



The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

REPORT TO THE

Federal Inter-Agency

River Basin Committee

*Proposed Practices for
Economic Analysis of
River Basin Projects*

PREPARED BY THE

Subcommittee on Benefits

and Costs

MAY 1950

REPORT TO THE
Federal Inter-Agency River Basin Committee

Corps of Engineers, United States Army
Department of the Interior
Department of Agriculture
Department of Commerce
Federal Power Commission

*Proposed Practices for
Economic Analysis of
River Basin Projects*

PREPARED BY THE
Subcommittee on Benefits and Costs

WASHINGTON, D. C.

MAY 1950

Foreword

IN 1946 the Federal Inter-Agency River Basin Committee appointed a Subcommittee on Benefits and Costs for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs for water resources projects.

After consideration of the benefit-cost practices currently in use and of an objective analysis of the economics of river-basin projects uninfluenced by current practices and legal or administrative limitations, the Subcommittee considered various approaches to the problem and presented its conclusions in this report *Proposed Practices for Economic Analysis of River Basin Projects*. There are appended summaries of previous Subcommittee reports on the qualitative aspects and measurement aspects of benefit-cost practices which were in use when the reports were issued.

At its meeting on May 25, 1950, the Federal Inter-Agency River Basin Committee considered the report of the Subcommittee on Benefits and Costs and adopted it as a basis for consideration by the participating agencies as to application in their respective fields of activity in river basin development. The committee also authorized transmittal of the report to the President's Water Resources Policy Commission and arranged for reproduction of the report to facilitate consideration of the proposed practices by all concerned.

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

Table of Contents

	Page
Letter transmitting report of the Subcommittee on Benefits and Costs to the Federal Inter-Agency River Basin Committee.....	VII
Membership of subcommittee and staff.....	IX
Chapter I. Introduction.....	1
Outline of studies.....	1
Scope of this report.....	2
II. Basic assumptions and principles.....	5
Objectives of economic analyses.....	5
Viewpoint for economic analyses.....	6
Basis for evaluation of river basin development.....	6
Basic concept of benefits and costs.....	7
Benefits and costs attributable to the project.....	9
Economic limitations on scale of project development.....	11
Summary of procedures for project formulation and analysis of justification.....	12
III. Measurement of benefits and costs.....	15
General measurement standards.....	15
Price levels.....	16
Interest and discount rates and risk allowances.....	21
Period of analysis.....	24
Measurement problems.....	26
Treatment of tangible and intangible effects.....	26
Adjustments for levels of economic activity.....	28
Treatment of costs of affected public facilities.....	29
Acquisition of land and improvements.....	29
Treatment of taxes.....	30
Displaced facilities.....	31
Extension of useful life.....	32
Consequential damages.....	32
Application of benefit-cost measurement in project formulation.....	33
Analysis of needs and objectives.....	33
Analysis of physical possibilities for meeting objectives.....	34
Measurement of physical effects of a project.....	34
General procedure for measurement of benefits and costs.....	34
Establishing scale of development.....	36

Chapter III. Measurement of benefits and costs—Continued	
Application of benefit-cost measurement in project formulation—Continued	
Consideration of other available means of accomplishing project purposes.....	37
Analysis of justification.....	37
Comparison of projects.....	38
IV. Application of principles to various project purposes.....	39
Irrigation.....	39
Flood control.....	41
Watershed treatment.....	44
Navigation.....	46
Electric power.....	49
Recreation, fish and wildlife.....	50
V. Cost allocation for multiple-purpose projects.....	53
Approach to cost allocation.....	53
Recommended method of cost allocation.....	53
Relation of benefit-cost data and cost allocations to assessment problems.....	56
Appendix I. First progress report, Qualitative Aspects of Benefit-Cost Practices.....	58
II. Second progress report, Measurement Aspects of Benefit-Cost Practices.....	71

Letter Transmitting Report of the Subcommittee on Benefits and Costs to the Federal Inter-Agency River Basin Committee

MAY 15, 1950.

The CHAIRMAN,

Federal Inter-Agency River Basin Committee,

Washington, D. C.

DEAR MR. CHAIRMAN: Since April 1946, at the direction of the Federal Inter-Agency River Basin Committee, the Subcommittee on Benefits and Costs has been engaged in a comprehensive study of principles and practices pertinent to the economic analysis of river basin projects. The stated purpose was for formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects.

The first progress report of the Subcommittee, dated April 1, 1947, covered the Qualitative Aspects of Benefit-Cost Practices used by the participating Federal agencies concerned with river basin planning. The purpose of that report was to summarize current practices with respect to the identification and definition of benefits and costs.

The second progress report of the Subcommittee, dated November 3, 1948, covered the Measurement Aspects of Benefit-Cost Practices. Its purpose was to indicate in summary how the several departments then measured benefits and costs for river basin analyses.

The Subcommittee now presents its report Proposed Practices for Economic Analysis of River Basin Projects after consideration of pertinent information including the various current practices, an objective analysis uninfluenced by present practices or current legal or administrative limitations, various alternative approaches to benefit-cost analysis, and a study of certain special problems. This report presents the conclusions and recommendations of the Subcommittee relative to the formulation of river basin projects, the analysis of project justification measured in terms of benefits and costs, and the allocation of costs of multiple-purpose river basin projects. The report expresses no conclusions applicable to questions of reimbursement or repayment policies, which are beyond the scope of the Subcommittee assignment.

As the Committee is aware, the report has been completed on an expedited schedule and is forwarded at this time to permit meeting a request of the President's Water Resources Policy Commission.

The Subcommittee submits this report of Proposed Practices for Economic Analysis of River Basin Projects to the Federal Inter-Agency River Basin Committee with the recommendation that it be adopted as a basis for consideration by the participating Federal agencies and other interested groups, looking toward the realization of improved practices in the analysis of river basin projects. The principles and procedures recommended in this report are necessarily expressed in general terms. In the interest of the effectuation of sound principles on a mutually consistent basis, the Subcommittee also recommends continued inter-departmental cooperation looking toward the translation of such principles into detailed working procedures. Furthermore, additional consideration of certain problems dealt with herein and the accumulation of experience should provide a basis for the revision and improvement of practices and procedures.

In presenting this report, the Subcommittee wishes to take this opportunity to emphasize that the report is the product not only of the Subcommittee but is in large part a direct result of the sustained and objective effort of the staff. The work has been carried forward without making any distinction between subcommittee and staff members. A list of the personnel active in preparation of the report is attached.

Respectfully,

For the Subcommittee on Benefits and Costs,

Reginald C. Price

REGINALD C. PRICE, *Chairman.*

Membership of Subcommittee and Staff

SUBCOMMITTEE MEMBERSHIP DURING 1949 AND 1950

Reginald C. Price----- (Chairman 1950)	Special Assistant to Assistant Secretary, Department of the Interior.
George L. Beard-----	Chief, Planning and Development Division, Civil Works ; Office of the Chief of Engineers, Department of the Army.
Victor Roterus-----	Assistant Chief, Area Development Division, Office of Domestic Commerce, Department of Commerce.
Frank L. Weaver-----	Chief, Division of River Basins, Bureau of Power, Federal Power Commission.
Ernst H. Wiecking----- (Chairman 1949)	Office of the Secretary, Department of Agriculture.

SUBCOMMITTEE STAFF DURING 1949 AND 1950

Nathaniel A. Back-----	Office of the Secretary, Department of Agriculture.
Max R. Bloom-----	Area Development Division, Office of Domestic Com- merce, Department of Commerce.
Joseph R. Brennan-----	Planning and Development Division, Civil Works ; Office of the Chief of Engineers, Department of the Army.
Albert R. Johnson-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.
Mark M. Regan-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.
Kenneth L. Roberts-----	Division of River Basins, Bureau of Power, Federal Power Commission.
George H. Walter-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.
Ira A. Watson-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.
Eugene W. Weber-----	Special Assistant on Civil Works ; Office of the Chief of Engineers, Department of the Army.
William M. White-----	Office of River Basin Studies, Fish and Wildlife Serv- ice, Department of the Interior.

CHAPTER I

Introduction

This report presents the conclusions and recommendations resulting from a series of studies by the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee, made for the purpose of developing acceptable principles and procedures for determining benefits and costs of water resources projects.

OUTLINE OF STUDIES

This series of studies was divided into the following major parts:

Part A. ANALYSIS OF CURRENT PRACTICES

The purpose of this part of the study was to obtain a mutual understanding of the current practices of each participating Federal agency in preparing its reports and recommendations on water resource projects. The results were summarized in the following reports which made available, for the first time, detailed statements covering the practices currently in use by 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 are important fundamental differences in the application of these practices. Such differences include variations in the concept of what economic effects should be measured as benefits and as costs, differences in methods of measurement, and differences in the extent to which costs are measured as compared with benefits. These differences in current practices result from various legal and administrative requirements of member agencies, and from complexities and difficulties inherent in the measurement of the various kinds of benefits and costs.

Parts B and C. OBJECTIVE ANALYSIS AND ANALYSIS OF SPECIAL PROBLEMS

The purpose of these parts of the study was to develop a systematic, consistent, and theoretically 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.

Part D. CONCLUSIONS AND RECOMMENDATIONS

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.

The adoption of the recommended set of criteria by participating agencies for benefit-cost analysis would result in more accurate formulation and 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 interagency comparison of projects and greater understanding by public and Government alike.

SCOPE OF THIS REPORT

The basic assumptions and principles involved in benefit-cost analysis are discussed in chapter II. Included are statements of the objectives and purpose of economic analysis, the character of the viewpoint upon which analysis is based, definitions of benefits, costs, and related terminology. Attention is focused on effects attributable to projects, the nature of secondary benefits, effects of alternative opportunities on evaluation, and a summary of procedures for analysis of justification of proposed projects.

The standards, problems, and procedures involved in the measurement of benefits and costs are the subject of chapter III. 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, acquisition of land and improvements, treatment of taxes, displaced facilities, extension of useful life, and consequential damages. Application of benefit-cost measurement in project formulation is also explained.

Chapter IV is concerned with the applications of principles and procedures for analysis of various project purposes. These are discussed in terms of the several project purposes, including irrigation, flood control, watershed treatment, navigation, electric power, recreation, and fish and wildlife.

The application of benefit-cost data in allocation of costs among project purposes is discussed in chapter V.

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 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 evaluation of projects.

The basic approach of this study reflects consideration of a 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.

Benefit-cost analyses are not always the sole basis for approving or disapproving resource development projects. For example, where the need for a project arises from considerations of public policy other than economic factors, such as foreign policy or national defense, these considerations may govern. Even in such cases, since economic resources are limited in relation to need, benefit-cost analyses serve a valuable purpose in revealing the relative economic efficiency of such projects.

The criteria and principles presented in this report are 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. They may not, for example, 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 those 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 highly desirable, and while the procedures in this report are of use in such analysis, those matters are beyond the scope of this report.

While this report affords a basis for considerable improvement in economic analysis of river basin developments, as the state of our knowledge and experience develops, and as testing of the recommendations becomes possible, further refinement and improvement of the

suggested techniques and recommendations in this report should become possible.

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 procedures 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 as to application of the recommended procedures and as to modification or supplementation of the recommendations to the extent found advisable through experience.

CHAPTER II

Basic Assumptions and Principles

OBJECTIVES OF ECONOMIC ANALYSES

The ultimate purpose of an economic analysis of a project is to ascertain the extent to which the use of economic resources such as the land, labor, and materials necessary for a project is more or less effective than would be the case if the project were not undertaken.

To accomplish this purpose, the economic analysis should include procedures which will permit taking into account the following considerations:

(1) The service to be performed by a project will have value only to the extent that a need or demand for that service is to be expected. This requirement affects the principles and procedures to be used in evaluating project effects.

(2) The most effective use of economic resources 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. This means 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. This criterion of maximizing net benefits is a fundamental requirement for economic justification of a project.

(3) The project and 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 which would be displaced or precluded from development if the project is undertaken. This is another fundamental criterion for project formulation and economic justification in addition to the requirement that benefits must exceed costs as outlined in (2) above.

(4) From an economic standpoint the order in which a number of economically justified 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 arraying a number of justified projects in the order of their economic desirability.

Additional Uses for Data from Economic Analyses

In addition to serving the foregoing purposes, the information obtained from economic analyses may be needed in allocating costs,

establishing repayment schedules and for any other purposes for which benefit and cost data are useful.

VIEWPOINT FOR ECONOMIC ANALYSES

The viewpoint from which the effects of a project are evaluated is of 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 of the group or local area involved. It is apparent that in Federal practice a comprehensive public viewpoint should be taken; that is, a viewpoint which 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 entire zone of influence of the project.

The adequacy of results obtainable in project formulation and in evaluation of the justification and relative desirability of projects depends on how completely a comprehensive public viewpoint can be realized; that is, how completely all effects on individuals and society as a whole can be traced and evaluated in comparable terms with full allowance for offsetting effects and the influence of time of occurrence on the value of project effects. 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. In addition, however, there may be tangible effects, beneficial or adverse, from the standpoint of society as a whole that would escape evaluation in a summation of individual effects based on market values, as for example, the value of resource conservation to future generations. Also, there may be other values not readily evaluated in terms comparable to exchange values, as, for example, effects on health and welfare and 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 viewpoints other than a public viewpoint are not adequate for satisfactory project evaluation generally, they may have to be considered where assessment or repayment problems are involved. (See ch. V.)

