**US Army Corps of Engineers**
Engineer Institute for Water Resources

# Assessment of the Economic Benefits from Flood Damage Mitigation by Relocation and Evacuation

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The object of this research was to assess the current Corps procedures used in the economic evaluation of flood plain relocation and evacuation plans for flood damage mitigation. Based on this assessment, the report offers a theoretically sound framework to evaluate the NED benefits from evacuation and relocation plans. The report presents the economic theory of the sources of NED benefits and its relationship to the theory of flood damage mitigation benefits in general. Based on the assumption that flood losses borne by activities located in flood prone areas are capitilized as reduced value of

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flood plain land, NED benefits from relocation are realized primarily from a reduction in externalized flood losses, in a large part through subsidized Federal Flood damage relief programs. This sound theoretical basis for NED benefits affords a framework for the review of past Corps evacuation and relocation planning benefit evaluate practice. In general, past practice was revealed to not follow a common methodology across relocation plans due the lack of consistent evaluation guidance. In addition, the review reveals the importance of the new use of the evacuated land if evacuation is to be an economically viable planning alternative. Economically sound redevelopment of the flood plain, in "flood wise" uses, generates NED benefits that may be crucial to the feasibility of evacuation and relocation plans. Importantly, this redevelopment can be controlled to preclude future externalization of flood losses by the new users of the flood plain. Based on generally accepted economic principles, in the light of past difficulties, and based on a review of Federal Emergency Management Agency flood insurance procedures and policies, the report presents guidance for identifying and measuring NED benefits from evacuation and relocation. This guidance is based on and is consistent with the economic principles articulated in the Principles and Guidelines (P&G).

Report

on

# Assessment of the Economic Benefits from Flood Damage Mitigation by Relocation and Evacuation

by

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# FOREWORD

This report is a product of the Planning Methodologies Research Program conducted by the U.S. Army Corps of Engineers, Institute for Water Resources.

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# Assessment of the Benefits from Flood Damage Mitigation by Relocation and Evacuation

## Introduction

Relocation and permanent evacuation of activities at flood hazard locations are nonstructural flood damage mitigation measures. These plans modify the susceptability to flood damage of flood plain activities by permanently removing them to flood free locations. The benefits from evacuation plans arise from the willingness-to-pay on the part of the removed activities and other affected parties rather than do without the plan.

The purpose of this paper is to present the conceptual basis for the existence and measurement of National Economic Development (NED) benefits from permanent evacuation and relocation of flood prone activities. In addition, the paper is intended to clarify the appropriate methodology for measuring these benefits, based on established economic principles. The discussion below presents the theory of the identification of relocation benefits as a part of a broadly applicable theory of flood damage mitigation benefits. The theory indicates the sources of benefits from relocation and the relationship between NED benefits and Federally subsidized flood damage relief programs, particularly flood insurance. Subsequent sections present the past and current Corps of Engineers guidelines for the evaluation of benefits and the current practice employed in specific Corps relocation project reports. This

section points out the past lack of consistent guidance for evaluating nonstructural measures and the problems encountered by various Corps districts considering relocation for flood damage mitigation. The most significant conclusion from examining relocation studies is the importance of the new use of evacuated land to economic feasibility. The final section provides recommended guidelines for the evaluation of benefits for plans incorporating relocation and evacuation in light of the theory and past practice.

## The Theory of Flood Damage Mitigation Benefits

The basic approach to the evaluation of any measure to reduce flood damages is the willingness-to-pay principle. Willingness-to-pay arises from an economic change that alters the level of indifference or utility of an individual and is measured as the monetary equivalent of the change in utility. This quantity represents the amount of money the individual is willing to pay rather than do without the economic change. One additional complication in a flood damage case is that the net income and therefore the level of utility of the individual is uncertain.

Consider a decision maker faced with an uncertain state of nature but who must choose a location. Assume the decision maker has only two locations from which to choose. Both locations are identical in every way, except for the flood hazard, and the level of activity at each will be the same. The level of net income actually realized at the flood hazard location, however, depends on the state of nature. The level of net income is a random variable that

depends on whether there is a flood or not.[1] Assuming the decision maker has at least subjective estimates of the probabilities of the state of nature, his problem is to choose the location to maximize the expected utility of net income. If the decision maker is risk-neutral, he will only choose the flood hazard location if he can obtain its use for a rental less than the amount of the flood free alternative. The rental rate must be lower by an amount greater than or equal to the expected flood damages. If the decision maker is risk-averse, the rental rate of the flood prone land must be lower than the flood free land by an amount greater than the expected flood damages. This extra "risk premium" is the amount a risk-averse decision maker charges himself to bear the risk of the flood prone location in addition to the expected value of the flood losses. If all decision makers are neutral toward risk, however, the difference between the rental value of flood hazard and flood free land will be the value of the expected flood damages.

This problem is illustrated in Figure 1. Point A represents the combination of net incomes, contingent on the state of nature, that can be obtained at the flood hazard location. Point B represents the certain combinations of net income that can be obtained at the identical but flood free location.[2] The distance CD measures the expected flood damages at the

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[1]For simplicity it is assumed that the flood, when it occurs, always results in the same amount of damage.

[2]The indifference curves are linear with slopes equal to the ratio of the flood - no flood probabilities. The indifference curves are linear under risk neutrality indicating indifference between receiving the random net incomes and receiving the expected value of the random net income.

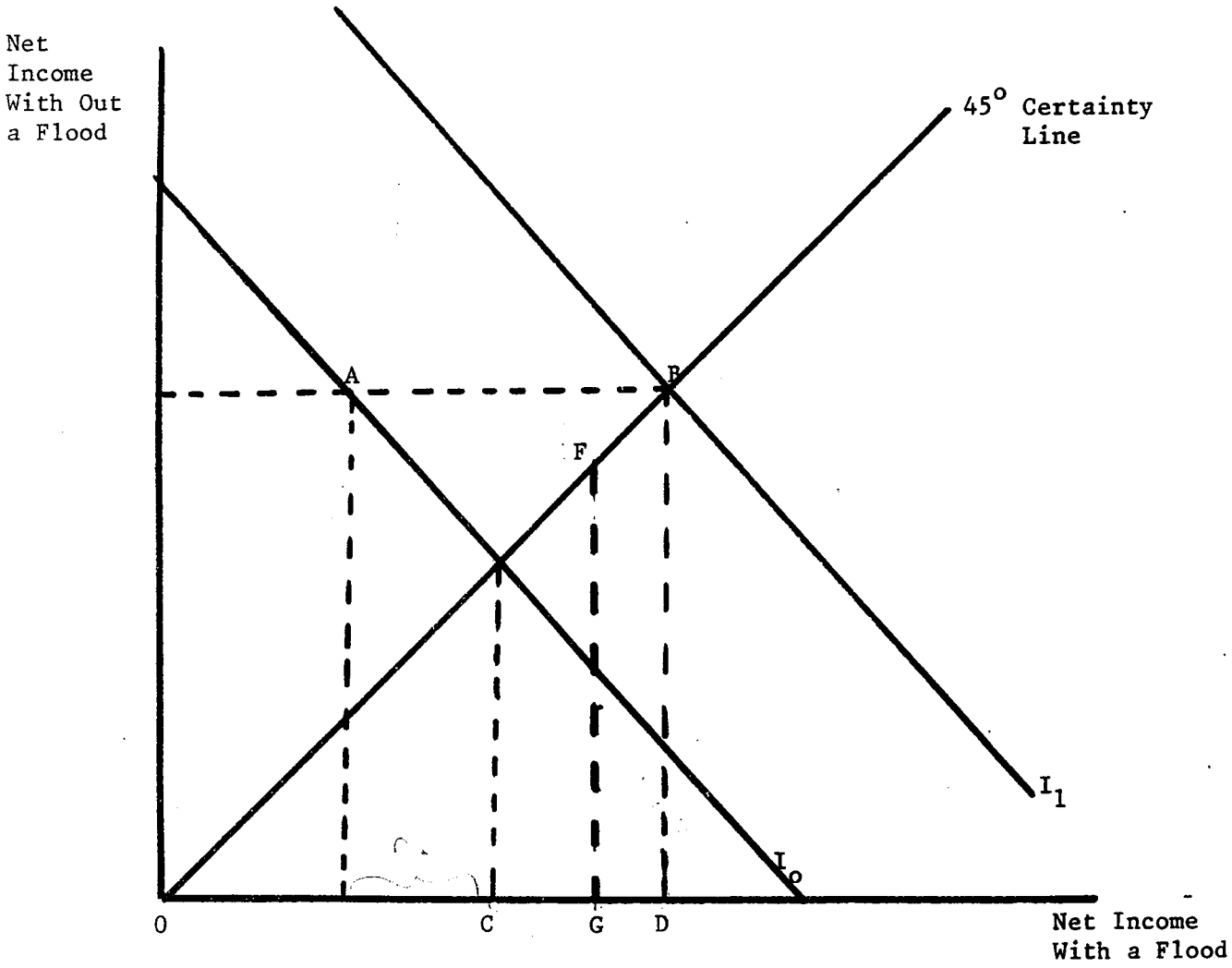


Figure 1

Expected Benefits from Flood Damage Mitigation Under Risk Neutrality

$A + E(CD) = B$

flood prone location. Assuming perfect land markets, the rental value of location A will be lower than that of location B by the expected value of the losses from flooding borne by the activity at A. Obviously, there may be a location advantage at the flood prone location A, compared to the flood free location B. In this case, the certain net income at B will be lower, say the amount indicated by F in Figure 1. The expected flood losses at A are still measured as CG. The difference in rental values, however, is less than expected flood losses at A and are measured as CD. Thus, the location advantage at A "pays" the activity for part of the expected flood losses.

