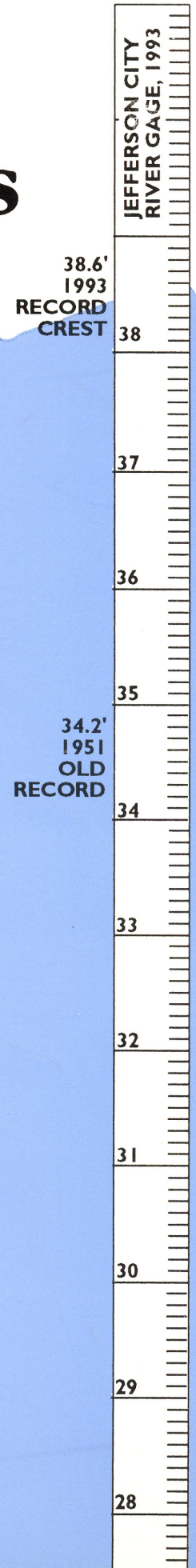
Water Resources Report Number 54

Flood Report Analysis



MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology and Land Survey

Water Resources Report Number 54

Flood Report Analysis

by
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1996

MISSOURI DEPARTMENT OF NATURAL RESOURCES
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FOREWORD

Flooding is a *natural event* and has been characteristic of rivers in Missouri throughout its history and prehistory.

Flooding becomes a *natural disaster* when it is of such magnitude that both man-made and natural landforms are destroyed or seriously damaged. When human development (structures and activities) are placed in the way of such floodwaters, the damage becomes overwhelming. Unlike the unpre-dictability of tornadoes, places where floods will occur can be predicted. Flooding that is not of major proportions has certain benefits. For example, flooding rejuvenates wetland areas in flood plains.

Over the decades, there have been divergent approaches to solving the problem of occasional or recurrent flooding. These approaches essentially fit into three categories: (A) to deal with the flood hazard itself (keep the water away from the people), (B) to deal with human development (keep the people away from the water), and (C) to deal with how the floods and the people come together (flood insurance and disaster assistance).

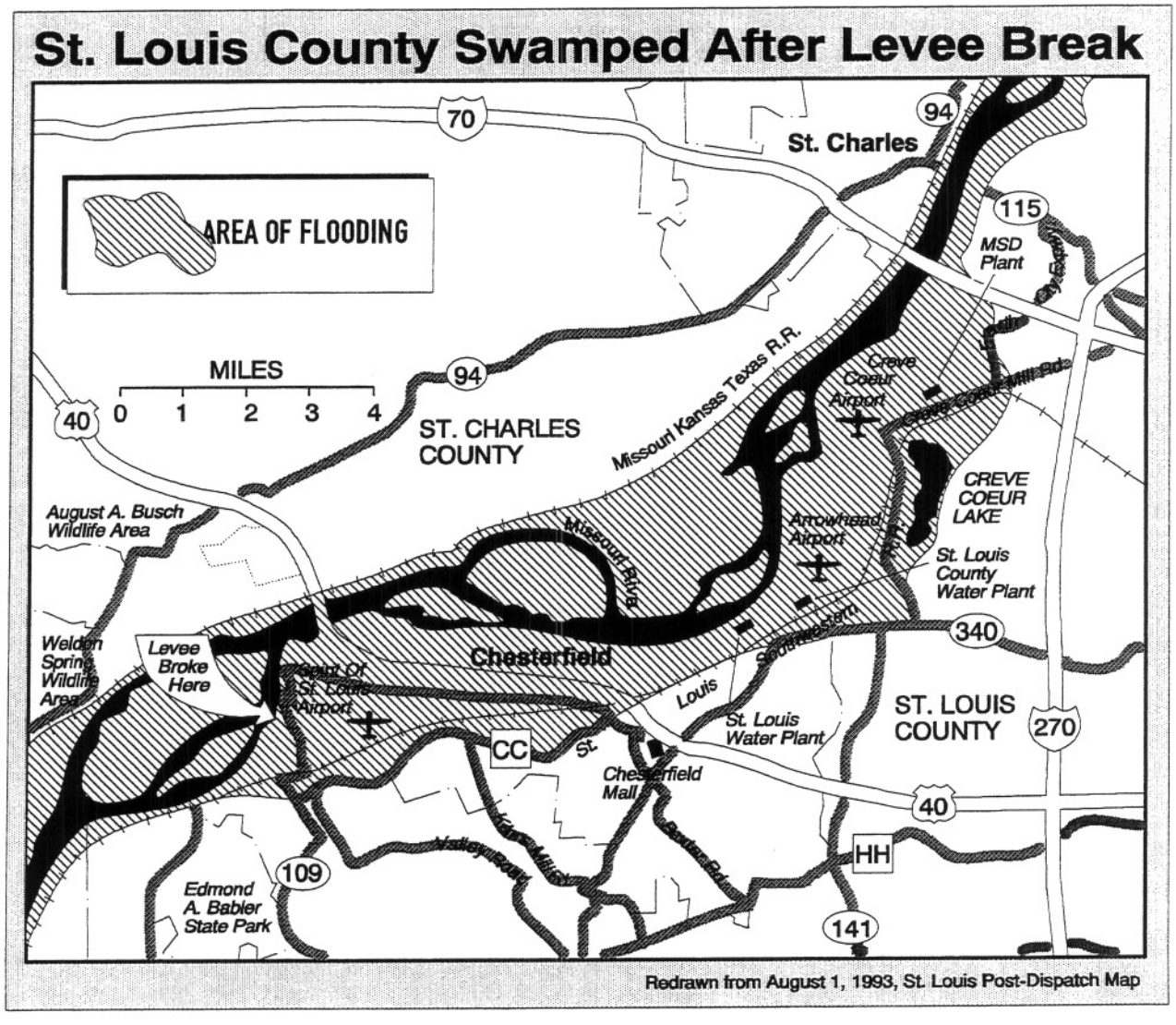
THIS DOCUMENT

This document is an analysis of four reports which were published by state and federal agencies as policy and planning documents following 1993 flooding in nine midwestern states. The reports contain recommendations for how to reduce flood damages in the likely event that another large magnitude flood should occur in the future. The four reports were also published for the purpose of influencing public policy in the areas of flood plain management, flood control, flood insurance, flood disaster aid, and other flood-related issues.

Three of the reports were commissioned by some authority: *The Report and Recommendations of the Governor's Task Force on Flood Plain Management,* on behalf of Governor Carnahan; *The Floods of '93 — State of Missouri*, by the Interagency Hazard Mitigation Team set up by the Federal Emergency Management Agency, under the terms of the Stafford Act of 1988; and *Sharing the Challenge: Floodplain Management into the 21st Century*, the report of the Interagency Floodplain Management Review Committee to the Administration (White House) Floodplain Management Task Force.

The fourth report, *National Flood Policy in Review — 1994,* by the Association of State Floodplain Managers (ASFPM), known as the organization "dedicated to reducing flood losses in the nation", was voluntarily produced for the guidance of decision makers and planners.

Each of the four reports approached the problem of flooding from a different perspective. The reports worded their recommendations differently. This analysis of the four reports sought areas of commonality which could be brought to bear on the issue of flooding in *Missouri*. Sometimes only two or three reports touched on a given point, although all four addressed some aspect of a point. Where possible, this analysis shows where common wisdom points the way to an improved approach to dealing with flooding.


St. Louis County Swamped After Levee Break
AREA OF FLOODING
MILES
0 1 2 3 4
70
94
115
40
340
270
109
141
St. Charles
MSD Plant
Creve Coeur Airport
Missouri Kansas Texas R.R.
ST. CHARLES COUNTY
CREVE COEUR LAKE
Arrowhead Airport
St. Louis County Water Plant
August A. Busch Wildlife Area
Missouri River
Weldon Spring Wildlife Area
Levee Broke Here
Chesterfield
Spirit Of St. Louis Airport
St. Louis Water Plant
ST. LOUIS COUNTY
CC
Chesterfield Mall
HH
Edmond A. Babler State Park
Redrawn from August 1, 1993, St. Louis Post-Dispatch Map

INTRODUCTION AND BACKGROUND

From April through October, 1993, very large flooding of the Upper Mississippi River and Missouri River caused serious damage and severe dislocations throughout the state of Missouri and eight other nearby states. The Flood of 1993 was a national catastrophe, interrupting transcontinental commerce for many weeks, including rail, highway, and barge traffic. Tremendous outlays of local, state, and federal dollars to aid recovery of people and property created major financial hardships. Man-made structures can be repaired or replaced, however, the personal hardships of the people affected will remain for years.

In November, subsequent to the Flood of 1993, additional heavy rains caused flash flooding in the southeast portion of the state, part of which had been spared earlier flooding. By year's end, nearly every county in Missouri had been declared a Presidential Disaster Area at least once. In the *three* 1993 Presidential Disaster Declarations for Missouri, some counties were declared all three times.

