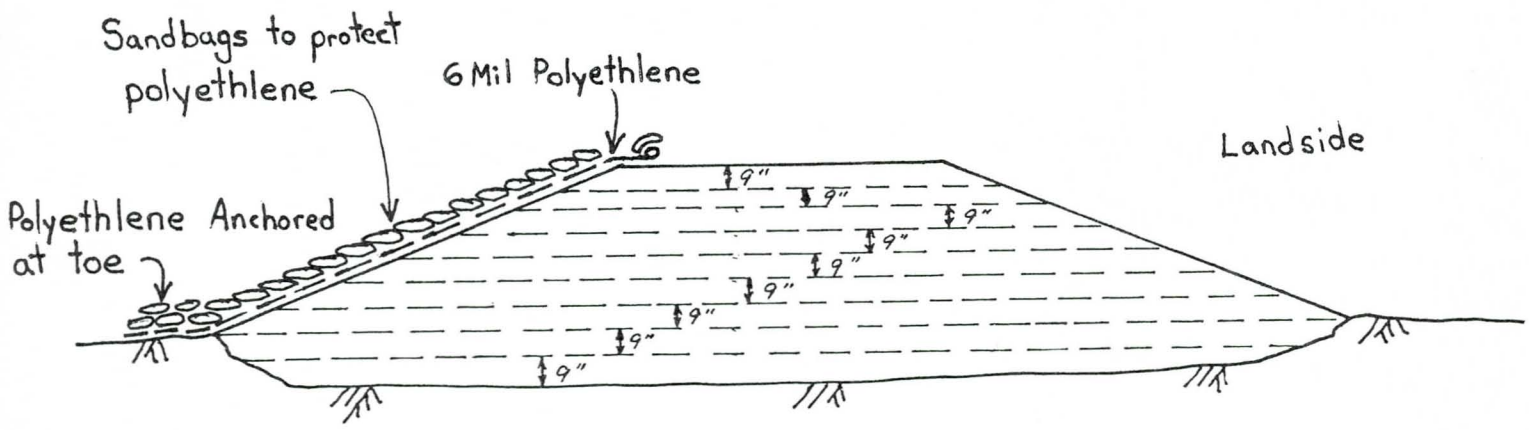
2. Top width - The levee top width should be about 10 feet.

3. Bottom width - For a clay levee on a pervious foundation the bottom width is dependent upon the foundation material. The bottom width should be estimated as follows:

Foundation Material	Bottom Width
Fine gravel	9 x height
Fine sand	15 x height

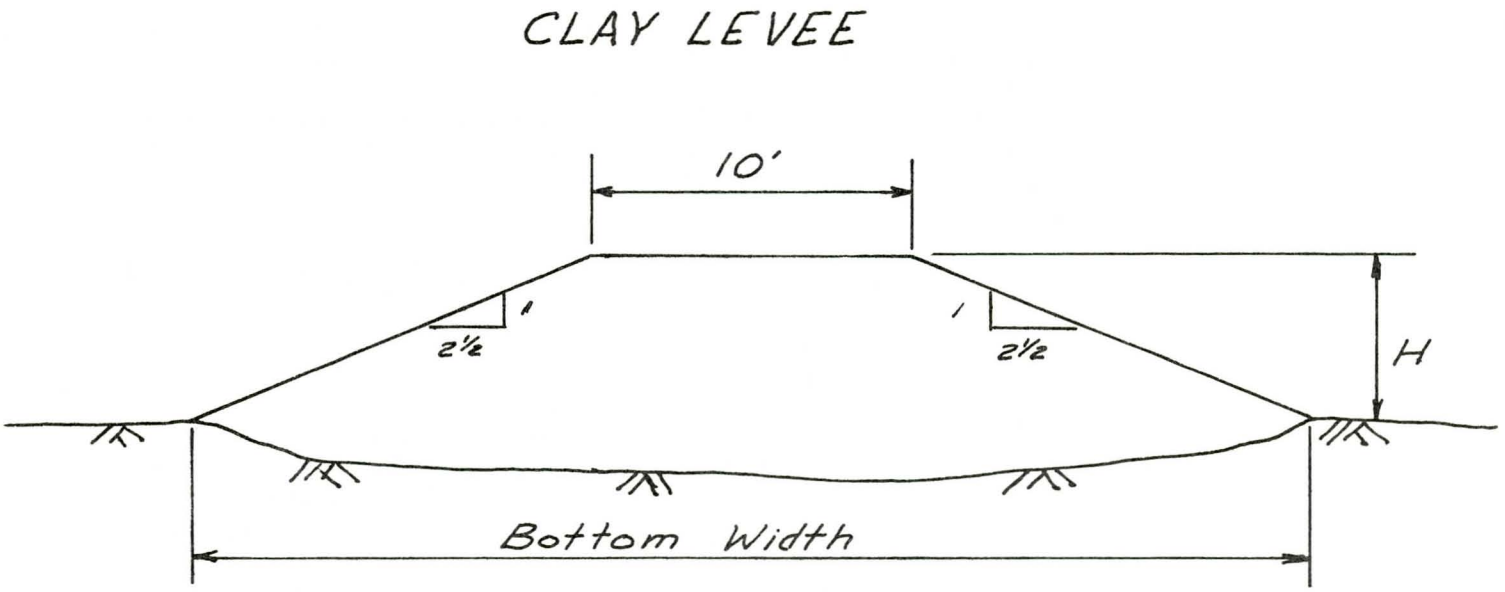
To achieve the necessary width, it would be possible to place berms that are 3 feet high or greater on either side of the levee. (See Figure 17B). These berms would counteract the uplift pressure, and would not have an impact on seepage.

4. Placement of Materials - The clay material should be applied in 9-inch layers. Under emergency conditions, each layer should be compacted by one complete pass of haul equipment. Normal construction practice would require 4 passes of a rubber-tired roller, or 9 passes of a tamping type roller, for each 9-inch layer.



PLACEMENT DONE IN 9" LAYERS

Fig. 16



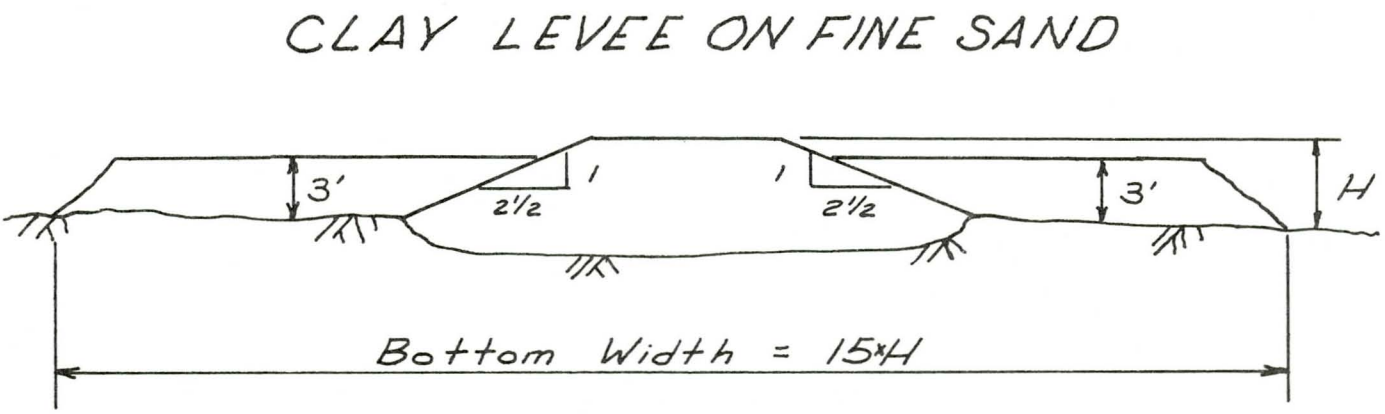
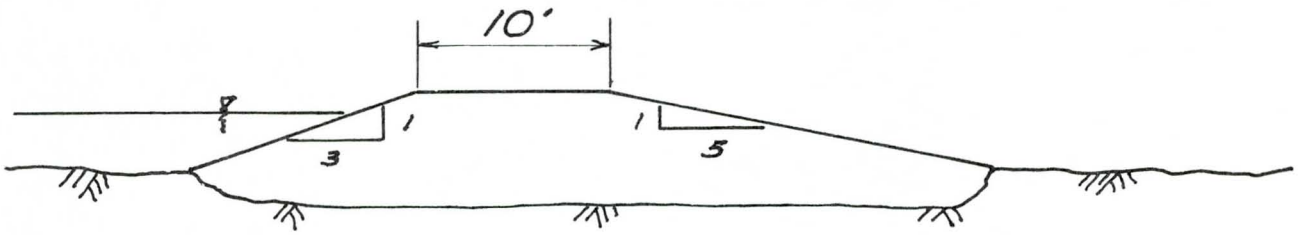