The above analysis assumes that the activity cannot transfer any of its losses to other parties. In addition, it assumes there are no other costs, borne by others, stemming from this activity choosing to locate on the flood plain. If the activity can transfer some of its flood losses to others, at a cost less than the losses, the net income of the activity and the rental value of the flood plain land will increase. If other parties incur costs because the activity chooses the flood hazard location, the social costs of flood plain occupance exceed the private costs. These extra costs are not reflected by the market for flood plain land but are a source of willingness-to-pay for flood damage mitigation.

The primary ways of externalizing flood damages are through the Federal flood insurance program and the uninsured casualty loss deduction from gross income for Federal (and to some extent state and local) income tax purposes. Insurance allows an individual to exchange an uncertain loss for a certain

annual payment. Thus, casualty insurance allows the transfer of risk but not of the expected costs because an actuarial insurance premium equals the expected value of the casualty loss. The voluntary purchase of casualty loss insurance at actuarial rates defines a risk-averse individual. An individual must be risk-averse to voluntarily purchase insurance at actuarial rates because an actuarial rate based insurance premium is composed of the expected value of the insured's losses plus a loading charge to cover the administrative costs of insurance. Only a risk-averse decision maker is willing to pay this extra cost of insurance. A risk-neutral individual is indifferent between bearing the loss and purchasing insurance at actuarial rates. If flood loss insurance is purchased at actuarial rates by a risk-neutral individual, there is no net change in expected utility or rental value of land.3 This results from the definition of risk-neutrality. If the insurance purchaser is risk-averse, the purchase of insurance at actuarial rates does result in an increase in expected utility and the rental value of land as long as the loading charge is less than the risk premium cost of the flood hazard. The expected utility of the individual and the rental value of land increase under risk-aversion because the flood plain occupant is able to reduce his cost of risk for less than the maximum amount he is willing to pay.

The uninsured casualty loss deductible feature of the income tax codes allows the individual to shift part of the losses and part of the risk to the general taxpayer. The portion actually shifted depends on the marginal tax

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3If the individual is risk-neutral, he will not voluntarily purchase insurance at actuarial rates if a loading charge, to cover administration costs, is included as part of the premium.

bracket of the individual. The effect of this provision is to reduce the rental value differential between flood free and flood hazard land that would occur in the absence of this provision. Recent recisions in the minimum amount of uninsured casualty losses that must occur to be allowable for itemized deductions from taxable personal income may reduce the amount of uninsured losses transferred to the general taxpayer. For non-income earning property, uninsured losses must exceed 10 percent of adjusted gross income to be deductible . Assuming flood insurance is purchased up to the limits of coverage, few individuals will have sufficient uninsured flood losses to qualify for the tax deduction. Thus, owners of this type of property will bear more flood losses than in the past. Owners of income earning property are still able to deduct all uninsured casualty losses to their income producing property. Therefore, expected damages to income producing and non-income producing property should be accounted separately.

Under the National Flood Insurance Program (NFIP), administered by the Federal Insurance Agency (FIA) within the Federal Emergency Management Agency (FEMA), some flood plain occupants in qualified areas can purchase flood insurance at less than actuarial rates.[4] To obtain flood insurance, the individual purchases insurance through a private licensed insurance agent. Part of the insurance premium received is used to defray the administrative costs and pay agents commissions. The remainder of the premium is held in the

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[4]Under PL 93-234 sec 103c, actuarial rates are to be charged property that has been constructed or substantially improved after 31 Dec. 1974 or the effective date of the initial rate map, which ever is later. The "substantial improvement" provision may also apply to repairs to flood damaged property. See page 46 below.

National Flood Insurance Fund for the compensation for flood losses that occur. The premium rates charged are less than actuarial rates, so that the expected insured flood losses exceed the portion of the insurance premium available for indemnification. These excess losses are paid by the Federal government out of the National Flood Insurance Fund.5

The effect of the subsidized Federal flood insurance is to transfer part of the cost of flooding to the general taxpayer. This increases the expected net income and rental value of flood plain land by the amount of the expected flood losses transferred to the Federal government. If the flood plain occupant is risk-averse, the expected utility and rental value of flood plain land increase by more than the amount of expected flood losses transferred to the Federal government. The extra increase in rental value under risk-aversion reflects the value of the reduction in risk.

The National Flood Insurance Program and the uninsured loss deduction from taxable income do not result in rental values of flood plain land equal to flood free land. The flood plain occupant does pay a premium for insurance. In addition, the program has a deductible feature, coverage limits and non-insurable losses that reduce the actual amount of losses that are covered for each flood. The taxable income deduction for uninsured casualty

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5Under a new "'write your own" program, private insurance companies can write flood insurance policies under their own name. The rates charged by private insurers are determined by FEMA. Premiums collected are used to pay administrative costs, agents' commissions and for indemnification for insured flood losses. At the end of each year, any excess funds accrued by the private flood insurance writers are paid into the National Flood Insurance Fund. If short falls accrue during the year, the private insurers are reimbursed from the National Flood Insurance Fund.

losses can only transfer a portion of these uninsured loss to the general taxpayer. Therefore, some of the expected flood damages are borne by the occupant.

The economics of flood insurance and the benefit from the reduction in the insurance subsidy is demonstrated below. Assume that the output of the flood prone activity is a function of two inputs: capital and land. The demand curve for capital is given by the marginal revenue product of capital curve, labeled $D_K$ shown in Figure 2. The social cost of capital is the private market cost OA plus expected flood damages, labeled C in Figure 2.

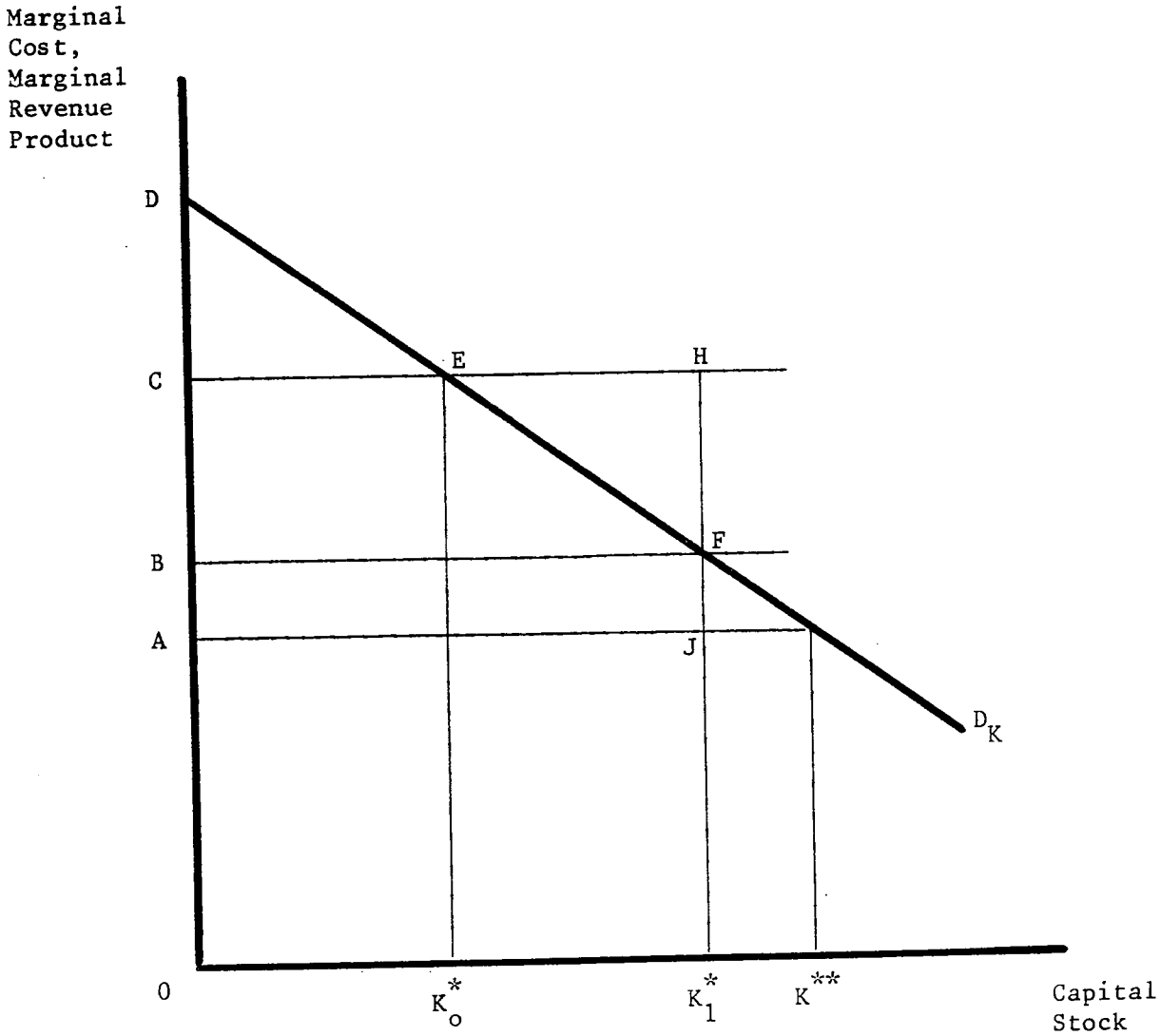


Figure 2

Land Value, Optimal Capital Stock, and the Variable Quantity Subsidy of Subsidized Flood Insurance

Assuming that the private cost of capital equals the social cost of capital, the activity maximizes expected net income by using $K_{\delta}^{*}$ units of capital. The total expected return to the activity is measured by $ODEK_{\delta}^{*}$, where area $OCEK_{\delta}^{*}$ is the return to capital to compensate for the market opportunity costs and expected flood damages. Area CDE measures the residual return available to pay land and represents the maximum rental this activity is willing to pay to secure the use of flood prone land.

