REPORT TO THE

Inter-Agency Committee

on Water Resources

M.C. Hass

# *Proposed Practices for Economic Analysis of River Basin Projects*

PREPARED BY THE

Subcommittee on

Evaluation Standards

MAY 1958

REPORT TO THE

## Inter-Agency Committee on Water Resources

Department of Agriculture
Department of the Army
Department of Commerce
Department of Health, Education and Welfare
Department of the Interior
Department of Labor
Federal Power Commission

# *Proposed Practices for Economic Analysis of River Basin Projects*

BY THE

## Subcommittee on Evaluation Standards

WASHINGTON, D.C.

Originally Issued: May 1950
Revised: May 1958

The Inter-Agency Committee on Water Resources has authorized the publication of this revised report in the belief that this material will be a valuable aid in the further consideration by the participating agencies and the interested public of the complex problems involved in evaluation of water resources projects. Publication of the revised report, however, and its adoption as a basis for consideration do not imply either that the proposed practices and recommendations of the report are thereby adopted for application by the participating agencies or that they represent Administration policy. Comments of the participating agencies are included in the appendix.

# Foreword

This Report on Proposed Practices for Economic Analysis of River Basin Projects was prepared by the Subcommittee on Evaluation Standards of the Inter-Agency Committee on Water Resources to enable re-publication with minor revisions of the May 1950 Report of the predecessor Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee. The original Report is now out of print.

The original Subcommittee on Benefits and Costs was established in 1946 for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects. The May 1950 Report was prepared after consideration of the benefit-cost practices then in use and of an objective analysis of the economics of river basin projects uninfluenced by those practices or by legal and administrative limitations. The Report was adopted by the Federal Inter-Agency River Basin Committee in 1950 as a basis for consideration by the participating agencies as to application in their respective fields of activity in river basin development.

Upon approval by the President on May 26, 1954, of the Inter-Agency Committee on Water Resources to succeed the Federal Inter-Agency River Basin Committee, the Subcommittee on Evaluation Standards was established with duties which include continuing the activities begun under the predecessor Subcommittee on Benefits and Costs. To supply the continuing needs of participating agencies and other interested groups, the Inter-Agency Committee on Water Resources on August 12, 1958, authorized this reissuance of the May 1950 Report, as revised, and its adoption as a basis for consideration by the participating agencies in the evaluation of river basin developments. It was expressly understood that the participating agencies did not thereby adopt the proposed practices and recommendations of the report for application to their programs. Agency comments are included in the appendix. Several aspects of the problem of developing principles and procedures for project evaluation continue to be under study by the Subcommittee.

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## INTER-AGENCY COMMITTEE ON WATER RESOURCES
## SUBCOMMITTEE ON EVALUATION STANDARDS

May 27, 1958

The Chairman,
Inter-Agency Committee on Water Resources
Washington, D.C.

Dear Mr. Chairman:

In May 1950, the Federal Inter-Agency River Basin Committee considered the report of its Subcommittee on Benefits and Costs on "Proposed Practices for Economic Analysis of River Basin Projects" and adopted it as a basis for consideration by the participating agencies for application in their respective fields of activity in river basin development. The report was printed and widely distributed in the United States and in other countries. Although there is a continuing demand for the report, the supply is exhausted.

There have been a number of significant actions concerned with the economic evaluation of water resource developments subsequent to the issuance of the Subcommittee's report. The report of the President's Water Resources Policy Commission was issued in December 1950. The Bureau of the Budget issued Circular A-47 in December 1952, outlining the standards and procedures for use in the Executive Office of the President in reviewing agency reports. In June 1955, the Commission on Organization of the Executive Branch of the Government issued its report, including the Task Force Report on Water Resources and Power. The report of the Presidential Advisory Committee on Water Resources Policy was issued in December 1955. Senate Resolution 148, adopted January 28, 1958, expressed the sense of the Senate that the procedures for evaluation of land and water resource projects should be improved and requested that certain evaluation information be included in reports on projects to the Congress.

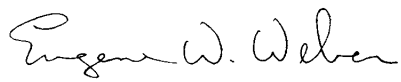
The Inter-Agency Committee on Water Resources late in 1954 established the Subcommittee on Evaluation Standards to succeed the Subcommittee on Benefits and Costs. The Subcommittee's review of its continuing responsibility for developing and recommending to the Committee uniform standards and procedures for project and program evaluation indicated that reissuance of the May 1950 report was desirable.

In order to meet the immediate need for copies of the report, revisions have been limited to matters on which there is general agreement at this time and to clarifications and minor additions. The Subcommittee is giving further study to several aspects of the problem of developing principles and procedures for project evaluation.

The Subcommittee submits this revision of the report on Proposed Practices for Economic Analysis of River Basin Projects with the recommendation that it be adopted as a basis for consideration by the participating agencies and that its early publication be authorized. While the Subcommittee is unanimous in its recommendation that the report be published at this time, the Subcommittee member from the Department of the Interior wishes to point out that he concurs in the recommendation only if it is understood that Federal agencies need not include in their reports analyses involving economic principles inconsistent with existing laws, interstate compacts, or established policy. The remainder of the Subcommittee considers that the recommendation does not imply imposition of any such requirement but rather that it proposes consideration by the agencies of the possibilities for use of the proposed practices whether or not amendments of laws or policies are involved.

As in the case of the original report, this revision is the product not only of the Subcommittee but is in large part the direct contribution of the Staff. A list of the personnel active in preparation of the report is attached.

For the Subcommittee on Evaluation Standards:



EUGENE W. WEBER, *Chairman.*

# Membership of Subcommittee and Staff (1956–58)

## SUBCOMMITTEE

| | |
|---|---|
| Lonzo N. Hansen | Administrative Officer, Bureau of Public Roads, Department of Commerce. |
| Lawrence G. Hines | Economic Consultant, Bureau of State Services, Public Health Service, Department of Health, Education and Welfare. |
| George E. Tomlinson (Chairman 1956) | Assistant Chief, Division of Project Development, Bureau of Reclamation, Department of the Interior. |
| Frank L. Weaver (Chairman 1957) | Chief, Division of River Basins, Bureau of Power, Federal Power Commission. |
| Eugene W. Weber (Chairman 1958) | Special Assistant on Civil Works, Office, Chief of Engineers, Department of the Army. |
| Ernst H. Wiecking | Assistant Director, Farm Economics Research Division, Agricultural Research Service, Department of Agriculture. |

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| George G. Adkins | Division of River Basins, Bureau of Power, Federal Power Commission. |
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## CHAPTER I

# Introduction

This report by the Subcommittee on Evaluation Standards of the Inter-Agency Committee on Water Resources is based on, and constitutes an interim revision of, the May 1950 report by the predecessor Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee. The revisions are limited to those changes upon which there was general agreement as a result of studies to date. A further revision of the report is contemplated when additional studies planned by the subcommittee are completed.

## SUMMARY OF STUDIES

Contributing to the preparation of this report were the subcommitee studies made prior to the original issuance of the report in 1950, and the subcommittee studies made subsequent to 1950. In addition, consideration was given in the report preparation to recent related studies by others.

### Subcommitee Studies Up to 1950

The initial step in the studies was to obtain a mutual understanding of the current practices of each participating Federal agency in preparing its reports and recommendations on water resources projects. The results were summarized in the following reports which made available, for the first time, detailed statements covering the practices then in use by the participating agencies:

Qualitative Aspects of Benefit-Cost Practices—1947.
Measurement Aspects of Benefit-Cost Practices—1948.
Allocation of Costs of Federal Multiple-Purpose Projects—1949.

The comparison of current practices indicated that there were important fundamental differences in the application of these practices. Such differences included variations in the concept of what economic effects should be measured as benefits and as costs, difference in methods of measurement, and differences in the extent to which costs were measured as compared with benefits. These differences in current practices resulted, in part, from various legal and administrative requirements of member agencies, and from complexities and difficulties inherent in the measurement of various kinds of benefits and costs.

The next step of the study was to develop a systematic, consistent, and theorectically sound framework for the economic analysis of river basin projects and programs, irrespective of current practices or legislative and administrative limitations. An objective analysis was made of the fundamental economic principles and standards that could be used as a basis for the economic analyses of proposed projects. Particular

stress was placed on the need for standards and procedures that would yield comparable estimates of benefits and costs, and would provide a proper basis for project formulation and selection. In connection with the objective analysis, the subcommittee studied certain special problems which had been selected for particular attention because of the difficulties encountered in handling these problems in the past. These studies culminated in the May 1950 report.

### Subcommittee Studies Subsequent to 1950

Studies have been made since issuance of the May 1950 report and are being continued on a number of phases of the problems involved, including particularly secondary benefits, taxes, interest rates, and the determination of appropriate price levels to be used in project evaluation. It is expected that additional studies of these and other problems, including problems of reimbursement of project costs, will be undertaken in the future by the subcommittee. Following completion of these studies, a further revision of this report is contemplated.

Among the recent reports and papers on related subjects considered by the subcommittee in the preparation of this report were the following of national scope by Federal bodies:

Report of the President's Water Resources Policy Commission (1950).

Bureau of the Budget Circular A–47 (1952).

Reports of the Commission on Organization of the Executive Branch of the Government (Second Hoover Commission) (1955).

Report of the Presidential Advisory Committee on Water Resources Policy (1955).

Senate Resolution 148, 85th Congress, 1st Session (1958).

The consideration of current practices, various alternative approaches to benefit-cost analysis, and practical limitations formed the background for the conclusions and recommendations presented in this report.

While many of the recommended practices for benefit-cost analysis and allocation of costs have been adopted by the participating agencies since the report was originally issued in 1950, it is believed that further acceptance of the recommendations set forth herein would result in improved formulation, better selection of projects, and more effective river basin development. It would enable this type of analysis to be conducted on the basis of improved measurement standards which, because of their uniformity, would facilitate inter-agency comparison of projects and greater public understanding.

## SCOPE OF THIS REPORT

The basic principles and concepts involved in benefit-cost analysis are discussed in chapter II. Included are statements of the character of the viewpoint for economic analyses, the basis for evaluation of river basin development, definitions of benefits, costs, and related terminology. Attention is focused on effects attributable to projects, the nature of benefits, and the effects of alternative opportunities on evaluation and project formulation.

Chapter III covers general principles and procedures for project and program formulation.

The standards, problems, and procedures involved in the measurement of benefits and costs are the subject of chapter IV. Measurement standards discussed include price levels, interest rates and risk allowances, period of analysis, amortization, and salvage. The measurement problems considered include the treatment of tangible and intangible effects, adjustments for levels of economic activity, treatment of costs of affected public facilities, acquistion of land and improvements, treatment of taxes, extension of useful life, displaced facilities, and consequential damages.

Chapter V is concerned with the applications of principles and procedures for analysis of various project purposes.

The application of data on benefits and costs in allocation of costs among project purposes is discussed in chapter VI.

## Setting for Economic Analysis of Project Effects

Basic to a consideration of the economic factors affecting projects for water resources development is the economic environment in which these projects will operate. The subcommittee considers that the appropriate general setting applicable is one in which, over the long run, an expanding economy will require increasing amounts of goods and services to satisfy increased needs resulting both from population shifts and growth and higher levels of living. Principles for evaluation of the difference in effects on the economy with and without a project include recognition of this assumed setting.

Assumption of this setting does not preclude consideration of the occurrence of short run or cyclical fluctuations in the economy. Changes in the level of economic activity have been considered as factors affecting the need for, timing, and evalution of projects.

The basic approach of this study reflects consideration of traditional economic theory, with some adjustment for institutional aspects and practical difficulties involved in application. The resulting presentation involves modifications rather than drastic changes from the prevailing evaluation practices.

## Economic Analysis and Public Policy

The public policies governing the development of the Nation's water and related land resources are not necessarily determined solely on the basis of economic considerations. Thus, for example, regional development and national defense have been objectives of various resource development programs. Even in such cases, economic analyses may serve a valuable purpose by showing the extent to which costs must be incurred to accomplish expected tangible or intangible results.

The criteria and principles presented in this report are intended for application by agencies within the framework of their particular programs and responsibilities. While the agencies responsible for river basin planning are concerned with general economic welfare, it may not be possible for them to extend their economic analyses beyond the scope of their operations. For example, they may not be in a position to investigate certain broad economic questions relative to evaluation of competing or alternative programs with regard either to allocation of limited public funds for resource development or the relative desirability of alternative programs which may or may not have objectives in common.

An example of the latter is to be found in the general problem of providing sufficient food for the nation. If an increase is desired, the question naturally arises as to the most desirable way of accomplishing this goal. Theoretically, this may be achieved in at least three different ways—by more intensive development of existing agricultural land, by development of new land, or by imports from abroad. Each of these alternatives will vary in impact upon regional, national, and international levels, and will have varying effects in terms of financial requirements, foreign economic policy, and net costs to the Nation.

Thus, there are problems of Government economic policy which are beyond the responsibility of resource development agencies, but which affect, and are affected by, resource development programs. Likewise the total size of a national public works program at any particular time is determined in the light of fiscal and other factors which are independent of the considerations pertinent in the analysis of individual projects. Such questions are appropriately handled at a higher level of government. This report does not suggest means of integrating broader economic policies with resource development programs. While such integration is highly desirable, and while the procedures in this report are of use in such analysis, those matters are considered beyond the scope of this report.

The principles and procedures recommended herein are outlined in general terms only. If they are to be effective, it will be essential that the agencies concerned with analysis of river basin development programs apply these practices to their respective activities in such a way that the results will be comparable and compatible. This will require additional and continuing cooperation among agencies in working out details on the application of the recommended practices and on adjustments found advisable through experience.

## CHAPTER II

# Basic Principles and Concepts

The ultimate aim of river basin projects and programs, in common with all other productive activity, is to satisfy human needs and desires. The objective of economic analysis in planning river basin and watershed programs is to provide a guide for effective use of the required economic resources, such as land, labor, and materials, in producing goods and services to satisfy human wants by determining whether economic resources would be used more effectively than would be the case without the project.

Although it is recognized that public policy may be influenced by other than economic considerations, this report is concerned with the economics of project development and justification.

To be most effective, the economic analysis must be oriented to and be consistent with the following principles:

(1) The goods or services to be produced by a project have value only to the extent that there will be need and demand for the product.

(2) The most effective use of economic resources required for a project is made if they are utilized in such a way that the amount by which benefits exceed costs is at a maximum rather than in such a way as to produce a maximum benefit-cost ratio or on some other basis. Maximization of net benefits is a fundamental requirement for the formulation and economic justification of projects and programs.

(3) The project as well as any separable segment or increment thereof selected to accomplish a given purpose should be more economical than any other actual or potential available means, public or private, of accomplishing that specific purpose. The cost of making the product or service available by alternative means establishes a limit to the justified project investment for accomplishing a specific purpose.

(4) From an economic standpoint the order in which a number of projects should be undertaken should be based on their relative efficiency in use of economic resources. The economic analysis should, therefore, provide data which can ultimately be used for comparing the economic desirability of a number of justified projects. In this comparison consideration should be given to the relative significance of effects which cannot be measured in monetary terms. It should be recognized also that the selection of a project for development may change the relationship of remaining projects in the array since the project undertaken may affect the relative efficiencies of the remaining projects.