Flood stage records were broken at nearly every Missouri recording location along the Upper Mississippi and Missouri Rivers. In many places, the magnitude of flooding was what had been predicted as a "once-in-five-hundred-year" flood. (See definition, page 41.) The historic flood (before the period of recording gages) nearest to the magnitude of the 1993 flooding was the flood of 1844.

But the Upper Mississippi River and Missouri River of 1993 were not the same rivers they were in 1844; the U.S. Army Corps of Engineers had changed them by the construction of "river training works." These navigation improvements narrowed and deepened their channels to improve waterborne commerce.

In 1993, a major portion of the rainfall occurred downstream of the large dams on the Missouri River. Thus, there was little to slow the torrents of runoff from the intense rains, especially in Kansas, Nebraska, Iowa and northern Missouri.

GOALS OF THIS ANALYSIS

This analysis is intended for elected officials and key decision makers, and should provide guidance for future flood-policy decisions. An effort was made to identify common threads of wisdom in the four reports applicable to Missouri. Since the reports approach the topic differently, and the recommendations are worded differently, the reports cannot be compared line-for-line. However, there are many recurrent themes and these areas of commonality are shown in tables accompanying the text.

There have been numerous reports published on the Flood of 1993. This analysis is *not* on the flooding. The Appendix lists some of the major reports about the Flood of 1993, for people wishing for greater detail about the flooding itself.

This analysis is the result of a review of the four major reports which made post-flood recommendations for averting such a national disaster in future years. There have been other post-flood recommendations, but this review

deals only with the following four published reports:

1. The *Report and Recommendations of the Governor's Task Force on Flood Plain Management*, or, simply, the *Governor's Task Force Report*, July, 1994.

2. *Sharing the Challenge: Floodplain Management into the 21st Century*; the Report of the Interagency Floodplain Management Review Committee to the Administration Floodplain Management Task Force; "A Blueprint for Change", June, 1994. Also called the "White House Task Force Report", it is also known by the name of the committee chairman, Brig. Gen. Gerald Galloway, U.S.A., Dean of the U.S. Military Academy, West Point, N.Y. (the Galloway Report). The Scientific Assessment and Strategy Team (SAST) Report, *Science for Floodplain Management in the 21st Century*, is Part V of "A Blueprint for Change". Part of the Appendix of the Galloway Report, it is not reviewed, here.

3. *National Flood Policy in Review - 1994*, by the Association of State Floodplain Managers, or, simply, the *ASFPM Report*.

4. *The Floods of '93 - State of Missouri*, the federal Interagency Hazard Mitigation Team Report for the three Presidential Disaster Declarations in Missouri, or, simply, the *IHMT Report*, April, 1994.

This volume is one of three State Water Plan publications initiated in 1995. The other two are the *Final Report of the Rural Water Systems Project* (in conjunction with the Missouri Department of Economic Development) and the *Drought Response Plan*, both published in 1995.

A note on terminology: *Flood Plain*

The term "flood plain," will be seen in this report as both two words, and as one word. In Missouri, the Governor's Task Force and the Department of Natural Resources use two words, and that is the style used in this report. Where the term is found in a title or a quotation, it is spelled as found in the title or quoted text.

SYNOPSIS

Post-flood recommendations made by the Governor's Task Force on Flood Plain Management and three other documents have been analyzed to provide this report. This synopsis outlines the gist of the several areas in which common wisdom could be distilled.

- **-All four post-flood reports recommend that the State should take an active role in flood plain management, determine state flood plain management policy, and implement it.** (Table 1)

- **-The reports generally agreed that the hydrology of the Missouri and the Mississippi rivers should be reviewed, with the possible result that base flood elevations should be recalculated, and new flood maps issued.** (Table 2)

- **-The encouragement of participation in the National Flood Insurance Program, both by communities and individual property owners, was stressed to the point that recommendations stated that post-flood disaster assistance to those *not* insured should be limited, reduced, or withheld. The problems of mortgage lenders and borrowers were addressed, and escrow of premiums for flood insurance was emphasized.** (Tables 4 & 5)

- **-Maintaining flood insurance purchase requirements behind levee protection works was recommended, along with legislating a state definition of market value, to assure compliance with flood insurance regulations dealing with substantial damages.** (Tables 6 & 7)

- **-Levees, levee districts, levee protection systems, state levee permits, levee construction criteria, levee repairs, and levee heights were addressed by the four reports as a result of the levee failures in the 1993 flooding. More state involvement in the whole topic area was universally recommended, especially in oversight and permits.** (Table 8)

- **-Greater environmental sensitivity, and increased state government involvement in flood plain matters was stressed in the post-flood reports. Public health and safety during flood events was also stressed, especially in regard to hazardous materials.** (Tables 9 & 10)

Missouri's state capitol, Jefferson City, during the flood of 1993. Photo by Steve McIntosh.

ANALYSIS OF FLOOD REPORTS

The four post-flood reports stressed that major flooding is not a once-in-a-lifetime event. It will happen again. Areas flooded severely in the flood disasters of 1973, 1979, 1982, 1984, and 1986, and even in 1844, were the same areas devastated in 1993. The repetitive nature of flooding has been made clear.

The reports highlight the values of flood plains in slowing floodwater velocities and reducing peak flood volumes. They also note that lack of adequate controls on design, construction, and maintenance has contributed to levee failures with resultant increased flood damages.

The analysis of the post-flood reports is presented on a topical basis, with flood plain management as the first topic. A matrix of the recommendations of the four reports is included in the topical sections. These are tables that allow the reader to quickly compare the four reports to determine if it would be worth while to consult the original for greater detail.

FLOOD PLAIN MANAGEMENT

Both the Governor's office and the President's office issued Executive Orders (EOs) on Flood Plain Management (FPM) many years before the Flood of '93. These policy statements were binding on state and federal agencies. The four reports stressed the importance of the policies. Two of the reports noted that government agencies should inventory their property to determine their vulnerability to future flooding. The recommendations were as shown in Table 1.

Some Background

The first real move to flood plain management, as a nonstructural alternative to flood control, was embodied in the National Flood Insurance Act of 1968. This was 40 years after the Flood Control Act of 1928, which authorized the Corps of Engineers to control the Mississippi River with dams, levees, and diversion channels.

Like 1993, the year 1927 was pivotal in regard to national policy on flooding. In that year, a major flood occurred on the Lower Mississippi River, causing great hardship among the tenant farmers and other residents of the Mississippi flood plain. One of the great photographic records of the 1927 flood was published in the *National Geographic Magazine* in September, 1927.

In passing the Mississippi River Flood Control Act of 1928*, Congress directed the U.S. Army Corps of Engineers to undertake the *structural approach* to reducing flood damages, (keeping the water away from the people.) This was in the affluent period following World War I, preceding the Great Depression. Confidence in human ability to control natural forces was expressed in this and other public works projects.

Forty years later, after numerous flood and hurricane disasters in the 1950s and 1960s, and spending billions of dollars on both flood

33 U.S.C. 702a, et. seq. (Or 45 Stat. 534).

Table 1

FLOOD PLAIN MANAGEMENT RECOMMENDATIONS

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Position on Executive Orders (EO) previously issued by Governor/President	*P. 2,* New Gov's EO on FPM needed (expanded). State agencies report to Gov. annually on compliance with EO on FPM.	*Action 5. 4,* New Pres's EO on FPM needed to reaffirm federal commitment (paraphrased)	*V. 3,* Pres's EO is powerful FPM policy: needs enforcement mechanism. (paraphrased)	*Rec. 1,* Establish state FPM policy and guidelines.
Position on agencies making inventory of vulnerability.	*P. 2,* Identify state structures vulnerable to flooding. Prepare emergency response and evacuation plans. Ensure structures are insured and meet NFIP standards.	*Action 5. 5,* Fed. agencies conduct vulnerability to flooding analysis.	Not addressed	Not addressed
Position on role of the state in flood plain management	*Rec. 1,* Create a multi-jurisdictional body to recommend FPM policy; and, empower a designated state agency to implement state FPM policy.	*Rec. 5. 2,* State role in FPM activities should increase.	*V. 1,* Federal policy needs to support state and local capability in FPM.	*Rec. 1,* Consider legislation to implement state FPM policy.
Designation/ mapping of flood plains	Not addressed	*Action 6. 6,* Map all communities with flood hazards.	*I. C, 2.* Areas flooded should be designated flood plains (A-Zones).	Not addressed

control works *and* disaster aid, Congress was convinced that another approach to reducing flood losses was needed. It did not mean abandoning the structural approach, but adding elements of a *non-structural approach* with the adoption of the National Flood Insurance Act of 1968**.

One aspect of the National Flood Insurance Program (NFIP) is that local governments must adopt regulations governing new development activities in identified (mapped) flood plains in order to be eligible for the sale of flood insurance within their jurisdictions. This couples the availability of financial protection for vulnerable properties with community action to limit new vulnerability.

