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(2)* Flooding and Flood Damage Reduction.

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STATE OF MINNESOTA

Prepared by the

(1B) Supply, Allocation and Use Work Group
Minnesota (1A) Water Planning Board

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P R E F A C E

This Technical Paper represents the analysis of flooding and flood damage reduction that has been conducted by the Supply, Allocation and Use Work Group of the Minnesota Water Planning Board. This paper has been reviewed by the regional review committees, the Water Interest Advisory Committee and the Technical Committee of the Water Planning Board and many modifications have been made based on this extensive review.

The report was prepared by John M. Callaway and Joseph C. Gibson of the Department of Natural Resources Water Policy Planning Section.

The Water Planning Board has not approved the whole report, but has approved the recommendations contained in the report.

Thomas Kalitowski, Chairman
Minnesota Water Planning Board

CHAPTER I

INTRODUCTION AND SUMMARY

Flooding and the damages caused by flooding are recurring problems along many of Minnesota's rivers and streams. The most common type of severe flooding occurs in the spring and may be the result of extremely heavy winter snow buildup, rapid increases in air temperature, high soil moisture levels, heavy spring rains, or a combination of these factors. Severe thunderstorms during the summer can also cause severe flooding such as the floods in Rochester, Austin and the Twin Cities during 1978.

The damages caused by flooding have steadily increased as man has continued to develop flood plain areas. A very conservative estimate of average annual flood damages for Minnesota in 1978 dollars is approximately 54 million dollars. Actual damages during 1978 were considerably higher than this figure because of the unusually severe flooding that occurred in several areas of the state, but during other years flood damages are minimal.

Until the late 1960's a common approach to flood damage reduction was to build reservoirs or impoundments to store flood waters or to construct levees or dikes to protect development in the flood plain.

Since the late 1960's both state and federal flood damage reduction policies have become more comprehensive and have placed increasing emphasis on non-structural flood damage reduction measures. Non-structural measures include flood plain zoning, flood proofing, flood warning systems, flood insurance, land acquisition and disaster planning. Both structural and non-structural measures are an integral part of a comprehensive flood plain management program.

The current flood plain management program of Minnesota places primary emphasis on flood plain zoning and other non-structural measures, while recognizing structural measures as necessary components of the program. The law further stipulates that no structural measures be built until the community or county has adopted an approved flood plain ordinance.

The state's flood plain management program relies on studies that identify flood hazard areas. Once the studies are completed, counties and municipalities are required to adopt zoning ordinances at least as stringent as minimum state guidelines. Other major activities under the program include disaster training and assistance, development of flood-proofing guidelines and encouraging people to enroll in the Flood Insurance Program.

Two additional state programs provide financial assistance for the construction of flood water retarding and retention structures in Minnesota River Basin Area II and in the Red River Valley.

During the summer of 1978 several proposals were made for the state to increase its role in providing financial assistance for flood damage reduction measures. If the state does expand its flood damage reduction program, it is necessary to determine: 1) the types of flood damage.

reduction measures that should receive state financial assistance; 2) the types of criteria that could be used to evaluate flood damage reduction measures; and 3) the potential effects of providing financial assistance for different flood damage reduction programs.

In order to evaluate flood damage reduction measures, four different principles are presented. These principles are closely related to the policy goals of the state. As such, they provide a useful point of departure for establishing specific criteria to assess the contribution of different measures to different goals. These principles can also be used to select the criteria necessary to evaluate the trade-offs that are generally present when multiple goals exist. The principles presented in Chapter 5 of this paper can be classified under the following headings:

Economic Efficiency	Environmental Quality
Community and Regional Development	Social Welfare

Economic Efficiency

While it may be possible to eliminate flood damages in a specific location, either by means of structural or non-structural measures, providing complete protection from flooding would be extremely expensive. The purpose of economic efficiency is to ensure that the state does not allocate too few or too many of its resources to flood damage reduction measures. The principle of economic efficiency can be applied to flood damage reduction by maximizing the benefits over costs produced by a particular measure. If the decrease in flood losses produced by a particular measure is viewed as an economic benefit of flood damage reduction, the optimal level of protection occurs at the point where the incremental cost of a small amount of additional protection just equals the incremental value by which damages are reduced. Where more than one type of measure is being considered, economic efficiency is achieved by applying this test to all alternatives and selecting the one for which the benefits over costs is the greatest.

The principle of economic efficiency can also be used to guide state policies regarding cost-sharing for flood damage reduction measures. In order to ensure that local interests do not select inefficient types of measures in a given situation, the percentage of local cost-share should be the same for all of the different techniques used to reduce flood losses. To ensure that the level of protection sought by local groups is consistent with the best interests of the state, local cost-shares should equal the ratio of marginal local costs to marginal state costs for any given measure. If these rules are not followed, experience at the Federal level has shown that public investments in flood damage reduction may not be optimal, and that the burden of financing these measures will fall more heavily on taxpayers who receive no benefits than on those who do benefit directly.

Environmental Quality

In almost every case, reducing flood damages, whether by structural or non-structural means, will have some impact on the natural environment. If a given measure enhances the environment in any way, this represents

an environmental benefit of flood damage reduction. If environmental resources are displaced or their quality is degraded by a measure, then this action results in environmental costs. In most cases, environmental benefits and costs are not accurately reflected in calculations of economic efficiency, because the services of the environment are rarely subject to market transactions.

Trade-offs between environmental quality and economic efficiency are hard to evaluate because market values and environmental values are not comparable. Methods currently employed at the Federal level to evaluate these trade-offs in water resources projects are inherently biased against environmental quality, and result in plans that are not optimal from the standpoint of both principles. Present developments in the field of natural resources economics have produced a variety of new methods for estimating surrogate prices for environmental resources, which reflect the value of these resources to society as a whole. Where these methods are used, maximizing the value of market and non-market benefits attributable to flood damage reduction results in optimal plans that are both economically efficient and environmentally sound.

Currently, there is considerable resistance to the idea of "pricing" the services of the environment. The general feeling is that by doing this there will be greater justification for the implementation of environmentally unsound water resources projects. Existing research does not support this view. In several cases where environmental costs and benefits have been included in economic efficiency calculations for large projects, the resulting plans have been shown to be too costly to construct on the basis of the social value of environmental resources displaced by the projects.

Community and Regional Development

Flood damage reduction measures - particularly structural measures - can help to foster economic growth of communities and regions by increasing the value of existing goods and services produced locally, and by encouraging new development in protected areas of the flood plain. Flood damage reduction plans are often formulated with this goal in mind, generally as a part of a more comprehensive development strategy for depressed regions.

Measures designed to enhance community and regional economic development may call for a level of protection that is inconsistent with the principles of economic efficiency and environmental quality. This will depend ultimately on the priorities which public decision-makers attach to assisting depressed communities and regions as opposed to their desires to maximize the return on government investments in flood damage reduction or to protect the environment. If more weight is attached to the former goal, then a major consequence of the decision will be the transfer of income from taxpayers throughout the state to the direct beneficiaries of flood damage reduction measures in the affected community or region.

Social Welfare

An important goal of flood damage reduction policy in the State of Minnesota is to minimize loss of life and threat to health. Unquestionably, the most effective means of achieving this end is through preventative measures such as land use controls and flood warning systems. However, there are two serious problems associated with project evaluation from the standpoint of social welfare costs and benefits. The first of these is that the empirical basis for designing flood damage reduction measures to achieve social welfare goals is poorly developed. Apart from the unrealistic and far too costly alternative of completely eliminating human exposure to flooding, the relationships between lives saved due to various techniques of flood damage reduction are not well known.

Whether these kinds of relationships can be established or not, an equally serious problem exists due to the difficulties of evaluating the trade-offs between human lives, on the one hand and economic efficiency and environmental quality, on the other. This difficulty is due in part to the fact that social welfare benefits and costs are hard to evaluate from a monetary standpoint, and in part to the politically sensitive nature of establishing trade-off criteria where human lives and health are concerned. As a result, consideration of these trade-offs is often ignored for reasons of political expediency. Where this is done, there is no assurance that flood damage reduction measures will conform to any of the principles outlined in Chapter 5.

This discussion of principles briefly outlines some of the considerations that must be taken into account if Minnesota's comprehensive flood plain management program is to be expanded into the area of cost-sharing or other funding assistance. These same principles may provide a basis for examining the contribution of existing or proposed flood damage reduction measures to the state's flood damage reduction goals.

Problems with the Flood Plain Management Program

During the analysis of the state's flood plain management program, a number of problems were identified that keep it from being as effective as it might be. These problems include: the lack of a process for evaluating the effectiveness of flood damage reduction measures; the lack of a systematic process for setting priorities for flood damage reduction measures; the lack of authority to regulate activities outside of the flood plain, that may influence flood flows; the lack of priority given to implementing certain activities already authorized by the Flood Plain Management Act; the lack of a statewide program for cost-sharing for structural and non-structural programs and projects; and the effects of federal policy changes on the implementation of program and projects in Minnesota. In addition there are numerous serious problems that are not statewide in nature, but which have detrimental effects in particular flooding situations.