The selling of flood insurance at subsidized rates results in an excise or variable quantity subsidy to users of flood prone land. The subsidy lowers the private cost of capital to B, below the social cost. The effect of the subsidy is to increase the expected net income maximizing level of capital stock to $K_{\dagger}^{*}$, resulting in an increase in expected flood damages to an amount measured by the area ACHJ. Of these damages, area ABFJ measures those borne by the flood prone activity through the insurance premium, while area BCHF measures those borne by the general taxpayer. A portion of area BCHF, area BCEF, is captured by the landowner as an increase in the rental value of land. The remaining portion, triangle EHF, represents the net welfare loss due to the variable quantity subsidy.

An alternative method of measuring the same welfare loss is to measure the difference between the incremental private returns and incremental social costs to capital. Reducing private costs to B results in a private benefit of area $K_{\delta}^{*}EFK_{\dagger}^{*}$. This area represents the additional total return from employing the additional capital. Because the social cost of capital is still C,

however, area $K^*oEHK^\dagger$ measures the addition to social cost from the extra floodplain investment. The total social cost measures the opportunity costs of the additional investment as the foregone private market return plus the additional expected flood damages. The difference between these areas is also the welfare loss from the subsidy, area EHF.

In an evacuation project, part of the benefits are the reduction in the government subsidy to removed activities paid through the flood insurance program. The subsidy for damages (not including any subsidized agents' commissions or administrative overhead) is measured as area BCHF. Therefore, the welfare loss, area EHF, is included as a benefit.

There are substantial additional costs of flood plain occupance not reflected in the rental value of flood plain land. These include the public cost of emergency response to flooding, flood damages to public utilities and services, increased flood damages to other activities due to floodway encroachment, and any additional administrative costs of the Federal insurance program borne by the general taxpayer.

A flood damage mitigation plan, whether structural, non-structural or a combination, reduces both the internalized and externalized cost of flood plain occupance. In either case, most of the willingness-to-pay and benefits arise from the reduction in the externalized costs. Whether the reduction in the internalized costs, resulting from evacuation, creates a net benefit depends on how much of cost of the higher valued flood free land is borne by

the removed activity. The higher rental value of the flood free land reflects the expected flood losses and insurance premium borne by the activity at the flood hazard location, but avoided at the flood free location. If the removed activity bears the cost of the higher rental rate, the reduction in the internalized costs are exactly offset by the higher rental costs. If, however, the higher rental costs are borne by the general taxpayer through the "Uniform Relocation Assistance and Land Acquisition Policies Act" (PL 91-646), the reduction in the internalized costs represents a willingness-to-pay for evacuation on the part of the removed activity and is a benefit from the plan.6

A flood plain evacuation plan not only creates value by reducing the private and public costs of flood plain occupance, it also creates value in terms of the product of the vacated land in a new use. The value of the product of the vacated land is the rental value of the land in its new use. The new use, however, must be consistent with the evacuation project's purposes. If it is efficiency improving to remove activities that rationally locate in a flood hazard location, it is also efficiency improving to prevent the location of new activities on the flood plain that incur external costs?7

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6There is some question whether the provision of flood free land to the removed activity constitutes "replacement in kind" or "betterment" not for project purposes. The situation described in the text above considers the land provided as replacement in-kind. If it is considered as betterment, however, neither the additional value of the flood free land nor the internalized costs avoided should be included as project costs or benefits.

7If all costs of a new activity locating on a flood plain are internalized, the market is the best mechanism to determine the new use. If some of the costs of the new use are externalized, the government has an obligation to ensure that the new use is economically efficient not just the profitable in an account's sense.

The types of new uses that are typically consistent with the project purposes are open space and recreation. In addition to the value of product from these uses that could be at least potentially sold in a market, these uses may also yield technological external economies, increasing the rental value of land adjacent to the project site. Part of this increased rental value of adjacent land, if recreation use is envisioned, however, is the reduced travel time for recreation. In the actual measurement of the benefits from evacuation, care must be taken not to double count this value.

There is no reason to believe that the only economically efficient new use of the vacated land is open space. Any new use will not be able to transfer flood damages to the general taxpayer through the NFIP since any new construction, covered by insurance, must pay actuarial rates. The new use could still transfer some of the flood damages by deducting them from taxable income and some other external costs might be incurred. The externalization of the costs could be minimized, however, through appropriate zoning and construction regulations applicable to any new use of the vacated land. An alternative to zoning and regulation is to rent the vacated land with a long-term lease. The rental rate charged could then be used to internalize the external costs.

The redevelopment of the flood plain may make structural flood damage reduction measures economically feasible in the future. As long as new development is required to purchase insurance at actuarial premiums and does not generate external costs, a second evacuation at public expense will never

be justified. A structural measure for the redeveloped area would be justified when the reduction in annual flood insurance premiums, allowed with the structure, exceeds the annual cost of the structure. Flood insurance premiums would not have to be simply reduced as is the current policy, however, forcing the general taxpayer to bear the cost of the flood protection. The premiums could, instead, remain at their previous levels, constituting a user fee to recover the cost of the structure from the beneficiaries. Premiums could be reduced by the amount by which the benefits exceed the costs.

Other valuable goods stemming from an evacuation project are the equipment and material salvaged from a demolished structure. In structure relocation, the valuable good is the relocated structure at the relocation site. The accounting of these values in benefit-cost analysis, however, is a potential source of confusion.

Benefits account for the value created by the project for which there is a willingness-to-pay. Costs account for the opportunity costs of the resources used to complete the project. Whether a value is added to benefits or subtracted from costs does not alter the net benefits from the project. The accounting procedure, however, does alter the benefit-cost ratio. In an evacuation project, the accounting problem encountered is whether the salvage value of a demolished structure should be added to benefits or subtracted from costs. The act of salvaging material does not produce an output but rather reclaims an asset: there is no new willingness-to-pay generated. Therefore,

the effect of salvaging equipment and materials from a demolished structure is a reduction in the opportunity costs of the demolition. It reduces the amount of capital destroyed and so the market value of the salvaged materials should subtracted from the costs of project.

In a relocation project, the accounting problem encountered is whether the value of the relocation sites with relocated structures should be added to benefits or subtracted from costs. The structure is an asset which could be sold for private relocation. The amount paid for the structure by the private enterprise prior to relocation is analogous to the salvage value of a demolished structured. The transaction doesn't produce a value but simply transfers the ownership of assets. Therefore, the amount paid by the private relocator should be subtracted from the opportunity costs of the projects. If the Federal government finances the relocation of the structure, however, the resulting transactions should be entered differently in the benefit and cost accounting. The Federal government can use the private market relocation revenue and cost accounting as an analogy to account for federally financed relocation of structures. A private enterprise includes in its costs the purchase price of the structure prior to relocation, the purchase price of the unimproved relocation site, the cost of the preparation of the relocation site and actual costs of moving the structure (abstracting from the additional interest expense costs and income taxes). The revenue generated is the sale price of the relocation site with the relocated structure. The Federal government is, also, engaging in productive activity when it relocates a structure. Therefore, additional costs of relocation (cost of site, site

preparation and structure moving) should be added to costs and the value of the relocation site with relocated structures should be added to costs and the value of the relocation site with relocated structures should be added to benefits.

A final potential benefit from a flood plain evacuation project is the benefit of employing otherwise unemployed or underemployed workers in project construction. The rationale for this benefit is that the opportunity costs of employing the unemployed are less than the expenses incurred by employing them for the project. The difference between the expenses and the opportunity costs represents a net contribution to national output.

Summary

In summary, the following economic effects have sound theoretical basis for inclusion in the assessment of evacuation and relocation plans. These are divided into effects that either reduce costs or produce an output.

1. Sources of cost reduction from evacuation and relocation
    a. The internalized cost of flooding reflected in the rental value of land.8
        1. The flood insurance premium
        2. The flood insurance deductible

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8See note 5 above.

3. Flood losses over limits of coverage

4. Non-insurable losses

b. The externalized costs of flooding reflected in the rental value of land.

1. Flood insurance indemnification

2. Casualty loss deduction from taxable income

c. Other externalized costs

1. Public flood emergency response costs

2. Flood damages to public utilities and services

3. Induced flood damages to other activities

4. FIA administrative costs above charges for administration included in the premium

2. Sources of value produced by evacuated land in new use.

a. Rental value of vacated land

1. Value of land as open space

2. Value of land for recreation

3. Value of land in other use consistent with economic efficiency

b. Rental value of adjacent land

c. Value of relocation sites with relocated structures

3. Employment Benefits

## Future Values

The proper application of the "with and without" principle for evacuation and relocation requires the estimation of the future real values of many of the costs of flood plain occupance. The project not only lowers existing costs but also lowers costs that would be incurred in the future without the project. If the costs change over time, the value of benefits from the project will differ from the reduction in existing costs.