BASIS FOR EVALUATION OF RIVER BASIN DEVELOPMENT

The ultimate aim of river basin development, in common with all productive activity, is to satisfy human needs and desires. The problem of evaluating, from a public viewpoint, the extent to which a project accomplishes this aim 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 values placed on

"goods and services" through the exchange process afford one means of measuring the degree of want-satisfying power attached to those goods and services by those who participate in the exchange. Most of the effects of projects involve goods and services which are readily evaluated in terms of market prices. Some effects of a project, however, such as improvement of health and enjoyment of recreation, have not been customarily evaluated in the monetary terms used in the market system. Furthermore, it is recognized that the values attached to goods and services in the market may not always reflect accurately the want-satisfying power from a public viewpoint because of various influences such as subsidies, tariffs, price supports, and imperfect markets as reflected by surplus commodities. It is, however, extremely difficult to give precise quantitative expression to these considerations in a technique of benefit-cost measurement. Nevertheless, the principle that project services or products have value only to the extent that they fulfill needs or demands is inherent in the very process of benefit-cost measurement. Therefore, it is necessary to evaluate conservatively the benefits associated with the product affected by the foregoing factors.

Despite the limitations of the market price system in reflecting values from a public viewpoint, it is concluded that there is no other suitable framework for evaluating the effects of public works projects in common terms. Accordingly, a market price system has been selected as the starting point for formulation of the subcommittee recommendations for 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, prevention of loss of life, improvement of health and provision of facilities for recreation should be evaluated in monetary terms as fully as possible. Intangibles, that is, effects which it is considered impossible or undesirable to express in monetary terms such as scenic values, 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. (See ch. III.)

BASIC CONCEPT OF BENEFITS AND COSTS

The phrase "goods and services" as commonly used in the economic sense is utilized in this study to encompass all objects and activities which have the power of satisfying human wants and which may be increased or decreased in amount (or value) as a result of a project. Goods and services which fulfill human needs and desires and which are limited in supply have economic value. Any goods and services for which there is no need or demand have no economic value. In order for the effects of a project to have economic value in terms of benefits or costs it is necessary that there be a need or demand for the goods and services produced by or used for the project.

The most practicable measure of the relative desirability of goods and services for meeting the various needs and demands which exist is the market price in dollars as previously discussed. To the extent that project effects can be assigned an actual or estimated market value, they may be defined as benefits and costs in terms of the market

value in dollars of the increases or decreases in goods and services that are expected to result if a project is undertaken.

Over-All Effects of Projects on the Economy

The economic effects which may be expected if a project is developed cover a wide range. The range of effects can be illustrated simply by considering just one chain of events that might stem from a typical irrigation project which makes available a supply of water for agriculture. The farmer uses the water in conjunction with land, labor, and materials to produce wheat. The wheat, in turn, is transported to and processed through an elevator and a mill to produce flour which is utilized by a baker to make bread for sale to a consumer. The problem is to determine which of the economic effects along that and similar chains of events are attributable, wholly or in part, to the project. To facilitate subsequent discussion of this problem, terminology for certain classes of effects is defined in the next paragraph and the terms are illustrated by application to the hypothetical irrigation project described above.

Terminology for Identifying Benefits and Costs

The term "project" is used in this study to encompass any program, project, or combination of river basin development measures carried out by the Federal Government or coordinately by Federal and non-Federal interests. In general, the non-Federal measures considered as a part of the project are those which the Federal Government requires non-Federal interests to perform as a condition to the Federal participation in the project.

Project costs are the value of the goods and services (land, labor, and materials) used for the establishment, maintenance, and operation of the project including allowance for induced adverse effects whether or not compensated for. In the irrigation project cited above, the project costs would be the costs of making irrigation water available to the farmer.

Associated costs are the value of the goods and services needed, over and above those included in the cost of the project itself, to make the immediate products or services of the project available for use or sale. In the cited example, the farmer's costs of producing the wheat (other than any charge for the irrigation water) would be associated costs.

Primary benefits are the value of the immediate products or services resulting from the measures for which project costs and associated costs were incurred. In the irrigation project illustration, the primary benefits are the value of the wheat produced by the farmer. The procedures through which these primary benefits (and secondary benefits described below) are translated into net benefits attributable to a project are discussed in subsequent paragraphs.

Secondary costs are the value of any goods and services (other than those covered by project and associated costs) which are used as a result of the project. These include the costs of further processing of the immediate products or services of the project and any other costs, over and above project and associated costs, stemming from or

induced by the project. In the irrigation project example, the costs of transporting the wheat, elevator and milling costs, bakery costs, and the costs of distribution to consumer would be secondary costs.

Secondary benefits are the values added over and above the value of the immediate products or services of the project as a result of activities stemming from or induced by the project. In the cited example, the value of the bread over and above the value of its wheat content would be a secondary benefit. The portion of this secondary benefit creditable to the project is discussed later in this chapter.

BENEFITS AND COSTS ATTRIBUTABLE TO THE PROJECT

Any economic effects which, although they will occur in a chain of events stemming from a project, may also be expected to occur if the project is not undertaken, are not attributable to the project insofar as measuring the efficiency of use of economic resources for project purposes is concerned. Therefore, in identifying and evaluating the benefits and costs attributable to a project for purposes of economic analysis, the possibility that the goods and services diverted for project purposes would be useful for other purposes in the absence of the project must be taken into account. Similarly, the beneficial effects that would result if goods and services were used for other than project purposes must be taken into account. Since there normally are other uses for the goods and services needed for river basin development projects, the effects of such possible other uses are limitations of fundamental significance in determining benefits and costs attributable to such projects.

Principles for Evaluation of Costs

When goods or services are utilized for any given purpose, the economic effect of that action is to preclude their use for other possible purposes. Therefore, the economic cost of using goods and services for a given purpose is, in effect, the value of benefits foregone in the most likely other use to be expected. If there is no other use to which the goods and services would be put in the absence of the project, the economic cost of using those particular goods and services for the project is nil. In general, however, there are other uses which may be expected for all of the goods and services needed for river basin development projects. For the usual case, it is assumed that the goods and services used for project purposes are diverted from uses in which the value of the goods and services produced would be approximately equal to the cost of the goods and services used. In such cases the cost, in terms of market value, of the goods and services diverted to project purposes is used as an adequate measure of benefits foregone. Market prices may, therefore, be used to evaluate costs of using goods and services for project purposes in the usual case. In 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 price of the goods and services used, an adjustment is necessary for proper accounting of costs. All costs defined above, that is, project, associated, and secondary costs, should be evaluated on the basis of the foregoing principles.

Primary Benefits Attributable to a Project

Primary benefits as defined above, are the combined effects of project costs and associated costs and are, therefore, attributable in part to the project and in part to the associated activities. The project should be credited with the difference between the total primary benefits and the benefits that could be expected to be realized by applying the associated costs in some other way if the project were not undertaken. In other words, the primary benefits attributable to the project are the total primary benefits minus the benefits foregone through use of the associated resources for project purposes rather than for other purposes. As discussed above, the benefits foregone are, in the usual case, assumed to be equal to the market value (i. e., the cost) of the goods and services used. Therefore, except when adjustment is necessary for unusual conditions as previously discussed, the primary benefits attributable to a project are equal to the total primary benefits less associated costs. In the irrigation project illustration, the market value of the wheat minus the farmer's costs (other than charges for irrigation water) would be the primary benefit attributable to the project.

Secondary Benefits Attributable to a Project

Secondary benefits as defined above are the values added by incurring secondary costs in activities stemming from or induced by the project. In considering conditions to be expected without the project, account must be taken of the values which may be added in such activities by processing similar products obtained from other sources or by utilizing the goods and services involved for some other productive activity. No secondary benefits are attributable to the project unless it can be shown that there is an increase in such benefits as a result of the project as compared with conditions to be expected in the absence of the project. For purposes of project formulation and analysis of project justification, the net secondary benefits attributable to the project can accrue, for example, under the following types of conditions:

(1) When the primary benefits attributable to the project exceed the project costs, the project, in effect, produces a surplus of goods and services as compared with the amount of production of goods and services to be expected in the absence of the project. If such primary benefits and project costs have been evaluated properly; that is, by taking into account the uses most likely to be made, in the absence of the project, of the economic resources required for the project, it follows that goods and services (in the amount of the surplus produced by the project) are being made available to secondary activities at less cost than would have been possible in the absence of the project. Without the project, goods and services equivalent to the project surplus could have been produced only at a cost equal to or greater than existing marginal costs. Therefore, in the absence of the project, the surplus could usually be made available to secondary activities only at an increased market price. The fact that secondary activities can obtain the project surplus without an increase in market price is a secondary benefit which is attributable to the project. The amount attributable to the project is the difference between the market value of the project surplus and the cost of producing an equivalent surplus by some other means in the absence of the project. In the irrigation

project example, if the project-produced wheat were made available to the miller at a prevailing market price of \$2 per bushel and conditions were such that, in the absence of the project, equivalent production of wheat by other means would have had to be sold to the miller at \$2.10 to cover costs, a benefit of 10 cents is creditable to the project for each bushel of wheat produced in excess of the amount that would have been produced and marketed at the prevailing price in the absence of the project.

(2) The second general condition under which net secondary benefits may be creditable to a project arises when the goods or services used in activities stemming from or induced by the project would have had a lower use value (i. e., would have been unused or underutilized) in the uses to be expected in the absence of the project. In such cases, the net increase in such value is a net secondary benefit attributable to the project. In the irrigation project illustration, if there were a grain elevator near the source of the project-produced wheat which had capacity over and above its expected requirements in the absence of the project and which had no prospects for use of such excess capacity unless the project wheat were grown, the increase in net income at the elevator due to processing the project wheat would be a net secondary benefit attributable to the project. The conditions under which this type of benefit could accrue are unlikely to be found in many cases. Furthermore, in measurement practice, as discussed later, allowance should be made for similar effects which could occur through processing the products which would result if the economic resources diverted to the project were used for other purposes.

Ascertaining and measuring net secondary benefits properly creditable to a project is a most difficult and complex problem and great care must be exercised in their use for project justification. Because of such difficulties, primary reliance in project analysis will usually need to be placed on the more direct types of project effects. The problem, however, merits continuing study.

Definition of Project Benefits

To serve the purposes of economic analysis, the costs charged to a project must be all costs necessary to produce the benefits attributed to the project. Conversely, the benefits claimed as project benefits must be net of all costs other than those designated as project costs. Project benefits comparable to the project costs previously defined are the primary benefits attributable to the project plus any net secondary benefits as discussed above, that is, the net value of the goods and services produced by the project and by activities stemming from or induced by the project after deducting all nonproject (associated and secondary) costs involved.

ECONOMIC LIMITATIONS ON SCALE OF PROJECT DEVELOPMENT

In the formulation of projects three points in the possible scale of development of a project which are significant are shown on figure 1 on the following page. 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

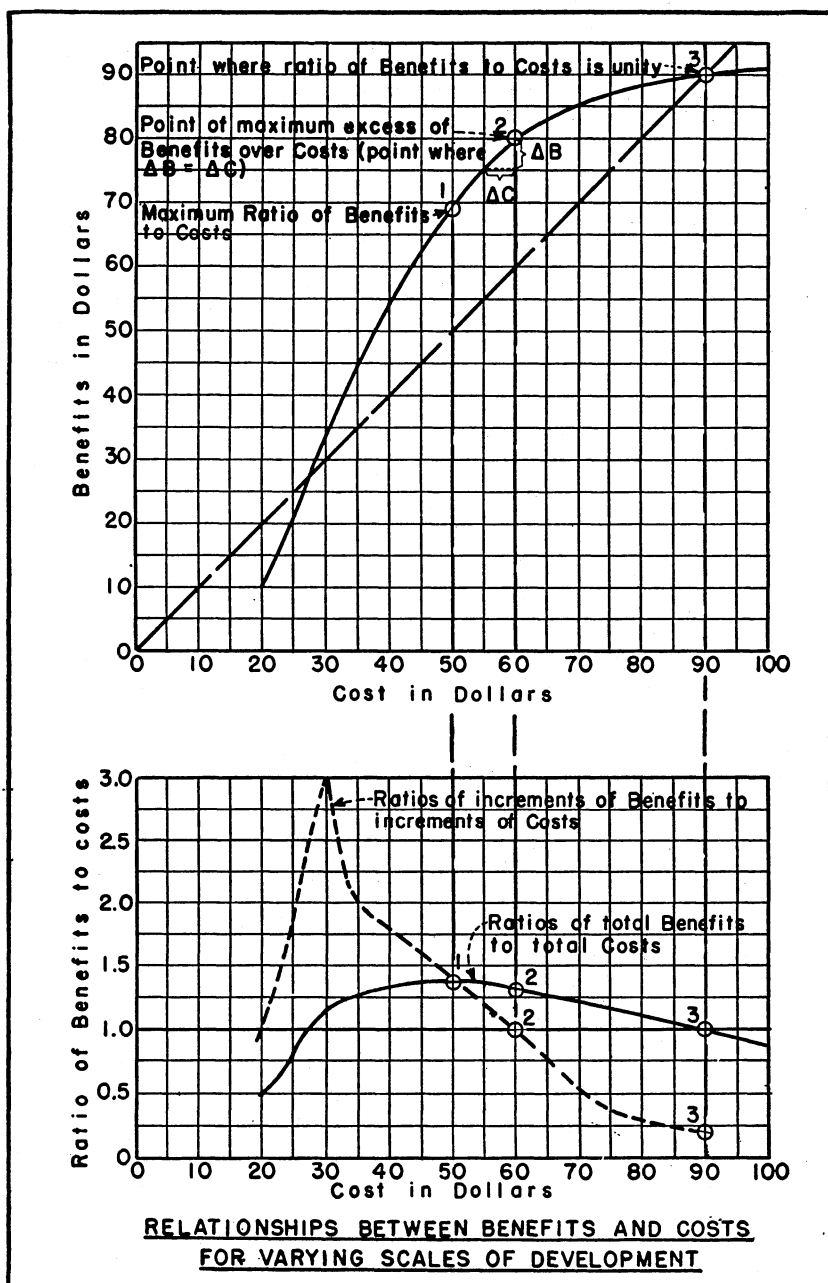


FIGURE 1.