FIGURE 17 CLAY LEVEES

SAND LEVEE

1. Side Slope - On the river side of the levee, the slope should be constructed using 1-foot vertical to 3-foot horizontal. On the landward side, the slope should have a slope of 1-foot vertical to 5-foot horizontal.



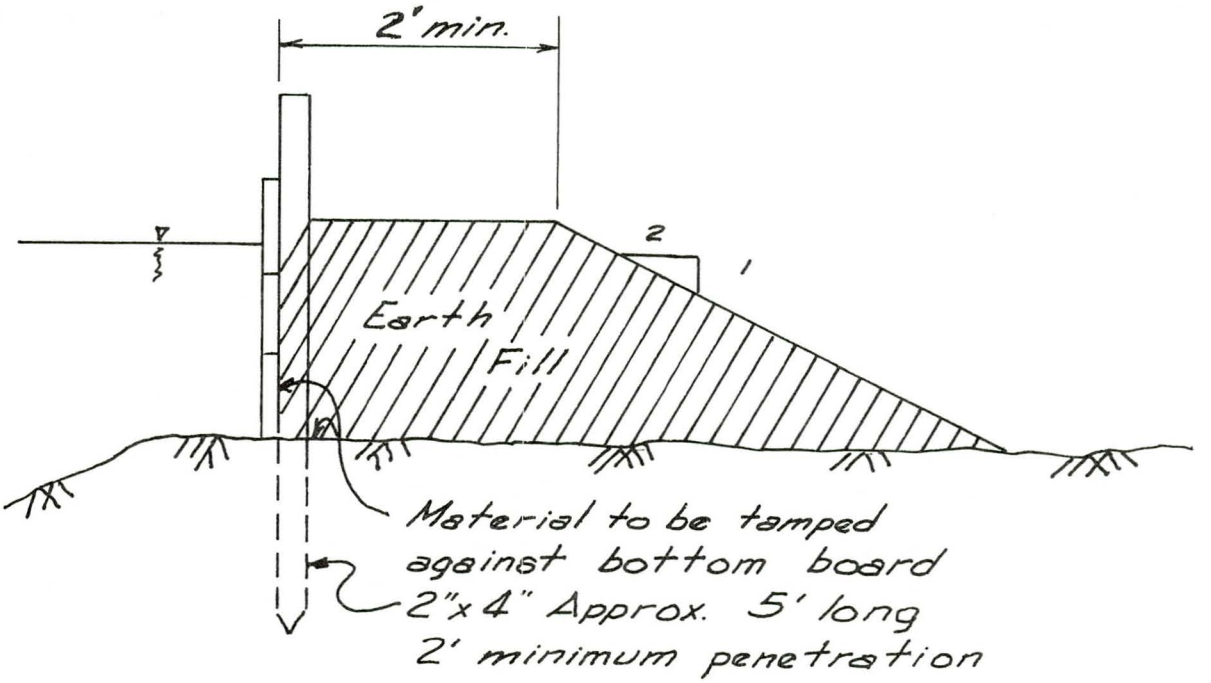
SAND LEVEE, Fig. 18

2. Top width - The top width should not be less than 10 feet.

3. Placement of Materials - The sand should be placed in 12-inch layers. Under emergency conditions, each layer should be compacted by one complete pass of haul equipment. Normally construction practice would require 3 passes of a crawler type tractor, or 2 passes of a vibratory roller.

FLASHBOARD LEVEE

A Flashboard levee (see Figure 19) is constructed using lumber and earth fill. 2" x 4" posts are driven at least 2 feet into the ground, located on about 4' to 6' centers. 1" x 12" boards are placed horizontal between the post. An earth berm is placed landward of the flashboards and is tamped against the bottom board. The berm has a minimum 2' top width, and a 1 on 2 slope on the landward side of the berm.

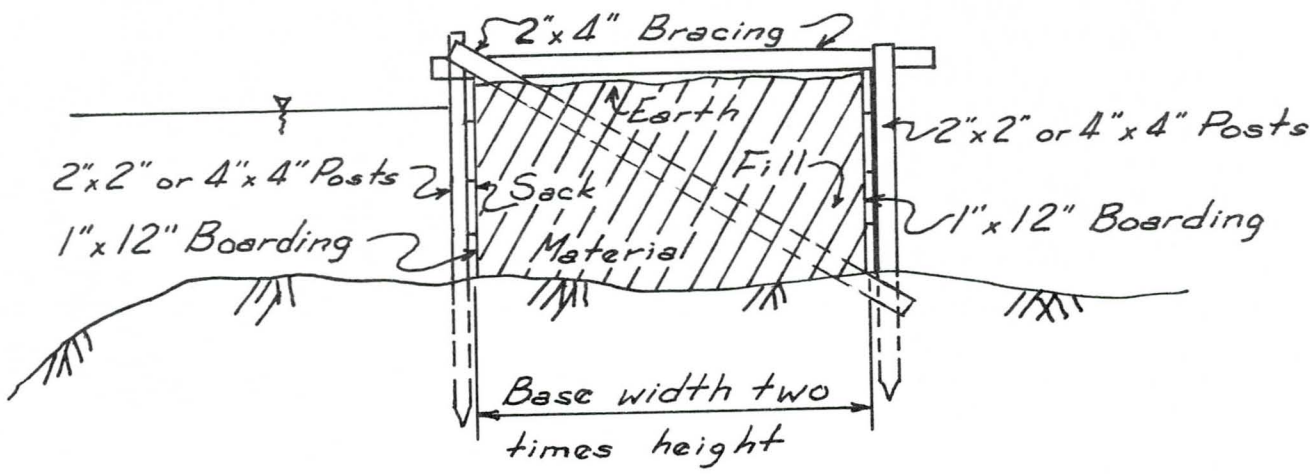


FLASH BOARD LEVEE, Fig. 19

BOX LEVEE

A box levee (see Figure 20) consists of two rows of 2" x 2" (or 4" x 4") posts driven at least 2 feet into the ground, located on about 4' to 6' centers parallel to flow. The parallel rows of posts are driven on a spacing of about 2 times the height of the box. (If box is 4 feet high, the rows of post are driven 8 feet apart). 1" x 12" boarding is placed horizontally inside of the posts to contain the earth fill, and 2" x 4" bracing is provided to hold posts in place.