Recommendations

A wide range of options were identified for alleviating some of the problems and shortcomings of the current flood plain management program. These options are enumerated in Chapter VI. The options were presented for

public review and comment and at its June 19, 1979 meeting, the Water Planning Board approved the following recommendations:

1. The comprehensive flood plain management program of the State of Minnesota should be expanded and improved.
2. The primary emphasis of the State should continue to be on non-structural means of flood plain management, while fully recognizing that structural controls are needed in some situations.
3. The State of Minnesota should establish a statewide program of cost-sharing to implement both structural and non-structural components of approved comprehensive flood plain management plans.
4. The Department of Natural Resources and the Soil and Water Conservation Board should develop joint criteria for evaluating and prioritizing the structural and non-structural components of approved flood plain management plans.
5. Appropriate statutes should be amended to require mandatory disclosure of flood hazard information prior to any property transactions.
6. The State should expand its programs for technical assistance for flood proofing, for assistance with applications for state and federal aid and for information dissemination and education which are currently authorized but have not received sufficient funding.
7. The State of Minnesota should begin to define the effects of wetland drainage and filling on flooding and consider the cumulative effects of these actions in evaluating the costs and benefits of wetland drainage activities.
8. Information on flash flood warning systems should be collected and be made available to areas subject to flash floods.
9. Appropriate statutes should be amended to include provisions for mandatory urban stormwater management plans to minimize increases in flood stages in urban flood plains.

These recommendations are discussed in more detail in Chapter VI of this report. These recommendations, if implemented, should lead to an expanded and improved comprehensive flood plain management program for the State of Minnesota.

CHAPTER II

FLOODING IN MINNESOTA

Definition

The U.S. Code defines a flood as "an overflow of lands which, although they are adjacent to water, are not normally covered by it, and hence are used (or usable) in the same way that other lands are used."¹ In the midwestern United States, most flooding occurs along rivers. When the amount of discharge exceeds the carrying capacity of the stream-channel, the excess flows inundate adjacent lands. Where this land has been developed for human activities, flooding may cause economic losses and occasionally loss of human life.

Types of Flooding in Minnesota

Historically, major flooding has occurred in every basin in the state. However, not every basin is exposed to identical forms of flooding. This section describes the major types of flooding that occur in the state.

The most prevalent type of flooding in the state is spring flooding caused by rapid snow melt, augmented at times by persistent spring rains. The severity of spring flooding depends on the amount of snow pack existing at the onset of precipitation, soil moisture, how thoroughly the ground beneath the snow pack is frozen, and the amount of precipitation. Spring flooding can occur over major portions of every basin in the state.

The accumulation of ice which occurs on many rivers during the winter may also contribute to stream flooding. Ice jams, which obstruct flow in a river and increase flood stages upstream, form under a variety of circumstances. Normally, ice jams form where there is constriction in the river caused by a sharp bend, or the presence of bridge piers, protruding bridge abutments, channel regulation structures, and shallow ridges and islands. Ice jams are rarely capable of producing flooding by themselves. When spring rains and rapid snow melt produce flood situations, however, ice jams along a river can produce additional increases in river stages.

In the Red River Basin, snow melt in conjunction with sustained precipitation produces two distinct types of flooding: stream bank overflow and overland flooding. The latter phenomenon is caused by run-off from snow melt or heavy rainfall which is trapped by plugged culverts and ditches within sections of land bounded by raised roadbeds. This water accumulates slowly, and when it reaches sufficient depth flows over the roadbed and inundates adjoining sections of land as it moves overland toward stream channels. In the area surrounding Oslo, Minnesota, this overland movement of surface run-off has, on occasion, inundated cropland and farmsteads ten miles from the main channel.

Another feature of the Red River which influences the magnitude of flood stages on the main channel is the northward flow of the river. Warm spring temperatures which produce snow melt run-off move from the headwaters region in the south of the basin in a northerly direction. Frequently, tributary run-off in the basin coincides with high flows on the Red River mainstem as it moves north. This results in progressively rising flood stages. This is in contrast to the flood sequence associated with southward flowing streams, where, under normal conditions, snow melt run-off in the southern portions of the basin subsides prior to the arrival of snow melt run-off from upstream.

Another form of flooding which occurs in Minnesota is cross-over flooding. Cross-over flooding occurs in situations where watershed boundaries along minor tributaries are poorly defined by topographical features. When the volume of run-off exceeds the discharge capacity of the watershed, the surplus run-off moves laterally and crosses over into adjacent watersheds compounding flooding problems there. Cross-over flooding is not wide-spread in Minnesota, but is an extremely important flood characteristic in the upstream areas of the Minnesota River Basin.

The final major cause of river flooding in Minnesota is intensive summer thundershower activity. The total number of thundershower days varies annually from 25 in the north to over 60 in the southern part of the state. The period of most severe thunderstorm activity in the state occurs from late spring to mid-summer. Since the major rivers in the state are generally well below flood stage during this period, thunderstorm activity rarely creates wide-spread flooding, but it can cause locally severe flooding. The impact of summer storms is most severe in the Cannon, Root, and Zumbro River Basins and in those watersheds drained by streams flowing into the Great Lakes, northeast of Duluth. The streams in these areas have small natural storage capacities and steep gradients which make them prone to flash flooding during severe summer storms. Flooding due to severe thunderstorms may also be a major problem in urban areas where the natural drainage system has been disrupted and storm sewer systems are inadequate to carry the excess water away.

Another type of flooding that occurs in Minnesota is caused by high water levels or wave action on lakes. High water levels have been a problem in many parts of the state and are due to a number of factors including above average precipitation, high ground water levels, wave action or a combination of these factors.

Flood Frequency and Magnitude

Floods are, to a large extent, climatically controlled events that are impossible to predict on a long-range basis. As a result, the occurrence and magnitude of floods is viewed as a probability problem. It is assumed that the floods occurring during a specific period of record represent a random sample of all floods that have occurred in the past and will occur in the future. Flood frequency analysis is a highly

complex field and there is disagreement among hydrologists regarding the procedures used to calculate flood frequencies. The basic goal of these methods, however, is to relate the severity of a flood, measured in terms of peak stage or discharge, to the probability of its occurrence in a given time span. For a particular river, a flood with a peak discharge of 1,000 cubic feet per second may have a 10 percent chance of occurring in any given year. Over a very long period of time a flood of this magnitude would occur on the average of once in 10 years. This is generally referred to as a 10 year flood.

A 100 year flood will have a higher peak discharge and will have a 1 percent probability of occurring in any given year. A flood with a lower peak discharge can be expected to occur more frequently. Although it is not probable, extremely severe floods can and have occurred in successive years in many basins in the state.

The reliability of flood frequency estimates is statistically related to the availability of data on streamflows. Complete records of flood stages and discharges are available for about 50 years on the major tributaries in Minnesota, and for approximately 100 years on the Red and Mississippi Rivers. For smaller streams in the state, records may go back no more than 10 or 20 years. Inadequate records of peak flows on a stream represent a problem in flood management programs although various modeling techniques can be used to estimate peak flows for ungaged streams or streams with short periods of streamflow records. Since many flood control measures are designed to provide protection against a 100 year flood, projects designed on the basis of inadequate data may provide more or less protection than is actually desirable.

Various actions of man on the landscape of a river basin will also have an effect on the magnitude and frequency of flooding. Although the most severe floods of record have in many cases occurred during the late 1800's, it does appear as though the frequency of severe flooding is increasing in several major basins of the state. This may be due to the extensive removal of vegetation, increased drainage and filling of natural water ponding areas, increased areas of impervious surfaces in urban areas, the destruction of natural drainage channels and activities that have restricted or constricted the floodway and flood plain of a river. In recent years many studies and investigations have been conducted to attempt to determine the effects of these various landscape changes on flood frequency and magnitude. These effects are, however, very difficult to evaluate because the landscape is undergoing constant change and because floods are random events and each flood is slightly different from a previous one even though stages may be the same at a certain point along the river. Additional research is needed in order to specify the effects of these changes on flood magnitude and frequency.

CHAPTER III

ECONOMIC IMPACTS OF FLOODING IN MINNESOTA

Introduction

A common misconception about the economic impacts of flooding is that the damages which occur when a river overtops its banks are due entirely to natural forces. This view overlooks the impact of human activity on the flood plain. This misconception requires that a distinction be made between the magnitude of a flood and the economic impact of a flood.

Floods are natural events which can be measured by the volume of discharge, or by the number of feet a river rises above its banks. The economic impacts of flooding can be measured by the value of all resources, goods, and services displaced directly or indirectly by a flood. The seriousness of a flood in economic terms depends on the magnitude of flooding and on the amount of development exposed to flooding. For example, an extremely severe flood, in hydrologic terms, can have a negligible economic impact because it occurs in an uninhabited region. Conversely, a relatively minor flood can result in large economic losses if the flood way or flood plain is extensively developed.

A flood damage reduction program could be established to clear the flood plain of all human activity and reduce the risk of exposure to flooding to zero. Obviously, this is not a desirable solution. Flood plains offer advantages to some forms of economic activity that are not available at other locations. Riverborne transportation, power generation, recreation, and waste-treatment are only a few of the economic activities which generally can take advantage of flood plain locations. In addition, flood plain fertility encourages agriculture, and the confluence of streams and rivers have historically offered major locational advantages for human settlement. Nature does not provide these advantages without costs. The trade-offs between the benefits derived from flood plain locations and the costs which firms and individuals must pay as a result of locating in the flood plain provide the central focus for the analysis of flood damages.

Types of Losses Due to Flooding

The losses attributable to floods can be divided into two broad categories, direct and indirect. Direct losses, as defined by Ekstein, occur largely in the form of physical damages to property by flood waters, and are measured by the cost of restoring or replacing this property.² Direct losses also include the reduction in net revenues of agricultural and non-agricultural activities which are inundated by flood waters.

1. Direct Losses

Direct losses can be separated into several different categories. The U.S. Army Corps of Engineers employs the following set of categories for classifying direct losses:³

Agricultural. This category consists of crop and pasture damage including costs incurred due to replanting, refertilizing, additional spraying, reduced crop yields, loss of animal pasture days, and other similar flood losses.