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 over-all 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.

SUMMARY OF PROCEDURES FOR PROJECT FORMULATION AND ANALYSIS OF JUSTIFICATION

The several steps necessary in an economic analysis to permit a determination of the relative efficiency with which economic resources will be used if a project is undertaken are summarized below.

Establishment of Need

The need or demand for the products or services of the project should be established. In general, the existence of a need or demand for project services is established in the process of evaluating project effects by considering the alternative uses of resources likely under conditions with and without the project. In some cases, the lack of need or demand for project services may be sufficiently apparent on the basis of analysis of over-all economic conditions to preclude further consideration of a project.

Estimate of Project Benefits and Costs

Project benefits and project costs should be estimated in accordance with the principles outlined in foregoing paragraphs. (Problems and procedures for measurement of benefits and costs are discussed further in chs. III and IV.)

Establishment of Scope of Project Development

The scope or scale of development of a project should be established at the point where the net benefits from use of resources for project purposes are at a maximum. Net benefits are at the maximum when the scale of development is established at the point where the benefits added by the last increment of extension of scope are equal to the cost necessary to add that increment of scope to the project. The least increment of scope to be analyzed is the smallest increment on which there is a practical choice as to inclusion in or omission from the project. At the point of maximized net benefits, the total project benefits will necessarily exceed the total project costs by the maximum.

Ascertaining Most Economical Means of Realizing Project Purposes

The project or any separable segment thereof selected to accomplish

a given purpose should be more economical than any other actual or potential means, public or private, available for accomplishing that specific purpose which would be displaced or precluded from later development if the project is undertaken. This is a fundamental criterion separate from and in addition to the requirement that project benefits exceed project costs. This limitation does not apply to the situation where two or more projects or methods of obtaining similar benefits are available and adoption of one means would not preclude the other. If two or more such projects are needed and justified, each should be considered and arrayed in order of relative efficiency to determine priority as discussed below.

Comparison of Relative Economic Value of Justified Projects

All projects which satisfactorily meet the criteria outlined above will necessarily be economically justified. The relative economic value of such projects under various economic conditions may be determined by several methods as 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 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 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 the proper 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 can be satisfactorily determined by comparing their ratios of project benefits to project costs. In cases where nonproject costs (associated and secondary) are of special significance or vary greatly among the projects being compared, it may prove desirable to compare the sum of project and nonproject costs with the gross benefits resulting therefrom.

CHAPTER III

Measurement of Benefits and Costs

The use of benefits and costs in connection with the formulation and the justification of water control projects requires their 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. These 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. Finally, procedures are presented for the application of benefit-cost measurement in project formulation.

GENERAL MEASUREMENT STANDARDS

The benefits and costs of projects occur in diverse physical forms, at different times, and have effect 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 various 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 an enterprise. While measurement standards indicative of the total interests of society would appear appropriate for evaluation from a comprehensive public viewpoint, there often are no practical or acceptable measure 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 limits the extent to which 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 taken account of in a public viewpoint evaluation might often be at a variance with customary concepts.

In view of the complexities and difficulties involved in appraising project effects in terms of the effects on society as a whole, it is recommended that, so far as is sound and reasonable, standards be used which are customarily recognized as acceptable. Such standards are also applicable in determining allocations of costs and the basis for determining repayment capacity. Where individual participation, particularly acceptance of repayment obligations, is required, the broad acceptability of measurement standards is of special importance.

Price Levels

Ideally measurement standards in project evaluation should reflect the interests of society as a whole. As such, these standards should be concerned with real costs and benefits. On that basis, the real cost to society of the resources used for project construction is measured 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 determined by the amount of goods for which they can be exchanged when the benefits become available. If it were possible to postulate price projections of real values, applicable to benefits when realized and to costs when incurred, and to supplement those values by consideration of society's long-range welfare, an adequate gauge of the public interest would be secured.

Unfortunately it is not practicable to establish and apply such a system of real value. There would be the technical difficulty of devising such a pattern upon acceptable assumptions, and furthermore, the administrators who recommend projects and the legislators who consider them would likely be averse to receiving project estimates couched in theoretical terms rather than in terms of expected dollar costs.

Another way of handling price levels would involve presenting both benefits and costs in terms of a single expected future price level, say, by placing all estimates on the basis of 1940 prices or on the basis of an average of prices over a period of years, if those prices were considered a reasonable guide to prices over the life of the project. Even though adjustments might be made to individual prices to take account of expected deviations from the general price level, this approach also would not use current prices for investments expected to be made soon after project authorization; i. e., practically on a current basis. Also it is doubtful that any past instantaneous or average expression of prices will reflect adequately expected future prices and their relationships. This approach is not recommended.

Still another treatment of price levels would entail accepting prices current at the time of the investigation as a guide to prices pertinent over the project life, modified only to the extent of allowing for anticipated changes in relative prices of specified goods and services. In comparison with the other alternatives already discussed, this method has the virtue of proceeding from a prevailing basis of values, and of approaching the objective of expressing benefits and costs in terms of relative values which are independent of changes in the general price level. An objection to this approach is that the resulting estimates of benefits would be in constant dollar values that would in most cases differ widely from the actual dollar values of benefits at the time such benefits accrue. This basis might be inadequate for the purpose of demonstrating the usefulness of the project to beneficiaries in terms recognized by them and would lead to difficulties in utilizing such benefit estimates in establishing repayment obligations, a purpose which benefit-cost analysis should serve if practicable. Therefore, this approach also is not recommended.

All things considered, the most satisfactory approach would result from using prices estimated as they are expected to be at the time when costs are incurred and benefits received. As a practical matter this would mean applying prices current at the time of investigation to project investment costs if the latter are to be incurred shortly after project authorization, as they often are. Benefits and other costs would be expressed in terms of a price level expected to prevail at the time when these benefits and costs would be expected to occur. This procedure is recommended as the best available alternative. It permits a useful working relationship with repayment determination. It takes account of future prices and price relationships based on the best judgment at hand.

Although the recommended procedure may fall short of assuring the measurement in terms of equivalent goods and services at all times, nevertheless, it does allow for the expression of certain aspects of the public interest that would be difficult to include by other means. This is the recognition of the stabilizing effect on the general economy which this approach to project analysis would tend to produce. In the past, low price levels have been associated with low levels of employment. Resource project costs incurred in such times are relatively low, and the benefits which accrue later are apt to have higher values in relation to costs than they would have if the projects were initiated during periods of high level employment. Under these circumstances of low employment, project justification and initiation are favored by the procedure recommended. Conversely, this procedure is less favorable to project justification and initiation when employment levels, and the associated phenomena of prices, are high. In terms of the general stability of the economy, there is less need for project initiation during these periods of high economic activity than there is during the periods when resources and men are not fully employed.

Procedure for determining applicable price levels.—For the purpose of evaluating benefits and costs on the basis of prices expected to prevail when benefits and costs occur, the effects of projects fall into three general classes:

- (1) Investment costs, which are usually incurred at the outset of the project.

(2) Operation, maintenance and replacement costs, which occur at various rates and times throughout the life of the project.

(3) Benefits, which can be assumed to accrue throughout the life of the project at uniform or varying rates.

Initial investment costs should usually be evaluated on the basis of prices prevailing at the time of project analysis if such costs are to be incurred shortly thereafter. However, if an analysis is being made of a project intended for development at a date substantially later than the analysis, it may be advisable to estimate prices at the level expected at the proposed time of construction.

Future operation, maintenance, and replacement costs and benefits should be evaluated on the basis of the prices estimated to prevail at the time of occurrence of such costs and benefits. The most practicable procedure is to estimate the average price level expected over the life of the project (or period of analysis as discussed in a following section). This requires consideration of population growth, technological developments, changes in consumption patterns, levels of employment, amount of foreign trade, possibilities of substitutes and alternative sources of supply, and monetary and fiscal policy. The difficulties involved in forecasting possible future developments and estimating probable future price levels are admittedly formidable but the problem cannot be avoided by merely accepting current or historical prices as a basis for future expectations. Such an uncritical procedure merely assumes that current or historical prices will prevail in the future and is, in effect, a forecast made without consideration of all pertinent factors. Use of future price levels estimated after careful consideration of all the factors likely to influence them is more likely to result in adequate appraisals than use of current or historical prices without regard for future trends.

The soundness of project formulation and justification analyses depends in part on the accuracy of benefit and cost estimates. In general, it is preferable that estimates be on the conservative side and have a reasonable high degree of certainty of realization. Future price levels as estimated for evaluating benefits and costs should, therefore, be the expected average price levels which may reasonably be estimated to prevail. In this respect, price level forecasts for benefit-cost analyses should be on a conservative basis. They should reflect a degree of certainty which may differ from that associated with estimates made for other purposes, such as estimates of desirable price levels and other factors intended as a guide to fiscal and monetary policies, or such as estimates of economic goals which are to be sought but which may have less than average chance of realization.

A practical approach for estimating future price levels.—There are few available estimates of future economic conditions which are useful for project benefits-cost analyses. The type of approach needed is exemplified in a 1948 report of the Department of Agriculture, Long Range Agricultural Policy. That report postulates three alternative levels of employment and for each includes a projection, for the period 1955–65, of a series of price, income, and other indicators of economic activity. This type of study, embracing both agricultural and non-agricultural factors involved in river-basin development, is needed for benefit-cost analysis. It is recommended that arrangements be made for periodic appraisal of future economic conditions to extend as far into the future as practicable, in order that it may reasonably be

assumed to be applicable over project period of analysis of from 50 to 100 years. Pending availability of such appraisals for use by all Federal agencies in project analyses, price level data based on the 1948 Agriculture report as recently adapted by the Department of Agriculture for use in its watershed treatment program under the Flood Control Acts, are suggested for consideration of the agencies concerned with agricultural prices.

The 1948 report, Long Range Agricultural Policy in its forecast of future levels of economic activity presents projected relationships between various economic factors for three alternative employment levels. In order to provide a conservative basis for the benefit-cost analyses in its watershed treatment program, the Department of Agriculture selected the intermediate level which is an expected future average employment of 58,000,000 with 8,000,000 unemployed, approaching the average relationship over the period 1921-40, when unemployment averaged about one-eighth of the labor force. The various economic factors projected under the intermediate employment assumption are believed by the Department of Agriculture to provide agricultural benefit and cost estimates having a reasonably high degree of certainty of realization.

The Department of Agriculture, also for use in its watershed treatment program, has made projections of future levels of prices for the principal groups of agricultural products including lumber, for specific crops, and for the principal agricultural production cost items: These projections for the 1955-65 period give a level of 150 (1910-14=100) for prices received by farmers, and 175 (1910-14=100) for prices paid by farmers for production cost items including interest and taxes. These represent reductions of 40 percent and 30 percent, respectively, below the 1949 averages. The Department of Agriculture has occasion also to require estimates of replacement and operation and maintenance costs for the kinds of measures installed in its watershed treatment program and has made price projections for such cost items. In making these estimates, probable trends in domestic and foreign requirements as well as price-support programs were taken into account and integrated within the framework of the general economic projections.

In connection with benefits and costs other than agricultural, there is need for a projection of prices associated with both benefits and costs in fields such as commercial fisheries, navigation, recreation, and others. In some cases, such as power, a national projection may be inappropriate. There is need for projections that will apply to the long-range future, preferably a period of some 50 to 100 years, for benefit analysis.

The projection of one or more indices of construction costs on a basis comparable to the projection to be used for agricultural prices and under the same general assumptions, is needed for estimating future construction costs and for other purposes. A projection of construction cost indices applicable to a particular type of construction would be preferred when practicable. In other circumstances, a projection of a construction cost index which is more general in character may be useful. A projection of such indices may be used as a specific or general guide in adjusting prices based on current cost estimates so that the cost of deferred installations and replacements may be expressed on an expected long-term level. It would also be useful in

estimating costs of repairing property damages in connection with appraisal of certain flood-damage prevention benefits, and in estimating operation and maintenance costs. In any such use, account must be taken of variation in trends between the components of future costs or damage estimates and the items in the construction cost index. Likewise, regional differentials which depart from a general index must be recognized. For all installations expected to be undertaken in the near future following an investigation, prices current at the time of the investigation or slight modifications of such prices to reflect conditions expected at the time of project construction should be used.