These types of levees are very costly and require a considerable amount of time to construct. Thus, they are generally not used, unless the area is very restrictive and earth fill levees will not work.



BOX LEVEE, Fig. 20

INTERIOR DRAINAGE

Temporary pumping may be required to remove the accumulation of snowmelt, rainfall, or seepage behind the barriers. Since the amount of pumping required is site specific it is not possible to give a rule of thumb. The pump size is dependent upon:

1) The drainage area being "cut-off" by the barrier
2) The amount of seepage through and beneath the barriers
3) Amount of storm sewer infiltration and back-up
4) The amount of ponding allowed before damage will occur.

This information may be determined by the community's engineer. Additional assistance may be available from the County Drain Commissioner, U. S. Army Corps of Engineers, MDNR or Soil Conservation Service.

Tables 1 and 2 provide a guide as to the capacity of various pumps.

It may be necessary to pump the sewer system to keep it functioning. For sanitary sewage pumping, the pump size needed could be estimated by allowing 100 gallons per day, per person, and infiltration of 15,000 gallons per mile of sewer, per day. For a town with 4000 people and 25 miles of sewer, the pump capacity would be estimated by:

4000 people x 100 gallon/person/day	= 400,000 gallon/day
15,000 gallons/mile/day x 25 mi	= 375,000 gallon/day
Total Pump Capacity	= 775,000 gallon/day or
	538 gallon/minute

Suggest using one 4-inch centrifugal pump or equivalent (See Table 2).

Pump Capacities
Table No. 1
Crisafulli Pumps

Size	Gallons per Minute	Head	Electric Horsepower	Gas or Diesel Horsepower
2	150		1	15
4	500		7.5	15
6	1000		15	20
8	3000	10'	25	25
12	5000		30	40
16	9500		75	100
2	150		1	
4	490		10	20
6	850		20	25
8	2450	20'	30	35
12	3750		40	50
16	8000		75	110

Table No. 2
Centrifugal Pump

Size	Capacity Gallons/Minute	Horsepower
1-1/2"	67	1.8
2"	117-167	2.3-4.9
3"	334-500	4.9-11.2
4"	500-665	20-28.8
6"	1500	43.5
8"	2080	62
10"	3330	62

Source: Handbook for Emergency Flood Protection (Reference 1)

CONTINGENCY PLANS

During a flood fight situation, problems will arise that could threaten the integrity of the flood barrier system. Listed below are several problems and the necessary responses. It must be emphasized that, without an adequate patrol of the barriers, the problems may not be discovered until it is too late. A levee may fail by several methods: overtopping, seepage, or boils.

OVERTOPPING OF A LEVEE

A levee is generally constructed with a crest that is 2 feet above the predicted flood elevation. However, if flood stages occur that are much higher than was predicted, or the barrier settles, or the levee is not completed, the flood water may overtop the levee.

The barrier can be raised using either earthfill or sandbags. If it is apparent that there is not enough time to raise the levee, it would be necessary to begin evacuation, if needed.

SEEPAGE

Seepage is the flow of water through or under a barrier. For a clay or other impervious barriers, seepage through a barrier generally should not be a problem. It is extremely difficult to eliminate seepage, and doing so may create a more severe problem by doing so.

If the pumping capacity is adequate to prevent damage due to ponding behind the barrier, and there is no slope or foundation failure noted, it is not necessary to try to eliminate the seepage.

If the landward slope of the levee begins to slough, it would be necessary to flatten the slope to 1-foot vertical to 4-foot horizontal. The material used to flatten the slope should be as previous as the embankment.

SAND BOILS

A "sand boil" may result when water is able to seep through the foundation material (typically sand or gravel) of the levee and rupture the surface on the landside of the levee. If the "boil" is eroding material from under the levee, the levee will begin to slump and possibly fail. Thus, if the seepage water is carrying material, it would be necessary to control the seepage. A typical method of control involves the construction of a ring dike around the boil to control the flow.

Another type of boil results from flow beneath the levee, but not in a definite path. This type of seepage may result in one or more boils occurring, and may undercut the landwater toe.

If many small boils occur, the strength of the foundation will be significantly reduced and the slope may fail due to sliding.

If the boil consists of clear water, there would not be a great danger to the safety of the levee. However, if the flow is increasing and is carrying material, there is a need for corrective action. This entails construction of a ring of sandbags around the boil (See Figure 21). The bottom width of a section of the ring should be 1½ times the height; weak ground near the boils should be included within the ring. The height of the ring should only prevent soil movement, and not eliminate seepage. It is not recommended to set the ring elevation equal to the river elevation. The complete elimination of seepage may force a new boil to appear resulting in a sudden failure.