All reports agree that new development in flood plains should still be permitted; however, design and construction in recognition of the hazard must be an absolute mandate. In flood plain management, all reports agree that the NFIP is a critical element, but eligibility and requirement of participation must be well defined and carried out. This includes the fact that eligibility for federal disaster assistance in the event of a flood is tied to participation in the NFIP.

New Management Approach

The new approach *(Galloway Report)* seeks to achieve the following.

- -Avoid the risks of the flood plain.
- -Minimize the impacts of those risks when they cannot be avoided.
- -Mitigate the impacts of damages when they occur; and
- -Accomplish the above in a manner that concurrently protects and enhances the natural environment (Page 68).

According to the *Galloway Report*, the citizens of the nation bear a responsibility to exercise good judgment in their use of the flood plain and to share in the costs of their judgments. Under this approach, the federal government provides support for state and local flood plain management, establishes broad national goals, and, by its own actions, leads (Page 68).

Recommendation 2 of the *Governor's Task Force Report* is for the state government to lead (Page 12).

State agencies in Missouri have already begun to respond. The State Emergency Management Agency (SEMA) and the Department of Economic Development (DED), in administering grants of aid after the Flood of '93, have helped purchase flood-damaged properties and get buildings removed from the flood plain. Deed restrictions assure that those properties will remain without structures in the future.

What is Flood Plain Management?

Flood plain management is a decision-making process, the goal of which is to achieve appropriate use of the nation's (state's) flood plains. Appropriate use is any activity or set of activities compatible with the risk to natural resources (natural and beneficial uses of flood plains) and human resources (lives and property) from occasional or frequent flooding.

Source: Adapted from the Galloway Report, page xxi.

**P.L. 90-448, since amended.*

HYDROLOGY RECOMMENDATIONS

Hydrology, in its simplest definition, is the "science of water". More to the point of this document, it has to do with the distribution of water on the earth's surface; specifically, how water flows in the rivers as a result of rain, snow, and meltwater runoff, and how it is released from reservoirs. While hydrology is much more than flood forcasting, hydrologists are engaged in that work, and employ computers and other technology.

Another point of commonality among the four major post-flood reports has to do with the hydrology of the Upper Mississippi and Missouri rivers, especially as it relates to computing the relationships among quantity of flow (discharge), flood heights (stage), and frequency of recurrence.

Several federal agencies are involved in hydrology studies. Among these are the National Weather Service (NWS), the U.S. Geological Survey (USGS), the Corps of Engineers (COE), the Natural Resources Conservation Service (NRCS), and the Federal Emergency Management Agency (FEMA). Many years ago, several federal agencies agreed upon methods to do hydrologic studies, and this effort bore fruit in the form of publications. One of the publications was *Guidelines for Determining Flood Flow Frequency*, Bulletin 17B, March, 1982, published by the Office of Water Coordination, U.S. Department of the Interior.

Bulletin 17B was written for use in federal planning "involving water and related land resources." Many agency planners and contractors still use this document in their hydrology studies. "State, local and private organizations are encouraged to use these guidelines also...".

At the state level, the Department of Natural Resources also conducts hydrologic studies and makes recommendations relative to federal hydrologic reports. Various universities do hydrologic studies in terms of engineering as well as the science of hydrology.

The hydrology recommendations in the four reports are shown in Table 2.

In addition to the recommendations given in Table 2, the reports made other points in this field, mostly aimed at the federal agencies.

The *ASFPM Report* noted that historically, the most reliable data source has been the stream gage network of the U.S. Geological Survey. "Unfortunately, this network has been shrinking and we are lacking the basic data needed from which to develop hydrologic and flood estimates," the report states (Page 12). As the ASFPM Report points out, river stage forecasts should help the public take appropriate actions (paraphrased). (Refer to "How to help the public," page 13.)

The *Galloway Report*, at Recommendation 11.2, calls upon federal agencies to "collaborate on an assessment of the effectiveness of the stream gaging network and flood forecasting during the 1993 Midwest floods."

The ASFPM Report asserts, (VII, 4,) that engineering models must be developed to take into account unsteady-state conditions,

Table 2

HYDROLOGY RECOMMENDATIONS

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Hydrology recommendations regarding river stage readings	*p. 7,* Encourage federal government to recalculate the BFE and make that information available to state and local governments.	*Rec. 11. 1,* Fed. Water agencies should review and update discharge-frequency relationships for gages in the upper Mississippi River Basin to reflect the 1993 flood data. The adequacy of the existing gage network should also be reviewed.	*VII. 1.* Expand stream gage network; cooperate with other agencies for data. (paraphrased)	7. Review Mississippi/ Missouri River hydrology.
Hydrology recommendations regarding mapping	Not addressed	*Action 6. 8,* Use technology to improve flood plain mapping	*VII. 5.* Maps should be be based on future condition hydrology.	Not addressed
	Not addressed	*Action 6. 7,* Improve delivery of FIRMs.	*VII. 5.* More funding for map programs is crucial.	Not addressed
	Not addressed	Not addressed	*VII. 5.* Qualified states should administer mapping programs for FEMA.	Not addressed

levee breaches, and other flood situations. Since then, the Corps of Engineers has produced a draft report titled *Flood Plain Management Assessment of the Upper Mississippi and Lower Missouri Rivers and their Tributaries (FPMA).* This assessment was based on the analyses of a wide array of alternative policies, programs, and measures.

Quoting from the Executive Summary of the FPMA: "These impact analyses were based on results of systemic hydraulic computer modeling that represents an advancement in the state-of-art in flood analysis. This modeling work was initiated by the Corps of Engineers prior to the FPMA, but funds budgeted under the FPMA and work performed for the Assessment contributed to the achievement of the first hydraulic modeling capable of predicting impacts of random changes in storage parameters (such as when a levee break occurs)." This appears to accomplish what the ASFPM recommended.

The *Galloway Report,* at Action 11.3, says, "The USACE, NWS, and USGS, with other collaborators, should continue development of basin-wide hydrologic, hydraulic, and hydrometeorologic models for the upper Mississippi River system." This will help in making flood-risk predictions.

How to help the public—

Each local government can help residents by relating the nearest river gage to the local topography, since each river gage has its own "zero" level and each local site has its own elevation. The data are available. The accompanying Table 3 of Missouri River gages from Yankton, South Dakota, to St. Charles, Missouri, provides river mile "zero" on the gage, and flood stage (bank full) on the gage. Similar tables exist for the Mississippi River and others. Local government officials can help citizens by using these data and NFIP Flood Insurance Study data to help the public take appropriate actions when flooding is forecast.

For the public, there remains some confusion, since river gage readings are usually given in feet of stage on the gage, not in feet above sea level. National Flood Insurance Program (NFIP) maps and studies provide base flood elevations (BFEs) in feet above mean sea level (MSL), rather than gage readings.

The last re-study of the Upper Mississippi River hydrology was performed after the 1973 Flood, and was published in 1979. Any new flood modeling of the hydrology of the Upper Mississippi and Missouri rivers will not only change the accompanying table, but is likely to change all the NFIP Flood Insurance Studies and FIRMs, as well. Because of the cost, this will require Congressional direction.

On **Table 3** (page 14), "**Mile**" means river distance above the mouth of the Missouri River, near St. Louis. "**Gage Zero**" means the historic foot of the gage (near what is today the river bottom). "**CRP Reading**" means Construction Refernce Plane, in feet on the gage. This is approximately "**normal river level.**" It is a number used by contractors in building levees and wing dikes. There is a table of CRP readings, by river mile, from which the river's descending slope (or gradient) can be determined. (The slope of the Missouri River is about one foot per mile.) "**Flood Stage**" is the height of the water surface of the river at which overbank flows begin (the water starts to flow over the normally dry land of the flood plain.

Table 3

MISSOURI RIVER STAGE GAGES

U.S. Army Corps of Engineers, Missouri River Division

CITY	MILE	GAGE ZERO	CRP READING	FLOOD STAGE
Yankton	805.8	1159.8		12
Sioux City	732.3	1057.0	23.8	36
Decatur	691.1	1010.0	24.4	35
Blair	648.2	987.3	6.2	19
Boatyard	627.5			
Omaha	615.9	958.2	7.5	19
Plattsmouth	590.5	938.8	7.5	16
Nebraska City	561.8	905.4	9.4	18
Brownville	535.2	860.0	24.4	32
Rulo	498.4	837.2	10.7	17
St. Joseph	448.2	788.2	10.2	17
Atchison	422.6	786.2	12.7	22
Leavenworth	396.7	742.2	8.7	19
Kansas City	366.1	715.8	6.1	22
Napoleon	328.7	702.0	7.3	17
Lexington	317.3	663.5	14.2	22
Waverly	293.4	645.5	11.5	20
Miami	262.6	621.4	8.1	18
Glasgow	226.3	586.1	12.2	25
Boonville	197.1	565.0	10.3	21
Jefferson City	143.9	519.7	9.8	23
Gasconade	104.8	485.9	9.3	22
Hermann	97.9	481.4	8.2	21
Washington	67.0	457.2	4.6	20
St. Charles	28.2	413.6	13.5	25
Mouth	0.0			

Please refer also to Figure 5, Historic Flood Discharges at Boonville Gage, Missouri.