Other Agricultural. This category includes damages to land from scour and gully erosion and deposition of undesirable material; losses to livestock and poultry; damages to fences, farm buildings and contents, and equipment; and damages to irrigation and drainage facilities.

Rural Non-Agricultural. This category includes damages to rural industrial and commercial properties, such as sand and gravel operations, quarries, sawmills and all other non-agricultural activities, not located in urban areas. Public damages to fish hatcheries, wildlife refuges, small dams, rural tourist camps, and recreational and park facilities are also included in this category.

Urban. This category consists of property damages to residences, businesses, churches, schools, automobiles, house trailers, public properties and their contents located in urban areas. Also included are damages to public works and communications facilities including streets, utilities, sanitary-storm sewer and telephone systems. In addition, this category includes the decreases in net revenues of all businesses and industries directly affected by flooding.

Transportation. This category consists of flood damages to railroads, highways, roads, airports, bridges, culverts, and waterways which are not included in urban damages. In addition to physical damages, transportation losses include the reduction in net revenues of all transportation activities whose local operations are directly affected by flooding.

2. Non-Economic Losses

Some of the costs of flooding are not directly measurable in economic units. The most important non-economic loss is the loss of life due to flooding. Deaths due to flooding have been substantially reduced by the development of flood forecasting and warning techniques and by improved flood emergency activities but some lives are still lost during severe flooding situations.

The emotional anguish of families whose homes have been destroyed, whose lives have been uprooted and other similar tragedies are other forms of non-economic losses. These do not appear in the standard regional and

national capital and income accounts as do other types of direct flood losses. Because it is virtually impossible to put an economic value on these types of losses and because there is no "acceptable" level of human tragedy, estimating the magnitude of these impacts is extremely difficult.

3. Indirect Losses

Indirect flood losses refer to the decrease in net revenues of firms and individuals, not directly affected by flooding, but whose activities are interrupted by floods. These losses occur when firms are engaged in activities linked to firms within the flooded area. Flooding can disrupt these linkages and produce bottlenecks in the exchange of products between linked industries. If this causes the net revenues of the firm outside the flooded area to decline, this loss represents a real cost of flooding.

In addition to losses caused by bottlenecks, indirect losses also include the cost of those activities made necessary by flooding. These activities include emergency flood fighting, emergency medical aid and rescue work, along with insect and disease control. These represent expenditures which would not take place in the absence of flooding, so they must be treated as costs. In some cases, however, these activities produce measurable benefits. For example, emergency diking operations may prevent flood waters from inundating a whole city. Only those costs in excess of benefits may be counted as indirect losses. Indirect costs are classified by the U.S. Army Corps of Engineers as "other flood damages."

Computation of Flood Damages

Precise information about the value of flood losses in a given area is required for three basic reasons: to evaluate the seriousness of flooding problems in that location; to enable hydrologists and economists to determine the most suitable types of measures for reducing flood damages; and to assess the effectiveness of these measures in reducing flood damages, after they have been implemented.

The economic losses associated with flooding are due to the magnitude of a flood, and to the value of the property and the nature of the economic activity located on the flood plain. Increasing the severity of a flood or the value of flood plain property will generally increase flood losses. Since floods are random events, and because the amount of development on the flood plain is constantly changing, losses due to a single flood provide inadequate information for planning purposes. What is needed is a means of determining an average value of flood damages which takes into account both the random nature of floods and the relationship between flood flows and losses. Also, there must be some way of relating the average damage figure to future changes in flood problems and control measures. These figures are referred to as average annual damages and projected average annual damages.

The average annual damage estimate has several important characteristics. These estimates can not be used to predict the damages that will occur due to flooding in any given year in a specific location. This is

because it represents an expected value, based on the random nature of flood flows. If the estimate is an accurate one, it represents the average annual damage that would occur due to all flooding over a long period of time. This means that average annual damage estimates can not be verified by referring to the relatively short historical record of most streams, or at least not with complete precision. There is often criticism about the validity of these estimates, particularly in the wake of several severe floods occurring within a short period of time. In these situations, recorded flood damages are considerably higher than average annual damages. However, this characteristic is in keeping with underlying assumptions about the random nature of flooding. Because very severe floods occur infrequently the damages they produce are weighted less heavily in computing average annual damages than the damages due to more frequent, but less severe floods. In the case of a 100 year flood the value of recorded damages will be multiplied by .01 and for a 10 year flood, by .10. Thus average annual damages will always be less than recorded damages for the most severe floods. Another feature of average annual damage estimates is that, in an economic sense, they represent the average cost to society of flood plain development, which can be compared to the benefits derived from having activities located there. Flood damage reduction policies which lower these costs, without adversely affecting existing benefits, produce a net increase in social benefits. This observation lies at the heart of the economic analysis of flood control.

Projected Estimates

Average annual damage estimates are computed on the basis of existing flood plain development during some base year. The economic development of flood plains, however, continues over time. Crop patterns change, new residences, commercial and industrial buildings are constructed, and as these events take place the value of flood plain property and the goods and services provided by economic activities located there generally increases. While this produces greater economic benefits to society, it invariably results in some increase in the costs of locating in floodprone areas. Because of this growth, average annual damage estimates must be updated in order to take into account the increased value of flood plain property and goods and services. If this is not done, flood problems will be understated, which may lead to the implementation of flood damage reduction measures that provide too little protection for flood plain occupants.

The methodology used to project flood damages is well beyond the scope of this study, but it basically consists of constructing growth indices based on regional population and economic projections, and applying these estimates to current average annual damage estimates. These projections are usually made for a particular river under two sets of assumptions. One set assumes that no flood damage reduction measures will be implemented. The other set assumes that flood damage reduction measures will be implemented.

In projecting damages with future flood damage reduction measures in place, the assumption is made that this added degree of protection will result in the development of additional land and better utilization of existing lands within the flood plain area. The value of this additional activity is counted as a benefit of flood protection. However, this

increased level of development - over and above what can be expected without future protection - may produce substantial increases in average annual damages. While this is entirely consistent with the normal sequence of events if development is left unregulated, projections of this type are often used to justify additional expenditures on flood damage reduction measures.

Flood Damages in Minnesota

It is difficult to measure the current economic costs of flooding in Minnesota because up-to-date estimates of average annual damages, by subbasin, are not currently available. However, current average annual flood damages in the state can be approximated by updating earlier estimates to 1978 dollars. Such an approach takes into account only the impact of inflation upon construction costs and prices received and paid by farmers. It ignores any increase in the costs of flooding due to flood plain development since the original estimates were made.

Table III-1 shows the updated estimates of average annual damages for each of the four major basins in Minnesota. The base years listed in this table refer to the year in which the initial average annual damage estimates were calculated. Since the base years associated with these estimates are different, summing these figures for the entire state would be misleading. Updated estimates of average annual damages were obtained by separating base year damages for each basin into five components: agricultural, other agricultural, transportation, urban and other damages. Each of these components was then multiplied by the inflation index that applies to that component. The sum of these "inflated" components represents the updated average annual damages in 1978 dollars for each basin in the State.

TABLE III-1. Estimated Average Annual Damages in Minnesota by Basin.
(Damages in Base Year Prices Adjusted to Reflect 1978 Prices)

Damages expressed in thousands of dollars

River Basin	Base Year	Damages in Base Year Dollars	Damages in 1978 Dollars	Basin Damages as % of Total Damages
Mississippi <u>1./</u>	1966	\$15,369	37,163	68.76
Red River <u>2./</u>	1967	7,367	16,257	30.08
Rainy River <u>2./</u>	1967	149	338	00.63
Great Lakes <u>1./</u>	1970	266.7	288	00.53
<u>Total State</u>			54,046	100.00

Existing conditions

With existing projects, including those for which construction has been started or has been funded prior to December, 1967.

Sources: Upper Mississippi River Comprehensive Basin Study, Vol. V., 1970; Souris-Red-Rainy River Basins Comprehensive Study, Vol. III, 1972; and Great Lakes Basin Framework Study, Appendix 14, 1975.

It is important to keep in mind the fact that the \$54,046,000 figure cannot be used to predict flood damages. This figure represents a low estimate of the average damages that would occur annually based on the damage frequency of flooding over a long period of time.

Table III-2 is an expanded version of the previous table, showing current estimates of average annual damages at the subbasin level. It reveals that almost 80 percent of the average annual damages estimated for the State occur in five subbasins: the Mississippi Headwaters, Cannon-Zumbro Root Rivers, the Minnesota River, the Mississippi Mainstem and the Red River Mainstem. These five subbasins also contain over 70 percent of the state's population. Approximately 76 percent of all damages experienced in these basin areas are non-agricultural.

Agricultural and non-agricultural average annual damage estimates are presented in Table III-3. The agricultural component consists of two categories: agricultural and rural non-crop damages (or other agricultural), and the non-agricultural component is made up of urban, transportation and other flood damages. These estimates show that slightly more than half of current average annual damages are non-agricultural damages. In fact, the non-agricultural share is probably closer to 60 percent given the increase in the value of non-agricultural goods and services over the last decade. However, as the number of communities which have adopted flood plain ordinances grows in future years, this figure may begin to stabilize, and perhaps decline.

The estimates that have been presented in this section should be used cautiously, given their conservative bias. Better estimates are available for some areas of the State, where the Corps of Engineers or the Soil Conservation Service have prepared specific flood studies. The estimates shown here are designed solely to illustrate the magnitude of flood costs in Minnesota and are inadequate for detailed planning or evaluation purposes.