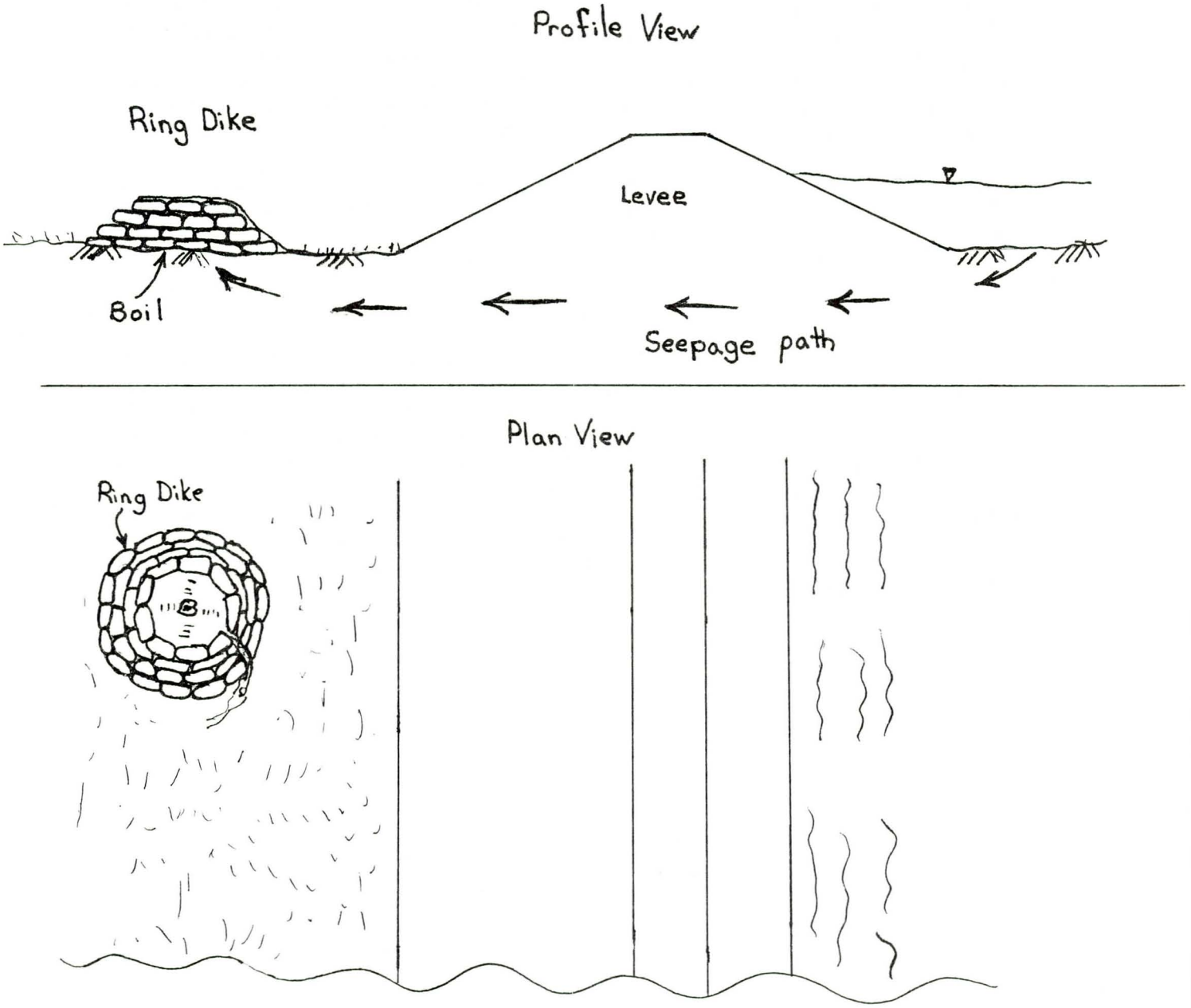


FIGURE 21 Controlling seepage through a sand boil by using a sandbag ring dike

STORM AND SANITARY SEWERS

If pumps are not able (or not available) to keep up with the overflow of manholes it is possible to ring the manhole with sandbags. Due to the high pressures that could result, it is not recommended to build the ring dike above the river elevation. It is suggested that the ring be built part way and dispose of the leakage. As an alternative to sandbags, concrete "ring dikes" may be used. Manhole covers should not be attempted to be weighted down by sandbags, if high heads may occur.

PREVENTION OF SEWER BACKUP

During flood stages, water may "back up" through the sewer outfalls and cause flooding of basements and low lying areas.

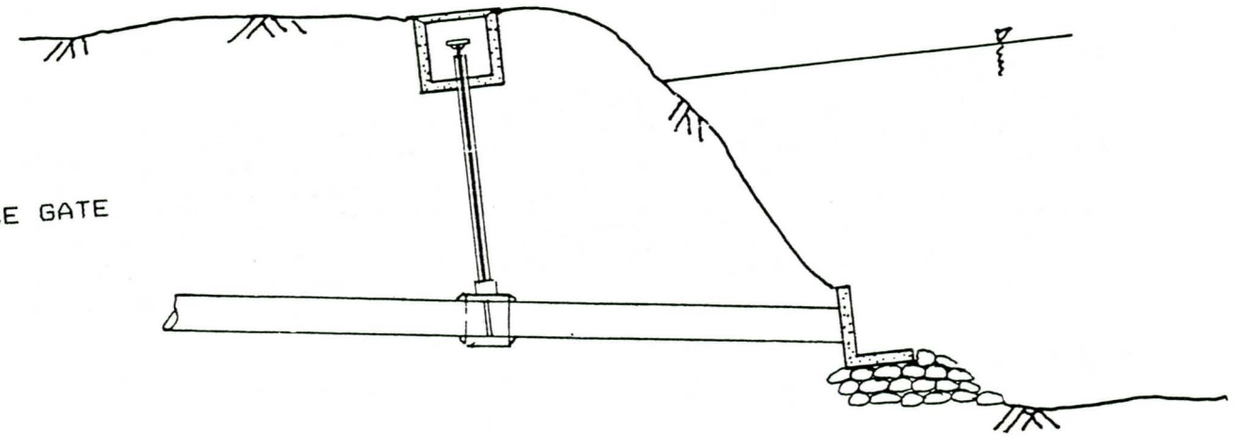
The methods of preventing sewer back up include (See Figure 22):

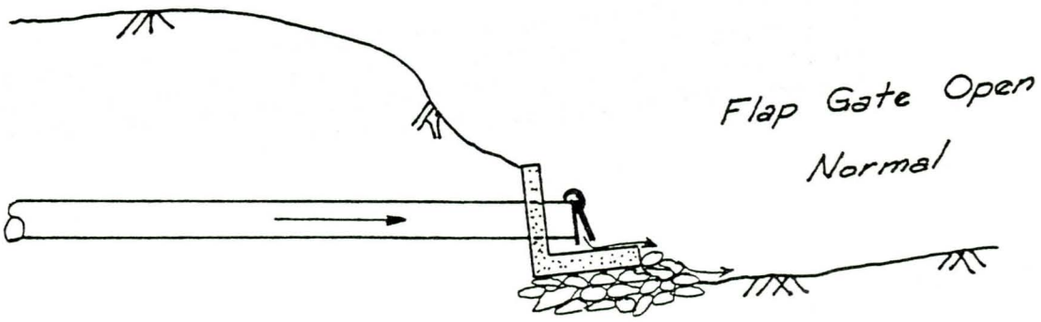
1. Sluice gates are generally closed manually, and are less likely to be blocked by debris than flap gates.

2. Flap gates close automatically if the river stage exceeds the stage on the sewer system. There is a potential problem that the gate may be propped open or blocked by debris.

3. Plugs are available which are inserted into the sewer pipe. Under emergency conditions, lumber, sandbags, and polyethylene can be used as a seal, placed on the outfall pipe. There are also manufactured pipe stoppers available.

SLUICE GATE





FLAP GATE

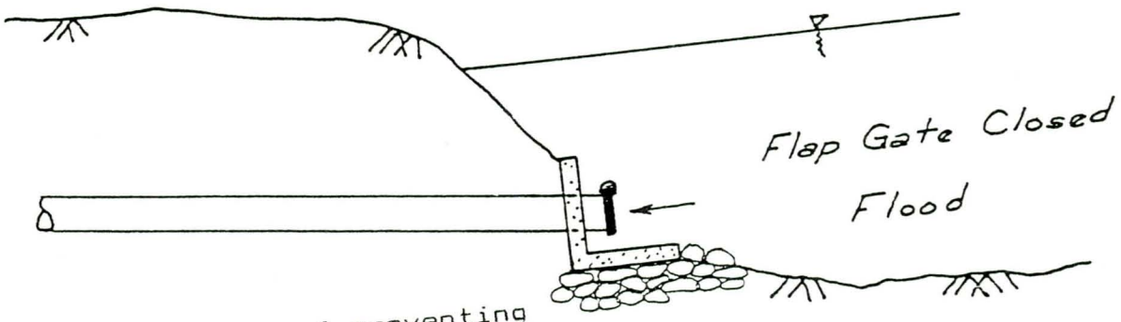


FIGURE 22 Methods of preventing storm-sewer backup

DEVELOP A FLOOD FIGHTING PLAN

The coordination of a flood warning system with emergency response activities (such as sandbag dike construction) to create a flood fighting plan can be quite complex and require considerable pre-planning and organization. A flood fighting plan that is well-organized and implemented effectively can save lives and greatly reduce property damage. The plan should be straight forward, yet detailed enough to describe the various phases of flood fighting activities required as flood stages increase. When the plan is developed, warning time must be considered. If a sand bag levee is needed, enough advance warning is required to ensure that the levee can be constructed in time. Major commitments of manpower and material for floods that do not materialize can be avoided by "staging" the plan--development of a chronologically ordered set of actions based on given conditions (as the watercourse reaches certain levels, predetermined flood fighting activities would be undertaken).

When the flood fighting plan is developed, the following questions should be addressed:

1. Is there going to be a flood, and how severe will it be?

2. What is going to flood at the predicted flood stage? (i.e., homes, industry, waste water treatment plant, and etc.)

3. Will anyone need to be evacuated?
   Where will they go?
   What route(s) will they use?

4. Can the flood related damage be prevented?
   What flood fighting alternatives can be implemented?
   Where will they be implemented?