POST-FLOOD DISASTER ASSISTANCE

Flash flooding creates instant and catastrophic endangerment of public safety. Even general flooding, as seen in the 1993 flood, creates major public safety risks. Property destruction becomes a state and national burden, not to mention the traumatic effects on the property owners. Every level of government must respond when rivers and streams go over their banks in major flash and general flooding events. For example, most flooding casualties involve motor vehicles driving on flooded roads. Attempts to wade or boat in swift flood waters also causes loss of life.

Prevention, preparedness, response and recovery are sequential elements in comprehensive emergency management. Because public health, public safety, and general welfare are involved, the public expects every state and local government agency to be able to deal with flooding and other emergencies. Chapter 44, RSMo, calls upon every local jurisdiction to be organized to handle emergencies, and the State Emergency Management Agency (SEMA) provides planning assistance, training, and other support for local governments.

The Department of Natural Resources responds to a variety of needs, varying from disposal of flood debris to assisting with water supplies. The Department of Agriculture provides broad areas of support to the agricultural community. The Highway and Transportation Department has a major task relative to highway safety during flooding, as do county highway departments.

Table 4 shows the recommendations of the four reports on disaster preparedness, post-flood assistance priorities, and the limiting of disaster assistance. County governments have been given the opportunity to enter the NFIP by means of Chapter 49, Section 600, RSMo. Municipalities of all classes have the power to join the NFIP. Participation in the NFIP makes flood insurance available within the jurisdiction, and the jurisdiction enters by application and by providing evidence that it regulates new development in flood hazard areas. The linkage between flood insurance and disaster assistance was clearly made in the reports.

The *Governor's Task Force Report*, in Recommendation 3 (page 13) says, "As a result of the Flood of '93, Governor Carnahan decided that the highest recovery priority goes to assisting individuals to return their lives to normal, or as normal as possible, given the circumstances." Helping people move from the flood plains, using Community Development Block Grants, FEMA Section 404 funds, and other financial assistance, was a priority following the 1993 flooding.

Table 4

DISASTER RECOMMENDATIONS

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Position on priortizing or limiting who is to receive post-flood disaster assistance	*4*. The State should *affirm* that in future flood incidents... communities...in the NFIP will recieve priority in block grant and disaster assistance funding.	*Action 5.6*. Limit public assistance for non-participating communities.	*II. A, 2*. Disaster... assistance should be withheld from flood plain communities not in the NFIP.	Not addressed
Position on assistance priorities	*3*. Assist people to move from flood plains.	*Action 9.5*. Reduce post-disaster assistance to those not flood-insured....	*I. B,1*. Withhold disaster relief from those who willingly drop (NFIP) coverage. *II. A,1*. Total assistance should be reduced to reflect what *could* have been covered by flood insurance.	Not addressed
Position on Disaster Preparedness	*1*. Develop and implement an effective overall strategy for FPM.	*Rec. 6.1*. Enhance pre-disaster planning and training.	*II. A*. Encourage pre-disaster mitigation and FPM.	*13*. Organize a group to prepare and present seminars and/or pamphlets on flood preparedness.

RECOMMENDATIONS RELATED TO LENDING AND FLOOD INSURANCE

As seen from the *Galloway Report* recommendations and the *ASFPM Report*, both local governments and private individuals are expected to take action to make flood insurance available and to purchase flood insurance. (See Table 5.)

Repetitive losses show how repeat flood insurance claims are very costly to the NFIP. (The NFIP is backed by the taxpayers of the United States.) Missouri ranks first among non-coastal states in repetitive losses.

For years, state and federal officials have heard reports of borrowers having been uninformed of the flood hazard at properties they have purchased. Sections 407.010 and 407.020, RSMo., explicitly state that pertinent facts concerning real estate being sold must not be concealed from the buyer. The existence of flood hazards, as shown on NFIP maps, must be revealed, by law.

Officials have also received reports of borrowers not being required to purchase flood insurance coverage, or who bought one year of coverage and then did not renew the policy, for various reasons.

Another is the idea that federal disaster assistance will cover flood losses. But not all floods are followed by a Presidential Disaster Declaration, which is necessary to make federal loans and grants available. Federal loans must be repaid, with interest. Federal grants are available only to those who do not qualify to receive a loan, and have a maximum level. For the Flood of 1993, the maximum grant was $11,900, which was not enough to replace most homes.

Bank loan officers generally say that escrow for flood insurance is not authorized. The report's recommendations are intended to clarify that escrow is authorized, as well as to require escrow for the coming year's premium, so that policies will not lapse.

If an uninsured property has a mortgage, a flood can wipe out the collateral, and the lender may be left with nothing to show but a piece of paper. Forcing borrowers to be insured protects the borrower, the lender, and the taxpayer.

Since the National Flood Insurance Act provides the only financial protection for those exposed to the risk of flooding, it is no wonder that the reports included several flood insurance recommendations. The federal Interagency Hazard Mitigation Team, set up by FEMA, spent less time on that topic, since FEMA oversees the NFIP, and they felt others should make the recommendations.

Table 5

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Recommendations related to lending and flood insurance	*7, 1.* Encourage Fed. gov't. to set penalties for lenders that fail to notify... mortgagees of flood hazards, or fail to require flood insurance coverage for the life of the loan;	*Action 9. 2.* Improve NFIP lender compliance.	*I. B, 1.* Authorize civil actions against lenders that fail to enforce insurance purchase requirements. Impose penalties on lenders for non-compliance.	Not addressed
	7, 2. Require escrow for flood insurance premiums, and authorize lender to purchase the insurance on behalf of the borrower.	*Action 9. 3.* Provide for escrow of flood insurance premiums.	*I. B, 1.* Provide for escrow of flood insurance premiums.	Not addressed
	P. 4, Encourage maximum community participation in the NFIP, to allow all Missourians that live in flood plains the opportunity to purchase flood insurance.	*Rec. 9. 4.,* States should actively encourage flood insurance purchase.	Not addressed	Not addressed

INSURANCE BEHIND LEVEES RECOMMENDATIONS:

By the rules of the NFIP, if a levee provides base flood protection plus three feet of freeboard, FEMA can remove a flood hazard area designation, (upon request of the local jurisdiction) by either a letter of map revision (LOMR) or by printing a new map. Removing the designation removes the mandatory flood insurance purchase provision in the NFIP. Three of the four reports said that this is not a good idea.

NFIP rules were written to allow for the protection of flood plain land from major flooding. Since the base flood (hundred-year-flood, or one percent chance flood) is the criterion for flood insurance rates and building codes in flood plains, NFIP rules stated that if a piece of property is protected from the base flood (with freeboard), the flood hazard designation can be removed.

The reason for these recommendations is that there were flood damages in protected areas during the flood of 1993 that might have been covered by flood insurance, had the insurance requirement not been lifted. Insurance should be purchased behind levees to protect citizens against future flood losses.

The "protected" areas were flooded by events ranging from vandalism to levee failures as a result of overtopping or saturation, and internal strength loss caused by the flood magnitude and duration. In some places, high velocity flows eroded levees to cause failure.

Table 6

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Position on requirement of insurance behind levees	Not addressed	*Action 9. 6.* Require actuarial-based flood insurance behind all levees....	*V. 5.* There is a need to maintain flood plain management practices... behind flood control works.	*6.* The FIA should specify an A-zone designation behind levees.

Figure 1.

PAYING CLAIMS BEHIND THE MONARCH-CHESTERFIELD LEVEE

The Monarch-Chesterfield Levee at Chesterfield, Missouri, is an example of a levee that induced floodplain development and of the residual risks that result from depending on a levee for flood protection. The Monarch Levee was an agricultural levee with an extensive emergency repair history that was upgraded during the 1980s to meet early NFIP standards. Subsequent to the completion of the levee and its being credited by the NFIP as providing 100-year protection, an industrial area developed behind the levee. In 1993 when it became apparent that the levee might overtop or fail, many property owners were able to purchase flood insurance and later to receive claims payments. Other property owners did not have flood insurance or did not meet the 5-day waiting period for coverage. The Review Committee identified at least 67 flood insurance claims payments behind the Monarch Levee that totaled $13.2 million. This represents nearly 5 percent of the total flood insurance payments for the 9-state region. The flooding of this industrial area had severe impacts to the area not only from insured and uninsured damages but also from the temporary or permanent loss of jobs.

SOURCE: FEMA Federal Insurance Administration, claims data for 1993, geocoding by the Floodplain Management Review Committee.