At present, the State of Minnesota has no method of monitoring its flood damage reduction programs to determine the impact of these measures on average annual damages. Developing the capacity to monitor flood damages on a recurring basis and developing average annual damage estimates on the basis of these reports may be a desirable goal of future state activity in the area of flood damage reduction.

TABLE III-2. Estimated Average Annual Damages in Minnesota by Subbasin,
(Damages in Base Year Prices Adjusted to Reflect 1978 Prices,)
Damages Expressed in Thousands of Dollars.

Subbasin	Base Year	Damages in Base Year Dollars	Damages in 1978 Dollars	Damages as % of Total Minnesota Damages
<u>Mississippi 1./</u>				
Headwaters Cedar, West Fork Cannon, Zumbro, Root Minnesota West Fork & Des Moines Mississippi Mainstem	1966 1966 1966 1966 1966 1966	2521 38 2700 8040 140 1930	5966 87 6632 18950 338 5190	11.04 00.16 12.27 35.06 00.63 9.60
<u>Red River 2./</u>				
Mustinka Roseau Two Rivers Tamarac Middle Snake Red Lake Sand Hill Wild Rice, Marsh Buffalo Ottertail Red River, Mainstem Red River Tributaries	1967 1967 1967 1967 1967 1967 1967 1967 1967 1967 1967	243 666 75 105 466 535 138 760 609 119 2200 1451	503 1480 168 234 1010 1251 289 1635 1290 249 5136 3012	00.93 2.74 00.31 00.43 1.87 2.31 00.53 3.03 2.39 00.46 9.50 5.57
<u>Rainy River 2./</u>				
Lake of the Woods Little Fork River	1967 1967	106 43	225 113	00.42 00.22
<u>Great Lakes 1./</u>				
St. Louis River Superior Slope	1970	122.9 20.9	245 43	00.45 00.08
<u>TOTAL STATE</u>			54,046	100.00

1. Existing conditions.

2. With existing projects, including those for which construction has been started or have been funded prior to December, 1967. Sources: Upper Mississippi River Comprehensive Basin Study, Vol. V, 1970; Souris-Red-Rainy River Basins Comprehensive Study, Vol. III, 1972; and Great Lakes Basin Framework Study, Appendix 14, 1975.

TABLE III-2 Agricultural and Non-Agricultural Average Annual
Damage Estimates by Basin.

Damages expressed in thousands of 1978 dollars

River Basin	Agricultural Damages	Non-Agricultural Damages	Non-Agricultural Damages as Total Damages
Mississippi	15501	21662	58.29
Red River	10773	5484	33.73
Rainy River	193	145	42.90
Great Lakes	182	106	36.81
<u>Total State</u>	26649	27397	50.69

Sources: Same as Tables III-1 and III-2.

CHAPTER IV

FLOOD DAMAGE REDUCTION MEASURES AND PROGRAMS

Approaches to Flood Damage Reduction

Historically, three different approaches have been used to reduce the economic impacts of flooding: 1) decreasing flood losses by redirecting, modifying or changing the probability distribution of flood flows are corrective approaches; 2) decreasing flood losses by reducing the value of property exposed to flooding are preventative approaches; and 3) reducing the economic hardships associated with flooding are compensation approaches. Each of these approaches are further characterized by their reliance on specific kinds of flood damage reduction measures, the principal features of which are discussed below.

1. Corrective Approaches

The primary method for reducing flood losses has been the use of structural measures. This is a collective term for those flood damage reduction projects which lower flood damages by restricting the movement of flood water onto the flood plain. Structural measures reduce average annual damages by eliminating smaller, more frequent floods, which in most watersheds account for a very large share of total flood losses. Structural measures include the following kinds of projects:

Reservoirs are designed to store flood flows in excess of channel capacities, and thereby prevent these discharges from spreading out across the flood plain and causing damage downstream of the reservoir.

Retarding structures are small ungated storage reservoirs, which perform the same function as reservoirs but on a smaller scale.

Levees and floodwalls are earthen or concrete barriers designed to protect a specific area from flooding.

Channel improvements increase the channel capacity of rivers and streams, allowing them to safely accommodate higher peak flows. Specific types of improvements include increasing the channel cross-section by dredging and excavation, and reducing frictional drags of obstacles within the channel through clearing and snagging of debris and vegetation. Channel improvements are generally used in conjunction with other measures.

Diversion channels are used to re-route flood flows from normal river channels to a new channel bypassing areas of potential damage. A diversion channel involves the construction of a diversion structure and excavation of a new channel around the damage area.

Land treatment measures decrease run-off by increasing the rate of infiltration of precipitation into the soil. Typical measures include contour plowing, range seeding, and farm ponds on pasture land. These measures increase the moisture storage capacity of the soil and are effective in controlling the run-off from minor storms.

2. Preventative Approaches

A second way of reducing flood damages is by reducing the level of damages associated with a given flood stage. Measures which fall into this category are frequently referred to as non-structural measures because no attempt is made to alter stream hydrology through physical means. Preventative, or non-structural approaches, include the following practices:

Flood proofing includes all actions taken by flood plain residents to reduce flood damage to their property. Until recently, most flood proofing was conducted on an emergency basis only, by means of flood forecasting and warning procedures, sandbagging, evacuation of residents and property, and the construction of temporary levees. More recently, greater emphasis has been placed on permanent flood proofing measures, which will make structures located in the flood plain less susceptible to flood damages. These measures include elevating new buildings above flood stage levels, the use of construction materials which are more resistant to flood damage, and methods to prevent flood water from entering buildings by sealing openings which are exposed to flood waters.

Land Use Regulation refers to a wide range of measures designed to control the level of development on flood plain lands. The most widely used of these management methods is a flood plain zoning which regulates certain land uses in areas subject to recurrent flooding. Zoning ordinances may greatly reduce flood damages by excluding future development from the floodway, or by restricting the use of the floodway to land uses which suffer little damage, such as parks and open spaces. Other forms of land use regulation include subdivision regulations which can be used to specify the elevation of building sites and the uses to which subdivision properties can be put; the State Building Code which requires flood proofing measures in the construction of new buildings and additions to older structures; and health regulations to regulate the use of septic tanks and to restrict garbage dumps, the storage of toxic substances and combustibles, and other activities which would create health hazards in the flood plain. Land use regulation measures may also include public programs to purchase flood plain property and to relocate families in areas outside of the flood plain.

Flood Insurance does not actually reduce the physical damages caused by floods, but it does transform highly irregular flood losses into a uniform series of annual payments. According to some economists, implementation of a national flood insurance

program on a strictly actuarial basis - so that policy premiums reflect expected flood losses - will both discourage uneconomic forms of flood plain development and greatly reduce the need for public intervention in the area of flood control.⁴ The national flood insurance program in its current form appears to be moving in this general direction.

3. Compensation Approaches

Compensation measures are payments from the government to landowners, for floods that meet certain criteria qualifying them as "disasters." While compensation measures do decrease the flood losses of individuals receiving aid, they tend to increase the costs of flooding to the nation. This is because flood relief measures are income transfers from taxpayers in general to people who live in flood plains. Compensation approaches have been frequently criticized because they tend to encourage individuals to take greater risks than they would in the absence of these payments.⁵ It is at least arguable that the effect of flood relief programs is to increase flood losses by increasing government costs.

Federal Flood Damage Reduction Programs

There are several major programs through which the Federal government is currently attempting to reduce the economic impacts and the human suffering that result from flooding in Minnesota are. These include:

1. The flood control activities of the Corps of Engineers of the United States Army, which are carried out under the authority first made available to that agency under the Flood Control Act of 1936. These activities have been expanded considerably since that date by additional legislation.
2. The program of the Soil Conservation Service (SCS) of the U.S. Department of Agriculture, conducted under the authority of the Watershed Protection and Flood Prevention Act of 1954 (P.L. 566). This act gives the SCS responsibility for flood control measures for watersheds under 250,000 acres.
3. The National Flood Insurance Program is directed by the Federal Emergency Management Agency. This program was mandated by Congress under the National Flood Insurance Act (P.L. 90-448) of 1968 and subsequently strengthened by the Flood Disaster Protection Act of 1973 (P.L. 93-234).
4. Emergency programs, not under the administration of either the Corps or SCS, which are designed to minimize losses of life and property when major floods occur.

This is not intended to be an exhaustive description of federal flood damage reduction programs but it does illustrate the scope of federal activities.

Programs of the Corps of Engineers

The legislative basis for the involvement of the Army Corps of Engineers in flood control is a series of Flood Control and Water Resources Acts, the first of which was enacted in 1936. This Act gave the Corps the authority to conduct investigations and to construct flood control improvements on navigable waters and their tributaries, with the condition that improvements authorized under this Act or subsequent amendments would have to produce benefits in excess of all project costs.⁶

Major flood control and multiple purpose projects, undertaken by the Corps as a result of these authorities, are generally initiated by local interests. When local interests recognize a need for flood protection they may petition their representatives in Congress, who then can request the Congressional Public Works Committee to direct the Corps of Engineers to undertake a feasibility study and furnish a recommendation. When the feasibility study is completed, it is submitted to Congress and, if approved, is authorized by Congressional Act.