Information obtained from economic analyses may also be useful in allocating costs, establishing the bases for cost sharing and charges for project services, and for other purposes.

## VIEWPOINT FOR ECONOMIC ANALYSES

The viewpoint from which project effects are evaluated is a fundamental importance in meeting the objectives of economic analyses. A limited point of view as to what constitutes benefits and costs, such as that of one individual evaluating only the beneficial and detrimental effects upon himself, is obviously inadequate for public works projects. Similarly, a viewpoint such as might be taken by a group of individuals organized to undertake river basin development as a private enterprise or as a limited local public improvement would not necessarily include evaluation of effects on persons outside the group or local area involved. For Federal projects, a comprehensive public viewpoint should be taken. Such a viewpoint would include consideration of all effects, beneficial or adverse, short-range or long-range, that can be expected to be felt by all persons and groups in the project's entire zone of influence.

The adequacy of results obtainable in project formulation and in evaluation of the justification and relative desirability of projects depends on how completely all effects on individuals and society as a whole can be traced and evaluated in comparable terms with full allowance for off-setting effects and for time of occurrence. A summation of project effects, beneficial or adverse, to whomsoever they may accrue, in terms of market values would approach full coverage from a public viewpoint if allowance could be made in the summation for all transferences, cancellations, and offsets; i.e., values that are realized by one individual or group at the expense of some other individual or group.

In addition, however, from the standpoint of society as a whole there may be beneficial or adverse effects that would escape consideration in a summation of individual evaluations, as for example, effects on health and welfare, improvement of underdeveloped areas, value of resources conservation to future generations, and effects on national security. In applying the public viewpoint to economic analysis of projects it is essential that consideration be given to all effects of a project and that such effects be evaluated as completely as possible and on the same basis.

Although a public viewpoint is essential for project evaluation generally, other viewpoints may be applicable where assessment, repayment, or non-Federal participation is involved.

## BASIS FOR ECONOMIC EVALUATION

The problem of evaluating, from a public viewpoint, the extent to which a project accomplishes the aim of satisfying human needs and desires presents a major difficulty at the outset, because there are no common terms in which all effects of a project are normally expressed. All objects and activities which have the power of satisfying human wants and which may be increased or decreased in availability to satisfy such wants as a result of a project are referred to in this statement as "goods and services." The prices placed on goods and services through the exchange process afford a means of measuring the value attached to those goods and services by those who participate in the exchange, and provide a basis for evaluating project effects in monetary terms. It should be kept in mind, however, that the use of market price as a criterion for determining the worth of public projects

may involve certain deficiencies as well as present difficulties of measurement. Specifically, the price of a product or service in the private market may inadequately reflect its value from a public viewpoint. Rigidities in the economic system, the lack of complete consumer knowledge, patterns of income distribution, and the absence of an entirely satisfactory means of expressing the public viewpoint through purchase decisions, limit the area in which the private market can provide completely satisfactory standards for the evaluation of project effects. It is recognized, moreover, that certain effects of a project, such as improvement of health and enjoyment of recreation, have not been customarily evaluated in the monetary terms used in the market system.

Despite the limitation of the market price system in reflecting values from a public viewpoint, there is no other suitable framework for evaluating the effects of public works projects in common terms. Accordingly, the market price system is the starting point for formulation of principles for benefit-cost evaluation. Project effects which are ordinarily evaluated incompletely or not at all in actual exchange processes should be given, insofar as possible, an adjusted or estimated market value in monetary terms in order that all project effects may be summed up as completely as possible in the same terms. For example, improvement of health and provision of facilities for recreation should be evaluated in monetary terms as fully as possible. Intangibles, i.e., effects which are impracticable of being expressed adequately in monetary terms such as scenic values or prevention of loss of life, for example, should be considered and described in such a way that their importance and influence on project formulation and selection can be clearly indicated. As indicated in chapter IV, it may be desirable in some cases to provide uniform allowances of justifiable expenditure values for certain intangibles.

## BASIC CONCEPTS OF BENEFITS AND COSTS

Goods and services produced by or used for a project which are needed and limited in supply have economic value. As previously indicated, market prices provide the most practicable measure of the relative value of goods and services for meeting the various needs and demands.

Systematic treatment of all costs and benefits in an economic analysis is essential for consistency and comparability of results. The evaluation of a project and any alternatives should take into account all resource requirements necessary to realize project benefits.

### Terminology for Identifying Benefits and Costs

The term "project" as used in this study means any separable integral physical unit or several component and closely related units or features or system of measures, undertaken or to be undertaken within a specific area for the control and development of water and related land resources, which can be established and utilized independently or as an addition to an existing project, and can be considered as a separate entity for purposes of evaluation. Any combination or system of two or more interrelated projects is considered as a "program." Projects and programs may be undertaken by the Federal



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Government, by non-Federal interests, or jointly by the Federal Government and non-Federal interests.

*Project costs* are the value of the goods and services (land, labor, and materials) used for the establishment, maintenance, and operation of the project together with the value of any net induced adverse effects whether or not compensated for.

*Associated costs* are the value of the goods and services needed, over and above those included in the project costs, to make the immediate products or services of the project available for use or sale.

*Primary project benefits,* or primary benefits attributable to a project, are the value of products or services directly resulting from the project; net of all associated costs incurred in their realization.

*Attributable secondary benefits* are the secondary benefits attributable to a project from a national public point of view and are the values added over and above the value of primary benefits after taking account of expected conditions throughout the economy with and without the project. From this viewpoint, the secondary benefits properly attributable to a project for purposes of economic justification are the excess of secondary beneficial effects over the sum of: (a) the costs incurred in secondary activities; and (b) the net secondary benefits that would have been expected from other uses of project required resources. These contrast with the overall secondary benefits which, from a local or regional viewpoint are the total values added in secondary activities and are net of only the cost incurred in secondary activities. The overall secondary benefits may be appropriate for consideration in cost sharing determinations, in demonstrating the repayment potential of a project, and in illustrating the significance of projects from a local or regional point of view.

*Project benefits* for purposes of economic evaluation from a national public point of view are the sum of the primary project benefits and the attributable secondary benefits.

## EVALUATION OF BENEFITS AND COSTS

In identifying and evaluating the benefits and costs attributable to a project for purposes of economic analysis, account must be taken of the value of goods and services diverted to project purposes from other activities. Since there normally are other uses for the goods and services needed for river basin development projects, their value in such possible other uses are limitations of fundamental significance in determining benefits and costs attributable to such projects.

### Evaluation of Costs

When goods and services are utilized for any purpose, the economic effect of that action is to preclude their use for other purposes. The economic cost of using goods and services for project purposes is, in effect, the benefits foregone; i.e., the value that would have resulted from alternative uses. Under the usual conditions of relatively full employment there are other uses for the goods and services used in river basin projects. In such cases, it may reasonably be assumed that the goods and services used for project purposes are diverted from uses in which their consumptive or productive value would be approximately equal to the prices paid for them. Therefore, the market prices of the goods and services diverted into project uses may usually

be regarded as an adequate measure of the alternative uses foregone and of the economic cost. In the absence of an alternative use for goods and services required for a project, the economic cost of using them in the project is nil. In such exceptional cases, where a particular kind of goods or services would not be used in the absence of the project (such as labor during periods of unemployment) or where the expected opportunity for other use is of greater or less value than indicated by market prices of the goods and services used, an adjustment is necessary for proper accounting of costs. The concept of "alternative use value" is fundamental to project evaluation, whether the cost of the project "input" is measured by market prices or some other basis.

### Evaluation of Primary Project Benefits

Primary project benefits, as defined above, are the value of the immediate products or services of the project net of associated costs which are all costs other than project costs required for the realization of the benefits.

The immediate products (goods and services) of a project usually are the combined result of project costs and associated costs and include increases in production, reductions in costs, and advantageous effects on the time or certainty of income or cost accrual. These goods and services should be evaluated at the earliest stage for which estimated market prices are considered applicable. Where the market is considered reasonably adequate, the value of the products should be based on probable exchange values as measured by market prices expected to prevail at the time of benefit accrual. In the absence of an adequate competitive market, the expected cost of production by the most likely alternative source that would be utilized in the absence of the project may serve as a basis for measuring the value of goods and services. Adjustments to reflect the public value of lower prices or costs warrant consideration where such effects are attributable to a project as discussed under Price Levels in chapter IV.

The associated costs, which are deducted in deriving primary project benefits, are any costs involved in utilizing project services in the process of converting them into a form suitable for use or sale at the stage benefits are evaluated. Project costs include all costs necessary to provide the services for which the project is designed in a form available for initial use by immediate beneficiaries.

### Evaluation of Secondary Benefits

Secondary benefits as defined above are the increase in net incomes or other beneficial effects as a result of the project in activities stemming from or induced by the project. For use in project evaluation from a national public point of view, only the secondary benefits attributable to the project from that viewpoint should be considered, and account must be taken of the net incomes in such acitvities by processing similar products obtained from other sources or by utilizing the goods and services involved for some other productive activity. Secondary benefits are not attributable to the project from a national public viewpoint unless it can be shown that there is an increase in net incomes in such activities as a result of the project as compared with conditions to be expected in the absence of the project.

The increase in net income from secondary activities from other uses of resources in the absence of the project is usually not determinable, but allowance for such effects can be made through the use of assumptions considered reasonable. Under the expectations of a growing economy and relatively high levels of resources employment, applicable to all phases of the economic analysis, it may be expected that other uses would ordinarily be made of the resources required for the realization of project benefits. The value of production that may be expected in the absence of the project from other uses of project required resources should be based on the assumption of marginal uses of such resources. The increase in net income in secondary activities that might be expected with such nonproject uses represent values foregone, and hence must be deducted from increases in net income in secondary activities expected with the project in order to determine the net secondary benefits attributable to the project and available to justify project cost. Allowances for secondary effects from nonproject use of resources should be carried to a stage in the chain of economic activity comparable to that used in computing secondary effects from project use of resources. In the absence of data on the secondary benefits produced by primary investments in the general economy it may be assumed that the relationship between primary and secondary benefits from other uses of resources required for the project would usually be approximately the same as the relationship estimated for the project. Although secondary benefits may be significant in the economic justification of projects from a local or regional point of view or in reimbursement and assessment considerations, the assumptions indicated lead to the conclusion that from a national public point of view such benefits usually have little significance in project formulation, economic justification, and array.

## CHAPTER III

# Project and Program Formulation

The objectives of economic analysis set forth in chapter II indicate that proper formulation of projects is the core of the evaluation problem. The general objective of project formulation is to maximize net economic returns and human satisfactions from the economic resources used in a project. This requires that a project should be so designed as to include each separable segment or increment of scale of development which will provide benefits at least equal to the cost of that segment or increment. Separable segments or increments of size of a project are the smallest segments or increments on which there is a practical choice as to inclusion or omission from the project.

In the broad sense, the process of project and program formulation from beginning to end is largely a matter of weighing alternatives. For example, each route, site, or location is considered for possible development and the advantages and disadvantages of each relative to costs and ability to meet needs are appraised. By the process of elimination the most promising site or location is identified and tested to determine if development is justified. This nucleus or core is then further adjusted to arrive at the optimum scale of development at which the greatest net benefits will be produced.

The measurement of benefits and costs is an essential part of the process of formulating and selecting projects that will be economically sound and give the best possible combination of results in meeting the various objectives of river basin development. The process of formulation must also consider existing and probable future economic conditions, the probable need for the various results obtainable from river basin development, the physical possibilities for such development, and the most practicable plans available for realizing the desired objectives.

Although the principles and procedures discussed hereinafter are usually referred to in terms of analysis of a project, they apply as well to segments of projects and to analysis of river basin programs comprising a number of projects.

## ANALYSIS OF NEEDS AND AVAILABLE RESOURCES

An essential step in river basin studies is the analysis of the existing and potential needs or demands for the useful purposes which can be served by improvement and development of the resources of the river basins. This involves an estimate of what use, if any, will be made of the potential products or services of a project at the prices or values expected to be applicable to such products or services. Any potential products or services for which there is no foreseeable need or de-

mand within the range of prices expected to be applicable should either be excluded from the purposes of the project or assigned no value in the project economic analysis.

Consideration of the probable demand for project products or services in light of prospective economic conditions in the future period during which a project would be effective provides a basis for establishing the objectives for river basin development as a framework for further planning. These objectives can be expressed in terms of estimated demand for power at the rates expected to be applicable, the need for irrigation water to produce specific crops at the market prices expected to be applicable, the need for preventing damages from floods of the magnitude considered probable during the life of the project, etc.

Another essential step in river basin study is the examination and the analysis of the physical possibilities for improvement or development of the basin's resources to meet the needs or objectives. At all stages of such analysis—preliminary, intermediate, and final—the advantages and disadvantages of the various physical possibilities can and should be evaluated and compared in terms of benefits and costs, measured with successively increasing degrees of refinement, as required, to eliminate the obviously unjustified and least favorable possibilities, until the optimum plan of development is formulated. It should be stressed again that the process of formulation from beginning to end is largely a matter of weighing alternatives.

## ECONOMIC EVALUATION AND THE PROCESS OF PROJECT FORMULATION

Throughout the process of project formulation the physical effects of each plan or proposal must be measured and translated into benefits for comparison with the costs of the plan. Project benefits and project costs should be estimated in accordance with the principles outlined in chapter II. Problems and procedures for measurement of benefits and costs are discussed further in chapters IV and V.

An important phase in the formulation process is the comparison of each plan or proposal with possible alternative means of accomplishing the project purposes.

## ESTABLISHING SCALE OF DEVELOPMENT ON THE BASIS OF BENEFIT-COST ANALYSIS

As a starting point for the analysis of the possibilities for river basin development to meet any given objective, it is usually necessary to analyze a specific initial proposal. This is usually a nucleus of development which may be selected on the basis of judgment through the consideration of the initial data available and which appears to offer possibilities of meeting the objective wholly or partly. After the initial proposal or nucleus of development has been selected for analysis and its benefits and costs measured, consideration can be given to scales of development greater or less than the selected nucleus. This applies to: (1) variations in scope of each purpose of a single project, (2) additions or omissions of projects from a program, and (3) inclusion or exclusion of specific purposes from a project or program.