Action 9.6: *Require actuarial-based flood insurance behind all levees that provide protection less than the standard project flood.*

The FEMA should designate as AL zones those areas behind levees designed to meet current minimum NFIP criteria but which do not provide protection from the Standard Project Flood (SPF) discharge. The AL zone would include those areas landward of the levee that are below the 100-year flood elevation. The mandatory flood insurance purchase requirement would apply within this AL zone, and new buildings would pay flood insurance premiums based on actuarial rates. The FEMA could establish floodplain management requirements for these areas, although elevation or floodproofing to or above the 100-year flood elevation should not be mandatory. This recommendation is similar to one in the 1982 National Academy of Science's National Research Council report, *A Levee Policy for the National Flood Insurance Program.*

A mandatory flood insurance purchase requirement behind such levees would provide a number of benefits to the public and to property owners:

- Property owners would be insured against the real possibility that a levee will be overtopped or will fail,
- Federal expenditures for disaster assistance would decline,
- Property owners would be more fully aware of the residual risk in building or locating behind a levee, and
- Communities would have an incentive to seek higher levels of protection.

Existing Flood Insurance Rate Maps should be revised where appropriate to reflect AL zones. The FEMA should obtain a legal opinion on whether this designation could be made based on residual risk of catastrophic loss, or if it would require legislation.

SOURCE: Galloway Report

MARKET VALUE DEFINITION

The definition of Market Value of property is an issue addressed in all four reports because of the NFIP regulations in regard to "substantial damages." *Substantial* is defined as fifty percent of the pre-damage or pre-improvement value of a building. *Substantially improved* buildings must meet the NFIP code as if they were new buildings; or, the improvement (if an addition) must meet the code. Substantially damaged buildings must be made to meet the code (elevated, if their lowest floor is too low). The *value* of a building is critical to the definition of substantial damages and substantial improvements.

Substantially damaged buildings will be rated as "new" buildings for flood insurance purposes, and if not built correctly (lowest floor high enough), will be rated such that premiums would be unaffordable. So, what is a building's "market value"?

A real estate *appraiser* uses the definition of "market value" as an appraisal figure. *Some* county *assessors*, in rating a building for real property taxes, do not use an appraisal figure. In such a case, a "replacement value" is used, together with the age of the building, to determine a value for assessment purposes. The latter method does not take into consideration other factors which may affect the sale of a property, including location. There is no universal agreement.

Figure 3 illustrates the difference between using an appraised market value (Formula 1) to determine if there has been substantial damage, and using a replacement value (Formula 2) to determine if substantial damage has been done to a flooded building. In each of the two cases shown, the damage to the building (cost to repair) is the same. After the Flood of 1993, either definition could be used in Missouri because the state had not defined market value and FEMA had not defined market value in the NFIP rules.

Recommendations relative to the definition of fair market value are shown in Table 7.

HISTORY OF PROBLEM

The issue of needing a state definition of market value was raised *in all four reports* because of two things: (1) The NFIP rules do not provide a definition of market value, and (2) FEMA has not always abided by its definition of substantial damage. Following Hurricane Andrew in Florida, administrators in Washington, D.C., issued "partial waivers," and did not require damaged buildings to be elevated according to regulations.

Following the Flood of 1993, officials in Washington, D.C., again waived the lowest floor elevation requirement on the rationale that it would cause a hardship for flood victims. The waiver allowed many more properties to be rebuilt "as were" than would have been the case. (See "Two Formulae" in Figure 3.)

A large number of these were buildings that had been flooded before, and would be flooded again. **The largest single drain on flood insurance reserve funds are repetitive claims.** (See page 126 of the *Galloway Report*, Figure 2.)

MARKET VALUE DEFINED

The definition of market value (also spoken of as "fair market value"), as given on forms used by private appraisers in Missouri, reads as follows:

> *The most probable price which a property should bring in a competitive and open market under all conditions requisite to a fair sale, the buyer and seller, each acting prudently, knowledgeably and assuming the price is not affected by undue stimulus.*
>
> Source: Pratt Appraisal, Inc., Jefferson City, Mo.

Such a definition could be adopted by the Missouri General Assembly in response to the Task Force recommendation.

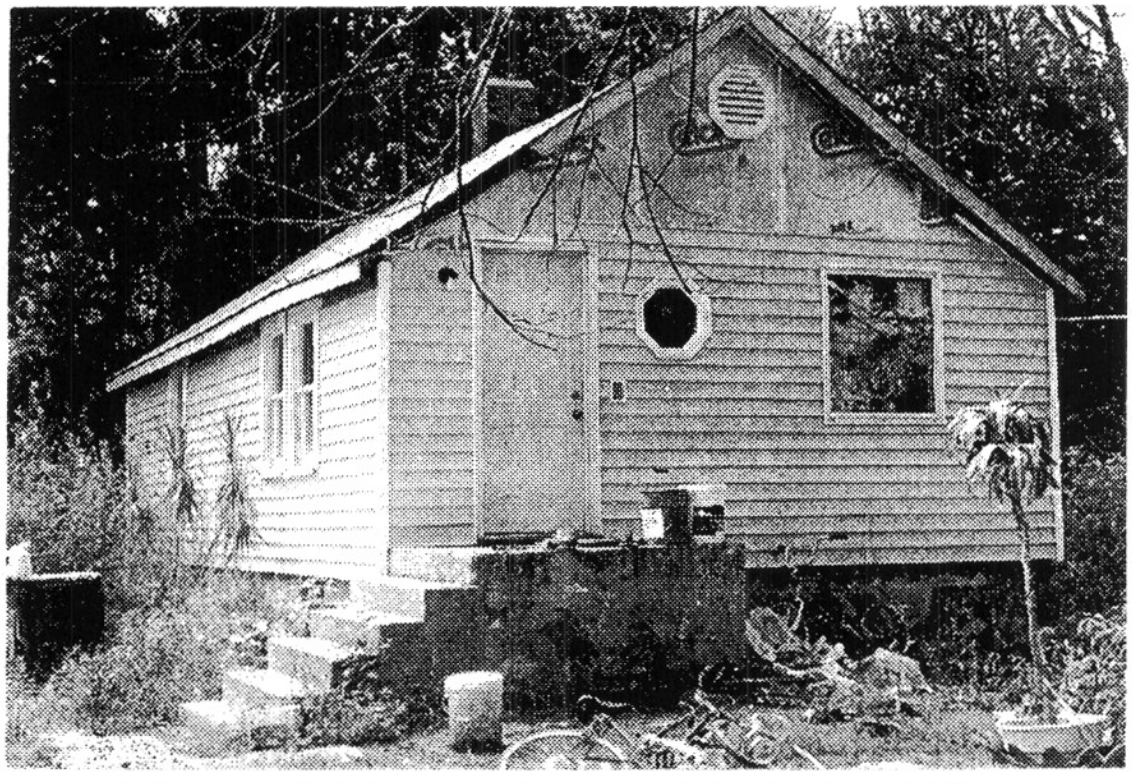
Figure 2.

State	Buildings with Repetitive Losses	Number of Losses for Such Buildings
Missouri	3,268	10,038
Illinois	1,351	3,774
Iowa	287	565
Nebraska	247	608
Minnesota	201	627
Kansas	175	441
North Dakota	142	713
Wisconsin	66	177
South Dakota	16	35
TOTAL	5,723	16,978

Source: Federal Emergency Management Agency, Federal Insurance Administration, computer printout, Washington, DC, February 7, 1994.

SOURCE: Galloway Report

Figure 3.



Using Formula 2, the home above, at 182 Charles Street in West Alton, was able to rebuild.

FORMULA 1	
Market Value	**$18,979**
Flood Damage	$12,621
Percentage	66%

Result: Home is substantially damaged, must be elevated or torn down because damage exceeds 50 percent of market value.

FORMULA 2	
Replacement cost	**$31,328**
Flood Damage	$12,621
Percentage	40%

Result: Home is NOT substantially damaged, can be rebuilt in place because damage does not exceed 50 percent of replacement cost.

SOURCE: St. Charles County Planning Department Post-Dispatch Graphic

From: St. Louis Post-Dispatch, September 4, 1994, Page B1.

Figure 4. *Rhineland relocation.*

This house in the relocated town of Rhineland was moved from the flood plain of the Missouri River to the hill north of the former site. This and scores of houses were moved to a 52-acre plat purchased by Rhineland, using state and federal grants, following the Flood of 1993. Photo by Richard M. Gaffney.

BUY-OUTS AND HAZARD MITIGATION

Hazard Mitigation is a term widely used in emergency management. Mitigation means relief, alleviation, or correction. Its purpose is to make things better than they were. Hazard mitigation may be structural (as in flood protection) or non-structural (as in removing buildings from the flood plains).

Several agencies were involved in post-flood relief in 1993 and 1994. It quickly became apparent that some agencies parcelled out funding and undertook projects quicker than others. The fact that each agency had its own forms to fill out, and communities had to "shop around," were disadvantages. Table 7 shows the recommendations for common procedures in this area.