In addition to responsibility for major flood control projects, several laws permit the Committee on Public Works of the Senate and House of Representatives, the Secretary of the Army, and the Chief of Engineers to authorize projects of limited scope. Special continuing authorities, as they are known, include:

1. Small Flood Control Projects (Section 205, Flood Control Act of 1948) authorized the Chief of Engineers to build small flood control projects that have not been specifically authorized by Congress.
2. Snagging and Clearing (Section 208, Flood Control Act of 1954) provides for clearing and straightening of stream channels, and the removal of accumulated snags and other debris which may reduce channel capacities. Any project recommended must be "justified" under established Federal planning criteria, complete in itself and must not obligate the Federal Government to future work.

Since 1960, the Corps has become increasingly active in the area of flood plain management. Under Section 206 of the Flood Control Act of 1960, the Corps was authorized to provide states and localities with data needed to effectively regulate land use in flood plains. As a result of this authority, the Corps has established a flood plain management services program. The over-all objectives of this program are comprehensive flood damage prevention planning at all government levels, and encouraging the wisest possible use of flood plains, consistent with national welfare. Under this program the Corps provides flood plain information reports, flood insurance studies, and technical assistance to state and local governments to aid them in the preparation of flood plain regulations and to evaluate flood hazards.

The Corps is also directly involved in a variety of flood emergency activities. Under Public Law 87-99, Congress authorized the creation of an emergency fund to be used at the discretion of the Chief of Engineers for flood emergency preparations, flood-fighting and rescue operations, or for the repair or restoration of flood control structures threatened or destroyed by flooding. The Corps also furnishes flood forecasts under this authority. In addition, under P.L. 93-288, the Corps is authorized to cooperate with the Federal Disaster Assistance Administration in providing assistance to state and local governments in dealing with natural disasters. Corps activities included under this Act are performing emergency work essential for the preservation and protection of life and property, conducting damage survey investigations after major floods, repairing and replacing public roads, and providing technical and engineering services.

Programs of the Department of Agriculture

The Watershed Protection and Flood Prevention Act of 1954 (P.L. 566) authorized the Soil Conservation Service (SCS) to carry out a program of structural flood damage reduction in upstream areas. Typically Watershed Districts sponsor the construction of P.L. 566 projects. Projects initiated under this program are limited in size and restricted to upstream locations, or watersheds under 250,000 acres. The SCS also has a program for delineating flood hazard areas in upstream communities and distributing this information to local units of government.

By recent amendment to P.L. 87-639, SCS has been authorized to conduct joint investigations, with the Army Corps of Engineers, in watershed areas for purposes, including flood prevention. Reports are made jointly on these surveys and investigations, and submitted to the Congress for approval. Under this legislation, a joint study is now underway in the Yellow Bank, Lac qui Parle, Yellow Medicine, Redwood, and Cottonwood watersheds of the Minnesota River Basin.

The Department of Agriculture also administers the Federal Crop Insurance Program, under the Federal Crop Insurance Corporation. This program, established in 1938, is designed to provide indemnification for crop losses due to natural events. This insurance is not available in areas subject to recurrent flooding, so most flood plain areas are excluded from the program.

The Agricultural Stabilization and Conservation Service administers the Agricultural Conservation Program which provides cost-sharing for applying soil, water, woodland and wildlife conservation practices on farmland. Many of these practices will increase the soil moisture storage capacity of the soil or reduce runoff through small sediment traps, diversions or other measures.

National Flood Insurance Program

In 1968 Congress passed the National Flood Insurance Act (P.L. 90-488) which authorized the Department of Housing and Urban Development (HUD) to establish and carry out a national flood insurance program. The

objectives of this program are to provide flood insurance at subsidized rates for existing structures and their contents, provide coverage at actuarial rates for future properties located in the 100 year flood plain, and to promote appropriate land uses in areas subject to flooding in order to reduce flood hazards. To achieve the latter objective, state and local governments are encouraged to adopt land use regulations to: 1) restrict the development of land exposed to flood damage; 2) guide the development of proposed future construction away from locations which are threatened by floods; 3) assist in reducing damage caused by floods; and 4) provide for proper land use and land management in flood-prone areas by recognizing the degree of the existing flood hazard.

Under the program, which is currently administered by the Federal Emergency Management Agency, the agency is authorized to undertake and carry out studies to determine where insurance will be made available, and to establish premium risk rates once the eligibility for insurance has been established. The Act allows five years to identify and publish information with respect to all flood-prone areas in the United States and 15 years to establish flood-risk zones and premium rates. Under the Flood Disaster Protection Act (P.L. 93-234), communities designated as having a flood hazard are required to participate in the program, subject to withholding Federal financial assistance for acquisition or construction of residences and small businesses in cases of non-compliance. Once a community enters the program it becomes eligible for subsidized flood insurance, on an emergency basis. Specifically, this means that individuals may purchase federally subsidized insurance policies on existing residences and small businesses, regardless of where these structures are located. The insurance is available at a flat rate, and there is a minimum premium of \$25.00. Coverage on single family residences is limited by law to \$35,000 on the residence, and \$10,000 on contents and to \$100,000 on structures and the contents of small business and other types of residential property.

Upon completion of a flood plain study, a community must prepare a flood plain management ordinance to regulate future development within the 100 year flood plain. Once that ordinance is approved by the Commissioner of Natural Resources, the community becomes eligible for the regular flood insurance program. Under this part of the program structures located outside the 100 year flood plain can be insured at actuarial rates, which as a rule will be lower than the emergency subsidized rate in these areas. Rates and the amount of coverage on existing structures located within the 100 year flood plain do not change. However, properties built subsequently in the special hazard areas must pay actuarial rates. As a rule, these latter rates will be considerably higher than the current subsidized rate, reflecting the much higher expected losses associated with flood plain occupancy.

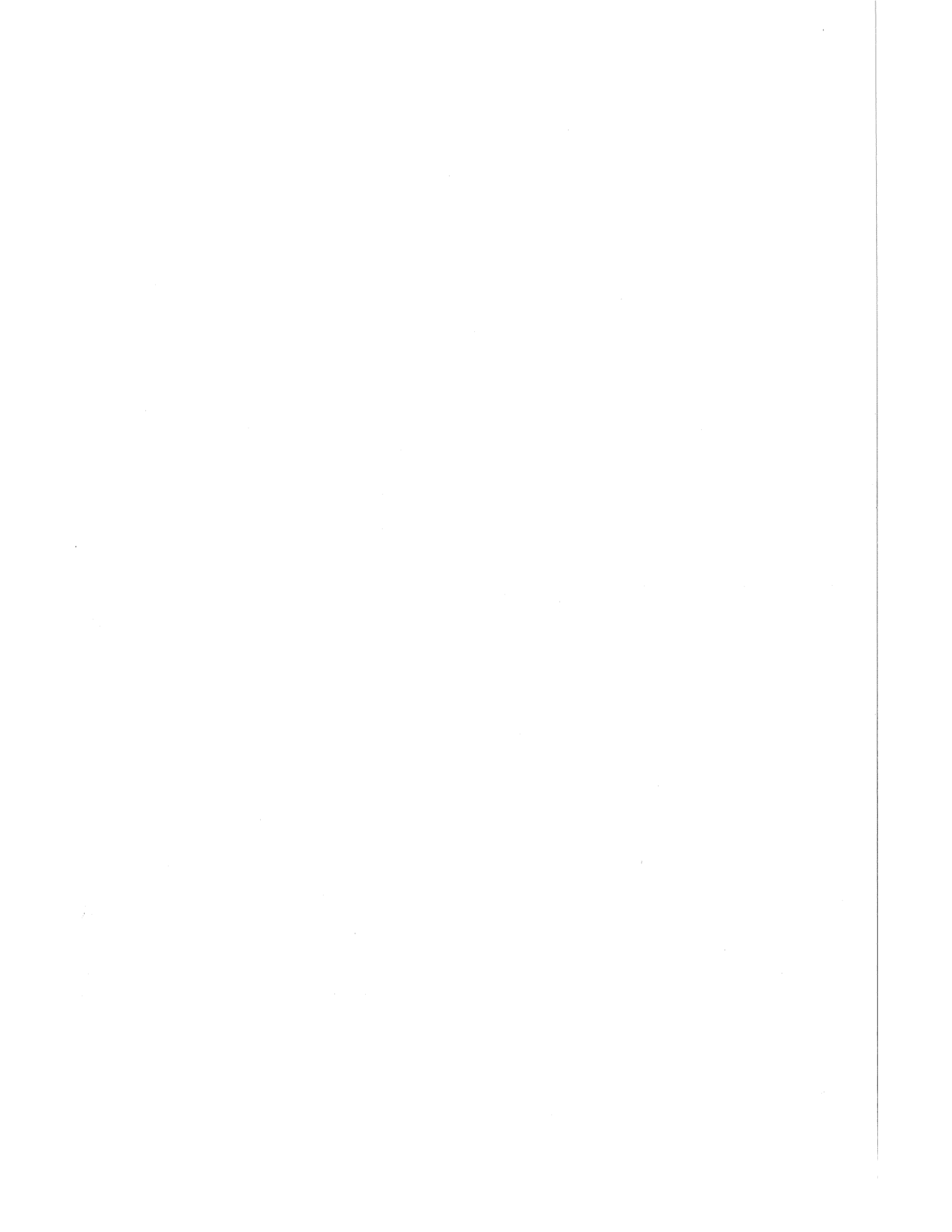
Currently, a total of 438 Minnesota communities are participating in the National Flood Insurance Program. Forty-nine of these are now a part of the regular program, having adopted flood plain ordinance based on published flood insurance studies. Three hundred and ninety-four communities are in the emergency program. One hundred eighty-two communities are not currently participating in the program.