The real value of damagable property may be expected to increase in the future leading to increases in real internalized and externalized costs of flood plain occupance. The amount of these increased costs that are externalized depends on the future values of: (1) flood insurance rates; (2) the insurance deductible; (3) the limits of insurance coverage; and (4) the income tax rate of the flood plain occupant. It is possible, however, that the real value of damagable property may decline due to changing flood plain land use or from property depreciation and abandonment. In addition, the effects on future development, of flood plain regulations required for flood insurance eligibility, must be considered.

## Historical Perspective on Corps of Engineer Nonstructural Planning

The policies and practices of the Corps in developing and evaluating evacuation and relocation plans for flood damage mitigation has a long

history. Placing the current guidance in historical perspective with help in understanding the past practice and current guidance.9

Prior to the 1960's, nonstructural measures for flood damage mitigation, particularly evacuation, were allowed to be considered by Corps planners as an alternative to structural measures.10 Nonstructural alternatives, however, were not stressed as a significant element in flood control planning. In the 1960's, Legislative and Executive initiatives were begun to give greater emphasis to nonstructural measures. This increased importance of nonstructural planning was fostered by the recognition that structured projects often gave a false sense of security and may have encouraged unwise development in the flood plain. The increased environmental concerns of the 1970's provided a further impetous to the consideration of nonstructural alternatives. It was recognized that structural flood control projects, in some cases, created environmental problems.

Significant legislative and related executive actions since 1966 regarding nonstructural flood damage mitigation include:

A Unified National Program for Managing Flood Losses, House Document 465. In 1966 the Presidential Task Force on Federal Flood Control Policy reported 16

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9This informal history is drawn from a report by Allen E. Chin, Corps of Engineers Implementation of Nonstructural Measures (1981) and a paper by William Donovan, "The Less Traveled Road: An Overview of Nonstructural Measures in Flood Plain Management Planning," in Seminar Proceedings: Implementation of Nonstructural Measures (1983)

10Flood Control Act of 1938 (PL 75-761, Sec. 3)

recommendations that dealt with needs and problems regarding existing Federal programs. The report recommended a "unified national program" for managing flood losses. It also called for dissemination of information on "alternative methods" to lessen the risk of flood losses. Nonstructural measures that were discussed included flood proofing, flood plain regulation, flood forecasting, flood insurance, land acquisition, and relocation.

Executive Order 11296 (August, 1966). This Executive Order was issued in response to the recommendations contained in House Document 465. It directed the heads of Federal Agencies to evaluate flood hazards and take action to preclude the uneconomic, hazardous or unnecessary use of flood plains.

National Flood Insurance Act of 1968 (PL 90-448). This Act was also passed in response to House Document 465. It made subsidized flood insurance available to flood plain occupants. Section 1314 encouraged participation in the program by prohibiting Federal disaster assistance to persons who did not purchase flood insurance even though it was available. Section 1315 promoted improved flood plain land use by requiring local public bodies to institute flood plain land use control measures as a condition for future flood insurance availability.

Flood Disaster Protection Act of 1973 (PL 93-234). This Act amended the National Flood Insurance Act of 1968. The Act was intended to encourage participation in the flood insurance program by raising the limits of coverage. More important, it prohibited Federally supervised, regulated or

insured financial institution from granting loans secured by real estate in flood prone areas unless it is covered by flood insurance at least equal to the outstanding principle of the loan. It also reaffirmed the land use control requirement of the 1968 Act but did repeal Section 1314 requiring the purchase of insurance as a condition for Federal disaster assistance.

Principles and Standards for Planning Water and Related Land Resources (September, 1973). This Presidential policy statement outlined a planning process involving "an evaluation of alternative means, including both structural and nonstructural measures, to achieve the desired affects."

Water Resources Development Act of 1974 (PL 93-251). Section 73(a) of this Act required the consideration of nonstructural measures in flood control projects. Section 73(b) provides up to 20 percent non-Federal cost-sharing in recommended nonstructural measures. The Act also authorized 3 Corps flood control project that involved nonstructural measures: Praire du Chien, Wisconsin; Charles River Basin, Massachusetts; and Littleton, Colorado.

Executive Order 11988 (May, 1977), This order outlines the responsibilities of Federal agencies in the role of flood plain management. Each agency is to evaluate the potential effects of it's actions on flood plains and is not to undertake actions which induce growth in the flood plain unless there is no practical alternative.

The President's Water Policy Message of 8 June 1978. This policy message encouraged greater utilization of nonstructural measures by its specific directives to: (1) require the formulation of at least one primarily nonstructural alternative plan where a structural plan is being considered; (2) restructure Federal cost-sharing to remove biases against nonstructural measures; and (3) use Federal programs to acquire flood-prone land and property.

A Unified National Program for Flood Plain Management, September, 1979. Prepared by the Water Resources Council, this report set forth a conceptual framework and identified strategies fundamental to implementing flood plain management. Particular emphasis was placed on nonstructural measures while recognizing the significance of structural measures.

Procedures for Evaluation of National Economic Development (NED) Benefits and Costs in Water Resources Planning (Level C).Final Rule. Federal Register, Vol. 44, No. 242, December 4, 1979 (Revised Principles and Standards). In response to a memorandum from President Carter to the Water Resources Council, the Principles and Standards were revised. One of the major revisions required the preparation and inclusion of a primarily nonstructural plan as one alternative whenever structural projects or program alternatives are considered. Revisions also directed that alternative plans should not be limited to those that the Federal Government could implement and stressed the cooperative role of local, state, regional, and Federal organizations in

implementing alternatives. The evacuation and relocation evaluation procedures were not identical to those in ER 1105-2-353.

Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. (March 10, 1983). Principles and Guidelines (P&G) carrys over the basic guidance provided under Revised Principles and Standards (P&S) for the evaluation of nonstructural measures. The basic difference between P&S and P&G is that while P&S requires the consideration of a nonstructural alternative, P&G only suggests that nonstructural alternatives be considered.

The Corps has responded to these Legislative and Executive actions by issuing numerous engineering circulars, regulations, and policy guidance papers to attempt to clarify the procedures that Corps planners should follow in developing and evaluating nonstructural measures. The more significant of these instructions include:

EC 1120-2-40 (26 April 1968), "Treatment of Non-Structural Alternatives." Directs the Corps planner to consider nonstructural flood plain management measures in all survey studies, including small projects. (Rescinded)

ER 1120-2-117 (17 August 1970), "Alternatives in Flood-Related Planning. This ER constituted the first articulation of the present Corps policy on

nonstructural plan formulation. It required the consideration of, "all relevent means and alternative approaches contributing to the appropriate use of flood plains." (Rescinded)

ER 1105-2-351 (13 June 1975), "Evaluation of Benefical Contribution to National Economic Development for Flood Plain Management Plans. Stated the principles, standards, and procedures for evaluating NED benefits for all floodplain management plans including nonstructural plans. Specific differences between structural and nonstructural evaluation procedures were not well developed. (Rescinded).

ER-1105-2-200 (10 November 1975) "Planning Process: Multiobjective Planning Framework." This ER required that alternative plans be formulated without bias toward structural or nonstructural measures. (Rescinded)

ER 1105-2-353 (4 April 1979), "Evaluation of Nonstructural Measures." This regulation provided the first instructions tailored specifically to the evaluation of NED benefits and costs for evacuation and relocation measures for flood plain management. (Rescinded)

Policy Guidance, Nonstructural Alternatives, DAEN-CWR-P, 15 October 1979. This Policy Guidance was written in the format of 16 questions and answers on issues pertaining to nonstructural measures. Its purpose was to clarify policy established in ER 1105-2-353, as well as issues raised in a report by the St. Paul District, The Development of Nonstructural Alternatives (1979).

This history shows that nonstructural flood damage mitigation measures have become an integral part of Corps planning efforts. It also indicates the recognition of the difficulties of applying basically structural evaluation methods to nonstructural measures. Principles and Guidelines guidance, as adopted from the Revised Principles and Standards (1979) represents the culmination of efforts to provide Corps planners with theoretically sound techniques to evaluate the NED benefits and costs of Corps projects containing evacuation and relocation elements.

## Current Corps of Engineer Guidance for Evacuation and Relocation

The basic guidelines for the evaluation of benefits from Corps projects containing evacuation and relocation features are given in the new Principles and Guidelines. In addition, ER 1105-2-353., although rescinded, is the basic guidance used for many of the projects reviewed below. Although these regulations provide fundamentally the same guidance they do differ in scope of benefits allowed and in their benefit-cost accounting procedures.

Under Principles and Guidelines three basic categories of benefits for evacuation and relocation are allowed including: (1) inundation reduction benefits; (2) location benefits; and (3) unemployment benefits. Two basic assumptions about flood plain occupant behavior are considered to hold in the process of benefit measurement. First, it is assumed that flood plain occupants are engaging in economically rational behavior. This assumption

implies that activities repair all property damaged by flooding to preflood condition. As a corollary to rationality, it is assumed that decision makers are neutral towards risk meaning that they maximize the expected value of net income.[11] A second assumption is that eligible flood plain occupants purchase flood insurance. The rationale for this assumption is that the market values of land reflect the availability of insurance. This assumption implies that the analyst should consider that all flood plain occupants purchase flood insurance up to the limits of coverage or actual value of damagable property, which ever is lower.