As previously indicated, the optimum scale of development is that at which the net benefits are at a maximum. Net benefits are max-

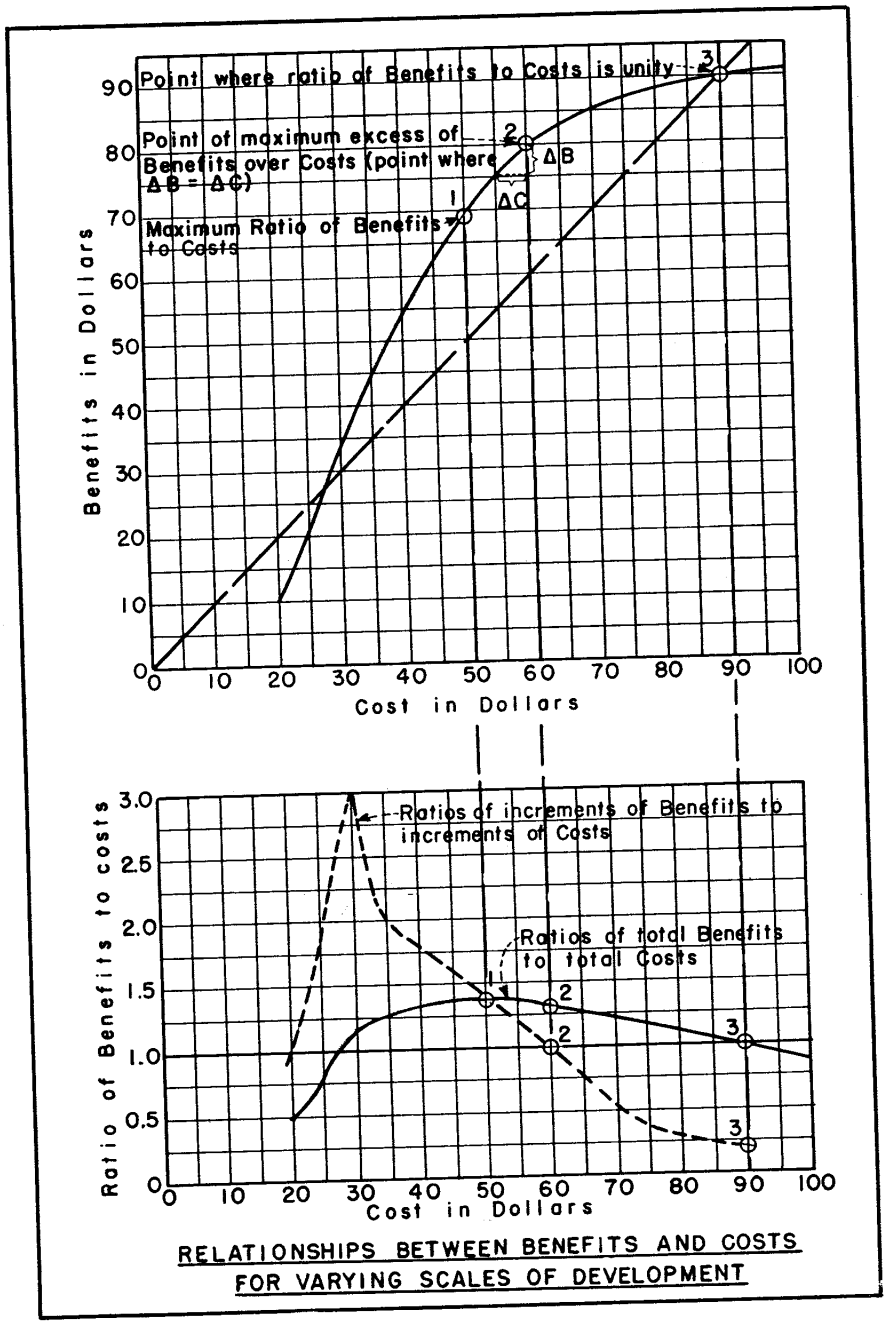
Point where ratio of Benefits to Costs is unity
Point of maximum excess of Benefits over Costs (point where ΔB = ΔC)
Maximum Ratio of Benefits to Costs
ΔB
ΔC
Benefits in Dollars
Cost in Dollars
Ratios of increments of Benefits to increments of Costs
Ratios of total Benefits to total Costs
Ratio of Benefits to costs
Cost in Dollars
RELATIONSHIPS BETWEEN BENEFITS AND COSTS FOR VARYING SCALES OF DEVELOPMENT

FIGURE 1

imized if the scale of development is extended to the point where the benefits added by the last increment of scale or scope are equal to the costs of adding that increment. The increments to be considered in this way are the smallest increments on which there is a practical choice as to inclusion in or omission from the project. The same principle applies when selecting a number of projects to form a program or system of projects to meet a given objective. To be justified for inclusion in a plan, each project in a group, each purpose of a project, and each separable segment of a project should add as much or more benefits than it adds costs. In practice, these principles should be applied at all stages of project analysis with successively increasing degrees of refinement until the numerous alternatives are reduced to those which it is practicable to analyze in detail.

Expressed in mathematical terms, three points in the possible scale of development of a project which are significant in the formulation of projects are shown on figure 1 on page 13. First (point 1 on fig. 1) is the scale of development at which the ratio of benefits to costs is the greatest. Second (point 2 on fig. 1) is the scale at which the benefits exceed costs by the maximum amount. Third (point 3 on fig. 1) is the scale at which the project benefits equal project costs.

If the scale of project development were established at point 1, the rate of benefit accrual per unit of cost would be at a maximum but the full economic possibilities of the site would not be utilized as there remain additional increments of development for which the benefits exceed the costs.

At point 2, the cost of adding the last increment in scale of development is equal to the added benefits resulting from that increment. At this point the total benefits exceed total costs by the maximum. Extension of the scale of development beyond this point would require expenditures in excess of the benefits added. Such extension would not be economically justified.

Between point 2 and point 3, although the overall ratio of benefits to costs is unity or better, the benefits added by each increment in scale of development are less than the costs of adding that increment. Extension of the scale of development into this zone is not economically justified.

## CONSIDERATION OF OTHER AVAILABLE MEANS OF ACCOMPLISHING PROJECT PURPOSES

At various stages of project formulation, the program, project, or segment of a project under consideration must also satisfy the criterion that it would be more economical than any other actual or potential available means, public or private, of accomplishing the specific purpose involved. A program, project, or segment of a project should not be undertaken if it would preclude development of any other means of accomplishing the same results at less cost. This limitation applies to alternative possibilities which would be displaced or economically precluded from development if the project is undertaken. Other means of obtaining similar benefits which would not be precluded from development are not limitations on project justification but are, in effect, additional projects which may be compared in an array to determine which should be given prior consideration from the standpoint of economic desirability.

The alternative possibilities to be considered in applying this limi-

tation should include all practicable means of accomplishing the desired results which are within the purview of the agency making the economic analysis. In theory, the broadest possible range of alternatives for any given objective should be considered but it is recognized that in practice, the range of alternatives that can be considered at regional levels may be limited by the information available at such levels. Also, there may be alternative possibilities which are outside the purview of or not known to an agency responsible for project analysis. Nevertheless, consideration of alternatives on the broadest possible basis should be given at all levels of responsibility and necessary information for that purpose should be exchanged among the Federal agencies involved and utilized at appropriate levels of project analysis and review.

## ANALYSIS OF JUSTIFICATION

In summary, a project is properly formulated and economically justified if: (1) project benefits exceed project costs; (2) each separable segment or purpose provides benefits at least equal to its costs; (3) the scale of development is such as to provide the maximum net benefits; and (4) there are no more economical means of accomplishing the same purpose which would be precluded from development if the project were undertaken. If all effects of projects could be evaluated in comparable monetary terms, further analysis of justification would be unnecessary. In some cases, however, the intangibles, that is, effects which cannot be adequately expressed as benefits or costs in monetary terms, may be of sufficient importance to warrant consideration in the formulation and selection of projects. In such cases, if the scale of development is extended or curtailed as compared with the scale indicated on the basis of tangible benefits and costs or if purposes are included or excluded because of intangible or other considerations, effects of such action in terms of increasing or reducing costs or benefits should be clearly stated. This is necessary to indicate the extent of departure of the final project recommendations from those that would have been made if based solely on tangible factors, evaluated in monetary terms.

## COMPARISON OF RELATIVE ECONOMIC VALUE OF JUSTIFIED PROJECTS

All projects which satisfactorily meet the criteria outlined herein will necessarily be economically justified. Economic comparisons of such projects may be made by several methods described below.

(1) A comparison of the respective amounts of excess of benefits over costs for several projects would indicate which projects would produce the greatest net benefits but would afford no comparison of the relative costs of realizing such benefits. Two projects with equal surpluses of benefits would appear equally desirable in such a comparison even though the costs of one might be several times that of the other. This method of comparison would be useful only if relative costs were no object.

(2) A comparison of the rates of return on the respective investments in several projects can be made by computing the percentage relation of the excess of annual benefits over annual costs to the investment in each case. Under this method comparison of respective operation and

maintenance costs is incomplete, since they are deducted before computation of percentages. The method has a limited usefulness, as for example, for determining the relative desirability of projects when construction funds are limited and when the relative cost of operation and maintenance is considered of secondary importance.

(3) The ratio of benefits to costs reflects both benefit and cost values and is the recommended basis for comparison of projects. If the sum of all beneficial effects were compared with the sum of all adverse effects for a project, the ratio of the benefits to the costs would reflect the effectiveness with which all the resources involved were being used. The procedures recommended herein are based on the assumption that, in general, the economic resources involved in the project development over and above those accounted for in project benefits and project costs would be used with equal effectiveness with or without the project. Therefore, a ratio of project benefits to project costs constitutes a useful measure of the effectiveness of use of the Nation's resources insofar as the use of such resources for project purposes is concerned. In the usual case, the relative desirability of a number of projects for which net benefits are at the maximum can be satisfactorily indicated by comparing their ratios of project benefits to project costs. In cases where nonproject costs (associated) are of special significance or vary greatly among the projects being compared, a comparison of the sum of project and nonproject costs with the gross benefits resulting therefrom may prove desirable.

## CHAPTER IV

# Measurement of Benefits and Costs

The use of benefits and costs in connection with the formulation and the justification of water control projects requires measurement in common terms. In placing benefits and costs on a sound and comparable basis, questions involving standards, problems, and procedures of measurement must be recognized and properly resolved. The measurement procedures must include consideration of the various types or classes of benefits and costs. The measurement standards relate to price levels, interest rates, risk allowances, and period of analysis including consideration of amortization of investment and salvage values. Particular problems of measurement include the treatment of tangibles and intangibles, adjustments for levels of economic activity, costs of affected public facilities, acquisition of land and improvements, taxes, displaced facilities, extension of useful life, and consequential damages.

### GENERAL PROCEDURE FOR MEASUREMENT OF BENEFITS AND COSTS

Translation of the physical effects of a project into benefits and costs involves estimates of the values of the increases and decreases in goods and services under future conditions with and without the project. For the purposes of economic analysis, the benefits and costs should be measured from the same viewpoint, to a comparable degree and on comparable bases for time of occurrence and other factors. Starting with an estimate of the expected physical effects of a project, it is necessary to evaluate those effects in monetary terms. As discussed in chapter II, a market price basis is considered the best available approach for such evaluation. The economic life of the project must be estimated and prices expected to be applicable during that time must be projected. Then, by applying measurement principles and standards, such as those for interest or discount, risk, and other factors, the benefits and costs of a project can be evaluated in monetary terms and reduced to a common time basis for comparison. Usually, it should prove most convenient to express benefits and costs in terms of their equivalent average annual value over the selected period of analysis. This is the basis recommended for use by all agencies to attain uniformity and comparability in project analyses. Other bases which put all effects on a common time basis, such as in terms of present worth as of the time of initiation or completion of the project, would be acceptable also, but, in most cases, the average annual basis appears most convenient.

## Measurement of Tangible Benefits

For convenience in measurement, tangible benefits have been classified in two categories; primary and secondary. The amount of benefits of each type attributable to the project is the difference in the amounts of that type estimated as likely to accrue under conditions expected with and without the project. Beneficial effects of a project should be assigned monetary values by directly applying projected market prices or derived prices based on projected costs of production by alternative means. Predictable risks may be accounted for by direct adjustment of benefit estimates. Benefits may be conservatively estimated in order to provide allowance for unpredictable risks. All benefits should be converted to a common time basis, usually in terms of an average annual amount over the period of analysis. Benefits which accrue on other than a uniform annual basis should be converted to an equivalent average annual amount by applying the appropriate interest rate.

*Primary project benefits* should usually be evaluated at the first point in the chain of effects of a project where the products or services have an actual or estimated market value. In some cases, a market price estimated from the most likely alternative cost of production of the products or services may be the measure of value.

*Attributable secondary benefits* are more difficult to appraise and their measurement requires estimates of the net income from secondary activities with and without the project; that is, the difference under the two conditions in the total value of the product of such activities and the costs necessary to produce such values. Any increase in net income to processors or savings to consumers in secondary activities under conditions to be expected with the project, as compared with the net income or savings from similar secondary activities probable under conditions to be expected without the project may be credited as secondary benefits attributable to the project.

## Measurement of Tangible Costs

There are two basic classes of tangible costs to be measured: (1) project costs which are to be compared with project benefits; and (2) nonproject costs, which are the associated costs which must be deducted from overall benefits to obtain project benefits. All costs are measured on the basis of the value of the benefits foregone through the use of goods and services for the project and related activities rather than for other uses. Usually market prices are the best available measure of such value, but, in some cases, they should be adjusted to allow for lower value in alternative uses, as discussed later in this chapter under Adjustments for Levels of Economic Activity.

*Project costs* include the initial investment in land, labor, and materials and subsequent costs for replacements and for operation and maintenance. Costs of post-authorization investigations, interest during construction, engineering, inspection, administration, and overhead in general should be included. Also included are costs induced by the project even when actual compensation is not involved. Project costs should be evaluated in terms of prices expected to be applicable at the time costs are incurred. As in the case of benefits, project costs should be converted to a common time basis, usually the average annual equivalent. The rate of interest for computing the charges for

interest and amortization of the investment over the economic life of the project and for discounting deferred costs should be applied as discussed later in this chapter under General Measurement Standards.

*Associated costs* are measured on the basis of the same principles and standards applicable to other project effects. Such costs should be measured to a degree comparable with that used in measuring benefits and should be deducted from overall benefit estimates to obtain project benefits comparable to project costs.

## GENERAL MEASUREMENT STANDARDS

The benefits and costs of projects occur in diverse physical forms, at different times, and over varying periods of time. It is necessary to bring these effects to a common basis of measurement to permit sound comparison of benefits with costs in a particular project, and to permit comparison of various projects. The most convenient and widely recognized basis for doing this is the monetary unit.

The use of the monetary unit for translating project benefits and costs to a basis permitting their comparison and comparison between projects entails selection of consistent standards. These standards necessarily include the prices by which the physical effects of a project are translated into monetary values, the interest and discount rates by which these effects are translated to a common time and risk basis, and the selection of a period of analysis for a project.

As discussed in the paragraphs below, standards selected as applicable from a comprehensive public viewpoint may vary from standards considered appropriate for an evaluation from the viewpoint of an individual or a local interest. While measurement standards indicative of the total interests of society are considered appropriate for evaluation from a comprehensive public viewpoint, there often are no practical or acceptable measures of values as appraised from such a viewpoint. Measurement from such a viewpoint requires reliance upon theoretical assumptions for which verification is frequently difficult if not impossible. Also, the practical problem of obtaining acceptance of these results may limit the extent to which the public viewpoint standards might be applied.

For example, valuation from a comprehensive public viewpoint should logically be in terms of dollars of constant rather than of varying purchasing power. The discount rate and risk allowance which might indicate the value of benefits and costs to society as a whole will frequently be different from those in actual usage and to which beneficiaries or bearers of costs are accustomed. Also, the treatment of such problems as taxes, ownership transfers, public facilities, and other types of problems involving compensatory offsets that need to be considered in a public viewpoint evaluation are sometimes at variance with customary concepts.

### Price Levels

As pointed out in chapter II, market prices established under competitive economic conditions may be assumed to reflect the demand for products and services and their cost of production. Price standards for project evaluation should reflect the exchange values of the goods and services involved, and, in addition, should take account of variations in the abundance or scarcity of all goods and services as

reflected in general price levels under various conditions of resource employment (use of labor, materials, and other productive resources).