Federal regulations require that a separate environmental quality plan be evaluated in any flood damage reduction study. This plan either minimizes environmental damage or enhances the environment in the study area. This plan usually incorporates non-structural rather than structural flood damage reduction measures. A procedure similar to this could insure that comprehensive flood plain management plans are developed rather than primarily structural programs.

The environmental assessment or environmental impact statement process is a separate mechanism for evaluating the positive and negative environmental impacts of a project or program. This process has slowed construction of projects, caused projects to be redesigned to be more environmentally sensitive and in some cases has stopped projects completely. In many cases federal agencies negotiate to mitigate adverse environmental impacts on fish and wildlife, water quality or unique landscape features.

Regional development and social welfare principles are most often used to justify the implementation of measures that are not economically or environmentally feasible although this is not always the case. These principles will allow a comparison of various plans to determine the plans impacts on social welfare and the regional economy. These principles are used less often as more project review mechanisms are implemented.

While the state may wish to utilize principles similar to these for the evaluation of flood damage reduction programs, it should be remembered that the state does not currently have the capability to conduct the stringent analysis that the federal government does for each project. At the same time some means of evaluating the cost-effectiveness and environmental sensitivity of flood damage reduction programs is probably necessary.



CHAPTER VI

CONCLUSIONS, OPTIONS AND RECOMMENDATIONS

Introduction

In 1967, average annual damages due to flooding in the State of Minnesota were estimated at approximately 23 million dollars. In 1978 dollars, average annual damages are in excess of 50 million dollars and may be closer to 70 million dollars. In future years, expected flood damages may continue to increase to even higher levels as a result of inflation and additional development of the state's flood plains. Under the very restrictive assumptions of a 5% per year rate of inflation and a .05% per year rate of growth in the real value of property located in the flood plain, average annual damages may exceed 180 million dollars by the year 2000.

Flood plain management ordinances do little to reduce current flood damages but they will restrict the amount of future development in the flood plain that would be subject to damage by floods. While flood plain management is the cornerstone of the state's flood damage reduction policy, residents of Minnesota in areas subject to severe flooding have increased their demands for the state to become actively involved in other flood damage reduction measures in order to reduce current damages.

In 1975, the state Legislature established a grant-in-aid pilot program for the construction of small agricultural impoundments in Study Area II of the Minnesota River Basin. More recently, a similar program has been established in the Red River Valley.

Given this backdrop of rapidly increasing flood damages, and growing concern about the role of the state in reducing flood losses, there is a serious need to examine the current policy of the State of Minnesota regarding flood damage reduction. The purpose of this final section is to address that need by, first, identifying existing problem areas in the state's flood damage reduction policy and programs that will affect future state efforts to reduce the costs of flooding in Minnesota; secondly, to examine a number of options that have been considered by the public and by the Water Planning Board; and finally to identify the options that have been selected by the Water Planning Board for recommendation to the Governor and the Legislature.

Problems with Existing Policies and Programs

During the assessment of flooding problems and current flood damage reduction programs, six major problems or shortcomings were identified.

1. There is currently no state evaluation of the effectiveness of flood damage reduction programs either before or after program implementation. The goals of the State of Minnesota's flood damage reduction policy are clearly stated in existing laws. They are:

- (1) To minimize loss of life and threat to health.

- (2) To reduce private and public economic losses.
- (3) To minimize the adverse effects of flood damage reduction on the natural environment.

Despite the presence of a set of clearly defined goals, the state currently does not have adequate planning criteria for evaluating the contribution of specific types of measures to achieving these goals or for evaluating measures once they are implemented.

Chapter V outlined four principles for evaluating flood damage reduction measures. These principles are closely related to the state's flood damage reduction goals. From these four principles, specific criteria can be derived to identify the contribution of a particular flood damage reduction measure to one or more of the state's goals and can also be used to analyze the tradeoffs between different goals. While the criteria may not make decisions about which measures to accept any easier, they do point out the economic, environmental and social costs and benefits associated with various flood damage reduction measures. These criteria will also provide a reference point to see if various flood damage reduction measures have been successful at meeting state goals after implementation.

If criteria are not adopted for evaluating flood damage reduction programs, too little or too much money may be spent on flood damage reduction measures and the tradeoffs between goals may be ignored. If the state is going to take an increasingly active role in flood damage reduction, it should at least insure that the measures undertaken are the most effective measures in meeting the state's goals.

2. There currently is no formal and systematic process for establishing priorities for flood damage reduction programs and projects.

A problem that has become apparent during the participation of the State of Minnesota on Federal-State River Basin Commissions is that Minnesota currently has no formal, systematic approach for establishing state priorities for various federal projects and studies including flood damage reduction projects. This may be limiting our effectiveness in dealing with the federal agencies. The problem may become worse if the state begins to provide financial assistance for flood damage reduction measures without an established mechanism for determining priorities within the state.

3. There is currently a lack of authority to regulate activities outside of the flood plain that have a probable effect on the frequency or magnitude of flooding.

When flood hazard studies are conducted a "protected elevation" is established for the flood plain. Construction above the protected elevation will generally be safe from most flood events. Development outside of the flood plain, however, is increasing the amount of impervious surfaces and is destroying natural water retention areas and drainage corridors. This development is in some cases increasing the magnitude of floods to the point where property that was thought to be protected is experiencing recurring flooding.

A similar situation may exist in some rural areas where extensive drainage activities may be affecting the frequency or magnitude of flooding. The research that has been done on the effects of drainage on flooding is inconclusive and depends on the characteristics of the watershed. The Department of Natural Resources currently regulates drainage only if the drainage system will affect public waters. There are no provisions for evaluating the incremental effects of increasing drainage within a watershed. A combination of local and state planning and regulation may be necessary to alleviate this problem.

4. There is currently a lack of priority given to the activities authorized by the Flood Plain Management Act of 1969 by both the Department of Natural Resources and the Legislature as evidenced by insufficient staffing and funding to accomplish the activity authorized by the act.

The Act requires that the Commissioner of the Department of Natural Resources collect and distribute information on flooding and flood plain management; coordinate local, state and federal flood plain management activities; do all other things necessary and desirable to manage the flood plains for beneficial uses compatible with the preservation of the capacity of the flood plain to carry and discharge the regional flood; and, conduct periodic inspections to determine the effectiveness of local flood plain management programs including an evaluation of the enforcement and compliance with local flood plain management ordinances.

Furthermore, the act identified four specific types of non-structural flood plain management activities that are to be encouraged. These are: flood plain zoning, flood proofing, flood warning practices and flood insurance.

During the past 10 years staff efforts have been primarily directed at promulgating rules and regulations, conducting and monitoring flood hazard studies, assisting local units in adopting and administering local zoning ordinances and getting local government units enrolled in the National Flood Insurance Program.

As more and more local government units adopt flood plain zoning ordinances, an increasing amount of staff time must be directed to assisting local officials in administering the ordinances. This greatly reduces the amount of time available for work on flood proofing, flood warning systems, disaster training, emergency assistance and technical assistance for various federal flood damage reduction programs.

The maintenance of the current level of services to local government units will require some additional staff as the program grows and any program expansion, such as state cost-sharing for flood damage reduction measures, will require even more staff for effective program implementation.

5. The State of Minnesota does not currently have any statewide programs for supplemental funding for implementing either structural or non-structural programs.

Two state programs are currently available to provide state cost-sharing for structural flood damage reduction measures in specific areas, but these programs are not available statewide and neither program gives sufficient emphasis to the implementation of non-structural measures. Even though state policy identifies non-structural measures as top priority no supplemental funding or cost-sharing is available for assistance with such measures as flood proofing, flood warning systems or land acquisition or easements.

6. The long time frames for federal project implementation and proposed changes in federal flood damage reduction policies will have serious effects in Minnesota.

Estimates have been made that it now takes 15 to 25 years for a federal project to move from initial problem identification to project implementation. This long time frame greatly inhibits the ability of the state and local units to alleviate critical flooding situations relying on federal flood damage reduction programs.

Two proposed changes in federal flood damage reduction policy may also affect Minnesota.

Executive Order No. 11988 signed by President Carter requires that the federal agencies "shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare and to restore and preserve the natural and beneficial values served by flood plains ..." It is unclear at this time what the long term effects of this policy will be but it does appear as though there will be increasing emphasis on non-structural measures by the federal agencies as this policy is implemented.

Another change proposed by President Carter is mandatory state cost-sharing on federal projects in addition to the local and federal cost-share. In the past most federal projects have been constructed with strictly federal and local funding. The new proposals would result in an increased level of non-federal cost-sharing with some part of this funding being provided by the state. Failure to provide state cost-sharing on projects may possibly result in postponement or cessation of project implementation. Although there are only a few feasible federal projects that have been identified in Minnesota, this policy change may require that millions of state dollars be expended to implement these projects.

The preceding discussion identified a number of major programs and policy problems that have been identified. Other specific problems have been identified for particular flooding situations but it is not possible to deal with all of these in this paper.

Options for Modifying Minnesota's Comprehensive Flood Plain Management Program

A wide range of options can be identified for improving Minnesota's Comprehensive Flood Plain Management Program. These options can be grouped into three categories: non-structural options, structural options and evaluation and coordination options.

Non-structural options include:

1. Appropriate statutes should be amended to authorize the mandatory disclosure of flood hazard information before any property transactions take place for areas where flood hazard studies or flood plain management plans have been completed.

Prospective property buyers usually do not have adequate information about the flood hazard to property they plan to purchase. Even in areas where flood hazard information is available, prospective buyers are not aware of it. Most mortgage lending institutions require flood insurance for property with a significant flood hazard, but the buyer may not be aware of the flood hazard until he makes application for a mortgage. If other methods of financing are used the buyer may not be aware of the flood hazard until after he has purchased the property.