Adjustments in price-level projections.—Any over-all national estimates of price levels require adjustments before being used in a benefit-cost analysis to reflect area and regional conditions. The specific commodity projections can usually be made by applying the percentage changes expected for the country as a whole to the appropriate base level for the area on the assumption that future area differences in prices for each of the commodities will be proportionately the same as those in the base period. Special consideration should be given to the infrequent case where a shift from a deficit to a surplus-production area (or vice versa) might be expected to result from project production or utilization of some commodity.

Special treatment will be required whenever the project production is sufficient to affect materially the relationship between area and national averages. Whenever the project production or requirements are expected to influence market price, the use of a price about midway between that expected with and without the project is recommended as justified to reflect the public values involved, as illustrated in chapter IV. For example, where prices were expected to be lowered as a result of project production, such an adjustment might be needed to reflect the benefits from avoiding more costly production and higher prices that might result in the absence of the program. The difficulties of making estimates for adjustments of this type with any degree of precision are obvious and such effects will most often need to be treated as intangibles.

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 of benefit and cost accrual is recommended. For installation costs, prices expected during the construction period should be used. This may or may not mean the use of current prices prevailing at the time of the investigation, depending upon how soon construction will begin and the extent of price changes anticipated in the interval. In calculating most types of benefits and in calculating costs for operation, maintenance, and minor replacements, the prices used should be the average prices estimated to prevail over the life of the project.

It is further recommended that arrangements be made for a study or studies which will lead to recommendations as to long-term projected prices applicable to all kinds of benefits and costs considered by Federal agencies and for the periodic reappraisal and refinement of such projected prices. The projection should extend as far into the future as practicable, in order that it may reasonably be assumed to be applicable over project periods of analysis of from 50 to 100 years.

Finally, it is suggested that where agricultural benefits and costs are

involved in benefit-cost analyses, the projections used by the Department of Agriculture in its watershed treatment program with such adaptations thereto as the agencies may need to make in practice, be used as the most appropriate at this time, until longer range projections as recommended above become available.

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.

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 could be estimated with reasonable assurance, or the costs of their prevention if such is possible, 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 bases are not available for calculating their value.

Methods of allowing for uncertainties or unpredictable risks include the use of prices in estimating benefits that are reasonably conservative (as recommended in the previous section); the assumption of a limited economic life, with minimum allowances for salvage, which results in amortization of costs over the 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. Even though the allowance for uncertain risk may be materially reduced by several other recommended practices, it appears probable that some residual risk may still usually need to be reflected in the discount rate, particularly if the benefit estimates are to be acceptable to individual beneficiaries.

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 mutually comparable only if all are adjusted to a uniform time basis. Interest rates are a measure of the value attached to time differences and, hence, provide a means for converting estimates to a common time point or period.¹

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 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 cost of investing such resources in a particular project is measured by the rates applicable to other uses that are foregone. This cost is over and above allowances for risk and arises regardless of whether a private or public viewpoint is involved. The interest rate on investments such as longer term government bonds would appear to be a reasonably satisfactory measure of the interest return with minimum risk opportunities available for capital investment. Although such a rate may not fully reflect the justifiable preference of society for present goods, it still provides a measure of the yield of other opportunities for capital investments that are foregone by society if resources are invested in given projects.

Were it possible to eliminate all risk elements from the calculations, the use of an interest rate reflecting only capital productivity would provide an appropriate basis for treating all types of time differentials. In practice, however, there appear to be at least two principal limitations on the use of a single minimum risk interest rate, such as the government borrowing rate, in discounting and converting all types of benefits and costs to a common time basis. The first is the

¹Interest 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 investments that over time will yield a return in excess of the initial cost of the 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 consumption that is foregone. With new capital formation limited by savings and existing capital being depleted by use and obsolescence, the possibility of the supply of capital being sufficiently plentiful to satisfy all requirements at a rate of zero interest appears remote.

need to take account of the residual risks that may be associated with a particular project. The government borrowing rate is relatively risk free because the security is the general taxing power and because the over-all degree of certainty of return is pertinent rather than the degree of certainty that may be attached to particular projects that may be undertaken. Since it is often impractical if not impossible to adjust estimates of deferred effects to a certain or risk-free basis, some element of risk still must usually be accounted for in the interest or discount rates applied to deferred effects.

A second consideration involves the need for recognizing the rates necessary to induce participation by individuals and groups utilizing project services. In estimating net benefits accruing from associated activities in utilizing project services, the rates used in charging costs for initial investments by individuals and groups and discounting benefits accruing to them must be sufficient to obtain their participation.

In view of these considerations, it is recommended that the expected average long-term government bond rate be used as the basis for calculating Federal or non-Federal public investment costs and that higher rates be used for private investment costs and in the treatment of deferred benefits.

A rate of $2\frac{1}{2}$ percent is recommended for current use in calculating the annual cost of initial Federal investments and in the conversion of replacement costs to an annual equivalent basis. The rate indicated approximates the current cost of long-term Government bonds and probably approaches as nearly as can be estimated the average rate likely to prevail in the foreseeable future. The use of that selected rate should be continued until pertinent considerations may make it desirable for Federal agencies which plan river-basin development to change simultaneously to another rate more suitable to new conditions.

For non-Federal public investments, the interest rate should be the expected long-term borrowing rate for the particular non-Federal public body involved, but not less than the rate used for Federal investments. For current use a rate of not less than $2\frac{1}{2}$ percent is recommended.

A rate of not less than 4 percent is recommended for current use in converting deferred benefits and private costs to an average annual equivalent basis. This higher rate would be in keeping with the values attached to deferred benefits by beneficiaries and approach the rate of return needed to induce private investment and participation. This rate corresponds to the minimum current costs to private borrowers for obtaining funds through mortgage loans secured by real property or other substantial assets. Although prevailing rates on such loans are materially under the average for the interwar period, there appears to be little basis at this time for projecting any substantial change. The extent and type of other risk allowances which are made in the analysis will necessarily furnish the basis for a judgment decision as to whether a higher than the 4-percent minimum rate should be used.

The use of this higher rate for converting irregular benefits to a present worth basis would make a substantial allowance for unpredictable risks. However, if the present worth of such benefits is reconverted to an average annual equivalent basis, much or all of this type of allowance for such risks is offset. If benefits accrue regularly, they are unaffected by such a risk allowance, but risk can be adequately

allowed for by another means. The use of the 4-percent rate on non-Federal private installation costs does provide some allowance for unpredictable risks, as would the reconverting of benefits occurring irregularly or in the more distant future. The use of this higher rate would also be significant in cases involving cumulative damages expressed as an annual lump sum.

Summary of interest rate recommendations.—It is recommended that estimates of benefits and costs accruing at varying times be made comparable by adjustment to a uniform time basis through the use of interest rates. The interest rate for Federal, non-Federal public, and private investment should in general be the long-term borrowing rate applicable. A 2½-percent interest rate, which approximates the interest rate on long-term government bonds, should be used currently in calculating the annual cost of initial Federal investments and in converting replacement costs to annual equivalents. A current rate of not less than 2½ percent is recommended for calculating the annual cost of non-Federal public investment. A current rate of not less than 4 percent is recommended for calculating the annual cost of private investments and for discounting deferred benefits. This rate makes allowance for residual risks not elsewhere recognized, and corresponds generally to the minimum current cost of private borrowing.

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 economic life of a project is determined by the point in time at which the effect of the foregoing factors is to cause the costs of continuing the project to exceed the additional benefits to be expected from continuation. As so used the economic life is generally less than the physical life of a project, and never more than the estimated physical life.

While economic life establishes an upper limit on the period of analysis, it is often convenient and desirable to use a period short of this limit for purposes of economic analysis. The use of an evaluation period less than the ultimate expected economic life provides additional means of allowing for risks. Conservative estimates of salvage values, minimum estimates for the productive life of initial installations and replacements, and operation and maintenance allowances sufficient to provide full operating condition throughout the period of analysis all tend to serve as means for 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 asso-

ciated 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 period of analysis of 100 years be considered as the upper limit on economic life. Justification for this limit lies in the more than usual uncertainty involved in predicting the remote future and in the likelihood that any benefits and costs accruing beyond a 100-year cut-off 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 of the land less any 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 maximum length of project life and the basis for salvage determines the 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 charge for amortization should be calculated on a sinking fund basis. The interest rates for calculating the amortization or sinking fund charge should be the same as those used in calculating interest costs on initial investments. As recommended above, currently this would mean a rate of $2\frac{1}{2}$ percent for amortizing Federal public investment costs, not less than $2\frac{1}{2}$ percent for non-Federal public investment costs, and not less than 4 percent for private costs.

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 a procedure in the case where output declines over the course of its 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 extended life, and, those having continuing replacement possibilities, it is recommended that a 100-year period of analysis be used as the upper limit on economic life, with allowance for salvage at the end based on nonproject uses. 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

As recommended in the previous section adoption of uniform 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; analysis of displaced or abandoned facilities; measurement of the value of extending the useful life of a nonproject facility; 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 in monetary terms. Most of the effects of most 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 alternate means. 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 do not yield to dollar evaluation. Such effects in the field of costs may involve the possible loss of a scenic or historic site in connection with a proposed dam. On the other hand, intangible benefits may embrace such effects as the strengthening of national security and the national economy; the substitution of power from replenishable water resources for power produced from limited and nonreplaceable fuel resources; the encouragement of a more widely dispersed industry; the provision of

opportunities for new homes and new investment; and the provision of new avenues for the enjoyment of recreation and wildlife.

The saving of human life through flood control is an example of the kind of effect which proves difficult to evaluate in economic terms. Nevertheless, the analysis of individual projects and the comparison of an array of projects will be improved through the uniform use of a generally acceptable judgment value of such effects, based on consideration of the economic factors involved. For the purpose of establishing a greater comparability among benefit-cost analyses of the various agencies, a human life might be given, as a minimum, the same economic value as would be payable for a life lost during project construction under compensation arrangements which are normally included in estimates of project costs. According to a simplified summary, out of 27 States and territories which have a maximum lump-sum compensation provided by State law for accidental death upon construction jobs, the range is from \$3,500 to \$10,950. In another group of 15 States which have no maximum limitation, there is a time limit on the number of weeks' compensation that are to be paid, based on the employee's weekly earnings at time of accident. The time limit varies from 300 weeks to 600 weeks. One State has no provisions whatsoever. In 7 States, there is no limit in time or aggregate amount of payment of death benefits to widows or children. In 1 other State, death benefits payable by the employer amount to 4 times the average annual earnings of the deceased, subject to further consideration depending upon the age of the deceased at the time of the accident.

On a broader basis the value might approximate the average experience amount paid for accidental loss of life in court awards.

Use of one of these measures is suggested as better for benefit-cost analysis than considering the value of human life only as an "intangible." From a public viewpoint, of course, this economic consideration is incomplete, and the value of human life over and above any economic value placed on it must continue to be regarded as intangible and to be presented as a separate statement in project justification.

Project effects which cannot be given monetary values should be recognized and considered apart from the analysis of monetary values. If intangibles 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, that is, from their use for other expected purposes. If specific intangible effects are considered important enough to influence the recommendation for or against a project or the recommended degree of project development, the minimum value attached to such specific intangible effects in determining the recommended degree of development should be clearly 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 or

derived 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 minimum value attaching to such effects should be clearly indicated. It is suggested that the agencies concerned adopt uniform procedures for the treatment of these effects.

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 or wasted if they cannot be 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 such direct labor an estimate can be made of the amount of such labor 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. Because of the practical difficulty of summing up the numerous factors involved, it is suggested that the advantageous effects of the use of such labor for the project can be approximated by estimating the amount of reduction of unemployment compensation or relief payments made possible if the project is undertaken. The necessary adjustment could be made by decreasing project costs or increasing project benefits by this amount.

In times of relatively low economic activity, a project may result in employment of labor in nonproject 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 which might 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. Adjustments for underemployment of labor and other economic resources should be considered only if con-

struction is expected to be undertaken during a period of relatively low economic activity. In such a case, reduction in relief costs and unemployment compensation expected as a result of a project may be credited as a direct project benefit. Secondary effects of a project on otherwise unemployed resources should usually be regarded as intangible.

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 reflects 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 was reflected in prices paid for land. Although this may be a duplication of cost, such a payment is often necessary and is usually small in proportion to total project costs.

The relationship between acquisition of such public facilities and taxation is discussed below under "Treatment of taxes."

Recommendations.—It is recommended that allowances be made for public facilities in project costs as follows: If public facilities are to be replaced at project expense, no additional allowance need be made in project costs for the existing facilities nor for retiring outstanding debt. If public facilities are to be purchased at project expense, no additional allowance need be made in project costs for outstanding debts or replacements. Unless the public facilities are 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 less intensive uses but remain in agriculture, 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 either in project costs or benefits.