5. Who is in charge of the flood fight?
   Where is the command center?

6. Who is responsible for the different actions required?
   What is the priority of action?

7. Where will the materials and equipment come from?
   Will access to them be lost?

8. Who should be contacted in local, county, state, and federal governments?

9. What was the cost of the flood damage, flood fight, and clean-up? What money is available?

Note this is a continual process (See Figure 23). Each step should be evaluated periodically, particularly following subsequent flood events.

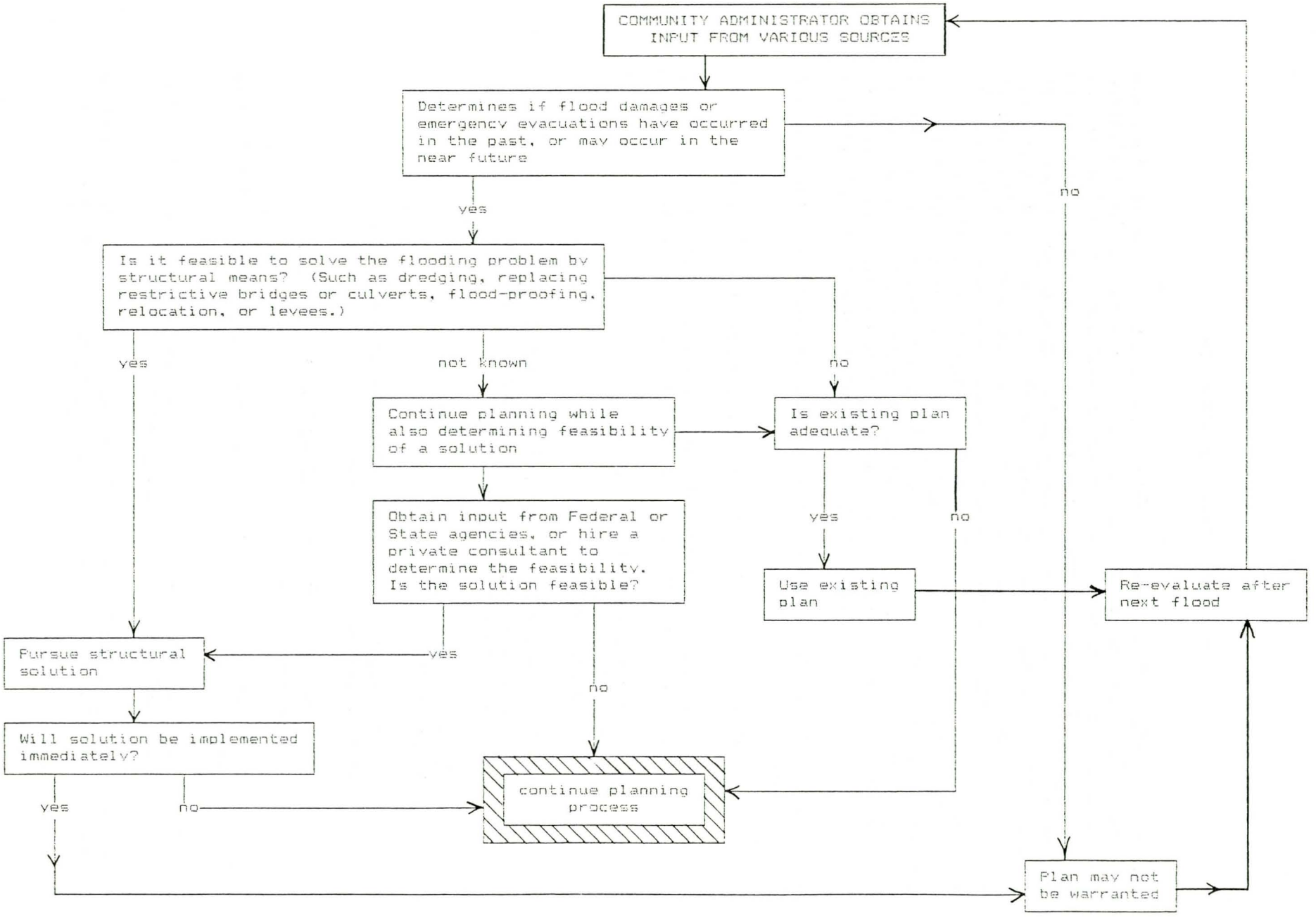


FIGURE 23 Decision Process for Determining if a Flood Fighting Plan Should be Developed

SELECTION OF ALTERNATIVE EMERGENCY RESPONSE MEASURES

Once alternative flood warning systems and emergency response measures have been reviewed, your community must determine which alternatives would be appropriate and effective for your unique set of circumstances:

1. Use the information from the Flood Stage Damage Forecast Map to determine which areas of the community are subject to the greatest flooding hazard and require the most emergency assistance. Be sure to consider critical buildings such as hospitals, nursing homes, schools, and emergency services.

2. Using the Flood Stage Damage Forecast Map and advice from the emergency services directors concerning past successful emergency assistance operations, determine the safest evacuation routes from the high hazard areas. Particularly good evacuation routes are on higher ground and have good access. (See FELV/SOP for more detailed information concerning evacuation procedures.)

3. Determine the type of emergency response that would most effectively protect the threatened areas and evacuation routes. The following information may be helpful in making this determination:

   (a) The community's Flood Stage Damage Forecast Map.

   (b) Characteristics of the flood source. (See pages 4-8 of this guidebook.)

   (c) Table 2 - Selection of Flood Fighting Methods.

MAKE ADDITIONS TO THE FLOOD STAGE DAMAGE FORECAST MAP

The flood Stage Forecast Map is one of the most important sources of information used in preparing a flood fighting plan. The next step is to update the flood Stage Forecast Map by adding the following information:

1. The location of critical areas such as hospitals, police and fire departments, nursing homes, schools, waste water treatment plants, etc.

2. The location of evacuation routes, especially those routes that should be protected by emergency barriers in the event of a flood, and routes that should be barricaded.

3. Areas that must be evacuated.

4. Areas that require sandbag or dike protection and the planned locations for the emergency sandbag barriers or dikes.

5. The locations of the Emergency Operations Centers and Evacuation Centers.

TABLE 2
SELECTION OF FLOOD FIGHTING METHODS

FLOODING CHARACTERISTICS	FLOOD FIGHTING METHODS			
	Sandbagging	Earthen Levee	Box Levee & Flash Board Levee	Evacuation
-Flood Depth				
less than 3 feet	yes	yes	yes	yes
3-6 feet	no	yes	yes	yes
greater than 6 feet	no	no	no	yes
-Velocity				
Less than 5 fps	yes	yes	yes	yes
greater than 5 fps	no	no	no	yes
-Flood Warning Time				
minutes	no	no	no	yes
hours	yes	yes	no	yes
days	yes	yes	yes	yes
-Duration of Flood				
hours	yes	yes	yes	yes
days	no	yes	yes	yes
weeks	no	no	no	yes
-Location				
Severe Wave Action	no	no	no	yes
located w/in floodway	no	no	no	yes
limited right-of-way	no	no	yes	N/A
-Resources				
heavy equipment				
not available	yes	no	no	N/A
clay	no	yes	no	N/A
sand	yes	yes	yes	N/A

YES-the flood fighting method is feasible for the given characteristic.

NO-the flood fighting method is not recommended for the given characteristic.

N/A-not applicable.

FLOOD FIGHTING ACTIVITIES

Once the most effective and appropriate emergency response measures have been determined, the flood fighting plan itself can be developed. Use the updated map as a basis for creating a general list of flood fighting activities -- any action that is necessary to accomplish effective flood warning, the construction of emergency barriers, the coordination of materials and resources, the coordination of the management of the flood fight, etc. Following is an example list of flood fighting activities to give you a better idea of what might be included in your list. (Due to the differences in the sizes of communities and the extent of the flood hazard area, each activity may not be applicable to all communities.)