Flood hazard information should be provided by the seller or realtor before any purchase agreements or other similar transactions are allowed to take place. This information is available from county or city zoning administrators for many flood prone areas now and studies for most other areas with serious, recurring flooding should be completed by 1980.

2. Funds should be appropriated to investigate the types of flash flood warning systems in use throughout the country. Flash flood warning systems can have a significant effect in reducing the number of lives lost by providing sufficient time for flood plain evacuation. Information on feasible flash flood warning systems should be disseminated to local government units that are subject to flash floods or that are located downstream from dams with possible safety hazards. State funds could be used to assist local government units in implementing appropriate warning systems.

3. A technical assistance program should be established within the Flood Plain Management Program to provide an increased level of assistance to local government units regarding state and federal flood damage reduction programs and in making application for various forms of state and federal disaster assistance.

There is currently a need to improve the access of local governmental units to information regarding flood hazards and the various forms of financial assistance available under state and federal programs. This includes not only those programs with the primary purpose of flood damage reduction, but also a number of other programs, primarily at the Federal level that provide local grants-in-aid for the acquisition and redevelopment of flood plain property for open space or wildlife and fisheries uses. Some technical assistance is already provided by the Flood Plain Management Program, however, the current level of staffing is inadequate to advise local units of government on the full range of opportunities available to them.

4. In order to reduce the private and public costs of disaster assistance, it is recommended that the state legislature appropriate the necessary funds for the State Housing Finance Agency to institute a program providing low interest loans and/or grants-in-aid for low income families to undertake approved flood-proofing measures for their residences. Technical assistance for flood-proofing measures should also be provided for commercial and industrial facilities.

In most cases, there is no economic justification for providing financial assistance for flood-proofing of private residential units. The benefits of this form of flood damage reduction are entirely private, and consequently all of the costs of flood-proofing should be borne privately

in the interests of economic efficiency. On the other hand, the benefit of relatively inexpensive forms of flood proofing can be quite high. In cases where individuals in the lowest income brackets can not afford even the most rudimentary forms of flood-proofing, the burden upon the state and federal governments to provide flood disaster assistance is increased. If subsidizing some part of the flood proofing costs of low income individuals results in a reduction of the total costs of flood government intervention in this form can be justified on the basis of economic efficiency. Information on various types of flood proofing techniques should be provided to developers and to commercial and industrial facilities so that they can make decisions on the most feasible means of flood protection.

5. To further reduce the public and private costs of flooding in the state, it is recommended that the legislature appropriate the funds required in order to increase the awareness of flood plain residents of existing hazards and the action they can take to reduce flood losses through a program of public meetings and seminars, the dissemination of educational materials, television commercials, and any other reasonable means consistent with this objective.

Most individuals do not fully appreciate the nature of the risks they assume when they locate in flood hazard areas, nor do they understand the nature of the benefits to be gained by purchasing flood insurance or flood-proofing their residences - until it is too late. Requiring mandatory disclosure of information relating to flood hazards before transfer of property located in the flood plain can help to improve this situation. However, this measure will have little effect upon property currently subject to flooding. The economic value of information related to flooding and the steps which can be taken by individuals to reduce their losses is potentially very great. The cost of providing this information, on the other hand, are relatively low in comparison to the reduction in flood losses that could be achieved with increased access to the proper information. While current authorities emphasize the educational functions of the Flood Plain Management Program, this office has not received sufficient funding to date to conduct educational activities on a large scale.

6. Existing authorities permit acquisition of private property as a part of Minnesota's comprehensive flood plain management program. Many cities and counties have been actively acquiring flood plain lands for parks, open space or for redevelopment to other more compatible uses. State funding assistance has not been made available for pursuing this alternative for flood damage reduction. This option should be considered for a feasibility study and for possible funding as a part of Minnesota's comprehensive flood plain management program.

In certain cases, state funding for the acquisition of private property located in the flood plain can be justified on the basis of economic efficiency. In deciding whether to purchase property from private parties, the state should consider whether the benefits of putting the property in another use, such as for parks and open space, exceeds the benefits of the best (most productive) private use of that land.

7. The appropriate state and federal agencies should begin intensive efforts to determine the effects of wetland drainage in basins with severe flooding problems. In some basins, wetland drainage or filling has had a significant effect on the frequency and magnitude of flooding. Studies are needed to determine the types and situations of wetlands that may provide significant flood damage reduction benefits.

Drainage projects are evaluated to determine if the outlet is capable of handling the additional flow. What is needed, however, is a mechanism for evaluating the cumulative effects of wetland drainage and filling. Establishing long range plans for drainage projects in a watershed area may be one means of identifying the cumulative effects of drainage and for restricting additional drainage once a critical point is reached.

8. Chapter 104 should be amended to require storm water management plans meeting minimum state standards, especially in the larger cities and in the metropolitan area. Flood hazard studies are becoming rapidly outdated in some areas because additional development and destruction of the natural drainage systems are causing flood flows to increase. "Protected elevations" identified in the flood hazard studies no longer provided the anticipated protection. Storm water management plans are needed in urbanizing areas to reduce the amount of runoff released to rivers and streams during high water periods. Minimizing the amount of impervious surfaces, maintaining natural water storage basins, constructing small impoundments or catchment basins and maintaining the natural drainage systems are all mechanisms that can reduce downstream flow-increases. Plans are needed because it is much easier to maintain or develop storm water management systems before large amounts of development occur.

Structural options include:

1. Discontinue the current state funded cost-sharing programs upon completion of the authorized and funded projects in the Minnesota River Basin and in the Red River Valley, and fund no new structural flood damage reduction programs with state funds. The state would continue to take advantage of worthwhile Federal projects. By adopting this option, however, the state may pass up many economically and environmentally feasible opportunities to reduce the private and public costs of flooding.
2. Establish a statewide grant-in-aid program to make state cost-sharing available for the planning and implementation of flood damage reduction projects subject to the state review and approval. Watershed Districts and other local units of government have identified and designed small projects. The state could provide cost-sharing on some of these projects but beneficiaries should pay project costs in proportion to the benefits they receive to maintain economic efficiency. Planning and engineering would be done at the local level in order to keep state staff requirements at a minimum. Some staff may be needed at the state level to review and evaluate projects and to administer the funds.

3. Fund and construct projects that have been analyzed and planned by the Federal agencies under Congressional authorization, but which are unlikely to have construction funded by the federal government.

In many cases federal projects have been planned but funding for construction is not available or it will take many years to get the funds. In these cases the state could cost-share on projects in a manner similar to the way the federal government does it. State staff requirements would be reduced because the planning would be completed. The state may be able to accelerate the construction of some projects in this manner but it may not be able to take advantage of federal funds for a project if funding is approved some time in the future.

4. Supplement the cost-sharing required of local government units for federal projects by making state funds available for structures or other measures that have been authorized and funded by Congress.

One of the criteria for funding projects proposed by President Carter in his 1976 Water Policy Message is that project funding may be accelerated if local and state governments are willing to fund more than the minimum cost-share requirement. State funds could be used to supplement local cost-share in order to get more authorized federal projects funded for construction. There are not many large projects in Minnesota that have been found feasible but there are numerous small watershed projects that might benefit from this course of action. Again state tax revenues would be used for projects with a relatively small number of benefited parties but it would allow the state to take advantage of available federal funds.

5. Provide a state program of long-term loans to local government units to undertake the planning and construction of flood damage reduction structures, subject to state approval. This program might require substantial funding for 10 years or so but after that point the program should be self-sustaining as the principle and interest are repaid. Interest rates should be established at current market rates unless special circumstances dictate otherwise. Some staff would be required to administer the loan program.

6. Establish a centralized state program for completely funding the planning and construction of flood damage reduction structures.

Under this option the state would completely fund flood damage reduction measures. This is economically inefficient because the people receiving the benefits of the flood damage reduction are not paying the costs of those benefits and the costs are distributed over the whole state. A large staff would probably be needed to conduct this program.

7. Allow mill rate increases over and above the current levy limits to allow local government units and benefited individuals to pay the cost for implementation of flood damage reduction measures. Many local government units are at or near the current levy limits and thus cannot afford to implement flood damage reduction measures without substantial state or federal assistance. By allowing these units to tax above the current levy limits, specifically for flood damage reduction measures, it would make it possible for local units to fund a greater share or all of the costs of flood damage reduction measures that primarily benefit the local area.

Coordination and evaluation options include:

1. The state should increase its lobbying efforts to implement economically and environmentally feasible flood damage reduction measures through the Basin Commission's Priority Processes and through the Minnesota Congressional Delegation.

There are not a large number of projects in Minnesota that have been found to be economically feasible, but the state should continue to seek implementation of projects that are feasible. There are, however, many potential non-structural and disaster assistance programs that the state should be working for.

2. The state should develop criteria and a process for evaluating and prioritizing flood damage reduction programs and for allocating potential state assistance funds.

Criteria should be developed based on economic efficiency, environmental quality, community and regional development and social welfare principles for evaluating flood damage reduction projects. These criteria should be developed in the form of rules for prioritizing and funding programs in a potential statewide cost-share program. In addition, programs should be developed for monitoring the effectiveness of flood damage reduction measures following their implementation.

3. The state should establish a priorities committee for determining programs for input to the Basin Commission Priorities Processes and for prioritizing and determining the allocation for potential state assisted flood damage reduction projects.