The real cost to society of the resources used for project and program construction and operation is measured primarily by the amount of other goods and services for which such resources could be exchanged at the time when they are to be used. Similarly, the real value of benefits is measured primarily by the amount of goods and services for which the benefits could be exchanged at the time they become available. If the degree of resource employment were to remain constant, prices reflecting these real exchange values would provide an adequate basis for project evaluation. Since this is not likely to be the case, it is also necessary to take account of the effects that various conditions or levels of resource employment have upon the price basis for project evaluation.

Variations in the degree of resource employment affect the values of the resources invested in a project. During periods of full employment, the resources required for investment in a project are scarce in the sense that the available supply of such resources is approaching full utilization. Conversely, resources are comparatively more abundant during periods when they are not fully employed. The general level of prices tends to fluctuate with the levels of resource employment and, therefore, provides a practicable measure of the changes in the values attached to goods and services because of their relative abundance or scarcity under varying levels of resource employment. Fluctuations in the general price level provide, therefore, a means of measuring in monetary terms the difference between the relative abundance or scarcity of the resources invested in a project at the time of development and the relative abundance or scarcity of resources at the time benefits are realized.

The prices used in project evaluation should exclude, however, effects resulting from changes in the value of the dollar over a long term. For example, a long-term, continuing depreciation in the value of the dollar would have the effect of increasing the monetary value of the future benefits of a project without increasing their value in exchange for other commodities. From the standpoint of society as a whole, any increase in the monetary value of benefits attributable solely to such a depreciation in the value of the dollar does not constitute a real benefit in the form of goods and services produced, and should not be included in an economic analysis for ascertaining the justification of a project. Deflationary shifts in long-term average prices should similarly be excluded.

Accordingly, for purposes of economic evaluation, it is appropriate to develop price projections. The projections for particular goods and services should be geared to the average of general prices that would be expected to prevail throughout the period of analysis if there were no inflationary or deflationary trends as discussed above. A projection at a level reflecting a growing economy and high employment conditions is believed warranted as the basis for estimating the average long-term price levels and relationships that may reasonably be expected to prevail over a period long enough to be applicable to extended periods of analysis. The price projections accordingly should be based on the anticipation that only moderate fluctuations in general prices will occur around the projected long-term average level.

Economic analysis of river basin developments in accordance with the foregoing principles involves using prices reasonably expected to

prevail at the time costs are incurred and at the time benefits are realized in terms of a constant general price level. Long-term projected prices provide an appropriate basis for estimating the value of projected benefits and recurring or deferred costs of operation, maintenance, and replacement, as well as the costs of deferred construction and installation. When the time of installation is deferred or indefinite, long-term projected prices are considered appropriate also for estimating initial construction costs. In some cases it may be desirable to present estimates of the costs of the initial construction of such deferred items on a current price base also. Where construction is expected or scheduled for early accomplishment, prices prevailing at the time of the economic analysis should be used for measuring the initial construction and installation costs. Evaluations made on this basis may be supplemented by analyses based on projected prices. When benefits are expressed in terms of the cost of an alternative means of producing goods and services, the prices for estimating alternative costs should be those expected to prevail at the time that they would be incurred.

The analysis should be brought up-to-date as required to reflect significant changes in previous assumptions on prices and employment conditions.

In order to apply the procedure proposed, it is necessary to prepare and, from time to time, revise the estimates of long-term projected prices that are to be used in the economic analysis of projects. Also, national long-term projected prices may require adjustments to reflect area and regional conditions before being used in the economic analysis of a project. The specific local long-term projected prices can usually be estimated by considering that they bear the same relationship to national long-term projected prices as the local prices during a base period bear to national prices during the base period. This involves an assumption that the future differences between the prices in the local area and the nation as a whole will be the same as those prevailing during the base period. The base period used should usually be a recent period of several years in order to reduce the effect of abnormal relationships between area and national average prices for any single year. Special consideration should be given to the infrequent case where a shift from a deficit to a surplus production area occurs, or vice versa. Such a change could materially affect the relationship between area and national average prices.

Whenever the project production is expected to influence market prices significantly, the use of a price about midway between those expected with and without the project may be justified to reflect the public values involved. However, the difficulty of estimating such effects with reasonable assurance will often necessitate treating them as intangibles.

It is recognized that adjustments or allowances may be necessary in using the projected prices for purposes other than project formulation and evaluation; for example, in repayment analyses.

*Summary of recommendations on price levels.* In order to satisfy the various purposes to be served by benefit-cost analyses, the use of prices reasonably expected to prevail at the time costs are incurred and at the time benefits are realized, in terms of a constant general price level, is recommended. Projected prices for the period of analysis should be used as the basis for evaluating project benefits, as well as all costs of operation, maintenance, replacements, and deferred con-

struction and installation. Long-term projected prices are also considered appropriate for estimating initial investment costs when the time of installation or construction of the project is deferred or indefinite. In this case it may be desirable to present the estimates of initial investment costs on a current price basis also. The projected general price level should reflect high employment conditions and stability in the long-term value of the dollar.

For projects or portions of a program expected to be placed under construction at an early date, prices current at the time of the analysis should be used in estimating construction and installation costs. It may be useful to supplement current cost estimates with costs based on long-term projected prices.

When benefits are expressed in terms of the cost of a justifiable alternative source of the benefits, the prices for the alternative costs should be the prices expected to prevail at the time the alternative costs would be incurred.

### Interest and Discount Rates and Risk Allowances

The values attached to benefits and costs at their time of accrual can be made comparable only after conversion to an equivalent basis for time and degree of certainty of occurrence. Interest and discount rates and risk allowances provide a means for giving monetary expression to differences in the time and certainty of occurrence of benefits and costs.

Prevailing interest and discount rates for loans and investments usually reflect both the "time" and "risk" elements. The wide range in such rates arises largely out of differences in the estimated risk on various types of loans or investments. However, ways other than adjustments in the interest and discount rate are available in benefit-cost analysis for treating at least part of the risk associated with a particular project. To the extent feasible, direct or specific risk allowances should be made. This would leave the interest or discount rate with the primary function of adjusting estimates for time of occurrence plus residual risks. It would be expected, however, that the total allowance for risk and interest appropriate in the analysis of a Federal project would be comparable with such allowance for private undertakings involving similar risk, uncertainty, and longevity.

*Risk allowances.* Adjustments for risk take account of the hazards and uncertainties that intervene between the commitment or investment of resources and the accrual of benefits. There are two principal types or categories of risk for which allowance must be made in benefit-cost analysis. One type is predictable, since bases are available to calculate the probability or frequency of losses associated with its occurrence. For predictable risks, the value attached may be converted into a reasonably certain annual amount, either through insurance or an appropriate allowance. To the extent feasible, the value of all predictable risks should be converted to an annual or present worth basis and allowed for either as a deduction from benefits or as an addition to project costs. For example, where losses from fires, storms, pests, and diseases, or the costs of their prevention, if such is possible, can be estimated with reasonable assurance, the returns available to justify investment costs should be reduced accordingly. The estimates of the resulting net returns would thus be as free as possible of all predictable risks.

Risks in the form of uncertainties for which no appropriate basis is available for prediction include the probability of errors in estimating benefits and costs due to such factors as fluctuations in the levels of economic activity, technological changes and innovations, and other unforeseeable developments adversely affecting the cost or value of project services. Risk allowances for this group of uncertainties must be based largely upon judgment, since precise information is not available for calculating their value.

Methods of allowing for uncertainties or unpredictable risks include the use of estimates of benefits that are reasonably conservative; the assumption of a limited economic life, with minimum allowances for salvage, which results in amortization of costs within the limited economic life (see following section); a risk component in the discount rate, safety margin requirements in project formulation, such as designing projects short of the marginal limit on scale of development or including a contingency reserve in project costs to cover unforeseeable developments; and finally, selection only of the more desirable projects.

*Summary of recommendations on risk.* It is recommended that net returns exclude all predictable risks, either by deducting them from benefits or adding them to project costs, usually on a present worth or annual equivalent basis. Allowance for uncertainties or unpredictable risks in benefit accrual should be made indirectly by use of conservative estimates of net benefits, requirement of safety margins in planning, or including a risk component in the discount rate.

*Interest and discount rates.* The monetary values of benefits and costs that accrue at varying times are comparable only if all are adjusted to a uniform time basis. The use of interest rates provides a means for converting estimates to a common time point or period.

Interest and discount arise because of the competing demands that exist for limited supplies of savings available for capital investments yielding returns in the future. The demand for savings stems largely from the opportunities for productive use of capital. With the supply of existing capital and savings limited, opportunities exist for new capital investment that over a period of time will yield a return in excess of the initial investment involved. Thus, the opportunities of obtaining net returns over costs from the utilization of income-yielding goods constitute a major source of demand for savings. The supply of individual savings available for investment is limited principally by the preference of individuals for present over future goods. Because of the higher valuations that individuals place on present goods, a payment in the form of interest is needed to induce savings and compensate for the current use that is foregone. Consequently, interest rates may be considered as an expression of the exchange relationship between present and future goods. This premium or interest rate is the added value of having resources presently available in comparison with future values. For comparison with present costs, the determination of the present worth of goods available in the future involves scaling down or discounting their future values.

With limited amounts of resources available for capital investment, the interest cost of investing such resources in a water development is measured by the rate of return that would be realized if the capital were invested in other uses of comparable risk and duration. This cost is over and above allowances for risk and arises whether a private



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or public viewpoint is involved. As explained in the preceding section, adequate allowance for risk should be made, to the fullest practicable extent, in the estimates of benefits and costs. On this basis, the minimum interest rate appropriate for use in project evaluation for converting estimates of benefits and costs to a common time basis is the risk-free return expected to be realized on capital invested in alternative uses. At a given time this rate is the projected average rate of return; i.e., yield, expected to prevail over the period of analysis, in the absence of inflationary or deflationary changes in the general price level, on such relatively risk-free investments as long-term Government bonds. Although apparently involving considerations generally similar to those in the projection of prices, only limited attention has been given to the problem of developing projected interest rates. Pending development of a projected rate, the average yield on long-term Federal bonds (preferably rounded to the nearest ¼ percent) over a sufficiently long period of time to average out the influence of cyclical fluctuations might be uniformly used by all agencies as an approximation of the expected long-term, essentially risk-free rate.

Use of the minimum risk-free rate assumes that risk elements have been adequately accounted for in the calculations of benefits and costs. If it is found impracticable or impossible to make the estimates of project effects on a risk-free basis, the risk allowance would have to be accounted for by an increment in the interest or discount rate applied to deferred effects. These considerations are of particular significance in evaluating associated costs and converting benefits to present worth or to a uniform annual rate. Thus, in the evaluation of associated costs and irregularly accruing benefits it should be recognized that the relatively risk-free long-term interest rates are inappropriate. The recommended interest rates for evaluating these effects should be those considered to be applicable to participants after analysis of the specific situation.

The economic analysis should also include a comparison of the cost of a project or increment thereof with available alternative means of accomplishing the specific purposes involved. In making such comparisons the project basis for treating interest should also be used for the alternative, with any necessary adjustments for differences in risk.

*Summary of interest rate recommendations.* It is recommended that estimates of benefits and costs accruing at various times should be made comparable by adjustment to a uniform time basis through the use of projected long-range interest rates. Pending the development of such rates, the average rate of return; i.e., yield, on long-term Federal bonds over a sufficiently long period of time to average out the influence of cyclical fluctuations is considered appropriate for uniform application by all agencies on the condition that adequate allowance has been made for uncertainties and risks. If such allowance is not possible, a component for risk should be included in the interest rate as may be the case for irregularly accruing benefits and associated costs. In comparing the cost of a project or increment thereof with alternative means of accomplishing the purposes involved, the treatment of interest for the alternative should be on a basis comparable with that of the project, with any necessary adjustments for differences in risk.

## Period of Analysis

A number of economic and physical forces limit the economic life of any project. Physical depreciation, obsolescence, changing requirements for project services, and time discount and allowances for risk and uncertainty may limit the present value of future project services. The upper limit of the economic life of a project is reached when the foregoing factors cause the costs of continuing the project to exceed the additional benefits expected from continuation. As so used, the economic life is generally less, and never more, than the physical life of a project.

Although the economic life of a project establishes an upper limit on the period of analysis, it may be desirable to use a period short of this limit for economic analysis in order to provide additional allowance for risk. Conservative estimates of salvage values and of the productive life of initial installations and of replacements, and allowances for operation and maintenance sufficient to provide full operating conditions throughout the period of analysis, justify reducing other allowances for risk and uncertainty.

Furthermore, in certain cases it may be advantageous to gear the period of analysis to the expected economic life of the major initial structure, or, where there is considerable variation in the expected life for various purposes, the probable life for each purpose may be used. The decision whether or not to replace the project at the end of the productive life of the basic structure can be made at a later time and is not an essential consideration or a necessary part of the initial project formulation or justification. In the case of major structural replacements, such as a set of navigation locks, the period of analysis needs to be of sufficient length to cover only the benefits and costs associated with the first or initial cycle of a project, even though economic life may be extended through successive replacements.

The difficulties and the uncertainty associated with estimating the value of remote effects provide another justification for limiting the period of analysis. Even though the character of the basic structures may allow an extended economic life, or the possibilities of replacement may be such as to suggest a continuing life, the limitations on the reliability of estimates projected into the distant future and their small present value when discounted provide reasons for selecting a maximum evaluation period.

It is recommended that a period of analysis of 100 years be considered as the *upper limit* on economic life. In cases where obsolescence is likely to be an important factor, use of an economic life substantially less than this upper limit, possibly not exceeding 50 years, may be warranted. Justification for the 100-year upper limit lies in the increasing uncertainty involved in predicting the more remote future and in the likelihood that any benefits and costs accruing beyond a 100-year cutoff would be largely offsetting in their amounts. Because of the low present worth of remote benefits, any benefits accruing beyond a 100-year period will seldom change the benefit-cost estimates significantly.

Any resources remaining at the end of the period of analysis should be valued in terms of their nonproject uses. For example, in the case of land, the salvage value should be based on its potential use at the

termination of the project, but not to exceed the initial cost or value of the land adjusted for any improvement or damages resulting from the project. For most other remaining resources, the salvage value would be either junk values or values of such goods for use in other locations, after allowance for transportation or reinstallation.

Establishing the length of the period of analysis and the basis for salvage determines the amortization period and the amount of the net capital investment to be amortized. The amortization charge should be sufficient to cover all capital investment costs in excess of salvage during the period of analysis. Either of the two common methods for treating salvage give approximately the same results. One is the deduction of the present worth of salvage from the present investment cost, with the remainder amortized over the period of analysis. The other is to charge interest on the total investment but to amortize only the investment cost in excess of the value of salvage remaining at the end of the period.

The logical basis for estimating benefits and costs accruing during the period of analysis should be in accordance with the changes in productivity or operating capacity expected during the assumed economic life. However, the difficulty of forecasting the rate at which project services are likely to change in amount often necessitates estimates being made on the assumption of full operating capacity throughout the project life. Such procedure in the case where output declines over the course of a project's useful life is likely to overestimate somewhat both benefits and costs. Although the net significance of this procedure is not likely to be serious in the usual case, it may be necessary in the case of some projects to gear estimates to expected levels of operating capacity in calculating both benefits and costs.