When land and improvements are acquired for project purposes, the acquisition costs, including legal fees and administrative expenses, are normally included as project costs. The acquisition 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 comparable 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 most cases it may be permissible to assume that the purchase price will adequately reflect the productivity value of the land and improvements from a public viewpoint. However, where such a reflection of costs is obviously insufficient, an adjustment may be advisable. 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. If the value of the decreased productivity exceeds the acquisition costs, a deduction from project benefits equal to this excess should be made to reflect this reduction in productivity.

Productivity in preproject uses is normally expected to be sufficient to justify the purchase price. If purchase costs exceed the productive value of the property, the excess cost must be justified by the benefits of acquisition to other project purposes. To the extent that the uses of lands and improvements are not changed by the project, only their acquisition costs are to be justified by the benefits from continuing their former uses.

Recommendations.—It is recommended that all land-acquisition 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 in project benefits to reflect this difference. For acquired property remaining in preproject uses, the benefits resulting from such productivity should be used only to justify land acquisition costs for that property providing the benefits.

Treatment of Taxes

Taxes are levied for defraying the expenses of government and their incidence and effects throughout the economy are varied. 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 and services used or produced in water resource development projects. There are, however, two aspects of taxes that need special consideration in economic analysis of proposed projects. These are (1) changes in tax revenues of local governmental units affected by the project, which are not fully balanced by changes in governmental expenses of the same units, and (2) the effect of taxes on the value of benefits when calculated on the basis of cost from an alternative source, as in the case of power.

The primary effect of a river basin project on local government units arises from changes in the real estate tax base. The local government revenues may in some cases be reduced to a greater extent than the corresponding reduction in the costs of the services it provides. In other cases, the local tax revenues may be increased by the project proportionally more than are the costs of providing services to such an area. When decreases in tax revenue in a given taxing unit are offset by decreases in the costs of governmental services, no allowance needs to be made in project costs. Also when increased revenues are sufficient just to cover both any increased costs of services and any losses

in tax revenues from lands withdrawn from the tax base, no allowance needs to be made in project costs. A tax-adjustment problem arises when an adversely affected taxing district cannot benefit from the increased tax returns in other areas which may have their tax bases raised by a project. The change in net tax revenues from the total area with and without the project is measured by the difference between the tax revenues received and the cost of services provided by the taxing unit. The total reduction in net tax revenues in adversely affected taxing districts may be treated as a project cost. Any increase in net tax revenues in beneficially affected taxing districts may be regarded as a project benefit, and may be accounted for as a deduction from tax charges included in associated costs.

When market prices are used to evaluate project benefits, adequate consideration of taxes, so far as such benefits are concerned, has already been provided. However, when the benefits of a Federal project are evaluated on the basis of the cost of producing similar products from an alternative private source, the estimate of private costs should include the taxes that would be payable.

Recommendations.—Thus, project costs or associated costs should include all increases in costs of governmental services resulting from the project. Some projects may temporarily or permanently reduce tax revenues in some taxing jurisdictions without corresponding reductions in the costs of public services. These disadvantageous effects should be included in the analysis as project costs. Advantageous effects such as increases in net property tax revenues should be deducted as an offset from associated costs. When the benefits of a Federal projects are evaluated on the basis of the cost of producing similar products from an alternative private source, the estimate of private costs should include taxes that would be payable. Proper comparison may also be obtained if project costs for given purposes are compared with the charges less taxes for comparable products and services from private sources. To the extent that governmental services are superior in quantity or quality to those that would be received without the project, there would be an intangible benefit if it cannot be evaluated in monetary terms. Except as noted, most other tax effects and income taxes are accounted for in the market prices or estimates of net income used in evaluating benefits and costs.

Displaced Facilities

Displaced facilities are facilities whose present use is abandoned because project facilities provide essentially the same services. In evaluating the services attributable to the project being analyzed, allowance must be made for the services that would have been provided by the displaced facilities. The effects attributable to the project are measured by the value of the difference in physical effects with and without the project, after allowance for any costs of the displaced facilities made unnecessary by their abandonment.

Recommendation.—It is recommended that the value of services that would have resulted from displaced facilities less their operation and maintenance costs should be subtracted from the total value of project services of the same kind to determine benefits attributable to the project.

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 or services provided or in terms of the reduced costs of providing such goods or 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 accomplishing the same results.

For example, 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 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, the uses most 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 that purpose should not exceed the cost of the most economical alternative means available for accomplishing the same results.

Consequential Damages

Consequential damages are uncompensated losses resulting directly from the development of a project. Even though no compensation may be required or possible, such losses are nonetheless a real part of the project development cost. For example, when lands are flooded to develop a reservoir, there are costs for relocation and reestablishment 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 measurable consequential damages should be included as project costs but only for the necessary readjustment period. On the other hand, projects requiring the taking of sub-marginal land for project purposes 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.

Recommendation.—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.

APPLICATION OF BENEFIT-COST MEASUREMENT IN PROJECT FORMULATION

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. Benefits and costs should not merely be measured and summed up after the purposes and scope of a project are determined. They require consideration at various stages in project formulation and selection in order to determine whether there is economic justification for inclusion of features in the project for various purposes and to establish the scale of development of the project which will maximize the net benefits.

The process of formulation of projects for river basin development is essentially the determination of what type of project or projects, what scale of development of each project and how many projects are required and justified to meet existing and potential needs. This requires consideration of existing and probable future economic conditions, the probable need for the various results obtainable from river basin development, the physical possibilities for such development, the most practicable plans available for realizing desired objectives and the justification for proceeding with such plans.

The purpose of this section is to illustrate how the principles, standards and special problem solutions of benefit-cost measurement can be applied in the formulation, evaluation, and selection of projects.

Although the principles and procedures discussed herein are usually referred to in terms of analysis of a "project," they apply to analysis of Nation-wide river basin development as a whole, to analysis of river basin programs comprising a number of projects, to analysis of individual projects and to an analysis of segments and individual purposes of a project.

Analysis of Needs and Objectives

The first step in river basin studies should be to analyze 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 need or demand foreseeable within the range of prices or values expected to be applicable should either be excluded from the purposes of the project or assigned no value in the project economic analysis.

After consideration of the probable demand for project products or services in the light of prospective economic conditions in the future period during which a project would be effective, objectives for river basin development should be selected as a basis 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 possible during the life of the project, etc.

Analysis of Physical Possibilities for Meeting Objectives

The next step in river basin study should be to examine and analyze 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.

Measurement of Physical Effects of a Project

As a starting point for 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 consideration of the initial data available and which appears to offer possibilities of meeting the objective wholly or partly. The physical effects of this initial proposal, in terms of erosion prevented, water furnished, power produced, etc., at various scales of development, must be measured and translated into benefits for comparison with the costs of the project in comparable terms: first, to determine the optimum scale of development of that particular project; second, its justification; and third, its relation to other available means of accomplishing the purposes of the project.

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, such as the production of so many bushels of wheat by irrigation or the prevention of loss of so many bushels of wheat on land subject to flooding or erosion, it is necessary to evaluate those effects in monetary terms. As previously discussed, 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 forecast. Then, by applying measure-

ment principles and standards previously outlined, 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 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 to be expected with and without the project. Beneficial effects of a project should be assigned monetary values by applying market prices, assumed exchange values or costs of production by alternative means, using the prices expected to be applicable at the time of occurrence of the benefit. Usually these are estimated average prices over the period of analysis. Predictable risks should be accounted for by direct adjustment of benefit estimates. In addition, allowance should be made for unpredictable risks in various ways such that estimates of benefits will be conservative. 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 interest rate applicable to private investment in the type of activity involved.

Primary benefits, which are the values of immediate products or services of a project, are readily measurable in most cases. They may 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, the most likely alternative cost of production of the products or services may be the measure of value. In any event, the amount of primary benefits attributable to the project is the value of primary benefits less all associated costs necessary for their realization.

Secondary benefits, which are values added over and above the value of the immediate products or services of a project, such as those resulting from subsequent processing, are more difficult to measure, and in some cases may be appreciable but relatively small compared to primary benefits. Measurement of secondary benefits requires estimates of the net income from secondary activities stemming from the project, that is, the difference between the total value of such activities and the costs necessary to produce such value. If there is 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, such increases in net income or savings may be credited as net secondary benefits attributable to the project. In most cases, it should be unnecessary to consider secondary benefits in the successive steps in project formulation. Unless the net secondary benefits attributable to a project are

appreciable as compared to primary benefits satisfactory results will be possible by deferring any estimates of such benefits until final estimates of total benefits are desired for use in computing the benefit-cost ratio and in comparing the project with other justified projects to determine priority of project selection and related questions.

Project benefits are determined by summing up the primary and secondary tangible benefits attributable to the project, that is, primary and secondary benefits which have been reduced by the amount of any costs other than project costs necessary for their realization.

Measurement of 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 and secondary costs which must be deducted from over-all benefits to obtain project benefits. All costs are measured on the basis of the value of benefits foregone through 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 in chapter III.

Project costs are the value of the goods and services used for establishing, maintaining, and operating the project. These costs include the initial investment in land, labor and materials and subsequent costs for replacements and for maintenance and operation. Costs of postauthorization investigations, interest during construction, engineering, inspection, administration, and overhead in general should be included. Also included are costs induced by the project, whether or not actually paid for by the constructing agency, as for example, consequential damages. Project costs should be evaluated in terms of prices expected to be applicable at the time the costs are to be 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 by types of investment, that is, Federal, non-Federal public, or private as discussed in chapter III.

Associated and secondary 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 over-all benefit estimates to obtain project benefits comparable to project costs.

Establishing Scale of Development

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 a single project, (2) additions or omissions of projects from a program, and (3) inclusion or exclusion of a specific purpose from a project or program.

As previously discussed, the desired scale of development is that at which the net benefits are at a maximum. That condition is met if the scale of development is extended to the point where the benefits added by the last increment of extension of scope are equal to the costs of adding that increment. The increments of scope 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 few which it is practicable to analyze in detail.

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 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 limitation 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 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) the 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 is 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 considerations, effect of such action in terms of increasing or reducing costs or benefits should be clearly stated. This is necessary to illustrate 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 Projects

The relative economic desirability (exclusive of consideration of intangibles) of a number of projects which have been properly formulated in accordance with the procedures recommended herein is reflected in their respective ratios of benefits to costs. In most cases the ratio of project benefits to project costs will provide a satisfactory basis for comparison. In some cases, it may be desirable to compare the sum of project and nonproject costs with the gross benefits resulting therefrom. Also, comparison of net benefits or rates of return on investment may be useful for some purposes, as discussed in chapter II.

CHAPTER IV

Application of Principles to Various Project Purposes

The purpose of this chapter is to illustrate the application of the recommended principles and practices to the measurement of benefits and costs of selected project purposes to the extent that there are special considerations peculiar to each purpose. Unless otherwise indicated in this chapter, the general principles, standards, and procedures outlined in previous chapters are applicable to measurement aspects of these and other purposes.

IRRIGATION

Irrigation projects provide a regulated water supply for agricultural land in areas of insufficient or undependable precipitation. Such projects make possible additional production of needed food, feed, and fiber through more intensive use of land and the application of additional labor and capital. The increase in production of crops, livestock, and livestock products in turn, affects such activities as marketing, processing, and transportation.

Benefits from Irrigation

Primary irrigation benefits include the value of any reductions in costs due to the project and of any increase of farm products marketed or consumed by the farm family. Reductions in costs include those arising from less costly means of providing irrigation water and reductions in the operating expenses of farmers as a result of the project. The increases in production are measured by comparing the volume of usable agricultural production from the area under future conditions with and without the project. This difference, in terms of average annual production, is converted to monetary values by application of expected market prices for each product as indicated in chapter III.

This increase in production results from the project and from the application 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 identify the increased investments required for land preparation, water distribution structures, livestock, buildings, machinery, and local gov-

ornmental 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 less the associated costs.

Secondary irrigation benefits are the values added by transporting, processing, and distributing the added farm products from the project, plus any value added by other activities stemming from or induced by the project. Such benefits should be measured by the difference in net incomes in secondary activities under expected conditions with and without the project. Secondary costs incurred in handling an increased supply of goods may thus be deducted to obtain net secondary irrigation benefits attributable to the project. It is important to recognize that under future conditions without a project, account must be taken of the values which are likely to be added in the secondary activities either by handling similar products from other sources, or by putting to some other productive use the economic resources necessary for the project and for the secondary activities.

Several types of secondary irrigation benefits may be claimed where they are found applicable. Where products of an irrigation project enter into secondary stages of production, such as processing and distribution, the increase in net income in such secondary activities under conditions with the project as compared with the net income expected in such activities without the project can be considered a secondary benefit. When the project makes available to secondary activities an increase in farm products at lower prices than would be expected to prevail in the absence of the project, the difference in price times the increase in project production supplied to secondary activities may be claimed as a secondary benefit. Where secondary facilities are expected to be unused or underutilized in the absence of the project, the increase in net income of such activities as a result of handling the project surplus of farm products may be a secondary benefit.