In an evacuation and relocation project, externalized flood damages and insurance overhead are reduced by removal or evacuation and are allowed as benefits. Externalized flood damages include the FIA insurance subsidy for insured losses, the income tax deduction for uninsured casualty losses, community flood emergency costs, and damages to utilities, transportation and communications systems. Losses borne by flood plain occupants are not allowed as benefits from evacuation and relocation. These are capitalized as a reduction in the market value of flood plain land and, therefore, reflected as reduced project costs.

The calculation of location benefits depends on the new use of the vacated flood plain land. If there is no specific new use planned, the

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[11]Other attitudes toward risk may be allowed if actual behavior deviates significantly from expected, risk-neutral behavior: Principles and Guidelines, 2.4.15(c).

location benefit is the value of land with encumbered title.[12] There is some confusion in the Principles and Guidelines on the appropriate accounting of land acquired in a relocation project. Although the value of land with encumbered title is to be added to benefits, the NED cost evaluation procedures direct that the salvage value of land should be subtracted from NED costs.[13] Since the open space created in a relocation project can be considered as salvage land, the guidelines imply two acceptable methods of accounting for open land values. Land left as open space may create an additional benefit as an open space externality. If this external benefit is created, the resulting increase in market value of land adjacent to the new open space measures the benefit. When a specific recreation use of the vacated land is planned an additional benefit, the value of the recreation use, is allowed. Although the value of adjacent land will increase in this case, a significant portion of the increased value reflects the reduced travel time for recreation purposes. This willingness to pay is included in the recreation benefits. It is possible, however, that part of the increased value of adjacent land reflects a visual social amenity that is not part of the recreation benefit. This would be the case if use of the flood plain,

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[12]Technically, the value of the benefit in new use should be measured as the change in the net income or market value of land. Because the market value of the acquired land is part of project costs, however, this method is equivalent to including the market value of the acquired land as a cost, the value in new use as a benefit and then subtracting the market value of the acquired land from both benefits and costs. The alternatives is to include the value of the land with encumbered title as a benefit and the market value of the acquired land as a cost.

[13]Principles and Guidelines, 2.12.4(c).

prior to evacuation, incurred external costs on adjacent land due to the flood plain properties' "blighted" condition.[14]

A third benefit allowed under Principles and Guidelines is employment benefits. It is assumed in the calculation of this benefit that the opportunity cost of employing previously unemployed labor is zero. Therefore, the total wages paid to formerly unemployed workers, hired directly to complete the project, are allowed as a benefit. The method of evaluation is based on studies of public works projects made by the Economic Development Administration.[15]

One potential source of confusion in Principles and Guidelines is the accounting of the salvage value of demolished structures and the value of relocated structures. As noted above, the measurement of net benefits is not affected by the accounting procedure, but the benefit-cost ratio is different under the alternative account schemes. Part of the accounting difficulty stems from changes in the methodology from that prescribed in ER 1105-2-353. Under this old regulation, the value of equipment and materials, salvaged from a demolished structure, is included as a benefit. The current guidance directs the analyst to subtract the salvage value from NED costs. This second accounting method is consistent with theoretically sound NED benefit-cost procedures. The value of the salvaged equipment and materials reduces the opportunity costs of demolition but does not add to National Income.

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[14]It is possible that the value of the increased recreation availability to adjacent land will be overstated if the increased usage of the land incurs the external costs of increased congestion and noise.

[15]Economic Development Administration U.S. Department of Commerce, An Evaluation of the Public Works Impact Program, Springfield, VA; National Technical Information Service, January 1975.

Another point of confusion is the accounting methodology if the acquired structure is relocated rather than demolished. When a project involves relocating structures, ER 1105-2-353 directs that the cost of the relocation site, site preparation costs, and structure moving costs be included as NED costs. The market value of the relocation sites with relocated structures is the corresponding benefit. The current guidance gives no specific methodology for accounting in relocation projects. The relocation is essentially government producing a marketable product using the flood prone structure as an input. The value of the output from relocation is the market value of the relocation sites with relocated structures. This value should be included in benefits and the additional expenses included in costs as directed in ER 1105-2-353.

One final accounting problem deals with the accounting of payments to evacuees under the "Uniform Relocation Assistance and Land Acquisition Policies Act of 1970" (P.L. 91-646). Engineering Regulation 1105-2-353 directs that all payments, made to evacuated activities under this Act, should be excluded from NED costs and benefits. This ignores the fact that some of the payments are made to compensate the evacuated activities for costs, they would not have incurred without the project, for which there is no offsetting benefit: these costs include moving and related expenditures. Under the Principles and Guidelines regulation these types of expenditures are to be included as project costs. In addition, costs for replacement "in kind" are directed to be included as NED costs. When the term "in-kind" is interpreted

to mean "of equal value", the owners of property purchased for the project are compensated "in-kind" by the purchase price of the property.16 Obviously, however, the term "in-kind" is subject to a wide variety of interpretations.

16From a conversation with Brad Folwer, Office of the Chief of Engineers, 10 March 1983.

## Corps of Engineer Reports

This section examines the methodology of benefit estimation used in several Corps project reports. The evaluation of benefits basically follows ER 1105-2-353, although this is not always the case when the project is primarily structural. This review identifies the difficulties Corps planners have encountered in the past in evaluating the economic benefits of proposed evacuation and relocation projects. In addition, it reveals the importance of the new use of the evacuated land for an economically viable project.

### Allenville, Arizona

The recommended flood damage reduction plan for Allenville involves the building of a new town out of the 100-year floodplain. Floods in March and December 1978 devastated the small community and, at the time of the study, the Allenville residents were housed in a temporary mobile home park developed with HUD funds. Two alternative evacuation plans were considered. Both alternatives required the acquisition of property and demolition or removal of the structures of Allenville. Under the individual relocation plan, the residents of Allenville would seek new homes in surrounding communities with assistance under P.L. 91-646. This plan was rejected in favor of the new Allenville plan that preserved the community.

The new Allenville is to be constructed at Federal government expense at a nearby flood free location. Relocation sites, purchased by the State of

Arizona, are to be exchanged with owners of the old Allenville sites and the newly constructed homes sold to the relocated residents. Former renters in the "Old Allenville" are to purchase land in the vacated area and exchange it for land at the relocation site developed as a mobile home park. The mobile homes in which the renters temporarily resided are to be sold by the State to the renters and located in the new development. Additional features of the plan include replacement of a park and community center, the provision of sites for future commercial and public uses, and a new water supply system.

The benefits from the Allenville evacuation project are: (1) the reduction in externalized flood damages to residential, commercial, public, and quasi-public structures, and contents[17]; (2) the reduction in public emergency costs; and (3) the reduction in flood damages to public utilities. This last category accounts for over one-half of total benefits. An open space external benefit was considered but not believed to be significant. Employment benefits are not mentioned in the report but might be applicable to the project.

Most of the expenses of the project are not included in NED costs since they represent betterment, not for project purposes. Correspondingly, the value of the new-sites after construction is not included as a benefit.

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17Although average annual damages are adjusted to reflect insurance premiums and average annual deductibles, there is no statement in the study that the Allenville residents qualify for flood insurance.

Burnett, Crystal, and Scott Bays, Baytown, Texas

The recommended plan for Baytown, Texas, requires the acquisition and demolition or relocation of 448 dwellings. The plan removes all improvements to lands located at or below the 50-year flood elevation. The flooding problem in the Baytown evacuation area is unique, because it resulted from land subsidence caused by groundwater withdrawals. The 50-year flood elevation, therefore, is expected to encompass more area in the future due to continued subsidence.

The economic evaluation of the project was completed prior to the adoption of ER 1105-2-353. Therefore, the analysts were required to adopt the existing structural guidance to evaluate the nonstructural plan. The resulting methodology, however, is fairly consistent with that required in ER 1105-2-353. Two different methodologies were used to calculate inundation reduction benefits. Both methods were intended to measure the externalized costs of floodplain occupance. One method calculated a value termed the Reduction in Federal Flood Insurance Costs (RFIC), while the other calculated the Reduction in Flood Damages (RFD). Reduction in Flood Insurance Costs measures the actual amount of loss payments, expected to occur each year, made through the National Flood Insurance Program. This value must be less than actual flood losses due to uninsurable losses and the deductible feature of the program. If each of the measures (RFIC and RFD) is properly adjusted they will yield the same results. For some reason not specified, however, the value of RFIC was estimated to be more than twice as large as the estimate for

actual annual damage. In addition the value of RFD was not adjusted to reflect the expected deductible and expected noninsurable losses. Inundation reduction benefits, measured as RFIC, accounted for 81 percent of total project benefits. When measured as RFD, this category of benefits accounted for 67 percent of the total.

An unusual category of benefits in the Baytown study is the Elimination of Losses from Abandonment. In the study, it was estimated that 50 dwellings would be abandoned by the time of project construction. There is no indication given in the study how the proposed project would eliminate losses from property abandoned prior to the project. The abandonment of property has an effect on the project by lowering site acquisition costs. A possible rational for including this benefit is that individuals will be less likely to abandon their property if they expect it to be purchased for an evacuation project.