*Recommendations.* It is recommended that the maximum period of analysis be the expected economic life of the project or 100 years, whichever is shorter. Even for projects involving basic structures of more extended life and those having continuing replacement possibilities, it is recommended that a 100-year period of analysis be considered as the *upper limit* on economic life. Any allowance for salvage should be based on the expected value in nonproject uses at the end of the period of analysis. The amortization charge should be sufficient to cover the capital investment during the period of analysis, calculated on a sinking fund basis using the investment cost interest rates. Except in special cases, the basis for estimating benefits and costs should be under the assumption of maintaining the project at full operating capacity.

## MEASUREMENT PROBLEMS

Adoption of the foregoing general measurement standards by the several agencies dealing with river basin planning would improve the quality of project analyses and the ease of understanding them. In addition, more uniform handling of certain measurement problems will be similarly beneficial. These problems include the treatment of tangible and intangible effects; the adjustments necessary to allow for levels of economic activity; the treatment of costs of affected public facilities; the nature of the recognition of costs of acquiring land and improvements; the treatment of taxes; measurement of the value of extending the useful life of a nonproject facility; analysis of displaced or abandoned facilities; and the handling of consequential damages.

These problems are outlined below and recommendations made as to sound means of treating them.

### Treatment of Tangible and Intangible Effects

The tangible effects of a project are, for the purpose of this report, defined as those measurable in monetary terms, and the intangible effects are those which cannot be measured satisfactorily in monetary terms. Most of the tangible effects of projects, whether benefits or costs, can be evaluated on the basis of market prices. Some tangible effects cannot be evaluated directly on the basis of market prices, but their values may in some cases be derived or estimated indirectly from prices established in the market for similar or analogous effects or may be derived from the most economical cost of producing similar effects by an alternative means. Certain effects that can be measured in physical units but for which no market values exist, such as prevention of loss of life or improvement of health may be assigned values for uniformity of treatment in economic evaluation and formulation of projects, on the basis of agreed upon estimates of acceptable expenditures for these items. Other effects cannot be evaluated in monetary terms by any satisfactory device and so are called intangible.

These intangible effects need to be described with care and should not be overlooked or minimized, merely because they are not susceptible of dollar evalution. Intangible costs may involve such effects as the possible loss of a scenic or historic site in connection with a proposed dam. On the other hand, intangible benefits may in some cases embrace such effects as the strengthening of national security and regional economies through the encouragement of a more widely dispersed industry and the provision of opportunities for new homes, new investment, and new employment opportunities; and the provision of new avenues for the enjoyment of recreation and wildlife.

Project effects that cannot be given monetary values should be recognized. If intangible effects are considered sufficiently significant to influence either project formulation or selection, it is important that intangible benefits and intangible costs be considered to a comparable extent. Since there may be general intangible effects from any economic activity, any intangible benefits or costs from using economic resources for project purposes must be considered in the light of those that would arise in the absence of the project. If specific intangible effects are considered important enough to influence the recommendation for or against project development, the value attached to such specific intangible effects should be indicated. This may result in either curtailing or expanding the scale of development as compared with that justified by tangible effects.

*Recommendations.* All project effects, both tangible and intangible, should be fully considered in making project recommendations. Project effects should be evaluated in monetary terms to the maximum extent practicable. If market prices are not available, estimated, derived or agreed upon values may be appropriate in some cases. In other cases, intangible effects will need to be considered on a qualitative basis. If the recommended degree of project development is influenced in either direction by specific intangible effects, the value assigned to such effects should be clearly indicated. It is suggested that the agencies concerned develop procedures for the treatment of intangibles including assignment of acceptable project expenditure values for effects that are measurable in physical units for which no market values exist.

### Adjustments for Levels of Economic Activity

From a public viewpoint, the cost of using labor and other economic resources for project purposes is measurable in terms of the benefits foregone from the most likely other uses that would be made of such labor and economic resources. During times when labor and other economic resources are relatively fully employed, market prices represent an adequate measure of the value of benefits foregone, but during times of relatively low economic activity, the reduction in or the lack of opportunities for nonproject uses of economic resources may warrant adjustment of the usual market-price evaluation of project costs.

In the usual case, adjustment of project costs to take account of variations in the level of economic activity should not be made in project formulation and long-range project analyses. During times of relatively low economic activity, however, it may be appropriate to analyze the effect of the lack of opportunities for alternative use for labor and other resources in the analysis of projects considered for construction under such conditions.

With but few exceptions, economic resources other than labor are not lost if not used at any given time. Adjustments of market-price evaluations of project costs will, therefore, usually be necessary only for the direct labor employed on the project.

For direct labor an estimate can be made of the amount which the project would employ and which would be unemployed if the project is not undertaken, taking into account such factors as the specific labor market area for the particular project and probable duration of unemployment conditions. During such periods consideration should be also given to any intangible advantages of using the labor that would otherwise be unemployed.

In times of relatively low economic activity, a project may result in employment of labor in secondary activities that would otherwise be unemployed and may result in use of otherwise idle plant capacity. The project can be credited only with the difference between such secondary effects resulting from the project and similar effects of any comparable increase in economic activity likely to be undertaken in the absence of the project. The net effect creditable to the project would be difficult to measure and should usually be regarded as intangible.

*Recommendations.* Except in unusual instances projects should be formulated and analyzed under the assumption of a relatively high level of resource employment. If a project is expected to be undertaken during periods of low economic activity, consideration should be given to the advantageous effects of using labor that would otherwise be unemployed.

### Treatment of Costs of Affected Public Facilities

If existing public facilities such as streets, roads, schools, and similar works are free of debt, a substantial part of their value is probably reflected in the market value of surrounding land. The market price paid for land usually includes much of the value of debt-free public facilities serving these lands. Debts for public facilities to be paid from future land taxes tend to lower the market value of property served by the facilities. The market value of such property tends to reflect the capitalization of the expected net income from the property less tax charges anticipated on account of the bonded indebtedness.

Accordingly, the allowance in project cost for acquiring privately owned land and other property should include both the market price to be paid for the property and the amount of remaining bonded indebtedness, if any, applicable to that property on account of public facilities.

In practice, it may prove necessary to pay school districts, towns, counties, or other governmental units for public improvements even though their value is reflected in prices paid for land. Although this is a duplication of cost, it is usually small in proportion to total project costs.

*Recommendations.* It is recommended that allowances be made for public facilities in project costs as follows: If public facilities are to be replaced or purchased at project expense, no additional allowance need be made in project costs for outstanding debts. If the public facilities are not purchased or replaced, the share of bonded indebtedness for such facilities assignable to private property acquired for project purposes should be included as a project acquisition cost.

### Acquisition of Land and Improvements

Most land and improvements acquired in connection with project development will have their use changed as a result of the project. Some lands are inundated for reservoirs, others are shifted to more or less intensive uses, while a few lands acquired may continue in their preproject use. The problem is to assure that the productivity of the land with and without the project is properly reflected in the evaluation.

When land and improvements are acquired for project purposes, the acquistion costs, including legal fees and administrative expenses, are normally included as project costs. The acquistion cost, however, may not always adequately reflect the total cost from a public viewpoint. The public cost of removing land from its present use or reducing its productivity from its present use should be measured in terms of the value of the production lost as a result of the project. A proper reflection of the public costs resulting from changes in land use would require that calculations be made in the same manner as used in evaluation of project benefits.

In certain cases it may be permissible to assume that from a public point of view the purchase price will adequately reflect the productivity value of the land and improvements in the absence of the project. However, where such a reflection of costs is obviously insufficient, an adjustment should be made. This would be done by evaluating the total project costs from a public viewpoint as the value of the decreased productivity, calculated in the same manner as used in calculating project benefits.

*Recommendations.* It is recommended that all land-acquition costs be included as project costs. If the value of any decrease in the productivity of acquired lands, evaluated in the same way as comparable benefits, significantly exceeds acquisition costs, an adjustment should be made to reflect this difference.

### Treatment of Taxes

Taxes are levied for defraying the expenses of government and their incidence and effects throughout the economy are varied. Three phases of the tax problem need to be considered in the economic analysis of proposed projects. These are: (1) allowance for taxes in project costs, (2) relation of taxes to benefits, and (3) treatment of

taxes in comparisons with alternatives in determining the most economical means of accomplishing a given purpose and limiting the extent of economically justifiable project costs.

*Allowance for taxes in project costs.* From a public evaluation viewpoint, only the increases in the costs of governmental services that are anticipated as a result of a project are properly chargeable, and should be included, as a tax cost of the project. Such increased costs of governmental services represent outlays for goods and services essential for project operations. Any allowances for taxes as costs in project analysis in excess of increased costs of governmental services constitute benefits produced by the project that are similar to other project benefits.

Treatment of taxes should include consideration of changes in governmental expenditures that are not fully balanced by increased tax revenues, especially in the case of local governments. The primary effect of a river basin project on the tax status of local governmental units arises from changes in the real estate tax base. The impact may vary considerably. The net revenue status of some governmental units may be improved by increased tax capacity, reduced cost of services, or some combination of these two effects. Conversely, other governmental units may be adversely affected; i.e., there may be a reduction in the tax base without a corresponding reduction in the cost of providing governmental services. Insofar as concerns the overall economic evaluation of a project, only the combined net effect on the revenue status of all governmental units over the period of analysis is significant.

*Relation of taxes to benefits.* To the extent that taxes are reflected in the market prices of goods and services, such taxes, whether on income or property, will have been considered in estimating the value of goods or services produced by water resource development projects. No deductions for taxes in market prices should be made since this would reduce the value of benefits below the actual appraisal of the market as indicated by consumers' preferences or willingness to pay.

In the absence of competitive market conditions, the usual basis for establishing a derived market value is the cost of equivalent services that would be available and purchased from the alternative source most likely to be utilized in the absence of the project. The taxes that would be payable by the alternative source, public or private, should be included in the costs used as a measure of the derived values. Thus, the treatment of taxes in such derived values and in market prices is comparable. In the absence of actual market prices, the use of derived market values is considered essential in project evaluation in that it provides a comparable basis for computing the benefits from various purposes and projects and hence facilitates comparisons.

*Treatment of taxes in comparing alternatives.* Benefits alone, however, are not a sufficient criterion to establish justification. As indicated in chapter III it is necessary also to include in the economic analysis the additional criterion that the project or increments thereof must be more economical than any other available means, public or private, of accomplishing the specific purpose involved. This requirement is applicable to project formulation and limits the project cost that is justified for any purpose to the cost of comparable services from the least costly alternative source.

A comparable basis for treating taxes should be used for both the project and the alternative being considered. Furthermore, in an evaluation from a public standpoint, account should be taken of all beneficial and adverse effects associated with both the project and the alternative. The consideration given beneficial and adverse effects should be in terms of real benefits and real costs, regardless of their incidence and irrespective of whether compensation or reimbursement is involved, the purpose of such comparisons being to determine which alternative is most advantageous from such a viewpoint, rather than who should be responsible for development.

Several procedures are available for achieving a systematic analysis from a public viewpoint. The most direct would involve using a tax allowance based on expected increased costs of governmental services for both the project and the alternative in formulating and determining the justification of the project. Comparability could also be obtained by applying the tax base considered appropriate for the alternative to both the project and the alternative in computing their costs, with allowances for any tax charges included in costs in excess of such increased governmental costs treated as benefits. A variant for determining justification and comparing net benefits would involve using a combination of parts of the two procedures indicated. For the project, the tax allowance could be based on the increased cost of governmental services; for the alternative, costs would include taxes expected to be payable, with any surplus over costs of governmental service considered as a benefit. Each of the procedures indicated should result in essentially the same project formulation but because of differences in the cost base, different benefit-cost ratios will result.

*Recommendations.* Economic analysis should take account of all expected changes in costs of governmental services and any net changes in tax revenues resulting from a project. Project costs or associated costs should include all increases in the costs of governmental services resulting from the project. Project benefits, evaluated on the basis of market prices or derived values measured by alternative costs, should reflect all taxes included in the market price or in the alternative cost basis used. The economic analysis must also include a comparison of the cost of the project, or increment thereof, with alternative means of accomplishing the purposes involved. In making such comparisons, the treatment of taxes in the project and the alternative should be comparable. Tax allowances based on the increased cost of governmental services for both the project and the alternative are sufficient for proper formulation and cost justification. Proper comparison of the project and the alternatives being considered may also be obtained by basing costs for both on taxes payable by the alternative and taking account of any economic surpluses from taxes in benefits. To the extent that governmental services are superior in quantity or quality to those that would be received without the project, there would be a tangible or intangible benefit.

### Extension of Useful Life

A project may have the effect of extending the useful life of a non-project structure or facility. The benefit creditable to a project for such extension of life is the difference in the net value of goods or services provided by the affected facility with and without the life-extending measures. Such benefits may be measured in terms of the

value of the increased goods and services provided or in terms of the reduced costs of providing such goods and services.

The cost of features being included in a project specifically for the purpose of extending the useful life of a facility should not exceed the cost of the most economical alternative measures available for providing substantially the same goods and services.

The benefit of extension of useful life of a reservoir by preventing siltation equals the difference in reservoir benefits expected with and without the silt-prevention measures, but the cost of the silt-prevention measures should not exceed, for example, the cost of removing the silt from the reservoir or providing equivalent alternative reservoir capacity.

Any effects of extension of useful life which would occur beyond the 100-year period previously recommended as the maximum period of analysis should not be credited to a project.

In the case of a facility having several uses, all purposes likely to be impaired (usually considered in order from least productive to most productive use) should be used as the basis for evaluating the benefits of the life-extending measures.

*Recommendation.* It is recommended that the benefits of a project in extending the useful life of a facility be measured as the difference in the net value of the goods or services provided by the affected facility with and without the project. The cost of measures included in a project specifically for the purpose of extending the useful life of an existing facility should not exceed the cost of the most economical alternative means available for providing the same goods and services.

### Displaced Facilities

Displaced facilities are facilities whose present use is abandoned because project facilities provide essentially the same services. In evaluating the benefits and costs attributable to the project being analyzed, consideration must be given to the value of the services that would have been provided by the displaced facilities. If such facilities are acquired, they should be treated as other acquired facilities as discussed previously in this chapter under Acquisition of Land and Improvements. If the displaced facilities are not acquired, they should be treated as other uncompensated adverse effects as explained subsequently under Consequential Damages.

*Recommendation.* It is recommended that displaced facilities that are acquired be treated as other lands and improvements acquired for project purposes. If the displaced facilities are not acquired, they should be treated as consequential damages.

### Consequential Damages

Consequential damages are uncompensated losses resulting from the development of a project. Even though no compensation may be required or possible, such losses are nonetheless adverse effects of the project and should be treated as project costs. For example, when lands are flooded to develop a reservoir, there are costs for relocation and re-establishment of the persons and enterprises which are displaced, and local enterprises which do business with people in the project area may have their volume of business and net incomes reduced if people move from the area. As another example, the ground water table adjoining a new reservoir may rise, threatening to flood

cellars nearby, to pollute wells, to cause waterlogging of agricultural lands or to produce other adverse effects.