Where an irrigation project results in increased incomes to businesses supplying goods and services to the project area or results in increases in the value of property for nonresidential purposes, the difference between the amount of such increased income or value expected as a result of the project and the increased income or value that may be expected in secondary activities stemming from the most likely alternative use of project resources in the absence of the project is a net secondary benefit. When benefits are derived from estimates of increased incomes, increased land values associated with the same benefit should not be included as a project benefit. Where a product stimulates development of residential use of land in the vicinity of the project, the increased value for such land may be considered as a secondary benefit.

Secondary benefits will usually be omitted from project formulation and used only in a final project analysis.

Measurement of Costs of Irrigation

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

FLOOD CONTROL

River basin projects which include measures for the control of floods provide benefits in two general ways: (1) By preventing the loss of goods or services which would otherwise occur as a result of floods, (2) by making possible increased production of goods and services through more intensive use of real property which would otherwise be underutilized because of a 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 primary 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 should, in general, be evaluated as the cost of replacing, repairing or rehabilitating the affected property. In theory, the costs used for this purpose should be adjusted to exclude any profit or benefit to those who make repairs or supply replacement to the extent that such profit or benefit could not be realized in other ways if floods did not occur but in practice it is questionable if this refinement of damage estimates need be made.

In addition to prevention of physical damage to property there may be primary 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 and rehabilitation of flood victims, the direct loss through disruption of business, and the increase in direct costs of doing business during floods. 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. If any of the goods or services involved in such costs would have been unemployed or underemployed if the floods did not occur, a downward adjustment in damage estimates would be necessary to obtain the real loss from a public viewpoint. In the usual case, however, it is unlikely that, in any given locality, the economic conditions under which such adjustment is necessary would be concurrent with flood conditions.

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 primary 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.

In estimating damage-prevention benefits, the intensity of future use of land and property assumed with flood control should be the same as the intensity of future use expected without flood control in order to prevent duplication with benefits arising from any changes in land or property use made possible 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.

Secondary benefits from flood control may arise in secondary activities such as those which stem from use or processing of the products or services which are directly affected by floods. Such benefits should be measured as the difference in net income in secondary activities under expected conditions with and without flood control. The estimate of net income without flood control should allow for all adjustments other than flood control which could and probably would be made to avoid losses in secondary activities. When this is done, the amount of such secondary benefits creditable to a project may often be relatively small in comparison with primary benefits realized through prevention of direct flood losses.

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. Because of the impracticability of estimating the various points in time when various amounts of flood damage may occur, the prices used in evaluating costs of restoration should be the average of prices expected to be applicable over the period of analysis, as outlined in chapter III.

Benefits Through Prevention of Flood Damage

The primary benefit resulting from changes in use of property made possible by flood control should be measured as the difference in the productive capacity of the affected property under conditions expected with and without flood control. The preferred method of measuring this difference in productive capacity is by direct estimate of the difference in net income expected from use of the property and associated resources with and without the project. The procedure is analagous to that previously described for measurement of primary benefits attributable to a project as a result of increased production through irrigation.

As an alternative method, an approximate estimate of the difference in productive capacity 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. This alternative method, which may be desirable in some cases to keep estimating work at a minimum, tends to underestimate the benefit creditable to the project because it may fail to reflect the amount of benefit accruing as a result of productive factors other than the property itself, as, for example, labor and management.

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

Any increases in productive capacity 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 basis. 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.

Secondary benefits in activities stemming from or induced by the increased production made possible through change in land use may arise and may be measured in the same manner as indicated previously for secondary benefits from irrigation projects.

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. In the past this benefit has usually been given consideration in nonmonetary terms. As indicated in chapter III, monetary values should be placed on such effects to the maximum extent practicable in order to make estimates of tangible benefits more comparable among purposes and projects 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.

Measurement of Costs of Flood Control

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.

WATERSHED TREATMENT

The watershed treatment programs consist primarily of measures to improve ground cover and condition including better cultural practices, shifts in rotations and intensity of use, strip cropping, contour farming, fire protection and controlled grazing; and small scale structures and measures including terraces, diversion ditches, stream protective measures, water spreading devices, gully control structures, farm ponds, and small detention reservoirs and debris basins.

The principal benefits resulting from either or both types of watershed program measures include:

- (1) Reductions in floodwater damage and higher or more intensive use of land.

- (2) Reductions in the rate of physical destruction of land and facilities from such causes as erosion, swamping, sediment, or deposition of infertile overwash.

- (3) Increases in land productivity over that expected in the absence of the program through preventing reduction in fertility or increasing productive capacity.

To the extent feasible, the benefits and costs of various classes or types of program measures should be considered separately for proper project formulation. Preferably, this would involve separate estimates for each practice or segment. Some of the benefits accrue largely upon lands receiving treatment while others accrue in downstream areas. Problems of measurement are such as to necessitate separate consideration so far as practicable of the benefits and costs accruing in these two major types of benefited areas. To the extent that such separations are not feasible, proper formulation could be approximated through estimating the total program effects expected with and without varying intensities of application of each measure or practice.

Benefit Measurement

Whenever watershed treatment program measures reduce flood damages or make possible a higher use of land, both primary and secondary benefits should be evaluated in the manner discussed in the section on flood control. Measurement of primary and secondary benefits due to increased production should follow the procedure outlined in the section on irrigation.

Measures designed to reduce the rate of physical destruction of land and facilities result both in on-site benefits from preventing land destruction and downstream benefits from reducing flood and sedimentation damages. Benefits from preventing downstream sediment deposition damages should be measured in terms of difference in damages, with and without the program, such as from: deposition on crops and lands, scouring, swamping resulting from stream channel sedimentation, costs of sediment removal from industrial and domestic water supplies; or in terms of costs in the case of dredging sediment from channels, ditches, and harbors. Estimates of benefits from preventing or reducing land damages should be based on either land values prevailing in comparable areas or the capitalized values of the difference in net land incomes. While some program measures may

permanently prevent damages, others may only reduce the rate or delay the time of damage accrual. In such cases, the project benefit should be measured by the difference in net income with and without the program over the period of analysis. Such estimates should recognize the limits of the area subject to permanent damage. Problems involved in the treatment of benefits from extending the useful life of a structure, such as a reservoir, have been discussed in chapter III.

The problems of measuring the effects of the forestry and farm land portions of watershed treatment programs raise a number of additional particular problems that merit special consideration. For instance, the need to evaluate benefits which increase gradually over a number of years rather than at a uniform annual rate is frequently encountered in watershed treatment programs. Benefits from improved management and silviculture practices and from improvement in range land grazing are examples. Such benefits should be evaluated in terms of the present worth of the increased benefits realized from the program practices for each year in the period of analysis plus the present worth of any increase in value of such resources as forests at the end of the period of analysis over their value at the beginning of the program. Such present worth may be reconverted to average annual equivalents as indicated in chapter III.

When a part of a watershed treatment program such as improved forestry practices is possible with Government land ownership but would not be possible with private ownership, any part of the costs of land acquisition not entirely justified by the present productivity of the lands may often be justified by the net returns from the improved practices thus made possible.

The measurement of the multiple effects arising from certain treatment practices involves the problem of determining what share of the costs were incurred to obtain a particular benefit. For example, while the use of lime and fertilizers may be essential to growth of vegetation necessary to prevent erosion, hold water, and slow down runoff, they may also increase agricultural production. Thus a part of their costs may be chargeable in part to each of these purposes. Likewise, the costs of preventing siltation of a farm pond or reservoir might include part of the costs of lime and fertilizer for the cropland draining into it. Such costs as well as the cost of construction of the pond, or reservoir should be justified by the beneficial effects over its life for stockwater, flood control, irrigation, etc. Another common case is that of justification of the costs of water and silt holding structures which provide downstream flood control and damage prevention and in addition may benefit lands on which they are located or which they adjoin.

The benefits from preventing land damages to the lands upon which measures are applied may have the effect of increasing productivity, or preventing its reduction, or may reduce expected production costs. Such benefits usually need to be measured by differences in net income with and without the program over the period of analysis. Estimate of expected future production with and without the program is required, such estimates being converted into monetary terms by applying prices expected to prevail at time of accrual and where necessary reduced to a common time basis. Comparable estimates for the project, with and without the program, are required for production costs.

Intangible and Other Factors Requiring Special Analysis in Watershed Treatment Program

Benefits from increased assurance of adequate future supplies of fibre, food, and forest products might be measured through an adjustment in the prices attached to the products to be raised. If a program has a significant effect on future production, the unit price expected with the program will be less than for the same supply without the program and an appropriate unit value for the difference in volume of production would be about midway between the two expectations. At least a part of any further net advantages to consumers or users from price or cost decreases or an increased volume of production attributable to the project or program are benefits, and if not otherwise included, may be claimed as a secondary benefit of the project. Because of the difficulty of estimating the influence of the project on future production and prices it will often be necessary to treat the benefits from assuring continued abundant food, fibre, and forest products as intangibles.

Provision of fire protection for forest lands is a recognized and accepted public policy considered in the general welfare, and its beneficial effects may often prove to be beyond normal evaluation procedure. Although the effect of improved cover on runoff is calculable, and the losses of timber by fire which is prevented may be estimated with reasonable assurance, these amounts establish only the minimum value of benefits from fire protection and may underestimate the total benefits attributable to forest fire prevention. Monetary measures of the benefits from fire prevention do not always adequately reflect the total public value of fire prevention and such added intangible values may need to be appropriately allowed for as indicated in chapter III.

Treatment Costs

Project costs for watershed treatment programs include not only the costs of features paid for by the Federal Government and the contributions of the Government for jointly financed features, but also the cost paid by farmers and others for features necessary to the program. Because of the necessarily cooperative nature of the watershed program, the project costs may include many costs normally treated as associated costs by other Federal programs. In all other respects, costs of watershed treatment programs should be measured as indicated in chapter III.

NAVIGATION

The product of navigation improvements is transportation service. The value of such transportation service may be measured in terms of the cost of the most likely alternative means of providing the service in the absence of the project. The project may then 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. In other words, the primary benefit creditable to a navigation project is the difference between the cost of transportation by an alternative means and the nonproject or associated cost of transportation by waterway. From a public viewpoint, a naviga-

tion project will be beneficial if it results in provision of needed transportation service at less total cost (project and associated) than may be expected to be necessary for such service in the absence of the project.

On the above basis, transportation costs rather than transportation rates (i. e., costs to shippers) should be used for measuring benefits whenever possible.

Benefits may result from navigation improvements 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 Existing or Potential 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 on an existing waterway are reduced as a result of the project, a primary 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 primary 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 primary benefit creditable to the project. The costs of transportation by waterway other than project costs are associated costs as defined in chapter II. In estimating such costs, which include investment and operating costs for vessels, terminal facilities, etc., allowance should be made for any increase in associated costs to shippers and receivers of cargo due to differences in the character of transportation service by waterway as compared with alternative means available. For example, the greater time in transit or storage and different handling requirements may be factors requiring such allowance.

In some cases it may prove necessary to use rates charged for transportation service as the measure of cost of transportation by an alternative means. From a public viewpoint, the benefit credited to the project should be reduced by the amount of any loss in net income by transportation services from whom traffic is diverted. In practice, it may not be possible to determine accurately if there will be any such loss in net income. Furthermore, there may be compensating effects to the transportation services involved through generation of new business in feeder and transfer traffic from the waterways.

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 primary benefit creditable to the project for such new traffic is the difference between the cost of transportation by waterway and the cost at which it would have been economical to move the various units of traffic involved. If data are available for estimating the costs at which various increments of the prospective new traffic could be moved economically, the difference between such costs and the costs of transportation by waterway can be readily computed to give the estimated primary benefit attributable to the project.

If data are not available for such a direct estimate, it is reasonable to assume that a few units of the prospective new traffic could move economically at a cost slightly less than the highest cost of available alternative means of transportation. Also, a few units could move economically only at a cost much less than the cost of the available means and probably not unless the cost were 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 of economical alternative movement of the new traffic is halfway between the highest and lowest costs at which any part of it would move. The difference between this average cost and the cost by waterway applied to the volume of new traffic expected is the primary benefit creditable to the project. If waterway rates rather than waterway costs are used in this calculation, allowance should be made for the difference between rates and costs (i. e., profit to water carriers) in order to insure crediting the full benefit attributable to the project.

Other Benefits From Navigation Improvements

Secondary benefits may arise or be induced as a result of a navigation project when the net savings on transportation service are applied to other productive purposes in any secondary activities to which all or a part of those savings may be passed along. Also, there may be new or increased economic activity engendered by the new transportation services which would not have been economically possible in the absence of the project. To the extent that there is an increase in net income in such secondary activities under conditions expected with the project as compared with net income expected in such activities without the project, such increase is a net secondary benefit attributable to the project.

The foregoing discussion of primary and secondary 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 monetary 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 ex-

ample, 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.

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. From a public viewpoint, a power project will be economically justified if it provides power needed to meet expected power requirements at a cost not greater than that of the alternative source of power most likely to be used in the absence of the project. Power benefits consist of primary benefits which are the value of the power produced at the project and any improvement in upstream or downstream power values which is attributable to the project, and any net secondary benefits which are attributable to the electric power production.

Primary Power Benefits

The primary 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 in the absence of the project.