Rhineland, a Montgomery County village, population of 157, suffered considerable flood damage in October, 1986. This flooding of the Lower Missouri River was a consequence of extremely heavy rains in the Osage River Basin. (In that notable flood, Harry S Truman Reservoir, built for flood control and hydroelectric power purposes, did its job of storing floodwaters and cutting off the amount of water that might otherwise have destroyed many settlements in the Lower Osage Valley and the Lower Missouri Valley. It was reported that the flood crest of 1986 was many feet lower than a similar flood crest in 1943.)

Having acquired about 50 acres of land on the river hills above (north of) the village, the Board of Trustees decided in 1993 that the time had come to move to high ground. Using post-disaster help from many sources, Rhineland moved homes and resettled in the hills. (See Figure 4.) The State Emergency Management Agency (SEMA) is coordinating hazard mitigation projects such as this, consistent with the report recommendations that the states coordinate such assistance.

Table 7

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Market value recommendations	*(P. 4).* Create a statutory definition of the pre-flood market value of structures for the purpose of compliance with NFIP regulations.	*Action 8. 8.* FEMA should stick to its definition of substantial damage.	*I. A, 2.* Adjust definition of substantial improvement to include cumulative improvements. *I. A. 3.* Be consistant in defining substantial damage.	*5.* Create a State "market value" definition.
Buy-out recommendations	*(p. 3).* Maximize use of federal funds in support of disaster mitigation... to fund community buy-out requests. FEMA "404" Hazard	*Rec. 8. 6.* State coordinate buy-outs mitigation. *Action 8. 5.* Make qualified states. Mitigation block grants an option.	*II. D, 2.* Administration of Mitigation Grant Program should be turned over to qualified	*4.* Remove substantially damaged and repetitively damaged structures from flood plain.
Recommendations on procedures	*3.* Assist people to move from flood plains.	*Action 8. 4.* Develop common procedures for buy-outs and mitigation programs.	*II. C, 1.* Coordinated strategy for federal agencies is needed; uniform rules and application forms.	Not addressed

"Block grants" are funds made available to the states by the federal government, to be spent according to an approved plan. They differ from individual grants, in that they are given as a package to a state agency for distribution according to prescribed rules. The following are federal programs which can provide funding for buy-outs following a disaster.

Figure 5.

PRINCIPAL SOURCES OF FUNDING FOR BUYOUTS

The following federal programs provide funding for buyouts following a disaster such as the Midwest Flood of 1993:

Department of Housing and Urban Development Community Development Block Grants (CDBG). The 1993 Supplemental Appropriation included $200 million for the CDBG program to assist in acquisition and relocation and in meeting other housing needs. The 1994 Earthquake Supplemental included an additional $250 million for a total of $450 million.

Federal Emergency Management Agency Section 404 Hazard Mitigation Grants. The Hazard Mitigation and Relocation Assistance Act of 1993, signed into law on December 7, 1993, revised the formula for determining the amount of the Section 404 Hazard Mitigation Grant in the Stafford Act and changed the cost share to 75/25. Under the revised formula the FEMA estimates that $134.9 million will be available through the Hazard Mitigation Grant Program funds for the Midwest flood.

Economic Development Administration (EDA) Grants. The 1993 Supplemental Appropriation included $200 million for EDA for grants to states and communities to preserve or create jobs or upgrade infrastructure. The funds can be used to assist in the relocation of businesses or for the infrastructure needed to support those businesses.

National Flood Insurance Program Section 1362 Flood Damaged Property Purchase Program. Several million dollars are available from the appropriation for the NFIP Section 1362 program for acquisition of insured properties. These funds are paid from the National Flood Insurance Fund, using premium dollars.

Other Programs. Funds were available from other programs such as the FEMA Public Assistance Program to assist in various aspects of buyouts and relocation. SBA loans are available to help individual property owners not eligible for CDBG monies.

Adapted from the Galloway Report, *p. 120.*

LEVEE POLICY

The issue of levee protection, addressed by all four reports, probably has been the most often discussed post-flood topic. People who have property on the flood plains of the Mississippi and Missouri rivers have a right to reasonably protect their property from flooding. However, levees have increased flood heights (stages) in the Mississippi and lower Missouri river valleys during low level floods.

Presently, the patchwork of Missouri River levees offers inconsistent levels of flood protection. During rare, high-level floods, only major protective works, like those at St. Louis, Hannibal, and Kansas City, offer protection. As in 1993, lower levees "disappear" under such floodwaters. Many lower levees are designed to protect agricultural lands from frequent minor flooding. These levees can suffer great damages in major floods, especially where floodwater velocity is high. Even the lower levees can cause unnecessary flooding on portions of flood plains if there is inconsistency in design, location, and other factors.

Levees may be built, maintained, enlarged, and changed in Missouri by private landowners, levee districts, drainage districts, and local governments. The levee should fit into a unified levee protection *system*. The levee may not increase flood stages more than one foot to stay within the bounds of the NFIP.

Levee recommendations were made *in all four reports*. This highlights the importance, as seen by the report authors, relative to property owners and the significance in raising flood stages (especially in the more frequent flood events). The need for a state permitting program for levee-building was universally recommended. These recommendations are summarized in Table 8.

Of more than 1,450 levees in Missouri, only about 110 participate in the Corps of Engineers' post-disaster levee rehabilitation program. The Corps' eligibility requirement is that the levee be part of a legal entity (such as a duly formed levee district) that has the power to tax in order to maintain the levee and pay its twenty percent share of post-flood rehabilitation costs.

The Governor's Task Force found that "the current levee situation in Missouri invites levee wars—", and "the aggregate result appears to actually increase the flood danger by increasing the height and velocity of river flow during floods" (Page 16).

The *Governor's Task Force Report* also noted that "prior to constructing new non-federal levees that protect principally farmland, that set-backs be considered" (Page 5). This brings the levee issue squarely into discussion of what are the best uses of flood plains. All uses including agriculture, land conservation, wetland habitat, industrial development, and flood-spreading are important. The report emphasized that the state should "maximize use of federal funds in support of acquiring easements on lands through the Emergency Wetlands Reserve Program, the Conservation Reserve Program, and any other federal programs" (Page 3). "The Task Force encourages all farmers who are willing to use federal and state programs to take damaged or marginal land out of production" (Page 14).

Table 8

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Levee Recommen-dations	*6.* Oversee levees. Enact legislation to make it easier to form levee districts... so they can be in Corps' program.	*Action 8. 1.* Establish COE as principal (fed.) levee construction agency.	*VI. 3.* Review levee system: Develop program to assure farmers of coverage while alternatives are decided.	*3.* Develop policies and legislation to provide for coordination of levees (permits, analyses, etc.)
	Affirm that those who fail to live up to COE commitments should be denied future federal repair aid.	*Action 8. 2.* Reaffirm COE criteria for P.L. 84-99 levee repair - no future exceptions.	*V. 5.* Flood control requires a commitment of resources.	Not addressed
	Review the current levee system...and make recommendations for alternatives.	*Rec. 8. 3.* Minimize impacts of levee overtoppings.	*V. 5.* There is a need for continued FPM... behind levees.	*2.* State should develop a long-term compre-hensive floodway plan, coordinated with COE, MHTD, etc.
	Encourage legislation to establish a permit program...for the purpose of developing... design criteria.	*Rec. 8. 4.* Coordinate on criteria for evaluating levee repairs.	*V. 5.* There is a need for continued O&M to prevent failures.	*6.* FIA should specify an A-Zone designation behind levees.

Table 8 continued

	Report titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Levee recommen-dations (cont'd)	*P. 5,* Encourage legislation to establish a permit program for construction or modification of levees.	*Rec. 10. 1,* States should take responsibility for levee regulation and flood fighting.	*II. C, 2.* Flood-fighting should be planned, with federal oversight for implementation and National Guard presence for enforcement.	*3.* Legislation should provide for coordination
	Encourage that existing levees be repaired to no higher than pre-flood height.	Not addressed	Not addressed	Not addressed
	Encourage that new, non-federal levees, built to protect farmland, should not exceed 25-year flood protection.	Not addressed	Not addressed	Not addressed
	Encourage that levee districts be consolidated, where possible.	Not addressed	Not addressed	Not addressed
	Assist farmers by facilitating repair of levees.	Not addressed	Not addressed	Not addressed

OPEN SPACE AND ENVIRONMENT RECOMMENDATIONS

The *Governor's Task Force Report* also says that the State should encourage open space use of the flood plain. Coupled with taking damaged or marginal land out of production (above), the report says, "If flood plain land is willingly offered for conversion to natural resource benefit, then this also will decrease the impact of future floods." Increased and continuous funding will be needed "to help willing farmers cease farming land in flood plain areas" (Page 13).

The Natural Resources Conservation Service (until recently called the Soil Conservation Service) used the Conservation Reserve Program (CRP), The Emergency Conservation Reserve Program (ECRP), the Wetland Reserve Program (WRP) and the Emergency Wetland Reserve Program (EWRP) to protect certain flooded lands, in response to property-owners' requests. The Missouri Department of Conservation also purchased some flooded lands, upon request.