Where individuals are expected to make shifts in order to avoid or minimize these losses, the measureable consequential damages should be included in the analysis as costs but only for the necessary readjustment period. On the other hand, projects requiring the taking of submarginal land may provide offsetting public benefits by increasing local net incomes or by causing migration to areas of greater productiveness. Such considerations are important from a public viewpoint, and their incidence may have an important bearing on repayment.

To the extent that consequential damages are measurable, not elsewhere accounted for, and not offset by realizable enhanced opportunities, they should be charged against the project. Long-term consequential effects, if any, should usually be considered as intangible.

*Recommendation.* Uncompensated adverse effects are costs of a project and should be treated in the same manner as other costs are treated for purposes of economic analysis.

CHAPTER V

# Application of Principles to Various Project Purposes

The purpose of this chapter is to illustrate the application of recommended principles and practices to the evaluation of particular project purposes, giving special attention to factors that are peculiar to the designated purposes. Although the chapter is concerned primarily with the problems of identifying and measuring the benefits and costs for the various purposes, the economic analysis of a project should also include a comparison of the project with available alternative means of accomplishing the purposes involved. As pointed out earlier, the treatment of taxes and interest in such comparisons should be on a comparable basis for the project and the alternative. The discussion of project benefits herein is limited to consideration of primary benefits on which principal reliance is placed in project formulation, economic justification, and selection from an overall public point of view. Although not discussed for all functions, specific intangible effects of significance in the justification of any function should show the minimum value assigned to such effects.

## IRRIGATION, DRAINAGE, AND FLOOD AND EROSION CONTROL FOR DEVELOPMENT AND IMPROVEMENT OF AGRICULTURAL LAND

Many water resources projects enhance the use and increase the productivity of agricultural lands (including forest lands). Agricultural benefits of this nature arise from the irrigation of lands with inadequate precipitation or water supply under existing conditions, from the removal of excess water by drainage, or from reduction of flood or erosion hazards. The general principles in the evaluation of the agricultural benefits from the different types of project development are the same—although survey techniques may be necessarily different. The objective of this section is to set forth the basic procedure and concepts that apply in the evaluation of agricultural features of water resource development projects.

In general, the measure of agricultural benefits attributable to a project should be the estimated increase in the annual net value of production from the affected land. The major considerations in evaluating increases in annual productive values are the changes in agricultural production and changes in costs as a result of the project. As stated in chapter II, the agricultural products should be evaluated at the earliest stage for which market prices are considered applicable.

Essential in the analysis of agricultural benefits is an evaluation of the need for, and prospective supplies of, the specific agricultural com-

modities to be produced by the project. Since most agricultural products are sold on a nationwide market or are influenced by nationwide considerations, such an evaluation should begin with nationwide studies summarizing prospective product requirements and supplies, as discussed under the heading of Price Levels in chapter IV. However, the project analysis may require local and regional studies to adapt such projections to project conditions.

Equally important in the evaluation of agricultural benefits is an inventory and classification of the land resources in the project area in terms of potential use and productivity under both "with" and "without" project conditions.

The evaluation of agricultural benefits requires projecting cropping systems and land productivity for with and without project conditions. Observations in areas similar to that anticipated with project development are valuable in estimating future conditions with the project. An analysis of current land use, productivity, and management practices may provide the best guide for estimating future conditions without the project, if projected economic conditions are similar to those that have prevailed in the recent past. Otherwise, modification from the current cropping patterns and yield levels may be necessary.

Since the evaluation of a project is necessarily oriented to expected long-range conditions, land use, cropping systems, and management practices should allow for adjustment and correction of uneconomic use of agricultural resources that may exist in the short run. Accordingly, the assumed systems and enterprises shown in the analysis of benefits should be based on an economic use of agricultural resources for both with and without conditions, sufficient to retain the continuing use of productive resources in the enterprise.

The consideration of expected technological changes and improvement in management skills poses a special problem in the evaluation of agricultural benefits. Where significant, reasonably expected changes should be estimated and their influence reflected in the analysis of production and net returns, for both with and without project conditions.

In forestry and in erosion control, the delay in accrual of benefits may be greater than in other kinds of land development programs and evaluation procedures should take into account any such delay through the use of appropriate discounting procedures.

### Irrigation

Agricultural benefits from irrigation development include reductions in production costs and increases in the value of agricultural production after allowance for associated costs. Reductions in costs include those arising from less costly means of providing irrigation water and other reductions in the operating expenses of farmers as a result of the project. The increases in the value of production are measured by comparing the expected annual net value of agricultural production from the area with and without the project.

This increase in production results from the project and from the use of associated resources. The costs for associated resources for irrigation are the additional costs of private farm investment and farm operation necessary to utilize the project services. Comparison of anticipated conditions with and without the project will indicate the increased investments required for land preparation, water distribution

structures, livestock, buildings, machinery, and local governmental services. The associated costs may be measured in terms of increased operating costs for production, interest on investment, maintenance, depreciation of equipment, property taxes, and family living expenses. The primary benefits attributable to the project from increased production are the value of the increased production after allowance for increased associated costs.

### Drainage and Flood Prevention

The drainage of excess water from agricultural lands by improving major stream channels, laterals, and field drains increases their productivity and enhances their value. The same measures may also help to reduce damage to the same land from flows that overtop the stream banks during flood periods. Estimates of benefits and associated costs of drainage measures should be treated generally the same as for irrigation. The estimation of the flood damage reduction benefits of such measures is discussed in the section on Flood Control.

For purposes of the economic analysis it is sufficient that the benefits from any drainage or flood control measure cover its costs. A problem may arise, however, in cases where it is necessary for purposes of cost sharing to distinguish between drainage benefits and flood damage prevention benefits. To the extent that drainage measures give rise to more intensive use of land, such effects should be treated in the same manner as similar effects from flood control measures, as discussed in the section on Flood Control.

### Erosion Control

The evaluation of agricultural benefits from erosion control is similar to other agricultural evaluations in that a with and without net income analysis is required with appropriate allowance for delay in accrual of benefits.

### Project and Associated Costs

All costs of development and improvement of agricultural land and all production costs must be considered in project evaluation. Costs not included in project costs should be taken into account in associated costs. The investment cost of all associated capital improvements should be amortized over the expected life of the improvement at the interest rate applicable to such investment.

Where possible, costs of both project and associated resources or inputs should be based on expected market prices. However, some input items, including management and family labor, may not be adequately priced in the competitive market. The cost of these items may be based on their estimated value in available alternative uses.

## FLOOD CONTROL

The control of floods by river basin projects provides benefits in two general ways: (1) by preventing the loss of goods or services which would otherwise occur as a result of floods; and (2) by making possible increased production of goods and services through more intensive

use of real property which would otherwise be under-utilized because of the flood hazard.

In general, the need for flood control depends on the need for the property, products or services which are destroyed or damaged, or which are prevented from being produced or used as a result of floods. The benefits of flood control are measured in terms of the decreases in net income prevented or increases in net income made possible by the flood control measures.

### Benefits Through Prevention of Flood Damage

The benefit obtainable through prevention of flood damage should be measured as the difference between the damage that is expected to occur throughout the life of the project if flood control is provided and the damage to be expected without flood control. The flood damage to physical property should, in general, be evaluated as the cost of replacing, repairing, or rehabilitating the affected property. Where replacement or repair is impracticable or unlikely, the damage should be measured by the reduction in the value of the property.

In addition to prevention of physical damage to property there may be benefits through avoidance of costs made necessary by floods, such as costs of evacuation and reoccupation of flooded areas, cost of emergency flood protection and flood fighting, cost of relief, care or rehabilitation of flood victims, the loss of income through disruption of business, and the increase of costs of doing business during floods. Reduced business income may reflect increased cost of doing business during floods and other direct losses. Care is needed in avoiding duplication in estimates of such losses. All such benefits should be measured in terms of the estimated costs or losses that would be avoided with flood control and which would be incurred if flood control is not provided. Any economic costs or losses which may reasonably be expected to be avoided, made up, or offset should not be included in the estimates of flood damages.

There is a possibility that some of the costs made necessary by floods; for example, flood fighting costs, may include wages paid to labor which is temporarily unemployed due to the disruption of normal business activity. From a public viewpoint, the amount of such wages is a loss in only one of the two categories in which it might be counted: either as a direct cost made necessary by the flood or as a loss of opportunity to work at normal pursuits. It may be necessary to analyze the basic estimate data to avoid double counting in such cases.

In estimating the benefits resulting from prevention of losses in agriculture, consideration must be given to the value of net crop losses prevented, to increased costs of production such as replanting and to physical damages other than crop losses. The net effect of all such factors may be summed up most conveniently in terms of the change in net income to farmers with and without flood control.

Estimates of damage-prevention benefits should be based on the intensity of future use of land and property expected without flood control in order to prevent duplication with benefits arising from any changes in land or property use made possible by flood prevention as discussed later. Also, allowance should be made in damage estimates for any alleviation of flood damage which may be expected to result from flood forecasting and warning services.

The amount of flood damage to be expected in a given area varies with the magnitude of the floods expected. Although the date of occurrence of a flood of any given magnitude cannot be predicted, the probability of occurrence of a flood of any given magnitude in a specified period of time such as 50 or 100 years or in a particular season of the year can be estimated when adequate stream flow data are available. Accordingly, the average annual damage to be expected from all floods that may occur in the period of analysis of a project can best be computed on the basis of the expectancy in any one year of the various amounts of flood damage that would result from floods of all magnitudes up to those approaching the maximum probable flood. The difference in expected damages with and without flood control is the benefit attributable to the project.

### Benefits of More Intensive Use of Property

The benefit resulting from changes in use of property made possible by flood control should be measured as the increase, in excess of the estimated reduction of flood damage, in the net income of the affected property under conditions expected with and without flood control. The procedure for measuring this benefit is analagous to that previously described for measurement of the benefits attributable to a project as a result of increased agricultural production.

As an alternative method, an approximation of the difference in net return from more intensive use may be made by estimating the increase in market value of the affected property and converting it to an average annual basis by applying a rate of return applicable to private investment in the type of activity involved, adjusted for flood reduction benefits.

Under either method, the associated costs (i.e., all costs other than project costs) necessary to increase the net return of the property must be deducted to obtain the amount of benefit attributable to the project.

Any increases in net income which are expected to accrue on other than a uniform annual basis following completion of the project should be discounted and reconverted to an equivalent average annual value. When flood control results in both prevention of flood damage and change in land use on the same piece of property, care must be taken to avoid double counting of the benefit. In such cases, the entire benefit may be measured as the increase in net income from the property with and without the project or part of the benefit may be measured as flood damage prevention and the remainder as a benefit of more intensive use.

### Intangible and Other Factors Requiring Special Analysis in Flood Control

The effect of flood control measures in preventing loss of life and impairment of health may be important in some cases. As indicated in chapter IV, agreed upon estimates of acceptable expenditures for such items may be desirable in the interest of uniformity in economic analysis and project formulation and to reduce the number of intangible factors which require consideration in nonmonetary terms.

An important consideration in analysis of flood control projects is the value of having a high degree of protection against floods as compared with having only partial or no protection. For example, if the

scale of development at which net tangible benefits are maximized proves to be one which will provide only partial protection such as protection against floods with an expectancy of, say, once in 20 years, construction of the project at that scale may create a false sense of security in the partially protected area and cause intensified development and use of the area which would then be subject to additional flood damage. The net effect of such changes should be taken into account in project formulation and in evaluation of benefits for scales of project development at which such conditions are applicable.

### Project Costs

In general, there are no problems in measurement of costs of flood control which are not covered by the principles previously outlined for application to all projects. Where land is acquired for project purposes, the economic cost thereof is its productive value in nonproject use. (See ch. IV.)

## NAVIGATION

The benefits of a navigable waterway are the value of the transportation services provided after allowance for the cost of the associated resources required to make the service available. Such values of transportation service may be derived in terms of the cost of the most likely alternative means of providing the service in the absence of the project. Thus, the project may be credited with the value of the transportation service that will be provided less associated costs (all costs other than project costs) necessary to provide the service. From a public viewpoint, a navigation project will be considered economically desirable if it results in provision of needed transportation service at a lesser total expenditure for goods and services than may be expected to be necessary to provide equivalent service in the absence of the project. On this basis, transportation costs rather than transportation rates (i.e., costs to shippers) should be used for measuring benefits whenever possible.

In considering the justified investment for project navigation, account must also be taken of the cost of equivalent transportation services by the most economical alternative means, with interest and taxes for both computed on a comparable basis.

Benefits from the utilization of navigation improvements may result in the following principal ways:

(1) If the project makes possible transportation service at a savings as compared with the cost of transportation service being performed or expected to be performed by an alternative means, such as existing waterway or by an existing or potential railroad, highway, or other means.

(2) If the project makes possible the provision of transportation service at a cost which will permit movement of new traffic which, in the absence of the project, would not be expected to move because of prohibitive cost of available means or lack of any available means.

### Benefits Through Savings Over Alternative Means

Savings in transportation costs with the project as compared with costs to be expected in the absence of the project may result as follows:

(1) When operation and maintenance costs of an existing waterway

are reduced as a result of the project, a benefit equal to the savings in cost is creditable to the project.

(2) When operation and maintenance costs of water carriers are reduced through improvement of channels, locks, etc., the difference in water carrier costs on freight expected to move in the future whether or not the project is built is a benefit creditable to the project.

(3) When traffic, existing or potential, which, in the absence of the project, would be expected to move by an alternative means, is attracted to a waterway, the difference between the costs by the alternative means and the costs by waterway other than project costs is a benefit creditable to the project.

In estimating associated costs, which include investment and operating costs for vessels, terminal facilities, etc., allowance should be made for any increase in costs to shippers and receivers of cargo due to differences in the character of transportation service by waterway as compared with alternative means. For example, the greater time in transit or storage and different handling requirements may be factors requiring such allowance.

Where it may be necessary to use rates charged for transportation service as the measure of cost of transportation by an alternative means, the benefit credited to the project should be adjusted for any reduction in net income by transportation services from which traffic is diverted.

### Benefits From Traffic Which Would Not Develop Without the Project

Under certain conditions there may be new traffic which would move by water as a result of the project which could not economically move by other means in the absence of the project. The benefit creditable to the project for such new traffic is the difference between the cost of transportation by waterway and the value to shippers; that is, the maximum cost they would be willing to pay for moving the various units of traffic involved. If data are available for estimating the value at which various increments of the prospective new traffic could be moved economically, the difference between such values and the costs of transportation by waterway provides a measure of the estimated benefits attributable to the project.

If data are not available for such a direct estimate, it may be assumed that a few units of the prospective new traffic could move economically at a cost to shippers slightly less than that of available alternative means of transportation. Also a few units could move only at a cost to shippers much less than that of the alternate means and only slightly greater than the waterway costs. The remainder of the new traffic could probably move economically at costs varying in a straight line relation between these extremes. Therefore, the probable average cost that could be borne by the new traffic may be assumed to be halfway between the highest and lowest costs at which any part of it would move. On this basis, the difference between this average value and the cost by waterway applied to the volume of new traffic expected is the benefit creditable to the project. If transportation costs by waterway are based on rates rather than costs, benefits should include any excess of rates over costs (i.e., profit to water carriers).