In most areas of the country the amount the user pays for power is approximately equal to the cost of producing the power, plus the associated costs of transmission and distribution, including a fair return on all investments involved, since the rate at which power is sold is in general regulated on that basis. A practical procedure, therefore, for measuring primary benefits from project power is to base the power values on the cost of equivalent power from the alternative source of power that would most likely be utilized in the absence of the project. The primary power benefits as so computed include any savings accruing to the users if project power is sold to them at rates less than the cost from the alternative source.

The primary benefits from power may also be measured on the basis of the estimated revenue to be received for project power, arrived at by applying expected rates to the project power. When this revenue is less than the amount that the power users would pay in the absence of the project, the savings to the power users are also creditable to the project as an additional primary benefit.

Under either method of measurement, the primary benefits attributable to the project are power values remaining after deduction of all associated costs. On the basis of comparable assumptions and data, both methods should give the same results.

When power loads of new type and character (for example, an aluminum plant) are brought into being because of low-cost project

power, and these loads would not develop in the absence of the project, a different approach is necessary to compute the savings component of the primary power benefit. 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 for direct measurement of these effects, the savings to be measured are the full difference between the cost of project power and the power cost at which the new loads would develop. In the absence of adequate data, the savings to these power users should be measured by the difference between the cost of project power and the mid-point of power costs between the two extremes outlined above. Such a procedure is analogous to that discussed under Navigation for new traffic.

Secondary and Other Benefits

Secondary benefits may arise or be induced as a result of an electric power project when the savings from lower cost power production are applied to other productive purposes in secondary activities to which all or a part of the saving may be passed along. Also, the increase in available power at reduced rates may engender additional economic activity which would not develop in the absence of the project. To the extent that there is an increase in net income in such secondary activities under conditions expected with the project as compared with net income expected in such activities without the project, such increase is a net secondary benefit attributable to the project. It is important to recognize that under future conditions without a project, account must be taken of the values which are likely to be added in the secondary activities either by utilizing equivalent power from other sources, or by putting to some other productive use the economic resources necessary for the project and for the secondary activities.

Electric power projects, particularly hydroelectric power, may give rise to other benefits which are difficult to measure in monetary terms. Electric power in abundant quantities, for example, may result in better living and working conditions, reduce labor in the home, and increase time available for leisure, bringing improved health and well being. In the case of hydroelectric projects, exhaustible fuel resources are conserved. Such beneficial effects must usually be considered as intangible.

Project Costs

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

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 have incidental effects of importance on 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

Primary benefits to commercial fishing and trapping consist 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 basis as that suggested for agricultural products in chapter III. Associated costs to be deducted from benefits are all costs incurred by fishermen and trappers in harvesting and marketing these products.

Primary 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.

Under one procedure which has been used to estimate such values, the value of a recreational benefit to an individual is assumed to be equal to the sum of expenditures by the recreationalist for such items as gasoline, food, lodging, and sporting equipment in connection with his use of recreational opportunities afforded by a project. This method, however, provides a measure of gross rather than net values and from the project standpoint does not measure benefits creditable to the project.

By another currently used method, recreational benefits are assumed to be equal to the cost of installing, operating and maintaining specific recreational facilities plus an equal amount considered to be the value of the benefits attributable to recreational use of project facilities provided for purposes other than recreation. This has the effect of assuming that the value of recreational benefits is equal to twice the specific project costs for recreation. This method does not provide an objective and independent criterion for determining recreational benefits creditable to the project.

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 pros-

pective users. In estimating or deriving these tangible values, consideration should be given to all pertinent factors, including the charges which the recreationalists 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 primary benefits attributable to the project.

In addition to primary benefits discussed above, other benefits may arise from subsequent handling of commercial fish and fur production or from such supporting activities as hotels, camps, equipment suppliers, guides, etc., providing goods or services to project recreationists. As discussed elsewhere in this report, such benefits are valued by measuring the net income with and without the project. The difference is a benefit 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 opportunities or fish and wildlife values without providing comparable substitutes for them. Such effects may arise if recreational use of 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 of 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 an 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. In many cases, these losses 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.¹

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.

¹The Congress has provided in specific legislation that the Fish and Wildlife Service and the State concerned shall recommend means and measures for preventing adverse effects on fish and wildlife, that these recommendations shall be made an integral part of the project report by the construction agency, and that the costs of such means and measures shall constitute an integral part of project costs.

CHAPTER V

Cost Allocation for Multiple-Purpose Projects

The benefit-cost analysis practices recommended in previous chapters provide for the formulation and 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 benefit-cost analysis 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 of 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 project analysis. 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 for simultaneous application to the two types of project costs: Investment costs and costs of operation, maintenance, and replacement. Cost allocation should be distinguished from 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 in the economic analysis 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,

described below, is recommended for general use in allocating costs on 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 now in common usage, 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 is required by this method of cost allocation.

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 joint 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. 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 arrigation 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, it may be necessary to use specific costs in lieu of separable costs in those cases where reestimating would be unduly burdensome.

Distribution of joint costs.—Joint 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. Joint costs thus represent a residual attributable to all or several purposes. The distribution of joint costs in proportion to the excess of benefits over separable cost assigns to each purpose an equitable share of project savings. The amount of project benefits used as a basis for allocation of costs to any purpose should not exceed the cost of providing equivalent services for the same area 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, joint costs are distributed in proportion to the remaining benefits for each purpose.¹

Total allocation.—The sum of separable costs and assigned joint 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 should 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 the footnote to the above paragraph), and should 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	Naviga- tion	Total
1. Benefits.....	500	1,500	350	100	2,450
2. Alternate cost.....	400	1,000	600	80	2,080
3. Benefits limited by alternate cost (lesser of items 1 and 2).....	400	1,000	350	80	1,830
4. Separate costs.....	380	600	150	50	1,180
5. Remaining benefits (items 3-4).....	20	400	200	30	650
6. Allocated joint 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 joint costs to be allocated (\$585,000 in line 6) are 90 percent of total remaining benefits (\$650,000 in line 5). Therefore each purpose is charged with joint 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 5 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 joint 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

¹ If the total separable costs of all purposes should exceed the cost of the multiple-purpose project, there are in effect no joint 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 joint costs to each separable cost as illustrated herein.

not all purposes of the project (allocated dual cost, in the example) is deducted from the total project cost to give joint costs. These joint 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. Alternate cost.....	400	1,000	600	80	2,080
3. Benefits limited by alternate 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 joint 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 in all future reports of Federal river-basin-development projects. While variations of this method may be necessary to meet special or legislative requirements in some cases, the use of a combination of cost-allocation methods or the averaging of the results of several methods is not recommended.

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

If the costs of a single-purpose water-control project are to be met by charging beneficiaries for project products or services on the basis of costs, there is no allocation problem involved in ascertaining project costs. If, however, as previously indicated, charges on a similar basis are to be made for all or some of the beneficial effects of a multiple-purpose project, the allocation of costs among the several purposes of the project is necessary. In some cases, charges for project products or services may be made on other bases such as the value of the services rendered, requiring no cost allocation. In other cases, the public may meet the costs of a project through taxes, in which case also no allocation of costs among purposes is necessary.

The purpose of this section of the report is to indicate the relation of benefit-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 by 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 costs 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 collections, 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 service 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 the following ways, 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-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 the 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 cancelled 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 I

First Progress Report of the Subcommittee on Benefits and Costs

To: The Federal Inter-Agency River Basin Committee

1. In accordance with instructions of the Federal Inter-Agency River Basin Committee, a Subcommittee on Benefits and Costs has been engaged, since April 1946, in a comprehensive study of the benefit-cost problem for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects.

2. A progress report is presented at this time in order to

(a) advise the committee as to the status of the studies,

(b) summarize the results of completed studies, and

(c) indicate the nature and extent of work remaining for accomplishment of the ultimate objective.

3. From April 1946 through March 1947, the Subcommittee has held 28 meetings totaling 84 committee-hours. In addition, the Subcommittee's working staff, usually comprising about 10 agency representatives, has held 22 additional meetings totaling 132 staff-hours. Preparatory work for these committee and staff meetings has required approximately 6,600 man-hours of work by the representatives whom the participating agencies have assigned to the study on a continuing basis. These figures indicate the intensity with which the studies are being carried on and, when considered in the light of work completed and remaining, indicate the magnitude and comprehensive nature of the Subcommittee's assignment.

4. A summary is attached which gives the results of studies to date and outlines the relationship of completed and current studies to the over-all assignment. This summary is divided into five parts:

Introduction, which outlines the scope of the comprehensive benefit-cost study and the procedure adopted for its prosecution.

Résumé of the subcommittee's previous statements on the qualitative aspects of the current benefit-cost practices of each agency.

Summary and comparison of current benefit-cost practices of the several Federal agencies.

Special problems encountered by the Subcommittee.

Remaining work of the Subcommittee.

5. In pursuing this study through its present phase, the Subcommittee has been impressed by the far-reaching influence of the benefit-cost problem on Federal project planning and construction policies; by the fact that although previous approaches have been made to this problem, none has been pushed to a final conclusion; and by the need of Federal agencies for conclusions on this matter. The problem is complex and difficult. Search of the available literature has yielded relatively little of value to the subcommittee. Even a standard terminology is lacking. The subcommittee believes that the mutual understanding of benefit-cost practices already has been materially advanced by completion of the analysis to date; and that a comprehensive study by the Federal agencies of the scope now planned is entirely justified, and is the best course of action for the purpose of formulating acceptable principles and procedures for determining the benefits and costs of water resource projects. It recommends, therefore, that the attached summary, and the detailed statements upon which it is based, be given careful study by the participating Federal agencies.

6. With respect to the future progress of the over-all study, as outlined in paragraph 1 of the attached summary, the subcommittee plans to complete and report upon the analysis of current benefit-cost practices within the next year,

and to have other parts of the study partially completed; and the subcommittee expects to attain, in the following year, the ultimate objective of formulating mutually acceptable principles and procedures.

For the Subcommittee on Benefits and Costs:

G. L. BEARD, *Chairman.*

FEDERAL INTER-AGENCY RIVER BASIN COMMITTEE SUBCOMMITTEE ON BENEFITS AND COSTS

MEMBERSHIP OF THE SUBCOMMITTEE AS OF APRIL 1, 1947

Mr. G. L. Beard (chairman)-----	Chief, Flood Control Division, Directorate of Civil Works, Office Chief of Engineers, War Department.
Mr. J. W. Dixon-----	Director of Project Planning, Bureau of Reclamation, Department of the Interior.
Mr. H. D. Kube-----	Office of Business Economics, Department of Commerce (member of subcommittee since December, 1946).
Mr. F. L. Weaver-----	Chief, River Basin Division, Bureau of Power, Federal Power Commission.
Mr. E. H. Wiecking-----	Office of the Secretary, Department of Agriculture.

MEMBERSHIP OF THE SUBCOMMITTEE WORKING STAFF AS OF APRIL 1, 1947

Mr. N. A. Back-----	Office of the Secretary, Department of Agriculture.
Mr. O. L. Endler-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.
Mr. W. S. Johnson-----	Office of Business Economics, Department of Commerce.
Mr. G. E. McLaughlin-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.
Mr. R. G. Ohlman-----	U. S. Fish and Wildlife Service, Department of the Interior.
Mr. Carter Page-----	Directorate of Civil Works, Office, Chief of Engineers, War Department.
Mr. R. C. Price-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.
Mr. M. M. Regan-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.
Mr. K. L. Roberts-----	River Basin Division, Bureau of Power, Federal Power Commission.
Mr. E. W. Weber----- (Subcommittee Secretary)	Directorate of Civil Works, Office, Chief of Engineers, War Department.
Mr. E. C. Weitzell-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.

SUMMARY OF QUALITATIVE ASPECTS OF CURRENT BENEFIT-COST PRACTICES

INTRODUCTION

1. *Scope of this statement.*—This statement is a summary of the qualitative aspects (as distinguished from the quantitative or measurement aspects) of the current benefit-cost practices of those Federal agencies represented on the Federal Inter-Agency River Basin Committee which are engaged in water-resources planning. It is the first segment of a comprehensive study which the Federal Inter-Agency River Basin Committee assigned to its Subcommittee on Benefits and Costs for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects.

2. *Scope of the comprehensive study.*—The comprehensive study is divided into four major phases with purposes as follows:

Part A. *Analysis of current practices.*—To obtain a mutual understanding of the practices of each participating Federal agency in preparing its reports and recommendations on water resource projects. (As sections of this part are com-

pleted they are being issued as interim statements of the subcommittee, subject to revision upon completion of later phases of the complete study.)

Part B. *Objective analysis.*—To develop a purely rational procedure for benefit-cost analyses, not influenced by present practices or current legal and administrative limitations.

Part C. *Analysis of special problems.*—To examine those special problems on which interim answers are desired and problems of an over-all nature which cut across various phases of the complete study.

Part D. *Conclusions and recommendations.*—To compare current practices (pt. A) with the objective analysis (pt. B) in order to develop mutually acceptable principles and procedures for benefit-cost analyses.