1. Obtain input from rain and river gage monitors, and make flood forecast.

2. Open the Emergency Operations Center for communications, record keeping, assessment, and public information.

3. Schedule regular meetings of key personnel to review and plan flood fighting operations.

4. Periodic levee inspection. Check for sand boils possible overtopping, or anything that may make the levee inoperable.

5. Establish communications system including: telephones for incoming calls from the public, incoming and outgoing calls for persons involved in the flood fight, two-way radios with flood fighting activities assigned to particular channels.

6. Construct sand bag dikes and levees to protect critical areas.

7. Record actions taken and money expended, establish an emergency account to handle purchases or leasing.

8. Provide traffic control along evacuation and access route.

9. Restrict access into flooded areas by using identification tag system.

DEVELOP THE FLOOD FIGHTING PLAN

The flood fighting plan is the ordering of the various flood fighting activities into a chronological sequence based on the level of flooding. As the flood level condition is met (using as U.S.G.S. gage reading of 12 feet), the planned flood fighting activity is accomplished. As an example, volunteers and materials are organized to sandbag the critical evacuation routes as specified on the Flood Stage Damage Forecast Map.)

Below is a brief example of some of the flood fighting activities that may be contained in a flood fight plan and what actions could be taken as flood stages increase.

Flood Fighting Plan for Confluence, Michigan

USGS Gage Reading (ft)	Responsibility	Description
8	Sewer Department	Shut off Lift Station #3
9	Sewer Department	Check flapgate near Lift Station #5
10	Sewer Department	Sandbag manhole at 434 Water St.
11	Street Department	River Street Bridge impassable, barricade street
12	Civil Preparedness Director	If stage is expected to reach 18 ft., have 30,000 sandbags on hand. Arrange for four shifts of sandbagging volunteers, about 40 volunteers per shift. Arrange for 4 endloaders, and 15 dump trucks
13	Sewer Department	Sandbag manhole at 529 First St.
14	Civil Preparedness Director	Begin evacuation of homes along Crawford St. between 1st and 3rd Streets. Arrange for evacuation of Sunnyside Nursing Home if stage is expected to reach 16 ft.
15	Civil Preparedness Director	Begin placing sandbag levee along Oak Street, from Main Street to Water Street, if stage is expected to reach 18 feet.
	Street Department	Barricade Maple St. Bridge
	Sewer Department	Sandbag manholes at 444 Portage, 336 Pleasant Drive, 373 Green

IMPLEMENTATION OF THE FLOOD FIGHTING PLAN

For a flood warning system and a flood fighting plan to be carried out effectively, it is necessary to identify tasks, who is responsible for the tasks, and who will have authority over the flood fight.

The Flood Fighting Plan should list the individuals and alternates for the following activities:

1. Overall responsibility (mayor, supervisor, etc.). This individual has overall responsibility for the community's functions and activities; coordinates requests for assistance with county, state and federal governments; makes declaration of emergency; determines the need for and timing of a flood fight (with input from staff).

2. Responsible for the planning and supervision of the actual flood fight (fire chief, police chief, etc.). This individual would report directly to the mayor/supervisor.

3. Responsible for technical advise and material supplies (director of public works, community engineer, etc.). Provide technical advise pertaining to the flood fight, such as the construction and maintenance of the flood barrier, and the availability of supplies. This individual should also maintain close contact with the Corps of Engineers.

4. Responsible for coordinating all the flood fighting activities provided by the community (police, fire, etc.), and volunteer groups. Generally referred to as Emergency Operations Center Commanders.

   Figure 24 shows a typical chain of command for the flood fight. To go along with the figure, a list would have to be developed indicating the key flood fight personnel, their alternates, and telephone numbers. Also included in a flood fighting plan should be a list of agencies and their responsibilities during a flood emergency. Following is a list of some of the agencies that should be identified:

Agencies and Their Responsibilties

1. Fire Department - In addition to fire fighting and life saving, the responsibilities may include: rescue and evacuation, shutting off utilities, and securing tanks containing fuel/hazardous materials.

2. Police Department - The responsibilities may include: normal activities, security to evacuated areas, traffic control during evacuation, coordination with National Guard and neighborhood groups, setting up communication equipment at Emergency Operations Center.

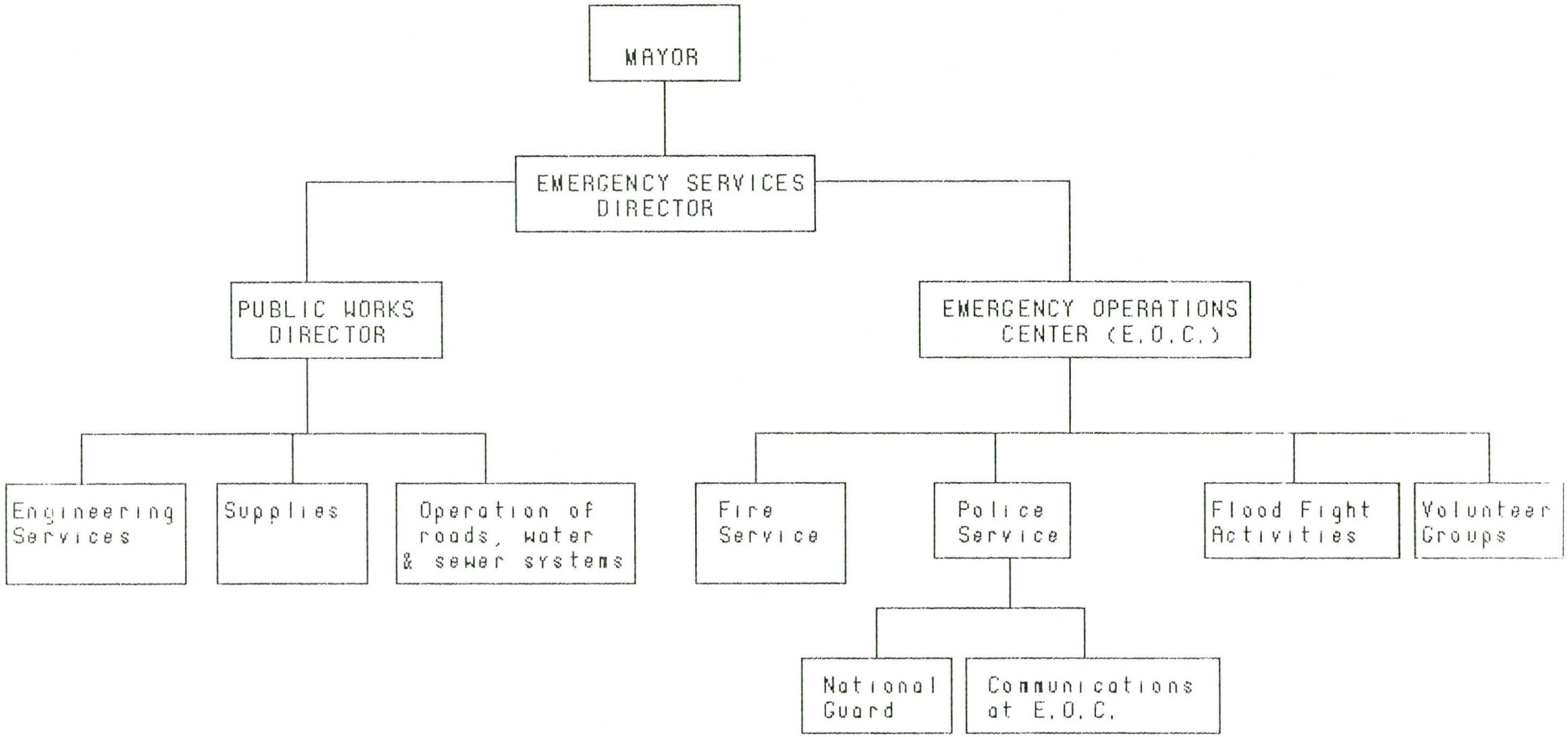


Figure 24

Typical Chain of Command for a Flood Fight Plan

3. Public Works/Engineering - Depending on the force available, the responsibilities may consist of: Engineering services for construction of new flood barriers raising existing barriers, or addressing problems that arise; sandbag manholes and pumping stations; closing sewers to prevent back up. This department may also be responsible for closing inundated roads, or identifying areas where sandbagging is needed.