Another outcome of the Flood of '93 is the ongoing work of the U.S. Fish and Wildlife Service, which is purchasing Missouri River bottom land from landowners willing to sell severely scoured and sedimented tracts. A series of tracts of land along the river from Lafayette County through Saline County, Howard County, and Cooper County to Osage County have been designated the "Big Muddy National Fish and Wildlife Refuge."

The properties were so badly damaged by the flood flows that restoring them to production would involve very costly land treatments. Left as is, with scour holes, levee breaches, and sand dunes, a varied habitat for fish and wildlife exists. There is also an opportunity for recreational public use such as bird watching, and giving the river flood retention capacity, thereby lowering flood stages. Sale of the damaged property provided the landowners with capital for reinvestment in their farming operations.

Acquisitions by the U.S. Fish and Wildlife Service include Lisbon Bottom (Howard County) and Jameson Island (Saline County) along with four other parcels still being purchased as this narrative is being written.

Table 9

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Open space and environment	*From Rec. 3, p. 13,* If flood plain land is willingly offered for conversion to natural resource benefit, then this also will decrease the impact of future floods.	*Action 7. 1.* Establish a lead agency for environmental land acquisition.	Not addressed	Not addressed
	P. 3, Assist farmers in getting...Emergency Conservation Practices Program (funds)....	*Action 7. 2,* Develop emergency implementation procedures for environmental land acquisitions.	*V. 6.* Zero floodways would be better than one-foot floodways	*2.* State should develop a long-term comprehensive floodway plan.
	Rec.1, Create a multijurisdictional body to recommend flood plain management policy.	*Action 7. 5,* Focus land acquisition efforts on river reaches with significant habitat values.	*IV. 3.* Develop a national riparian zone policy, recognizing multiple benefits.	Not addressed
			V. 6. FEMA should not be encouraging filling riparian areas.	
	P. 3, Encourage open space use of the flood plain.	Not addressed	*VI.* Examine incentives for farmers leaving flood plains open.	

HAZARDOUS MATERIALS POLICY

During the epic flooding of 1993, public safety officials were called upon to deal with many instances of volatile, flammable, or toxic substances that were dissolving, leaking, or floating in the floodwaters. Liquified petroleum (LP) gas tanks, gasoline and diesel fuel tanks, agricultural chemicals in paper bags or spray tanks, and even common household hazardous (cleaning) products were carried into floodwaters.

In some instances, life-threatening explosions and fires were reported by the news media. In most instances, conscientious company and public safety officials took measures to mitigate the hazards, contain the hazards, or round up the floating tanks.

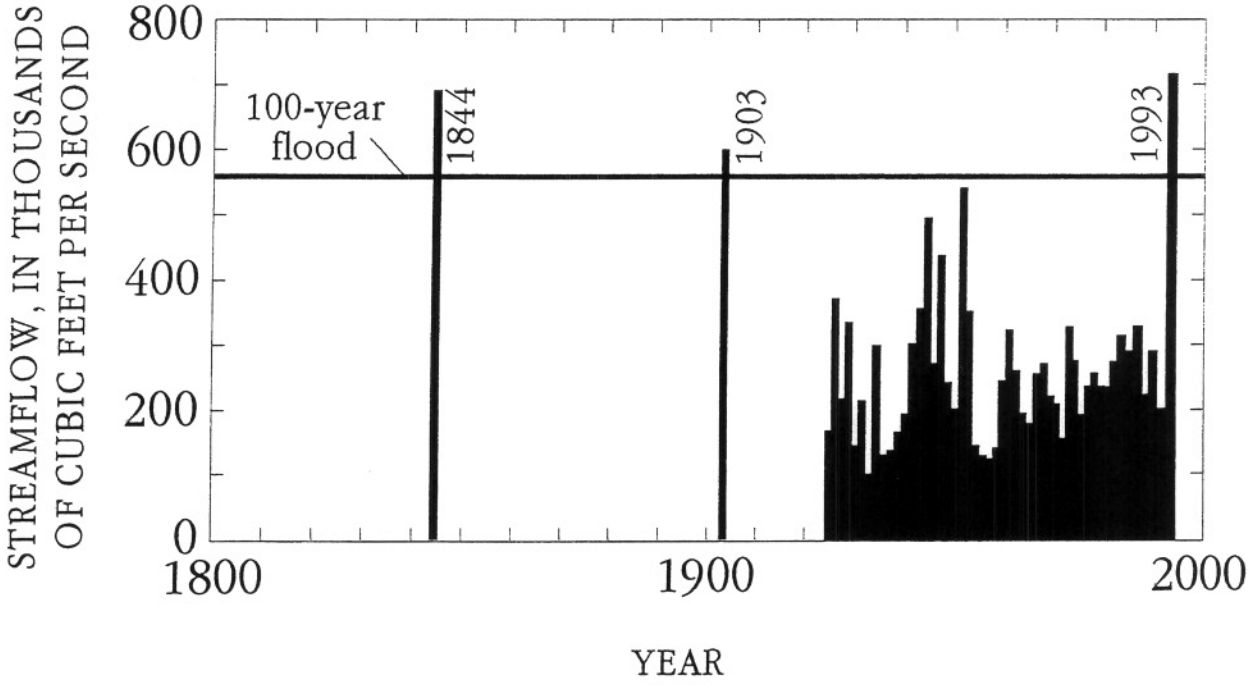
The *Governor's Task Force Report* and the *Interagency Hazard Mitigation Team Report* made very specific recommendations. This emphasized their concern about the placement and security of hazardous materials on flood plains. The *Galloway Report* merely addressed environmental sensitivity in general terms. These recommendations are summarized in Table 10.

Table 10

	Report Titles			
TOPIC	**GOVERNOR'S**	**GALLOWAY**	**ASFPM**	**IHMT**
Hazardous materials recommendations	*Rec. 5 (1)*, Prohibit commercial propane and gas storage facilities from location in the flood plain; *(2)* require all non-commercial propane and gas tanks in the flood plain be securely anchored to the ground; *(8)* prohibit future placement of hazardous substances from location in flood plain areas.	Not addressed	Not addressed	*Rec 10*, Enforce hazardous materials containment/ relocation standards
	Rec. 5 (2) Require name and address of owner (of propane and gas tanks) be permanently affixed.	Not addressed	Not addressed	*Rec. 11*, Require that identification of owner, location and contents be placed on all hazardous material containers.
Household hazardous wastes position.	Not addressed	Not addressed	Not addressed	*Rec. 12*, Develop public awareness program regarding household hazardous waste and establish hazardous waste dropoff points after major floods.

Figure 6.