The final three categories of benefits include: (1) the reduction in public utility service costs; (2) the reduction of temporary evacuation, public health, and relief costs; and (3) the value of the project land as open space. No mention is made of roadway damages, although, these may be included with public utility service costs. The temporary evacuation costs improperly include those costs borne by the floodplain occupant. Some of these costs are insurable while the remainder are reflected in lowered land values and, therefore, reduced project costs.

On the cost side of the evaluation, payments required by P. L. 91-646 are included as project costs but not as benefits. The value of salvagable materials is netted from costs.

Lock Haven, Pennsylvania

The nonstructural component of the recommended flood damage reduction plan for Lock Haven is designed to mitigate flood damages induced by the structural plan. Benefits from evacuation and relocation are calculated based on ER 1105-2-353. The largest component of benefits is the reduction in externalized flood damages. This category includes damages to utilities and highways, community emergency costs, and subsidized insured loss payments. No recreation use of the vacated land is planned so the value in new use is estimated as the value of the project land sold with encumbered title. The benefit from employing otherwise unemployed labor is counted for the entire project but not separated between the structural and nonstructural components.

Potential benefits not included are the externalized value of open space and the portion of uninsured losses transferred to the general taxpayer through the income tax deduction. No mention is made of the effects of P.L. 91-646 on project benefits or costs so they are probably not included in NED costs or benefits. If the nonstructural plan is separated from the structural plan, it is not economically justified as a separate project.

Midland, Michigan

The recommended plan for Midland proposes the acquisition of 101 residential and three commercial parcels in two separate areas. The structures and improvements on these parcels are to be demolished or relocated, removing all damagable property in these areas below the 100-year flood elevation. The plan does not include the acquisition of the entire 100-year floodplain in Midland so flood damages are not totally eliminated at elevations below the 100-year level.

Inundation reduction benefits are calculated by first estimating average annual flood damages to structures and contents. Average annual flood damages to residential contents are expected to increase due to increasing real income. The value of damagable contents, without the project, is estimated to increase over the project life so that it equals 75 percent of the base year structure value by the end of the project life.

Average annual flood damages to residential structures are assumed to decrease, without the project, due to property values declining from depreciation and abandonment.[18] Average annual emergency response costs and highway damages are added to structure and content damages to yield total average annual flood damages. Benefits are calculated as externalized flood damages. Therefore, the annual flood insurance premiums and expected annual

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18The result of the using content value and falling structure value is that the content value is estimated to equal the structure value by the end of the 50-year period of analysis.

deductible are subtracted from damages while savings in insurance administration costs and agents commissions are added.[19]

Additional benefits counted are the salvage value of the demolished structures, the benefit from employing unemployment labor for project construction, and the value of the portion of project land left as open space. Seventy percent of the total project benefits, however, arise from the planned recreation use of the remainder of the project land. Consequently, the recommended plan is not economically justified if the recreation plan's costs and benefits are eliminated from the calculations.

A potential source of the benefits not included is the proportion of uninsured damages transferred to the general taxpayer. Finally, none of the payments to evacuated activities, under P. L. 91-646, are included in projects benefits or costs.

Prairie du Chien, Wisconsin

The Prairie du Chien project is probably the most widely known Corps floodplain evacuation project. The recommended plan includes the acquisition and evacuation of 130 structures located, or with access, at or below the 10-year flood elevation. In addition, limited technical assistance by the Corps and possible financial assistance by the city is to be provided for

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19Several errors were made in the calculations since it was assumed the insurance deductible is on structure damage only and is paid every year. In addition, agents commissioned are added twice because private insurance company operating costs include the agents commission.

flood proofing to occupants of the 10- to 125-year flood elevations. The acquired structures, that can be feasibly relocated, are to be made available for purchase at salvage value to current owners, occupants or others, under the condition that the structure is moved by the applicable evacuation date.

Values that contribute to benefits with the project are: (1) flood damage reduction; (2) local employment; and (3) recreation. The flood damage reduction benefits include all damages, avoided with the project, that would occur to the evacuated and flood proofed structures and their contents. This category of benefits also includes all flood emergency costs and public damages. No adjustment is made to the damage estimates to separate internalized and externalized flood damages. The effects of the National Flood Insurance Program are not considered in evaluating the benefits of the selected plan. The benefits from reduced flood damages account for 67 percent of the total NED benefits from the project.20

Local employment benefits are estimated to contribute up to 28 percent of the total project benefits. These workers are expected to be employed in the demolition and site restoration at the project site as well as in the construction of replacement housing for residents displaced by evacuation.

Recreation benefits result from the projected increase in usage of existing recreational facilities, allowed by the project. Because no specific

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20The estimated value of this benefit accounted for 55 percent of total benefits in the Phase I, GDM (February 1977). The benefit from reduced flood damages was revised upwards by 80 percent in the Phase II, GDM (March 1978).

new recreation use is planned, the value of the vacated land as open space is included in recreation benefits.

To calculate NED costs, the salvage value of the acquired structures, whether demolished or relocated, is subtracted from the property acquisition costs. Payments to evacuees under P. L. 91-646 are not included in either NED costs or benefits.

St. Peter - East St. Peter, Minnesota

The recommended plan for St. Peter - East St. Peter includes the relocation of eight homes and business and the acquisition of 16 homes and businesses in East St. Peter. The plan removes most damagable property from the floodplain in East St. Peter. No economically justified plan could be identified for St. Peter.

Most of the benefits from the proposed plan result from the reduction in flood damages. The value of this benefit is calculated as the reduction in expected flood damages. As this study was conducted prior to ER 1105-7-353, no adjustment is made in the reduction in damages to reflect those borne by the flood prone activities and those borne by the public. The only other benefit from the plan is an employment benefit. No recreation use of the vacated land was planned but the value of the acquired land as open space is not included as a benefit.

The anticipated payments under P. L. 91-646 that are considered as betterment are not included as NED costs. The salvage value of acquired properties is not explicitly subtracted from the NED costs. Some of these payments for searching and moving, however, are counted as NED costs. The salvage value of acquired properties is not explicitly subtracted from the NED costs. This value may have been deducted since these structures are to be sold as salvage.

Village Creek, Jefferson County, Alabama

The recommended plan for Village Creek is the acquisition of 993 residential structures and a channel improvement. The residences are to be acquired by blocks rather than based only on elevation. The property acquisition and removal eliminates damages up to the 10- to 25-year flood elevations. Additional protection was deemed not economically justified.

Inundation reduction benefits are calculated following the standard procedure in ER 1105-2-353. The effects of rising affluence are projected to increase future contents and flood damages. Because the Village Creek floodplain residents are eligible to purchase flood insurance, benefits are calculated by adjusting downward damages, reduced by the plan, to reflect those borne by the occupants. The analysis is not clear on whether non-insurable damages are included as insurable damages reduced by the plan. Insurance administration costs and community emergency costs are added to the flood insurance subsidy to arrive at ununda tion reduction benefits. Other

public damages to utilities, highways, etc., reduced by the plan, may be included but are not separately counted as benefits.

A significant amount of the total benefits from the recommended plan result from the conversion of approximately one-half of the vacated land to recreation uses. The other half of the evacuated land contributes to benefits as the value of land with encumbered title. An alternative plan, not recommended, would have eliminated the recreation plan but counted as a benefit the increase in the value of land adjacent to the project.

Potential benefits not counted for any of the alternative plans are the income tax casualty loss deduction and the benefit from employing otherwise unemployed labor for project construction.

Summary

Several common characteristics of economically justified Corps evacuation and relocation projects can be identified:

1. Evacuation is economically viable only for property located in the highest flood risk areas. This typically means only property located in the 1-25 year flood zones can be acquired.

2. The decision on which properties to acquire cannot be made solely on the structure's elevation. This is particularly true in residential areas.

3. The acquisition of commercial and industrial establishments is not feasible except for small businesses, such as neighborhood retail establishments.

4. Reduced flood losses typically account for less than 50% of project benefits.

5. The new use of the vacated land is critical to the economic feasibility of permanent evacuation. Recreation usage contributed significantly to the benefits of several evacuation projects.

## Flood Insurance and Evacuation Benefits

The review of Corps studies of projects incorporating relocation or evacuation measures suggests a clarification is needed on the relationship between flood damages, flood insurance, and benefits.

### The National Flood Insurance Program

The National Flood Insurance Program provides indemnification to cover "direct physical loss by flood" to insured structures and contents.21 The expenses of removing and storing contents and the temporary removal of mobile homes away from the flood peril are also insurable. A final insurable expense is debris removal, after a flood, from insured structures and contents.

Some losses are not physical losses and not insurable, such as: (1) loss of access; (2) loss of use; (3) loss of profits; (4) loss resulting from interruption of business; and (5) other economic losses. Physical losses not insurable include losses to property improvements outside the insured structure's foundation, such as: (1) lawns, trees, shrubs, plants or livestock; (2) underground structures and equipment servicing an insured building, and (3) driveways. Under the program, structures that are primarily containers, such as gas and liquid tanks, brick kilns, and chemical container

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21Beginning 1 Oct 1983, new and renewed flood insurance policies will no longer cover the contents of finished basements or structures and equipment located below the floor of elevated structures.

tanks are not insurable. Container buildings for agricultural products, such as silos and grain storage buildings and their contents are insurable. Contents not eligible for insurance coverage are: (1) motorized vehicles licensed for highway use and not used to service premises; (2) motorized vehicles used to service premises, not licensed for highway use but outside an insured building; (3) aircraft and water craft; and (4) certain financial and other assets such as currency, deeds, coins, postage stamps, bullion, securities, or other valuable papers.