4. Health Department (City or County) - Responsible for public health, including inspection of water supplies, sewage treatment, and garbage collection. The department would have the authority to issue health-related directives.

5. State Government - Emergency Management Division, Michigan State Police (517-334-7950) acts as the primary point of coordination and contact for state government. The EMD may obtain the necessary technical support, authority, or resources to respond to the emergency. The community's liaison to the EMD is the District Emergency Management Coordinator. The contact and the appropriate telephone number should be listed in the plan.

   The Michigan Department of Natural Resources is responsible for various activities. The Land and Water Management Division is responsible for:

   Coordination between the State and the U.S. Army Corps of Engineers. 517-373-3930

   Coordination of the National Flood Insurance Program within the State. 517-373-3930

   Dam Safety and Technical Assistance. 517-373-0208

   Flood Hazard Management and Mitigation. 517-373-3930

   Emergency permit for replacement of bridges or culverts. 517-373-0133

   Mailing address: MI Department of Natural Resources
   Land and Water Management Division
   P.O. Box 30028
   Lansing, MI 48909

The Surface Water Quality Division is responsible for:

Inspection of Wastewater Collection and Treatment Systems for Municipal and Industrial Facilities. 517-373-1949

Mailing address: MI Department of Natural Resources
Surface Water Quality Division
P.O. Box 30028
Lansing, MI 48909

6. The Federal Emergency Management Agency - If an emergency or a disaster declaration is made, FEMA may direct any Federal agency to provide the following kinds of assistance to State and local governments:

Coordinating relief organization efforts.

Preparing damage surveys and assessment reports.

Granting individual and family financial aid.

Equipment, supplies, facilities, personnel, and other resources.

Providing emergency communications.

Providing emergency mass care.

Distributing medicine and food.

In day-to-day activities, the Federal Emergency Management Agency administers the National Flood Insurance Program:

Prepares and updates flood insurance studies and floodplain mapping.

Review communities coordination for compliance with NFIP guidelines.

Provide monetary and technical assistance for flood hazard mitigation opportunities.

The address for the Regional FEMA Office that covers Michigan is:

FEMA, Region V
175 West Jackson Boulevard
4th Floor
Chicago, Illinois 60604
Telephone: 312-408-5500

7. U. S. Army Corps of Engineers - The Corps is authorized to provide assistance to state and local governments during emergency flood conditions. The assistance includes:

   Disaster preparedness.

   Advance measures

   Flood fighting, technical advise, supplies, equipment, and personnel.

   Rescue.

   Post flood rehabilitation of flood control facilities.

   Provide clean drinking water.

   Debris removal.

   The mailing address is:

   U.S. Army Corps of Engineers
   Detroit District
   P.O. Box 1027
   Detroit, MI 48231-1027
   Telephone: 313-226-6762

8. The National Weather Service of the National Oceanic and Atmospheric Administration (NOAA), The National Weather Service, via various media sources will provide assistance to a community in establishing and calibrating flood warning systems.

9. Volunteer Organizations

   Volunteers may be needed for a wide range of activities including:

   Emergency flood preparation and distribution.

   Clothing.

   Shelter.

   Rescue.

   First aid.

   Flood fighting.

   Evacuation.

   Clean up.

Restoration.

Dike patrols.

Organizations - The plan should include a listing of all the contacts for the various organizations. Organizations that could be listed include: Red Cross, Salvation Army, Neighborhood Groups, Church Groups, High School/College Students, plus many other possible groups.

10. Materials Suppliers

Materials Needed - In addition to personnel, it is essential that the flood fight plan include a list of the materials and equipment that would be needed during the flood fight. The list may also include:

Supplier's name and address.

Telephone number, including after hours number.

The flood stage at which access to the supplier is lost. (Generally this information is most applicable to the sand and gravel source.)

In general, it may be necessary to develop lists of suppliers for the following items:

Sandbags

Polyethylene sheeting

Sand and earth fill

Lumber

Pallets

Pumps

Power sources

Tractors with power take-off units

Forklifts & operators

Heavy equipment & operators

Flood fighting supplies

Fuel supplies

Maintenance personnel

APPENDIX A
ICE JAMS

Ice jams can form very quickly and result in extensive flooding, destroy property, interrupt navigation and reduce power production. The flooding that results from an ice jam is generally much more severe than clear channel flooding, as the ice jam essentially acts as a dam on the watercourse. Currently, there are no certain methods of predicting an ice jam. It is possible to identify potential areas, such as: an abrupt decrease in stream slope, a bend, an island, a bridge or pier, or a shallow area.

For simple discussion, ice jams can be classified into two groups, a floating ice jam and a grounded ice jam.

A floating ice jam occurs as ice floes move downstream and encounter an obstruction, a restriction, or stationary ice. Once the ice is stopped, additional ice floes thicken the jam reducing the flow carrying capacity of the watercourse. And the water surface upstream of the jam is increased. This type of jam still allows some flow beneath it (See Figure 25).

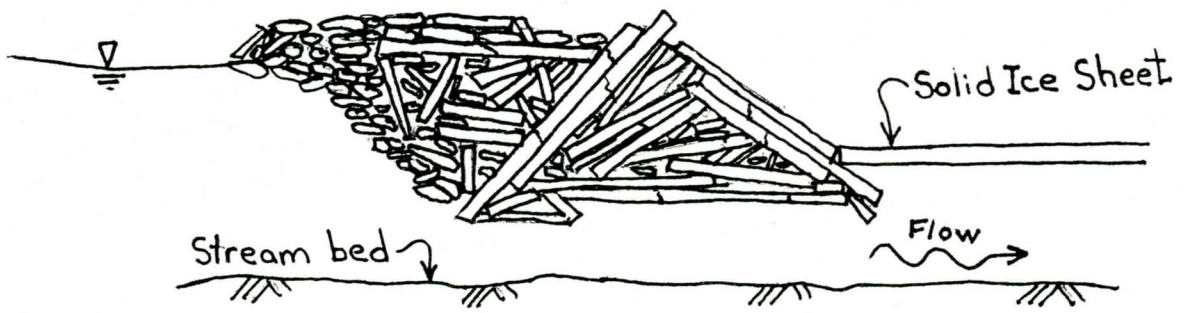
A grounded ice jam rests on the river bottom. Since the waterway area beneath the jam is blocked, the grounded ice jam is much more restrictive than a floating ice jam. This jam may occur in a shallow reach of a watercourse in which the ice forms on the rocks on the river bottom, or if a jam settles to the bottom because of reduced flows, or the collapse of floating ice jam. Because of the irregular shape and slope of most channels, if the channel carries ice floes, there is a possibility of a grounded jam occurring.

To relieve the flooding or to avoid a worsening condition, there are three methods of removing the ice jams: (1) mechanical, (2) blasting, and (3) ice breaking ships.