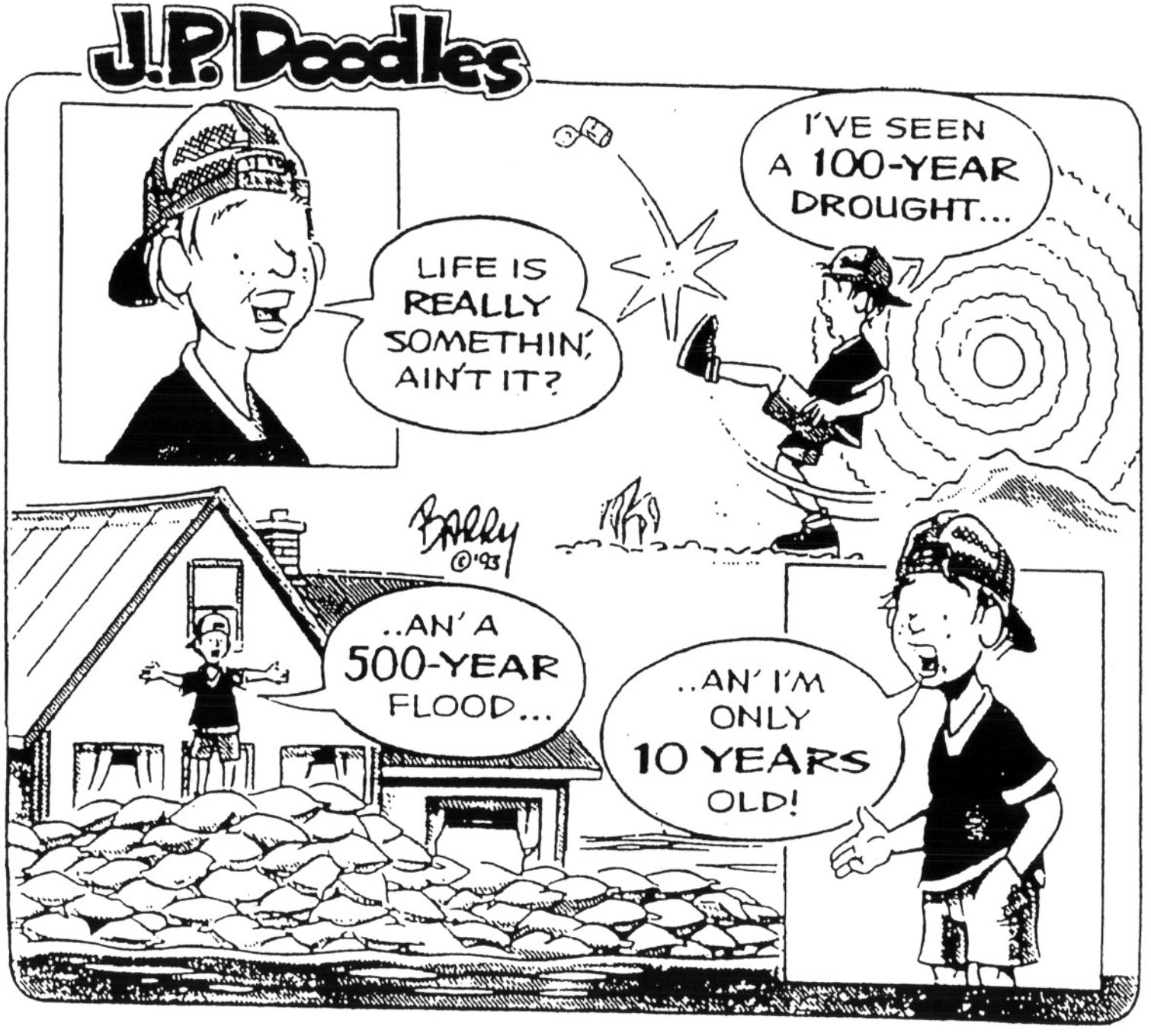
Historic Flood Discharges



Missouri River at Boonville Gage

N.B.— The bars shown for the 1844 and 1903 floods indicate estimated flows based on high water marks. These major flood events took place prior to the period of record at Boonville, Mo.

SOURCE: adapted from Parrett, et al, Flood Discharges in the Upper Mississippi River Basin, *1993, p. 7.*


J.P. Doodles
LIFE IS REALLY SOMETHIN', AIN'T IT?
I'VE SEEN A 100-YEAR DROUGHT...
..AN' A 500-YEAR FLOOD...
..AN' I'M ONLY 10 YEARS OLD!
©'93

AFTERWORD

This Flood Report Analysis has concentrated on the areas of commonality among the four major post-flood reports named. It is not exhaustive in regard to all the points made by the reports.

Paraphrasing has been used in many places where the wording is not shown in quotation marks. This has also been done in the tables to save space.

TABLE 11

ACRONYMS

ASFPM	-Association of State Floodplain Managers
A-zone	-Flood map area showing 100-year flood inundation
BFE	-Base Flood (100-year Flood) Elevation (stage)
COE	-Corps of Engineers, part of the U.S. Army
DNR	-Missouri Department of Natural Resources
EO	-Executive Order
FEMA	-Federal Emergency Management Agency
FIA	-Federal Insurance Administration, part of FEMA
FPM	-Flood Plain Management
LOMA	-Letter of Map Amendment, from FIA/FEMA
LOMR	-Letter of Map Revision, from FIA/FEMA
MHTD	-Missouri Highway & Transportation Department
MSL	-Mean Sea Level (May be NGVD or NAVD)
NAVD	-North American Vertical Datum, 1988
NFIP	-National Flood Insurance Program
NGVD	-National Geodetic Vertical Datum, 1929
NOAA	-National Oceanic and Atmospheric Administration
NWS	-National Weather Service, part of NOAA
USACE	-United States Army, Corps of Engineers
USFWS	-United States Fish and Wildlife Service
USGS	-United States Geological Survey

DEFINITIONS

Berm- A level place, such as alongside the toe of a levee, for stability. (A berm is not an embankment, levee, or mound of earth.) Source— Stormwater: Glossary, Bi-State Stormwater Committee Report 5, March, 1983.

Five hundred-year flood- A flood which has a 0.2 percent chance of occurring in any given year. If a person lived for a thousand years, one might expect to see two floods of this magnitude. (See 100-year flood.)

Flood- Overbank flows of river water, when too much water is present to be confined to the normal channel of the river. This may occur from headwater flows, heavy rains, snow melt or backwater, as when a larger river, downstream, is flooding. Lakes also can flood, as when too much water accumulates to drain off in the usual amount of time, so that shorelines are inundated. The FEMA definition goes further and includes "inundation of normally dry land areas by water from any source". This would include stormwater puddling/ponding, and rise of groundwater.

Flood Plain- The area on either side of a river bed or channel, subject to inundation.

Gage- Spelling used for river or stream gauges, either staff gages, that measure stage (which see); flow gages, that measure discharge (volume), or water quality gages.

Hundred-year flood- A flood which has a one percent statistical chance of occurring in any year. Statistically, it is assumed that floods are entirely random events. This also is termed the "base flood" for flood insurance purposes.

If one lived for a thousand years, one might expect to experience ten floods of this magnitude, but not necessarily a hundred years apart. For example, Rock Creek, Independence, Missouri, had a hundred-year flood in 1977, and another hundred-year flood in 1982. Also, Hermann, Missouri, had a greater-than-hundred-year flood in 1986, and another greater-than-hundred-year flood in 1993.

Levee- An earthwork controlling water. Levee is a French word. Missouri gets the word from Louisiana, by way of the Mississippi River. Basically, it means the same as dike, from the Dutch word "dyke." (In Missouri, the word "dike" is used for wing dikes, usually constructed of stone, extending into the major rivers to divert flows toward center channel to maintain depth.)

Regulatory Floodway- The area either side of a stream channel which must be kept clear for the passage of flood flows, without increasing 100-year flood stages

more than one foot (insurance definition). An administrative tool, the delineation of a floodway on a map helps local permit-granting authorities determine if a development proposal will increase flood stages more than the FEMA maximum limit, without having to do a study. It is presumed that the floodway fringe, the part of the flood plain beyond the floodway, will eventually be filled in or protected by a levee. (See Figure 6.)

The floodway is intended to carry deep and fast-moving water, hence it is usually the part of the flood plain that is most dangerous for any kind of development.

Stage- The elevation of the surface of a river, or a lake or reservoir, or of floodwater at a given location; the height reached by a flood at a given point in time. It may be measured by a staff gage or a recording gage, usually in feet above an historic "zero" point (known as the datum). Zero on the gage usually is at or near the bottom of the channel, and is given in feet above mean sea level (MSL).

Watershed- A drainage area, extending from high ground at the edges, to a valley and stream along a central axis. Also called a basin, it may have a subwatershed or sub-basin. Rain or snow falling within a watershed drains to the central drainageway, a brook, creek, stream, or river. Smaller watersheds are parts of larger watersheds.

The largest watershed or basin in the United States is that of the Mississippi River. Sub-watersheds of the Mississippi include the Missouri (its longest), the Ohio, the Arkansas, the Tennessee, and the Illinois. Sub-watersheds of the Missouri include the Osage, the Grand, and the Kansas.

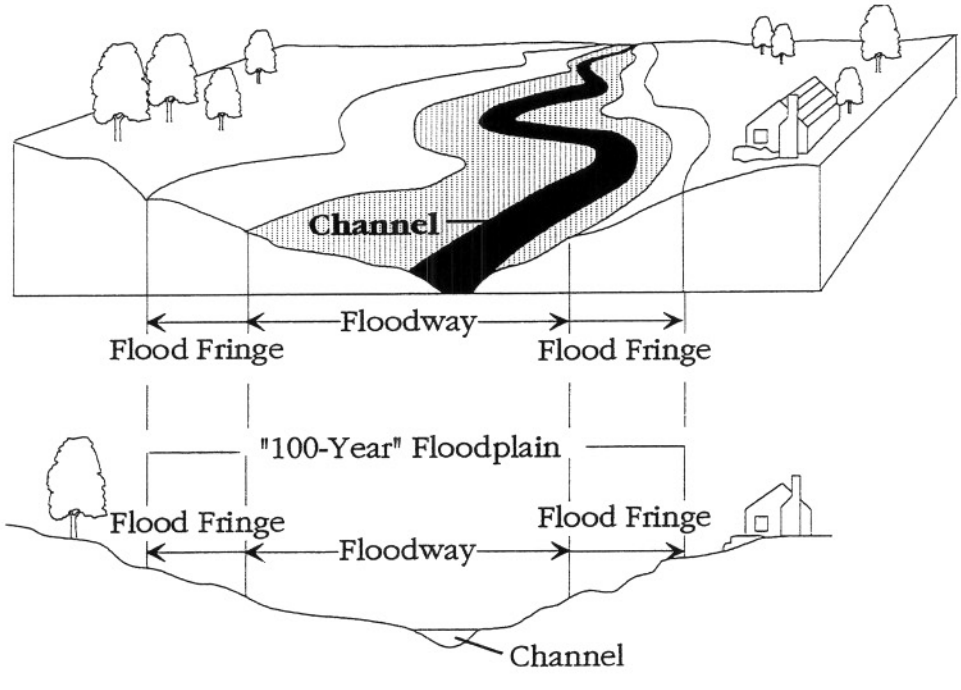


Figure 7.

APPENDIX

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