For each flooding event there is a $500 deductible clause for insured losses to structures and an additional $500 deductible for insured losses to contents. Expenses incurred from the temporary removal of insured contents or mobile homes carry a $50 deductible.

There are two types of insurance programs available to occupants eligible to flood insurance. The Emergency Program is intended to provide limited insurance coverage, at subsidized rates, until the flood risk zones and base flood elevation in the community are established. The coverage limits for a single-family dwelling under this program are $35,000 on the structure and $10,000 on the contents. The annual premium rate is $0.40/$100 value on the structure and $0.50/$100 on the contents.[22] In addition, an expense constant of $20 per policy is added to defray the costs of operating the program.[23]

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[22]As of June 1982.

[23]The expense constant is added to all premiums and is $20 regardless of the program.

Once the Federal Emergency Management Agency (FEMA) publishes the Flood Information Rate Map (FIRM) for a community, the participating community is converted to the Regular Program. This program contains two rate classification systems. The system a particular structure is insured under depends on its initial construction or substantial improvement date. If the structure was constructed prior to December 31, 1974, and has not been substantially improved, the owner can purchase insurance at subsidized rates (Pre-FIRM). If the structure was constructed or substantially improved after the publication of the FIRM (Post - FIRM) or December 31, 1974, which ever is later, the insured must by law be charged rates sufficient to cover the expected losses and administrative costs of the program.[24] The limits for Basic coverage of a single-family dwelling are the same as in the Emergency Program. Coverage of up to an addition $150,000 of structure value and $50,000 of content value is also available in the Regular Program.

It is possible that the repair of flood damage buildings could alter the insurance rating classification of a building. The Regular Program communities, buildings that are rebuilt after a flood are subject to Post-FIRM (non-subsidized) insurance rates if the cost of reconstruction equals or exceeds 50 percent of the pre-flood building value. This will be the case even if the building was originally classed as Pre-FIRM construction for insurance purposes. In Emergency Program communities, a flood damaged building whose reconstruction costs equal or exceed 50 percent of the pre-flood value must be certified to have its lowest floor elevation at or above the base flood elevation to qualify for the subsidized, Emergency

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24Flood Disaster Protection Act of 1973, Sec. 103, 87 Stat. 978-979.

Program rates. Without this special certification, these reconstructed buildings will be subject to higher insurance rates.

Available FEMA claims experience indicates, however, that building damages equaling or exceeding 50 percent of the building value rarely occurs. The depth-damage data generated by FEMA claims shows that 50% building damage is predicted to occur only when flood depths exceed 10 feet over the lowest finished floor elevation. Because this large depth of flood has such a low probability of occurrance in most locations, the repair of flood damaged buildings can be considered to leave the insurance rating classification of a building unchanged.

Given this preliminary background of the NFIP, the hypothetical example below demonstrates the relationship between flood damages, the flood insurance subsidy and benefits from evacuation.

Example:

Characteristics of Structure

| | | |
|---|---|---|
| 1. Structure type: | Single Family residence | |
| | One story, no basement | |
| 2. Value: | Structure | $30,000 |
| | Contents | $10,000 |

Note: Values assumed to be constant, in real terms, over the period of analysis.

| | |
|---|---|
| 3. Elevations: | Lowest floor is 5 feet below the base flood elevation (the 100-year flood elevation). |
| 4. Insurance Coverage: | Eligible for flood insurance under the Regular Program at Pre-FIRM Construction rates |

Table I

| Depth of Flooding Above Lowest Floor | Exceedence Interval (years) | Exceedence Probability | Estimated Damages Structures[1] | Contents[1] | Grounds[1] | Interval Probability | Average Damages in Each Interval Structures | Contents | Grounds |
|---|---|---|---|---|---|---|---|---|---|
| -2 | 2.5 | 0.400 | 0 | 0 | 0 | | | | |
| | | | | | | 0.200 | 0 | 0 | 50 |
| -1 | 5 | 0.200 | 0 | 0 | 100 | | | | |
| | | | | | | 0.100 | 1050 | 500 | 200 |
| 0 | 10 | 0.100 | 2100 | 1000 | 300 | | | | |
| | | | | | | 0.033 | 2550 | 1350 | 400 |
| 1 | 15 | 0.067 | 3000 | 1700 | 500 | | | | |
| | | | | | | 0.027 | 3600 | 2000 | 500 |
| 2 | 25 | 0.040 | 4200 | 2300 | 500 | | | | |
| | | | | | | 0.020 | 6000 | 2600 | 500 |
| 3 | 50 | 0.020 | 7800 | 2900 | 500 | | | | |
| | | | | | | 0.007 | 8100 | 3200 | 500 |
| 4 | 75 | 0.013 | 8400 | 3500 | 500 | | | | |
| | | | | | | 0.003 | 8550 | 3750 | 500 |
| 5 | 100 | 0.010 | 8700 | 4000 | 500 | | | | |
| | | | | | | 0.005 | 10500 | 4250 | 500 |
| 6 | 200 | 0.005 | 12300 | 4500 | 500 | | | | |
| | | | | | | 0.003 | 12600 | 4750 | 500 |
| 7 | 500 | 0.002 | 12900 | 5000 | 500 | | | | |
| | | | | | | 0.002 | 13050 | 5250 | 500 |
| Max. | | 0 | 13200 | 5500 | 500 | | | | |

[1] Includes debris removal.

Table I (cont.)

| Average Insurable Damages in Each Interval[1] | | | Annual Expected Damages in Each Interval | | | Annual Expected Insured Damages in Each Interval | |
|---|---|---|---|---|---|---|---|
| Structures | Contents | Grounds | Structures | Contents | Grounds | Structures | Contents |
| 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 |
| 800 | 250 | 0 | 105 | 50 | 20 | 80 | 25 |
| 2050 | 850 | 0 | 84 | 45 | 13 | 68 | 28 |
| 3100 | 1500 | 0 | 97 | 54 | 14 | 84 | 40 |
| 5500 | 2100 | 0 | 120 | 52 | 10 | 110 | 42 |
| 7600 | 2700 | 0 | 57 | 22 | 4 | 53 | 19 |
| 8050 | 3250 | 0 | 26 | 11 | 2 | 24 | 10 |
| 10000 | 3750 | 0 | 52 | 21 | 3 | 50 | 19 |
| 12100 | 4250 | 0 | 38 | 14 | 2 | 36 | 13 |
| 12550 | 4750 | 0 | 26 | 11 | 1 | 25 | 6 |
| Average Annual Damages | | | 605 | 280 | 79 | 530 | 205 |

[1] Five hundred dollar deductible on structure and $500 deductible on contents. Damages to grounds are not insurable.

NFIP Insurance Premium

| | Coverage | Rate | Premium |
|---|---|---|---|
| Structure | 30,000 | .40 | 120.00 |
| Contents | 10,000 | .50 | 50,00 |
| | | | 170.00 |
| | Expense Constant | | 20.00 |
| | Annual Premium | | 190.00 |

Agent's Fees= $190.00 x .15 = $28.50

Administrative Charges = $20.00

Federal Flood Insurance Subsidy

| | | |
|---|---|---|
| Average Annual Damages | | $964.00 |
| Plus: | | |
| Annual Agent's Fees | 28.50 | |
| Administrative Charges | 20.00 | |
| | | $1012.50 |

Less:

| | | |
|---|---|---|
| Annual Insurance | | |
| Premium | 190.00 | |
| Annual Uninsurable | | |
| Damages | 79.00 | |
| Annual Expected | | |
| Deductible | 150.00 | ($419.00) |

Average Annual Insurance Subsidy $593.50

Insurance Subsidy Reduction Benefit = $593.00 annually

In this example, the annual benefits from evacuation due to the reduction flood insurance subsidy are approximately 62% of average annual damages.

## Guidance for Measuring Benefits

Permanent evacuation removes people and damagable property from flood prone locations. The NED benefits from this type of plan result from a reduction in social costs and an increase in social output compared to the without condition. The part of the social costs reduced, counted as benefits, are the expected publicly borne costs, associated with the current and future flood plain use, that are avoided by evacuating the flood plain. This is analogous to inundation reduction benefits for a structural flood damage control project. The privately borne portion of social costs is also reduced by evacuation. This value enters net benefits, however, as a reduction in the costs of the evacuation plan not as an additional benefit. The increase in social output results from the new use of the vacated land and any social product, that exceeds the social costs, resulting from project construction i.e., employment benefits. The methodology outlined below would follow Evaluation Procedures: Steps 1-9 specified in Principles and Guidelines (Section IV) and conforms to the basic guidance given in P&G.

### Inundation Reduction Benefits (Reduction in Publicly Borne Costs)

The publicly borne costs of flood plain occupance, that are reduced by evacuation, are composed of private costs that are transferred to the public plus external costs. Flood prone activities can transfer part of the costs associated with their location, through government programs designed to reduce

the private burden of the costs of flooding. Public flood emergency relief, subsidized flood insurance, and the deduction of uninsured casualty losses from taxable income reduce the burden of flooding. Expenditures for these programs represent public costs that are avoided by evacuation.