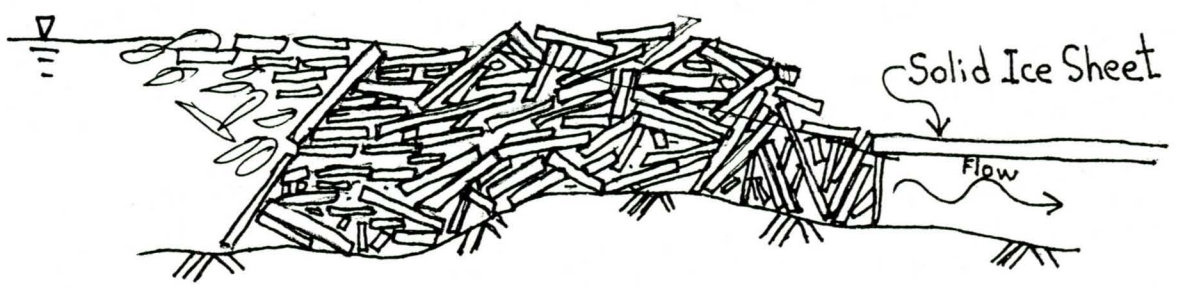
Before attempting to remove the ice jam, it must be remembered that ice loosened may jam farther downstream and cause additional damage for which the community may be liable.

The mechanical removal of an ice jam is extremely expensive and quite slow. Because of the expense and the equipment needed, the type of removal is limited to small, shallow streams. Since the ice is removed from the stream, it will not cause problems downstream. However, it will still be necessary to discard the ice in the overbanks, which may also be a problem.

The most effective way to remedy flooding problems due to ice jams is by blasting. However, before an ice jam can be blasted, there are several precautions that must be taken:



Floating Ice Jam



Grounded Ice Jam

FIGURE 26 TYPE OF ICE JAMS

1. A safety plan should be in place before blasting is utilized. The plan should indicate who is in charge, resources to be used, and a warning system. The U.S. Army Corps of Engineers should be contacted for assistance.

2. There must be some place for the ice to go. It will do little good to blast the jam if it cannot move downstream without causing additional problems.

3. There must be enough flow to carry the ice downstream. If there is not adequate flow, the jam should not be blasted.

4. The blasting should be done only by an experienced blasting crew.

The use of ice-breaking ships is limited to large rivers and the Great Lakes connecting waterways.

Another possibility is to weaken the ice before it jams by pumping water and bottom materials onto the ice or by dusting. However, this application assumes snow will not cover-up the material.

Before attempting any method it is advisable to contact the U.S. Army Corps of Engineer, Detroit District for assistance.

APPENDIX B
PREVENTION OF RESIDENTIAL SEWER BACKUP

Within residential units there are different methods of preventing sewer backup.

1. Plugs can be inserted into the floor drain which will prevent sewer backup into the basement. However, the sewer may then back up into the next highest drain opening such as a laundry tub, sink or toilet.

2. Standpipes inserted in the floor drain would allow the backup to seek its own level. This eliminates the possibility of the plug popping out of the drain. However, backup would still be possible to higher openings as with plugs.

3. A backup valve may be installed outside of the basement which would prevent sewer backup from entering the basement/house. (See Figure 26) These valves could either be automatic or manual. With either type of valve there is a potential for debris jamming the valve open, the automatic valve being most susceptible. The manual valve would have to be used periodically to prevent "freeze-up". It would be advisable to locate the valve in a manhole for easier installation and maintenance.

4. An overhead sewer system is the most expensive, but the most dependable method. It would require the sewage to be pumped into the sewer system through an overhead sewer line. The sewer would back up out of the system before backing up into the house.

The Illinois Department of Transportation has developed a booklet on preventing flood damage to a residence. The title of the booklet is "Protect Your Home From Flood Damage", and may be obtaiend from the Michigan Department of Natural Resources, Land and Water Management Division, P. O. Box 30028, Lansing, Michigan 48909.

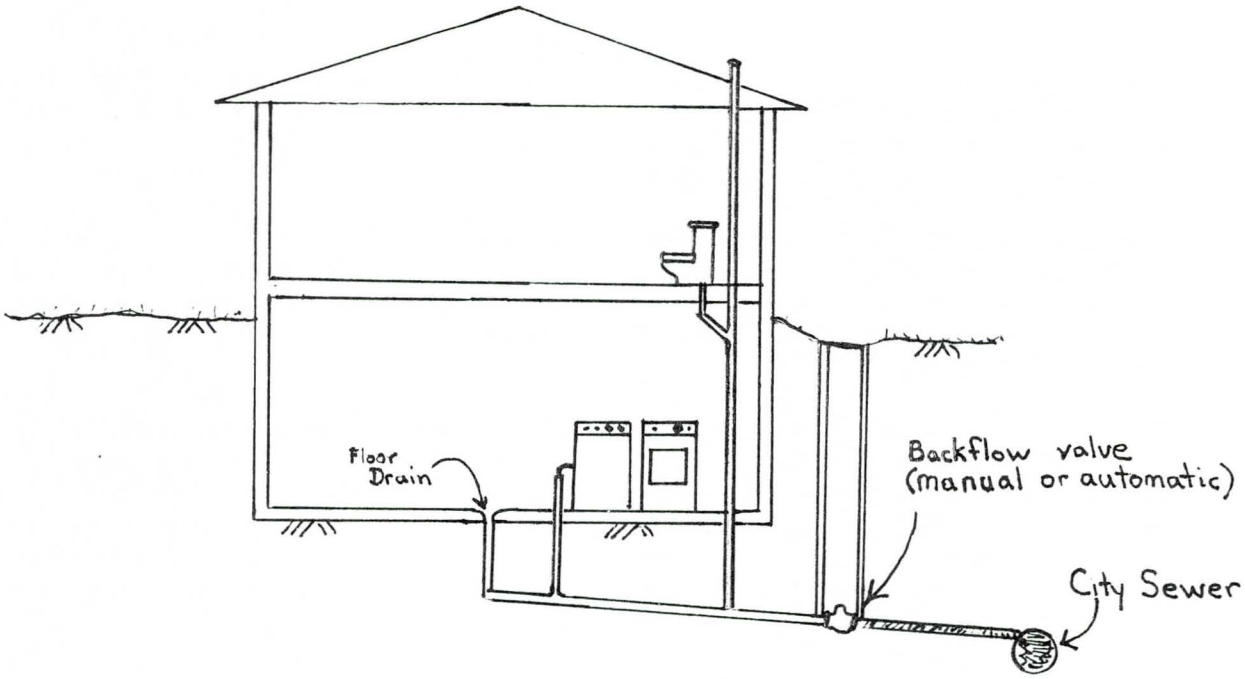


Figure 26 Backflow valve used to keep water from backing up into house

PRECAUTIONS:

When preventing sewer backup into the basement there are precautions that must be considered. The sewer pipes were not designed to operate under pressure. A plug or stand pipe in the floor drain may create enough pressure to break the sewer pipe.

The installation of a backup valve close to the property line would minimize the amount of sewer line exposed to the pressure. Since the backup valve results in the pressure being increased in the city system, it is advisable to check with the community to determine if a backup valve is allowed.

If the ground under a building becomes saturated, extensive water pressure will develop on the basement floors and walls. If the water is prevented from entering the basement it is possible that the floor may buckle or the walls collapse. Thus it may be possible to sustain expensive structural damage while trying to prevent damages due to flooding. It would be advisable to contact a plumbing contractor to determine the costs and possible risks of each method.

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