### Other Benefits From Navigation Improvements

The foregoing discussion of navigation benefits is applicable primarily to inland waterway improvements which are the type usually associated with river basin projects. The principles are also applicable to harbor improvements insofar as such projects result in benefits measurable in montary terms, as, for example, decreases in water-carrier operating costs. Some types of navigation improvements, particularly harbor projects, provide certain benefits to shipping, such as reduction of hazards from storms, which are difficult to evaluate in monetary terms. In some cases, for example, a harbor of refuge, most of the justification of the project may be based upon such intangible benefits.

The benefit of waterway improvements in recreational boating should be estimated in general accordance with principles discussed later in the section on Recreation, Fish, and Wildlife.

Benefits from more intensive use of land made possible by placement of dredged spoil should be evaluated in a manner comparable to similar benefits from flood control.

### Project Costs

In general, there are no problems in measurement of costs of navigation projects which are not covered by the principles previously outlined for application to all projects.

## ELECTRIC POWER

The use of water resources for the production of electric power is frequently one of the purposes served by the development of multiple-purpose river basin projects. Power benefits include the value of the power produced at the project and any improvements in upstream or downstream power values which are attributable to the project. The cost of power from the alternative source most likely to be used in the absence of the project normally provides a measure of the power benefits.

In addition to comparing the benefits of a power project with its cost, the economic analysis should include a comparison of the cost of the project with the cost of providing equivalent power by available alternative means, with interest and tax charges for the project and the alternative computed on a comparable basis.

### Power Benefits

The benefits of power produced by a project are the value of the power to the users as measured by the amount that they would be willing to pay for such power. For most areas of the country it may be assumed that power to meet most such demands could be obtained from alternative sources. Normally, therefore, the cost of power from the most likely alternative source provides a measure of the value of the power creditable to the project. A practical procedure for measuring the benefits from project power is to base the power values on the cost of equivalent power, including interest and taxes actually payable, from the alternative source of power, public or private, that would most likely be utilized to service the same market area in the absence of the project.

In special situations, such as the use of power by aluminum plants

in the northwest, power might not be purchased at prices at high as the cost of power from the expected alternative source but would be utilized because of the low cost of project power. Since such power loads would not develop with power costs at the level of the cost of alternative power sources, but would develop with the low-cost project power, it is likely that they would develop with power costs at some point between these two extremes. When adequate data for such loads are available, the value of the power to the users should be measured directly. In the absence of adequate data, the value of the power should be measured as the midpoint of power costs between the two extremes outlined above.

### Project Costs

In general, there are no problems in the measurement of hydroelectric power cost which are not covered by principles previously outlined for application to all projects.

## MUNICIPAL AND INDUSTRIAL WATER SUPPLY

The improvement of water supply for municipal and industrial uses is frequently one of the benefits from multiple-purpose water resources development projects. Improvement in water supply may result either from an increase in the quantity or an improvement in quality of the available water. From an overall public viewpoint, a municipal and industrial water supply development will be economically justified if it provides water to meet expected needs at a cost not greater than the cost of the alternative source that would likely be utilized in the absence of the project. The general basis for evaluation is essentially the same as that set forth in greater detail above for electric power.

## RECREATION, FISH AND WILDLIFE

Certain multiple-purpose projects may include specific measures designed for the purpose of protecting or enhancing recreation, fish, and wildlife resources or activities. Other projects, without such specific measures, may also have effects of importance to these resources. In either case, there may be beneficial or adverse effects which should be taken into account.

Basically, these effects are measurable as increases or decreases in needed fish and wildlife production or recreational use. While tangible effects on commercial production can be expressed in terms of market prices, effects on hunting, fishing, and other recreational activities not ordinarily priced in the market must either be expressed in terms of estimated or derived values comparable to market values or regarded as intangible. Certain types of effects such as those on wilderness areas or those on rare or vanishing species of wildlife probably will have to be regarded as intangible.

### Beneficial Effects

Benefits to commercial fishing and trapping consists of the value of an increase in the volume of the products expected to be marketed. This increase is measured by comparing volumes of future production with and without the project in operation. The value of the increased

production should be obtained by applying expected market prices for these products. Expected prices and average annual benefits for fish and fur products should be estimated on the same general basis as that suggested for agricultural products. Associated costs to be deducted from benefits are all costs incurred by fishermen and trappers in harvesting and marketing these products.

Benefits from hunting, fishing, and other forms of outdoor recreation consist of the value of any increase in the amount of recreational use expected as a result of the project. Such an increase may be expressed in terms of recreational days or in terms of sport fish and game harvests. This increase is measured by comparing expected future recreational activity in the area with and without the project. Since market prices are not available to express the value of this increase in monetary terms, an estimated or derived value comparable to market value may be used for this purpose.

To provide an approach consistent with the general measurement procedure outlined in this statement, it is suggested that the benefits of recreational use be derived or estimated values based on informed estimates of the average value of these recreational facilities to prospective users. In estimating or deriving these tangible values, consideration should be given to all pertinent factors, including the charges which the recreationists who may be expected to use the facilities would be willing to pay and to any actual charges being paid by users for comparable facilities in other areas. All applicable associated costs must be deducted from such values to provide benefits attributable to the project.

Any beneficial effects on recreation, fish and wildlife which cannot be evaluated under the procedures outlined above, as, for example, the preservation of rare species of wildlife, the creation of more favorable habitat for fish and wildlife, and the protection of aesthetic, scenic, historic, and scientific values, should be given consideration as intangibles.

### Adverse Effects

Frequently a multiple-purpose project may damage or destroy existing recreational resources and fish and wildlife values. Such effects may arise if the value of recreational use and fish and wildlife production is lower with than without the project.

A part of the value of any reduction in recreational use or fish and wildlife production may be measured in the same manner described above for increases in use or production. In addition, there may be other adverse effects which are important from a resource conservation standpoint and are not fully measurable under the procedure described above. Examples of such intangible effects would be the elimination of the last elk herd in a particular state, the destruction of any unusually scenic area, such as a portion of a national or other public park; or the destruction of an historically important site. Conservationists, generally, prefer that the project include measures to prevent such losses rather than requiring that other project benefits be sufficient to offset the value of such losses.

Cases may occur in which the commercial fishing industry is adversely affected. A dam, essential to the project, may greatly destroy the salmon runs. The market value of the reduced production will not fully reflect the loss to the industry whose plant and equipment cannot be transferred to other areas. This loss to the economy should

be treated as a project cost. In addition, there will be costs of shifting trained employees to other areas of the fishing industry which should be considered as a cost of the project.

In many cases, the losses to recreation and to fish and wildlife can be prevented in a manner compatible with the primary purposes of the project and the costs of such prevention should be included in project costs.

### Project Costs

Except as indicated above there are no problems in measurement of project costs to recreation, fish and wildlife which are not covered by the principles previously outlined for application to all projects.

## WATER POLLUTION CONTROL

Water pollution control is often one of the effects of water resource development projects. While pollution abatement may contribute significant economic returns to society and individuals, under prevailing practices relatively few of the benefits of pollution control are measured directly in monetary terms. Consequently, intangible considerations, such as the elimination of potential health hazards and aesthetic improvements, are frequently of controlling importance in the justification of pollution abatement.

Although all the gains from pollution abatement are not directly reflected in identifiable market values, the desirability of determining the economic validity of undertaking pollution control activities requires consideration of the problems of translating as many effects as possible into monetary equivalents. In the absence of market determined values to serve in the measurement of water pollution control benefits, economic indicators of the worth of pollution abatement must be sought in derived measures of value. Such measures include the cost of the most economical alternative means of accomplishing comparable effects, the decrease in expenditures by communities and business establishments for water treatment, and improvement in recreation facilities, such as boating, swimming and fishing, attributable to improved water quality and quantity. There is also need for extending the scope of measurement practices by devising simulated market conditions—possibly through the use of sample surveys—to establish a value for pollution abatement comparable to that obtained for other project purposes.

The effects that may be evaluated on the indicated bases may still not adequately reflect the total gains to society from pollution abatement. Recognition should also be given to any additional public or community interests involved.

## CHAPTER VI

# Cost Allocation for Multiple-Purpose Projects

The practices recommended in previous chapters provide for the formulation and economic evaluation of water resource development projects. Basic data developed in such studies will also be useful when cost allocation is utilized as a transitional step leading from economic evaluation into repayment analysis. This chapter presents a recommended method of cost allocation and makes several observations as to the possible relationships of benefits, costs, and cost allocations to problems of assessment and repayment. The determination whether project costs shall be financed by general taxation, by assessment of the beneficiaries, or by other means is governed by many considerations of public policy beyond the scope of this report. This chapter, therefore, does not include recommendations as to how project costs should be met.

Cost allocation is the process of apportioning project costs among the various purposes served by the project. The cost allocation procedure described below is applicable to total project costs, including investment costs and costs of operation, maintenance, and replacement. Cost allocation should be distinguished from the division of costs between Federal and non-Federal interests and the assessment of charges which is the process of determining amounts to be paid for project services by groups of beneficiaries and individuals.

## APPROACH TO COST ALLOCATION

Allocation of project costs may be desired for various administrative purposes. However, it is usually necessary only when public policy requires that charges for all or certain products or services of the project shall be based upon costs incurred therefor.

The objective of cost allocation is to distribute project costs equitably among the purposes served. On the assumption that the principles for project formulation recommended herein have been applied, equitable distribution may be obtained by preventing costs allocated to any purpose from exceeding corresponding benefits; by requiring each purpose to carry at least its separable cost; and, within these maximum and minimum limits, by providing for proportional sharing of the savings resulting from multiple-purpose development.

## RECOMMENDED METHOD OF COST ALLOCATION

The separable costs-remaining benefits method of cost allocation is a method for obtaining an equitable distribution of the costs of a multiple-purpose project among the purposes served. Briefly, it provides

for: (1) assigning to each purpose its separable costs; i.e., the added costs of including the purpose in the project; and (2) assigning to each purpose a share of the residual or remaining joint costs in proportion to the remaining benefits; i.e., the benefits (as limited by alternative costs) less the separable costs. Thus, the method provides for an equitable sharing among the purposes in the savings resulting from multiple-purpose development.

The separable costs-remaining benefits method described in detail below is recommended for general use in allocating costs of Federal multiple-purpose river basin projects. It differs from the generally recognized benefits method in that the amount of benefits used as a basis for the allocation in the recommended method is limited by the costs of available single-purpose alternative projects. In this respect it resembles closely the alternative justifiable expenditure method, except that the concept of specific costs for each purpose is replaced by the concept of separable costs for each purpose. The separable costs for each purpose are determined as part of the procedures recommended herein for project formulation, so that no added work should be required by this method of cost allocation. Since separable costs include all specific costs and generally include other added costs, residual joint costs to be allocated are usually smaller under the separable costs-remaining benefits method than under the alternative expenditure method. Thus, the separable costs-remaining benefits method maximizes the direct allocation of costs and minimizes the residual costs to be apportioned.

### Description of Method

The method consists of (1) determining the separable cost of including each function in the multiple-purpose project, and (2) determining an equitable distribution of costs incurred for several purposes in common. It makes allowance for any economic significance attributable to the peculiarities of any one purpose in its use of facilities or its prior right to project services. Thus, the use of benefits as a basis for cost allocation under this method makes allowance for both the use made of facilities and any prior rights because estimates of benefits reflect the conditions assumed with respect to those factors. Furthermore, the separable costs determined through project formulation reflect the costs of providing facilities used by each purpose as explained more fully below.

*Separable costs.* The separable cost for each project purpose is the difference between the cost of the multiple-purpose project and the cost of the project with the purpose omitted. Separable costs include more than the direct or specific costs of physically identifiable facilities serving only one purpose, such as an irrigation distribution system. They also include all added costs of increased size of structures and changes in design for a particular purpose over that required for all other purposes, such as the cost of increasing reservoir storage capacity. In effect, separable costs are computed from a series of project cost estimates, each representing the multiple-purpose project with one purpose omitted. Such information will be readily available when the recommended practices of project formulation have been followed. Where project formulation has not been of the detail suggested in the recommended procedure and separable costs are not available, specific costs may be used in lieu of separable costs (as in the alternative justifiable expenditure method).

*Distribution of residual or remaining joint costs.* Residual costs are here defined as the difference between the cost of the multiple-purpose project as a whole and the total of the separable costs for all project purposes. Residual costs thus represent a remaining joint cost attributable to all or several purposes. The amount of project benefits used as a basis for allocation of residual costs to any purpose is limited by the cost of providing equivalent services from the most likely economically feasible alternative source available in the area to be served. From such benefits for each purpose, separable costs are deducted to give remaining benefits. Then residual costs are distributed in proportion to the remaining benefits for each purpose. The distribution of residual costs in proportion to the excess of benefits over separable cost assigns to each purpose an equitable share of project savings.

If the total separable costs of all purposes should exceed the cost of the multiple-purpose project, there are in effect no residual costs as defined above, but rather a joint saving, which can be distributed among purposes by reducing separable costs to obtain the allocation to each purpose instead of by adding a portion of residual costs to each separable cost as illustrated herein.

*Total allocation.* The sum of the separable costs and the allocated residual cost for each purpose constitutes the total allocation to that purpose. Under the separable costs-remaining benefits method, the total cost allocated to each purpose will not be less than the cost of including that purpose in the project (unless the total of separable costs for all purposes exceeds the multiple-purpose project costs as explained in preceding paragraph), and will not be more than the benefits of that purpose or the cost of the most economical single-purpose alternative.

## General Application of Procedure

The recommended method of cost allocation is illustrated below for a multiple-purpose project for which the total project costs amount to $1,765,000. These include investment costs and operation, maintenance, and replacement costs, all reduced to a common time basis, and are expressed either as an average annual amount or a present worth amount.

***Allocation of Costs by Separable Costs-Remaining Benefits Method***

GENERAL CASE

(In thousands of dollars)

| Item | Flood control | Power | Irrigation | Navigation | Total |
|---|---|---|---|---|---|
| 1. Benefits | 500 | 1,500 | 350 | 100 | 2,450 |
| 2. Alternative cost | 400 | 1,000 | 600 | 80 | 2,080 |
| 3. Benefits limited by alternative cost (lesser of items 1 and 2) | 400 | 1,000 | 350 | 80 | 1,830 |
| 4. Separable costs | 380 | 600 | 150 | 50 | 1,180 |
| 5. Remaining benefits (items 3−4) | 20 | 400 | 200 | 30 | 650 |
| 6. Allocated residual cost [1] | 18 | 360 | 180 | 27 | 585 |
| 7. Total allocation (items 4+6) | 398 | 960 | 330 | 77 | 1,765 |

[1] In this example, the total residual costs to be allocated ($585,000 in line six) are 90 percent of total remaining benefits ($650,000 in line five). Therefore each purpose is charged with residual costs equal to 90 percent of its remaining benefits. The same results will be obtained by using distribution ratios (percent of each item in line five to their total).