Several federal agencies have indicated that they would like to have coordinated state priorities for input into the federal budgeting process and the River Basin Commissions also require state priorities in order to determine regional priorities for studies, programs and projects. In the past, Minnesota has participated in these efforts but the establishment of priorities has been done in an ad hoc manner. A State Priorities Committee would enable us to formalize and systematize the process and allow the state agencies to be more effective in addressing severe flooding problems and other water related issues from a state-wide perspective.

4. The state should continue the direct role for the Governor and the Legislature in determining priorities for federal programs and also for determining specifically where and what types of flood damage reduction measures should be funded with state dollars.

This option is a continuation of the current roles of the Governor and the Legislature. The Governor is responsible for providing federal agencies with state positions on federal programs and projects in the state. The Governor and the Legislature would also continue to determine where state funds are spent for flood damage reduction and what types of programs would be allowed as has been done in the Minnesota River Basin and in the Red River Valley.

These alternatives all provide opportunities for the state to expand its role in comprehensive flood plain management. All of these options support the existing flood plain management program but attempt to expand the program into areas that have not received enough emphasis to date.

The primary emphasis of the current flood plain management program has been on non-structural means of flood damage reduction but it appears that some combination of structural and non-structural measures may provide the best program for comprehensive flood plain management and flood damage reduction. The current program is primarily directed at reducing future flood damages but measures are also needed to reduce the current level of average annual damages occurring in the state to acceptable level. Many of the proposed options will help to accomplish this if they are implemented as part of a comprehensive flood plain management program.

These options were presented for review by regional committees, special interest groups, state and local agencies and the public. As a result of comments received from these groups, a number of options were modified and combined and were presented as staff recommendations to the Water Planning Board for its action.

Recommendations

The Minnesota Water Planning Board at its June 19, 1979 meeting adopted the following recommendations for improvements to the comprehensive flood plain management program:

- (1) Expanded state program. Because of the magnitude of the current urban and agricultural damages occurring in Minnesota and the numerous opportunities for action, it is recommended that the flood damage reduction program of the state be expanded and improved.
- (2) Program emphasis. The primary emphasis of the State of Minnesota should continue to be on non-structural means of flood plain management, while fully recognizing structural controls are suitable to some situations. Local flood plain zoning, flood proofing, and selected land use controls continue to be the most effective means of long-term flood damage reduction because they reduce the amount of development subject to flooding. However, there are agricultural areas and developed urban areas where structural measures are needed and can be effectively implemented as part of a comprehensive flood plain management program. These structural measures shall receive full consideration where they are found to be economically and environmentally feasible.
- (3) Statewide grant-in-aid program for flood damage reduction. Minnesota Statutes, Chapter 104 should be amended to provide for a statewide program of cost-sharing to implement both structural and non-structural components of approved comprehensive flood plain management plans. This program is intended to replace other specific flood damage reduction cost-sharing programs that are currently authorized and funded. The program should be jointly administered by the Department of

Natural Resources and the Soil and Water Conservation Board based on a formal agreement between the two agencies. The purpose of the program is to provide incentives to local units to implement flood plain management measures. The amount of the local cost-share should be proportional to benefits which accrue to the local area; while the amount of the state cost-share should be proportional to the benefits received by society as a whole from the flood damage reduction project (e.g., benefits which are too widespread to permit identification of direct beneficiaries).

- (4) Establishment of criteria for evaluating and prioritizing programs. The Department of Natural Resources and the Soil and Water Conservation Board in cooperation with other state and local agencies should develop joint criteria for evaluating and prioritizing the structural and non-structural components of approved comprehensive flood plain management plans. The criteria to be drafted should include but not be limited to:
a) types of programs and projects eligible for funding;
b) percentages or amounts of cost-sharing; c) environmental and economic considerations; and d) requirements for evaluation of alternatives.
- (5) Mandatory disclosure of flood hazard information. Minnesota Statutes, Chapter 104 should be amended to require mandatory disclosure of flood hazard information prior to any property transactions. Persons purchasing land or homes in flood plain areas have not always been able to obtain adequate information about flood hazards. For areas in which studies have been completed, flood hazard information is available through county or municipal zoning administrators and should be provided to the prospective buyer by the realtor or seller before contracts or purchase agreements are signed.
- (6) Technical and educational assistance. Technical assistance for flood proofing and for assistance with applications for state and federal aid and information dissemination and education programs are currently authorized by Minnesota Statutes, Chapter 104 but have not received sufficient funding. Training is also needed for local officials responsible for adopting and implementing local flood plain management ordinances. Additional funding should be provided to expand these components of the flood plain management program.

Many individuals do not fully appreciate the risks of locating in flood hazard areas and do not fully understand the benefits to be gained by purchasing flood insurance or by flood-proofing their residences. A similar situation exists with some small communities, which may be unaware of the types of state and federal acquisition and redevelopment funds or disaster assistance that are available. The economic value of information related to flooding and the steps which can be taken to reduce flood losses is potentially great. The cost of providing this information is low when compared to the reduction in flood losses that can be achieved with increased access to proper information.

- (7) Evaluation of the effects of drainage on flooding. The State of Minnesota in cooperation with the appropriate federal agency should immediately begin to define the effects of wetland drainage and filling in basins subject to severe flooding. All actions affecting wetlands should be considered in the context of the cumulative effects of wetland drainage and filling on flooding in order to evaluate the true costs and benefits of wetland drainage activities.
- (8) Flood warning systems. Information on flash flood warning systems should be collected and be made available to areas subject to flash flooding and to areas located downstream from dams with possible safety hazards. These systems allow timely evacuation of flood plain areas and help to prevent loss of life. Relatively inexpensive and simple systems are in use in some areas and their use in Minnesota should be encouraged.
- (9) Mandatory urban storm water management plans. Minnesota Statutes, Chapter 104 should be amended to include provisions for mandatory urban stormwater management plans meeting minimum statewide standards in urbanizing areas. One function of flood hazard studies is to identify a protected elevation above which structures will generally be protected except for the most severe flood events. Increases in urbanization upstream from flood plains may cause flood stages to rise higher than the protected elevation causing increased damages to generally protected structures. By retaining the water or delaying it until after peak flood periods, this problem can be alleviated. Maintenance of natural storage areas, provision of on-site or in-line storage areas, and minimizing the amount of impervious surface are all means of reducing flood stages downstream and may also help to improve water quality. It is easier and less expensive to plan for these features before development occurs than it is to try to establish an effective stormwater management program after an area has been extensively developed. (This recommendation also involves water quality benefits.)

It is felt that these programs along with the present flood plain management program will make significant improvements in the states program and lead to a more comprehensive flood plain management program for the State of Minnesota.

FOOTNOTES

- ¹U.S. Code (Washington: USGPO, 1940), P. 2964, cited in L. Douglas James and Robert E. Lee, Economics of Water Resources Planning (New York: Mc-Graw Hill, 1971), P. 229.
- ²Otto Ekstein, Water-Resource Development: The Economics of Project Evaluation (Cambridge, Mass: Harvard University Press, 1971), P. 127.
- ³Department of the Army, Office of the Chief of Engineers, ER 1105-2-351, "Evaluation of Beneficial Contributions to National Economic Development for Flood Plain Management Plans," (13 June, 1975).

⁴For discussions on the economics of flood insurance, see John V. Krutilla, "An Economic Approach to Coping with Flood Damage," Water Resources Research, 2 (Spring, 1966) PP. 183-190; and Robert C. Lind, "The Nature of Flood Control Benefits and the Economics of Flood Protection," Tech. Reprint No. 145 (Institute of Mathematical Studies in Social Science: Stanford University, 1966); and "Flood Control Alternatives and the Economics of Flood Protection," Water Resources Research, 3 (Spring, 1967) PP. 345-357.

⁵See John P. Brown, "Stream Channelization: The Economics of the Controversy," Reprint No. 120 (Resources for the Future; Washington, D.C., 1975) P. 564; and "An Economic Model of Flood Plain Land Use and Land Use Policy," 8 (Feb., 1972), PP. 29-31.

⁶P.L. 738, June 22, 1936. 74th Cong., 49 Stat. 1570.

⁷Minn. Stat. 105.42.

⁸First Amendment to "Joint and Cooperative Agreement for the Establishment of Criteria for Authorizing Dikes and Other Flood Control Structures and Measures on the Red River of the North and the Bois de Sioux River," Article IV, cited in Report of Hearing Examiner in the Matter of Proposed Rules for Regulating Agricultural Dike Construction along the Red River of the North and Bois de Sioux River (State of Minnesota Office of Hearings Examiner; State Printing Office, 1978). PP 1, 10-11.

⁹Orris C. Herfindahl and Allen V. Kneese, Economic Theory of Natural Resources (Columbus, Ohio: Merrill Publishing Co., 1974).

¹⁰See Harold E. Marshall, "Federal Cost-Sharing Policies for Water Resources," National Bureau of Standards Technical Bulletin NWC-SBS-2-039, Prepared for the National Water Commission (Washington, D.C.: NIS, 1972), PP. 55-83.

¹¹Charles W. Howe, "Benefit-Cost Analysis for Water System Planning," American Geophysical Union, Water Resources Monograph No. 2 (Baltimore: Publication Press Inc., 1971), PP. 65-70.

¹²Minn. Stat. 104.01, and 116D.02, Subd. 2 (r).

¹³Minn. Stat. 104.47, Subd. 4.

¹⁴Minn. Stat. 116D.04.

¹⁵See John V. Krutilla and Anthony C. Fisher, The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources. (Resources for the Future; Baltimore: John Hopkins University Press, 1975).

¹⁶Minn. Stat. 104.01, Subd. 2.