The benefit from the reduction in public flood emergency costs is measured as the average annual equivalent of current and expected future average annual public emergency costs. Future emergency costs may vary from current costs due to changes in flood plain usage without evacuation and hydological changes. Any projected changes in usage without the plan must take into account the effects of local land use and new construction regulations required for a community to qualify for flood insurance.

The benefits from the reduced flood insurance subsidy and tax losses depend on current and future average annual flood losses. In addition, future flood insurance rates, loss deductible, and marginal tax rates also influence the mount of this benefit. Changes in insurance rates, deductible amounts and tax rates are impossible to predict: therefore, it is reasonable to assume them constant at their current values over the period of analysis. The relationship between the level of flood losses and the insurance subsidy and tax loss benefits is demonstrated above.25 To reiterate, this benefit from evacuation can be calculated as follows:

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25Recall that the value of this benefit should be calculated assuming that all eligible activities purchase flood insurance up to the limits of coverage or property value, which ever is lower.

Average annual flood losses to flood prone activities

Plus: Annual agents fees

Annual insurance administrative overhead

Less: Annual insurance premium

Average annual insurance deductible

Average annual uninsurable losses

Average annual losses over limits of coverage

Equals: Average annual flood insurance subsidy

Plus: Tax loss = (Average annual insurance deductible
+ Average annual uninsurable losses
+ Average annual losses over limits of coverage) X
marginal tax rate.

Equals: Benefit from flood plain evacuation resulting from reduced flood insurance subsidy and tax losses.

The measurement of the Tax Loss is complicated by the Internal Revenue Service (IRS) regulation that only the uninsured losses that exceed 10 percent of adjusted gross income are allowable as an itemized deduction from personal taxable income. In general, non-income earning property is unlikely to incur

uninsured damages that exceed this minimum. Thus, only the uninsured losses to owners of income producing property will be transferred to the general taxpayer under current IRS regulations. Once this category of uninsured losses is measured, the evaluation of the Tax Loss due to flooding still requires the determination of the marginal tax rate of the property owners. Interviews with the affected property owners can be used to determine their taxable income, type of tax (personal, partnership, corporate), and marginal tax rate.

This calculation assumes that flood plain land use and the real value of damagable property will remain the same without the project over the period of analysis. Future flood losses may be projected to increase or decrease, without the project, reflecting the effects of depreciation, affluence, new construction, and changing hydrology.

New construction in communities in the Regular Program of NFIP will not increase the insurance subsidy. Actuarial premiums reflecting expected insurable flood losses, agent's fees, and administrative costs are charged for insurance on Post-Firm construction.

New construction in communities in the Emergency Program may result in future increases in the insurance subsidy without flood plain evacuation. The subsidy will increase if the Emergency Program premium is less than the acturarial premium. It is possible, depending on the lowest floor elevation, that new construction in Emergency Program communities will be charged a

premium greater than the acturial premium. Thus, future construction consistent with land use controls required under NFIP may increase or decrease the insurance subsidy in Emergency Program communities. Therefore, it is reasonable to assume that new construction does not change the future insurance subsidy, without evacuation, to Emergency Program communities.

New construction in Regular Program communities, that replaces currently subsidized activities, will reduce the future insurance subsidy. Therefore, future benefits, from the reduction in insurance subsidies with evacuation, will decline if projections indicate existing structures in Post-Firm communities will be replaced or substantially improved in the future without evacuation.

The real value of damagable property in flood prone locations without evacuation can be projected to change if increasing affluence of residential occupants is expected. The growth in affluence results in a growth in the real value of damagable property and flood losses without the plan. The growth in benefits with evacuation depends on the relationship between the growth in insurable loss and the growth in the insurance premium.

An additional complication arises in accounting for the effects of depreciation on the real value of damagable property and benefits. Depreciation, in the absence of expenditures for maintenance, reduces the real value of damagable property over time and, thus reduces future benefits. Flood prone property may be particularly subject to reduced maintenance and

suffer more rapid depreciation. Maintenance expenditures may increase, however, where most of the flood losses are covered by insurance. Therefore, the analyst must be guided by the past history of flood damage repair and maintenance expenditures for structures in the study area.

Future tax losses without the evacuation plan are affected by changes that alter average annual flood losses. New construction will increase tax losses if average annual uninsurable losses or losses over limits of coverage increase. Losses over limits of coverage might be significant for new construction in Emergency Program communities because of the low coverage limits. In areas projected to have greater affluence, uninsurable losses and losses over the limits of coverage may also lead to greater tax losses in the future without the plan. The Internal Revenue Service guidelines for the deduction of uninsured casualty losses should be used.

The externalized costs of flood plain occupance are the average annual losses to public utilities and other public services. Additional external costs are the flood losses to activities outside the study area caused by current and future study area land use. The removal of activities from flood prone locations allows the reductions in damage to public utilities and other services provided to the removed activities. The clearing of the flood plain may also reduce flood losses, incurred without the plan, to activities outside the study area. The level of these losses without the plan may be projected to increase in the future if new construction is predicted to occur without evacuation.

## Location Benefits

The Location Benefits category includes the value of the vacated land in its new use. In structural projects, this benefit is measured as the change in the net income of flood plain land and of land adjacent to the flood plain. An evacuation plan results in the public acquisition of the flood plain land so that the appropriate location benefit is the total value or net income of the land in its new use not just the change in value or net income. The value of this benefit depends on the new use of the vacated flood plain land.

The new use of the vacated land can be for public purposes such as for public open space or recreation. The benefit from the recreation usage of the land is the willingness-to-pay for the new recreation opportunity evaluated by methods prescribed in Principles and Guidelines. If the land is to remain public open space, the value of the location benefit is the value of the land if sold with a title encumbered to require continued open space. A potential additional benefit, in this case, is the increase in the market value of land adjacent to the new open space. This external benefit reflects the neighborhood social amenity value of the open space.

The measurement of this open space externality that may be created can be accomplished by estimating the effect of adjacent open space on property values. The best known and most widely accepted empirical approach to estimate the impact of externalities on property values is the use of hedonic

prices. In this method, it is assumed that housing values reflect variations in the housing characteristics and other characteristics such as spatial variation in the availability of public goods. The distance to and extent of open space may be a public good that is capitalized in property values.

Evaluating the impact of open space on property values can be accomplished by estimating the hedonic pricing relationship:

Property values = f (house characteristics, accessibility characteristics, neighborhood characteristics)

where the neighborhood characteristics would include a measure of the availability of open space. Since this equation must be estimated prior to the relocation project, data from other areas must be used.

An alternative approach, not yet implemented in Corps projects that create open space, is the use of a contingent value survey. The survey questionnaire would establish a hypothetical market for open space and be used to directly ask potential beneficiaries their willingness to pay for new open space.

One important consideration in either of these approaches is whether the potential additional benefits that can be measured are justified by the additional measurement costs. This question must be answered on a case by case basis.

The vacated land can be made available for private use either by sale or under long-term lease. The type of disposition of the vacated land is governed by the local cooperation agreement and by State public land disposition laws. Private use of the vacated land is governed by the principle that the new use must bear all the costs associated with the flood prone location. This requires that the new use not incur external costs to other parties, without paying compensation, nor be able to transfer flooding or other costs to the general public. This principle can be accomplished by the terms of the lease or by title encumbrance. There is no reason to expect that these provisions will preclude full or partial redevelopment of the evacuated land. Residential use other than with multistory, multi-family structures, however, is not likely to occur. Redevelopment for commercial and industrial development is more likely, especially if the project land is adjacent to remaining commercial and industrial development. The location benefit, if redevelopment is projected, is the market value of the land sold with titles encumbered to insure that new activities bear all the cost associated with the flood prone location.

A final benefit, that may be classified as a location benefit, is produced if the government finances the relocation of acquired structures. The benefit is the value of the relocation site with relocated structures. Public financing of relocation entails additional NED costs offset by this benefit. It is more appropriate that the acquired structures be offered for

sale for private relocation or demolition. The revenue generated by these sales reduce the NED costs of the nonstructural project.

Employment Benefit

This benefit results from employing otherwise unemployed or underemployed labor for project construction. Labor will be employed with the project, but not otherwise, for: 1) structure demolition and site restoration; 2) structure and personal property moving; 3) new construction for displaced activities. Estimates of these values should be made based on current guidance. This item captures some of the payments made under P. L. 91-646 as additional benefits. Care must be taken, especially in the estimation of employment for new construction, as this value can be easily overestimated.

The Importance of "Options" within the Evacuation Plan Alternative

The review of past Corps evacuation and relocation projects indicated that a significant problem was the delineation of the appropriate planning area. The Corps planner must recognize that the evacuation plan that maximizes net economic benefits will likely remove only the damagable property with the greatest flood risk. This is likely to lead to the formulation of an evacuation plan that relocates activities in a piecemeal fashion leaving some property and residents, with lower flood risk, isolated in otherwise evacuated neighborhoods. Therefore, one of the alternative formulations of a plan containing evacuation and relocation should include as an option the

evacuation of the flood plain by blocks, regardless of the flood risk of individual property within the block. Although this will sacrifice some net NED inundation reduction benefits, block acquisition will probably meet with greater local acceptance and allow a comprehensive, rational new use of the vacated property. Thus, the sacrifice of net NED benefits from inundation reduction may be offset by increases in net NED benefits from the new use of the vacated land.

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