## Special Application of Procedure

A special application of the recommended allocation method may be necessary whenever a significant part of project cost is incurred for

structures serving several but not all purposes. For example, in the illustration below, certain facilities involving dual costs at $300,000 are for joint use in connection with power and irrigation only. Such costs are a restricted type of joint costs but may be first treated as separable costs for the two or more purposes actually served rather than as residual costs for all purposes. This type of separable cost may be allocated in proportion to the remaining benefits in excess of other separable costs for each purpose served. In such cases, the sum of the total initially separable costs and total costs common to some but not all purposes of the project (allocated dual cost, in the example) is deducted from the total project cost to give residual costs. These residual costs should then be allocated on the basis of benefits in excess of all separable costs, as illustrated in the following example:

***Allocation of Costs by Separable Costs-Remaining Benefits Method***

SPECIAL CASE WITH DUAL-PURPOSE COST

(In thousands of dollars)

| Item | Flood control | Power | Irrigation | Navigation | Total |
|---|---|---|---|---|---|
| 1. Benefits | 500 | 1,500 | 350 | 100 | 2,450 |
| 2. Alternative cost | 400 | 1,000 | 600 | 80 | 2,080 |
| 3. Benefits limited by alternative cost (lesser of items 1 and 2) | 400 | 1,000 | 350 | 80 | 1,830 |
| 4. Initially separable costs | 380 | 600 | 150 | 50 | 1,180 |
| 5. Remaining benefits before dual cost (items 3−4) | 20 | 400 | 200 | 30 | 650 |
| 6. Allocated dual cost | --- | 200 | 100 | --- | 300 |
| 7. Total separable cost (items 4+6) | 380 | 800 | 250 | 50 | 1,480 |
| 8. Remaining benefits (items 5−6 or 3−7) | 20 | 200 | 100 | 30 | 350 |
| 9. Allocated residual cost | 16 | 163 | 81 | 25 | 285 |
| 10. Total allocation (items 7+9) | 396 | 963 | 331 | 75 | 1,765 |

*Recommendation.* Where cost allocations are required, the separable costs-remaining benefits method is recommended for use. Where formulation has not been carried out in accordance with the principles of project formulation outlined in chapter III and the separable costs cannot be readily estimated, the use of specific costs in accordance with the alternative justifiable expenditure method is acceptable. The use of a combination of cost allocation methods or the averaging of the results of several methods is not recommended.

## RELATION OF BENEFIT AND COST DATA AND COST ALLOCATIONS TO ASSESSMENT PROBLEMS

No cost allocation problem is involved: (1) in the case of single-purpose projects; (2) where charges for project products or services are based on the value of the product or service; or (3) where all of the costs of the project are nonreimbursable.

The purpose of this section of the report is to indicate the relation of benefit and cost data and cost allocation data to the various ways in which assessments might be made. The question of whether or not charges for project services should be made and determination of the way in which they should be made are matters of public policy beyond the scope of this report.

Assessments for project services may be made on either or a combination of two general bases, as follows:

(1) On the basis of the cost incurred for the service.

(2) On the basis of the value of the service rendered and without regard to project costs.

### Assessments on the Basis of Costs Incurred

If assessments are to be made for any particular project purpose with a view to recovery of the cost incurred for that purpose, an allocation of costs of a multiple-purpose project is a necessary prior step. If costs of all purposes of a project are to be met from general tax collection, no cost allocation is required. The costs for a particular purpose might be assessed in any of several ways, as follows:

(1) By appropriation from public funds.

(2) By charges to beneficiaries at a rate that will return the costs.

(3) By charges to beneficiaries at a rate that will return a fixed or sliding portion of the costs.

(4) By charges to beneficiaries (individually or by groups) in proportion to benefits received.

(5) By charges to beneficiaries (individually or by groups) in proportion to the separable costs of serving each beneficiary or group.

(6) By a combination of the above methods, such as setting charges within the range established by separable costs as a minimum, and benefits or alternate costs as a maximum.

### Assessments Without Regard to Project Costs

If assessments are to be made on the basis of the value of the services rendered and without regard to the costs of providing the project services or products, no allocation of costs among purposes is needed. Assessments might be made in any of several ways, including the following, leading to returns of less than or more than the project costs:

(1) By charges for project services based on rates established through competition.

(2) By charges to beneficiaries based on benefits received by them.

(3) By charges based on ability of beneficiaries to pay.

(4) By a combination of the above methods.

### Use of Benefit and Cost Data

The data on project benefits and project costs obtained in the course of economic analysis of projects as contemplated in previous chapters may provide necessary basic information for determination of charges for project services by several of the methods outlined above. If benefits are used as a basis for assessment, it may be necessary to adjust project benefits to reflect local incidence of project effects which may have been offset or canceled out in computing the benefits creditable to the project from a public viewpoint. Also, an allowance may need to be made for private evaluation standards insofar as they may differ from public evaluation standards.

## APPENDIX

# Agency Comments on the Revision of the May 1950 Report on "Proposed Practices for Economic Analysis of River Basin Projects"

*Bureau of the Budget*

The following text of a letter of October 13, 1958, from Mr. Elmer B. Staats, Assistant Director, Bureau of the Budget, to Mr. Fred G. Aandahl, Chairman, Inter-Agency Committee on Water Resources, presents the comments of the Bureau of the Budget:

> Thank you for your letter of August 18, 1958, enclosing a copy of the revised draft of the report on "Proposed Practices for Economic Analysis of River Basin Projects."
>
> We believe that this material will be a valuable aid in the further consideration by the participating agencies and the interested public of the complex problems involved in the evaluation of water resources projects. The Bureau of the Budget, therefore, perceives no objection to the publication of the revised report, subject to the understanding that no commitment is involved as to the practices to be followed by the agencies.
>
> Since the practices discussed in the report do not conform in all respects to the standards and procedures used by this Administration in evaluating proposed water resources projects, we would suggest some minor changes in terminology to make this fact clear. We suggest that the title of the report be changed to read "Methods for Economic Analysis of River Basin Projects." We further suggest that the paragraph below the issuance and reissuance dates be modified to read as follows:
>
> > "Publication of this revised report by the Inter-Agency Committee on Water Resources and its adoption as a basis for consideration do not imply either that the proposed practices and recommendations of the report are thereby adopted for application by the participating agencies or that they represent Administration policy. Comments of the participating agencies are included in the appendix."

*Department of Agriculture*

The Department of Agriculture concurs in the recommendation of the Subcommittee on Evaluation Standards that the revised report be published and that, as proposed by the Subcommittee, it be adopted as a basis for consideration by the agencies participating in the Inter-Agency Committee on Water Resources.

It also suggests that a letter to that effect (in substantially the form later adopted by the Committee) be sent by the Chairman, Inter-Agency Committee on Water Resources, to the Chairman, Subcommittee on Evaluation Standards, and that the letter be printed as a part of the revised report.

*Department of the Army*

The Department of the Army concurs in the recommendation of the Subcommittee that the revised report be published and that it be adopted as a basis for considera-

tion by the Agencies participating in the Inter-Agency Committee on Water Resources. The Department requests that the following comments on the revised report be considered and given recognition in some appropriate manner in the action of the Inter-Agency Committee on the Subcommittee's recommendation.

It would be preferable if the discussion of secondary benefits were to bring out more clearly that from a national public viewpoint secondary benefits will be applicable in project evaluation only under unusual circumstances.

The references to adjustments of estimates may encourage unwarranted manipulation of estimates and cause distortion of the basic, long-range project formulation and justification procedures rather than permit demonstration of the advantages of constructing projects in periods of low economic activity as apparently intended.

With reference to price projections, the Department of the Army believes that it is preferable to use current prices in estimating benefits and costs until improved procedures are developed for estimating long-range price projections.

While the report recognizes that the risk-free interest rate should be used only if risks have been adequately accounted for elsewhere, it might be preferable to indicate the unlikelihood of all risks and uncertainties being fully covered by means other than as a component of the interest rate.

Experience on civil works activities has convinced the Department of the Army of the advisability of a more conservative limit of 50 years for the maximum economic life of projects rather than the 100 year limit proposed.

While it may be true that it may prove necessary to pay school districts, towns, counties or other governmental units for public improvements even though their value is reflected in prices paid for land, the statement may be construed as an invitation for claims for such payments.

*Department of Commerce*

The Department of Commerce considers that the Subcommittee on Evaluation Standards should be complimented for its efforts in striving to clarify the language in certain portions of the publication, particularly with respect to secondary benefits, interest, and taxes. Although it appears that the Subcommittee intended to treat the revision from a technical economic standpoint, the proposed publication contains subject matter which is treated from a policy standpoint by executive agencies that are not represented on this Committee (ICWR). The intent of the proposed publication apparently is that such policies be uniformly applied in project analysis. To illustrate, the report itself expresses the belief that "further acceptance of the recommendations set forth herein would result in improved formulation, better selection of projects, and more effective river basin development." Similarly, the report states that the criteria and principles "are intended for application by agencies within the framework of their particular programs and responsibilities."

Among the items which need to be carefully reviewed is the treatment of interest. If adopted by the Federal agencies, the changes concerning interest would tend to place this aspect of project analysis closer to an equal footing for both public and private enterprise than was true in the original report. However, the Department of Commerce does not concur that the element of risk should be treated indirectly by conservative estimates of benefits or by safety margins in planning. Either of these alternatives, suggested in the proposed publication, is premised on continued use of an essentially risk-free interest rate. This Department strongly favors the third alternative, which would have a risk component included in the interest or discount rate. Also, for project features which may be constructed by public or private enterprise, this Department favors use of a common interest rate and suggests that a rate of interest applicable to private investment be used. In this connection, the Committee (ICWR) may recall that after much debate and discussion, the New England-New York Inter-Agency Committee decided to use an interest rate of 5½ percent for power projects.

The use of an interest rate applicable to private investment, which includes a risk component, would automatically preclude the possibility of having personal bias enter into any downward adjustment of benefits or any inclusion of safety margins. Similarly, such an interest rate, if used for both public and private investment, would do much toward assuring the general public that the practice proposed for economic analysis of water resources projects by Federal agencies is based upon principles that are sound and equitable to both public and private enterprise.

The proposed period of economic analysis is another item which this Department believes should be studied. In the light of a growing number of technological changes which affect many aspects of our economy, including water resources development, this Department questions the advisability of using 100 years as the upper limit on economic life. A more realistic approach would provide for the upper limit of a period of analysis generally in the range of 50 years, with a clear justification shown for each project or project feature on which a longer period is used.

In the light of the foregoing, if publication of the revision should be found acceptable by this Committee (ICWR), it is the belief of this Department that the Special Assistant to the President for Public Works Planning, the Council of Economic Advisers, and the Bureau of the Budget should be given a reasonable opportunity to review the revision before it is published. If provision for such review is made, this Department will interpose no objection to the publication.

*Federal Power Commission*

The Federal Power Commission concurs in the recommendation of the Subcommittee on Evaluation Standards that the revised report on Proposed Practices for Economic Analysis of River Basin Projects be published and that it be adopted as a basis for consideration by the agencies participating in the Inter-Agency Committee on Water Resources. Although the Commission concurs in most of the recommendations in the revised report, it notes that certain of the proposed practices differ from those currently used in Commission studies. These differences relate primarily to price levels, period of analysis, interest rates, and treatment of taxes, as summarized below.

The Commission practice is to use current prices for all estimates of benefits and costs made for project evaluation. Previous Commission experience with projected prices raised a number of questions as to application and as to the reasonableness of results thus obtained.

The Commission uses a maximum period of analysis of 50 years in the evaluation of Federal hydroelectric projects. It is of the opinion that 50 years provides a reasonable maximum period of analysis for such projects.

In Federal project evaluation studies the Commission uses the interest rate furnished by the Bureau of the Budget under the provisions of Circular No. A-47, issued December 31, 1952. Currently that rate is 2½ percent. The Commission believes that the proposal in the revised report is preferable to the procedure included in Circular No. A-47.

The Commission currently evaluates proposed Federal hydroelectric developments under terms of an agreement, dated March 12, 1954, among the Departments of the Army and the Interior and the Federal Power Commission. In accordance therewith, the value of power is derived generally on the basis of the cost of equivalent power from the most likely alternative source, including the taxes payable by the alternative source. Taxes in an amount equal to those which would be foregone as a result of Federal development of the power rather than the most likely alternative development are included as an economic cost of the project. Benefits and costs so derived are used to compute the benefit-cost ratio of the project and no further test is included in the economic analysis.

The Commission is of the opinion that the procedures of the March 12, 1954 agreement have considerable merit. In addition to the simplicity and the greater ease of understanding, the derivation of a single test of economic justification, rather than the double test proposed in the revised report, obviates difficulties inherent in presenting more than one test that might be selected alternatively for use. Also, the inclusion of an item of "taxes foregone" in project costs is in the direction of giving to the benefit-cost ratio its generally understood meaning; i.e., a measure of the economic efficiency of a proposed project. Under the proposals of the revised report, the benefit-cost ratio would be meaningless in many cases, and the comparison of project costs with the alternative costs would then become governing in project evaluation and formulation. The Commission believes that full consideration should be given to these points before a change from the present procedures is accepted.

*Department of Health, Education and Welfare*

The revised Report on Proposed Practices for Economic Analysis of River Basin Projects improves the original version by elaboration and clarification of several parts. The inclusion of a section on water pollution control, not covered in the original version, is especially valuable.

It is not necessary for the Green Book to contain an explanation of the nature of interest. If an explanation is retained, however, it should be more thorough than the time-preference doctrine now contained. The importance of credit expansion through the central banking system should be acknowledged as well as the relationship of savings to amount of loanable funds. The rationale for the use of the long-term government bond rate in project analysis should be explicitly stated and substantiated.

The Department of Health, Education, and Welfare concurs with the recommendation of the Subcommittee on Evaluation Standards of the Inter-Agency Committee on Water Resources that the revised Report be published and adopted as a basis for consideration by the participating agencies.

*Department of the Interior*

Concurrence of the Department of the Interior in the recommendation of the Subcommittee on Evaluation Standards that this revision of the May 1950 Report on Proposed Practices for Economic Ananlysis "be adopted as a basis for consideration by the participating agencies and that its early publication be authorized," is subject to the following considerations.

Since the 1950 Report is out-of-print, its reissuance, with minor revisions, is necessary if copies are to be made available to those interested in this phase of water resources planning.

Adoption of the revised Report "as a basis for consideration" is taken in its literal sense and does not imply that the practices and recommendations of the Report are thereby adopted for application.

The 1950 Report was prepared after consideration of an analysis of the economics of river basin projects uninfluenced by benefit-cost practices then in use or by legal and administrative limitations. Economic analyses regularly included in the reports of this Department, however, are necessarily based on prevailing laws, interstate compacts, and Executive and Congressional policy.

Both legal and policy considerations of significance to the programs of this Department have led to the establishment of practices for economic analysis differing in some respects from those proposed in the Report, although in many respects they are compatible.

The Report may accommodate many of these and similar considerations since it states, for example, that the criteria and principles presented are intended for application by agencies within the framework of their particular programs and responsibilities.

Among the considerations of significance to the Department of the Interior are:

Recognition of Federal and State laws, interstate compacts, and applicable policies; the tangible expression of benefits from the provision of settlement opportunities, assistance in the development of undeveloped regions, stabilization of existing developments; recognition of the many project effects accruing outside the immediate project area; the importance of regional viewpoint as well as national viewpoint; and, in cost allocation, continuation of studies of the application of the separable cost-remaining benefits method in order to assure that the savings arising from multiple-purpose construction are distributed equitably among the purposes served by multiple-purpose projects.

With regard to the evaluation of such resources as fish and wildlife, recreation, and minerals, as related to water developments, a wider latitude in choosing methods of evaluation than those suggested in the Report may be needed in order to cope with these complex problems.

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