3. *Status of the comprehensive study.*—Assignments have been made and studies are proceeding simultaneously under parts A, B, and C of the above outline. Part A, analysis of current practices, will describe benefit-cost practices now in use first on a qualitative basis and second on a quantitative basis. The qualitative study of current practices consists of identification and definition of type and nature of benefits and of the elements of costs involved. This qualitative study is now complete and is the subject of this preliminary summary statement. The quantitative study of current practices, which the subcommittee will undertake next, will cover the methods for and extent of measurement of the various benefits and costs. Part B, the objective analysis, is not discussed at this time as that portion of the study is not sufficiently advanced for that purpose. Certain special problems which will ultimately be covered in part C are reviewed briefly in paragraphs 14 and 15. Part D, consisting of final conclusions and recommendations, cannot be undertaken until parts A, B, and C are substantially completed.

4. *Procedure for qualitative study of current practices.*—A thorough study of the current benefit-cost practices of those agencies concerned with water resource developments is essential to a mutual understanding of those practices and is necessary to afford a basis for subsequent phases of the study. A study of current practices also will develop many of the major problems involved in project analysis. Accordingly, to develop this mutual understanding and basis for further study the Subcommittee has prepared and issued, with the minutes of its meetings, a series of statements which set forth its understanding of the current benefit-cost practices of each agency, but did not necessarily imply subcommittee concurrence in the practices. This summary, therefore, presents first, a résumé of the Subcommittee's statements on qualitative aspects of current practices, which extends from paragraph 5 to 10 and forms the basis for a summary and comparison of current practices (par. 11 to 13). The next portion of the summary covers special problems which have arisen during the subcommittee's study (pars. 14 and 15). The concluding portion of the summary is a brief discussion of the remaining work of the Subcommittee. Although the entire study thus far has been based on qualitative considerations, quantitative or measurement terms, such as reference to monetary evaluation, are utilized to some extent. This has been done to illustrate a qualitative point more simply or more directly. No attempt has been made to draw conclusions, however, which cannot be drawn on the basis of qualitative considerations alone. It is apparent, therefore, that further consideration, from a quantitative standpoint, will be necessary for complete understanding of most of the practices under discussion.

RÉSUMÉ OF THE SUBCOMMITTEE'S STATEMENTS ON QUALITATIVE ASPECTS OF CURRENT PRACTICES

5. The Federal agencies participating in this study as members of the Subcommittee on Benefits and Costs are: Department of Agriculture, Bureau of Reclamation of the Department of the Interior, Corps of Engineers of the War Department, Federal Power Commission and the Department of Commerce. The subcommittee has issued statements as listed in table 1 below outlining its interpretation of the current practices of the participating Federal agencies, except the Department of Commerce. That Department is interested in water resource development but is not responsible for the planning and construction of such projects and consequently has developed no specific benefit-cost practices. As used in the statements listed in table 1, and in this summary, terms such as "irrigation project" and "flood-control project" indicate the principal purpose for which a project is authorized and built but do not imply that the project is only for the single purpose named. The statements listed above are summarized in paragraphs 6 to 10 following.

6. *Department of Agriculture.*—The current benefit-cost practices of the De-

TABLE 1.—*List of statements issued by the subcommittee*

State- ment No.	Subject	Agency	Date of statement	Issued with min- utes of meeting No.
	Benefits of—			
1	Watershed treatment.....	U. S. Department of Agriculture..	Sept. 10, 1946	12
2	Flood control.....	Corps of Engineers.....	Oct. 3, 1946	15
3	Navigation.....	do.....	Oct. 22, 1946	17
4	Irrigation.....	U. S. Bureau of Reclamation.....	Nov. 5, 1946	18
5	Hydroelectric power.....	Federal Power Commission.....	Dec. 17, 1946	21
	Supplement on collateral and indi- cidental benefits of—			
6	Watershed treatment.....	U. S. Department of Agriculture..	Nov. 19, 1946	19
7	Flood control.....	Corps of Engineers.....	Dec. 3, 1946	20
8	Navigation.....	do.....	do.....	20
9	Irrigation.....	U. S. Bureau of Reclamation.....	Jan. 13, 1947	22
10	Hydroelectric power.....	Federal Power Commission.....	Feb. 25, 1947	25
	Elements of cost of—			
11	Watershed treatment.....	U. S. Department of Agriculture..	Jan. 28, 1947	23
12	Navigation and flood control.....	Corps of Engineers.....	do.....	23
13	Irrigation.....	U. S. Bureau of Reclamation.....	Feb. 11, 1947	24
14	Hydroelectric power.....	Federal Power Commission.....	Mar. 11, 1947	26

partment of Agriculture are set forth in Subcommittee statements listed in paragraph 5 above as numbers (1), (6), and (11). Although watershed treatment programs are carried out under a number of laws for soil conservation and administration of the national forests as well as under the Flood Control Act of 1936, only the latter requires a definite analysis of benefits and costs. This latter act also establishes the principle of comparing benefits to whomsoever they may accrue with the estimated costs. Watershed treatment programs, under flood-control laws, are designed to reduce flood damage due to water and sediment, and to secure other specific agricultural as well as more widespread benefits. They are installed within a limited development period on a watershed unit basis and include full use of natural processes and conservational practices in preserving soil and vegetative cover, as well as necessary structures and installations such as terraces and check dams. Both public and private lands are included in the programs.

(a) *Benefits of watershed treatment programs.*—The Department of Agriculture considers the following types of benefits as resulting from watershed treatment programs:

- (1) Prevention of flood and sedimentation damages both direct and indirect.
- (2) Increased or higher utilization of flood plain lands.
- (3) Conservation benefits on lands where improvement measures are installed, such as reduction in soil loss and higher crop yields.
- (4) Higher levels of living, increased security and reductions in disease, injury, and loss of life resulting from (1), (2), and (3) above.
- (5) Extended benefits, such as increased business activity arising from the project, which radiate outward to the locality, region, and the Nation.
- (6) Benefits accruing to functions other than flood control and land conservation, which are discussed later in paragraphs 10 and 11.

(b) *Costs of watershed treatment programs.*—In most watershed treatment programs a major portion of the improvement measures are installed on lands that are privately owned and privately operated. A part of the installation and operation costs of such measures is borne by the owners and users of these lands, and the Department of Agriculture includes such costs in its estimates of project costs. The elements of costs considered are outlined below:

- (1) Installation costs (establishment of the program) including investigations and surveys subsequent to program adoption; land and improvements thereon acquired by the public including assistance in readjustment where displacement of farm or other families is involved; and provision of project measures and structures both by the public and by owners and operators of private lands.
- (2) Operation and maintenance costs on both public and private lands involved, including replacements necessary to permanently maintain the effectiveness of programs; and any reductions in farm incomes and increases in normal operating costs resulting from program installations.
- (3) Other costs such as any adverse effects upon water rights and uses.

In addition the Department of Agriculture takes into account costs other than project costs necessary to obtain the benefits of its programs, and recognizes that there may be other costs of an indirect nature which have not been taken into account.

(c) *Benefit-cost practice.*—Benefit-cost evaluations of the Department of Agriculture have been limited largely to the more direct benefits and costs which can be evaluated in monetary terms. Evaluation of extended or secondary effects of both benefits and costs has been limited due to difficulties of devising satisfactory techniques for tracing and measuring such effects. The Department differentiates between off-site and on-site benefits. Off-site benefits, such as those resulting from prevention of flood and sedimentation damage, are benefits other than those accruing to parties on whose lands the improvement measures are installed. On-site benefits, such as reduction of soil erosion and higher crop yields, are those accruing to parties on whose lands the improvement measures are installed. The primary use made by the Department of its differentiation between off-site and on-site benefits is in designating beneficiaries. Off-site benefits only are used as a basis for determining the justifiable Federal contribution; whereas the amount of on-site benefits determines the upper limit for a non-Federal contribution. In computing the economic justification of its projects the Department enters on the benefit side of the ledger the total on-site and off-site benefits from which have been deducted those costs, other than project costs, which are necessary for realization of the full benefits. On the cost side of the ledger the Department enters the project costs which comprise the public and private on-site costs of the watershed-treatment program. Watershed-treatment programs are planned for and evaluated on a perpetual basis. The analysis includes allowance for sufficient maintenance and operating and replacement costs to operate the program permanently at the desired level. Benefits and costs are made comparable with respect to time through the use of interest.

7. *Bureau of Reclamation (Department of the Interior).*—The current benefit-cost practice of the Bureau of Reclamation is set forth in Subcommittee statements listed in paragraph 5 as numbers (4), (9), and (13). Under Federal reclamation law, as indicated by these statements, the Bureau of Reclamation follows the reimbursability approach and also presents benefit-cost analyses of its projects. Although these approaches involve much the same basic data they are independent of each other, and only the benefit-cost approach is considered in this subcommittee statement. The presentation of benefit-cost analyses, including irrigation and other types of benefits to whomsoever they may accrue, is considered by the Bureau to be in full accord with various acts of the Congress beginning with the act of June 17, 1902, which provide for examinations and surveys of projects and the presentation to the Congress of all facts relative to the practicability of each irrigation project and for making engineering and economic investigations of proposed Federal reclamation projects.

(a) *Benefits of irrigation projects.*—The benefits of irrigation projects considered by the Bureau of Reclamation may be summarized as follows:

(1) Increase in agricultural crops due to provision of a new or supplemental water supply.

(2) Reductions in the costs of irrigating lands that do not receive an increase in water supply, as, for example, through replacement of a pumped ground-water supply by a surface water supply conveyed by gravity.

(3) Benefits resulting from improved drainage, for example, the interception of ground water seepage and application of that water to beneficial use as described in (1) above, while at the same time reducing damages from seepage.

(4) Benefits from increased or higher use of nonagricultural land.

(5) Extended benefits which are the successive effects arising as the benefits from the immediate project radiate outward in the locality, region, and nation.

(6) Provision of new farming opportunities.

(7) Benefits from functions other than irrigation, which are discussed later in paragraphs 10 and 11.

(b) *Elements of cost.*—The Bureau of Reclamation considers the elements of cost of its projects to include both project costs and the costs of measures other than project works which may be necessary to secure the full benefit of the project. However, costs of the latter type, which include those incurred over a period of years by farmers (water users) for operation and improvement of their lands, are not included as part of the project investment or of operating and maintenance costs. Project costs that are considered are as follows:

(1) Construction or establishment of project and related facilities including investigations and surveys both before and after adoption of project; lands

and rights-of-way; provision of structures; relocation of existing structures and utilities; and operation and maintenance necessary during construction.

(2) Operation and maintenance of all facilities necessary for the project, including replacements and special costs such as purchase of electric energy.

(3) Intangible costs which may not be evaluated in monetary terms, such as loss or impairment of historic, scenic, or other values of sites.

In addition, the Bureau recognizes that there may be other costs, indirect in nature, which have not received full consideration.

(c) *Benefit-cost practice.*—In evaluating project benefits for comparison with project costs the Bureau does not evaluate separately the several types of benefits listed as items (1) to (6) in subparagraph (a) above but has utilized the increase in gross crop income on irrigated lands affected by the project as a convenient measure of the value of the irrigation benefits. This practice, in effect, assumes that the increase in gross crop income represents the sum of all net direct benefits to agricultural interests (increase in water users' net incomes) and of all net indirect benefits to both agricultural and nonagricultural interests resulting from the direct agricultural benefits. In effect, therefore, the Bureau considers that its benefits are on a net basis, although they are based on the increase in gross crop income. Interest and other time factors are taken into account in the economic analysis of a project, and a limited economic life, less than the probable useful life of the project, is assumed. Because of the importance of benefits and costs in project planning the Bureau has been engaged for some time in studies leading to improved methods of project analysis, and to probable revision of current practice.

8. *Corps of Engineers (War Department).*—The current benefit-cost practice of the Corps of Engineers is set forth in subcommittee papers listed in paragraph 5 as numbers (2), (3), (8), and (12). The practices described have their origin in enabling legislation and congressional procedure leading to authorization and construction of navigation and flood-control projects. Flood-control laws provide specifically for Federal flood-control improvements "if the benefits to whomsoever they may accrue are in excess of estimated costs, and if the lives and social security of people are otherwise adversely affected." River and harbor legislation, which is the legal basis of Federal navigation improvements, does not contain specific language providing for consideration of benefits to whomsoever they may accrue, but this viewpoint is implied therein and is applied to such projects by the Corps of Engineers.

(a) *Benefits of navigation and flood-control projects* considered by the Corps of Engineers may be summarized as follows:

NAVIGATION BENEFITS

(1) Savings in cost of waterway maintenance and operation, and of water carrier operating costs on an existing waterway.

(2) Savings on existing traffic expected to be attracted to a new or improved waterway.

(3) Benefits due to movement of new traffic, including that which could not develop or move previously because of prohibitive rates or physical isolation.

(4) Protection of life and property by elimination of obstructions and hazards.

(5) Extended benefits to the region and Nation as a result of the navigation project.

(6) Benefits from functions other than navigation, which are discussed later in paragraphs 10 and 11.

FLOOD-CONTROL BENEFITS

(1) Prevention of flood damages, both direct and indirect.

(2) Increased or higher utilization of property.

(3) Prevention of loss of life and promotion of health, welfare and security of people.

(4) Extended benefits to other than the immediate beneficiaries arise out of the benefits described under (1) and (2) above and are considered as part of those items.

(5) Benefits from functions other than flood control which are discussed later in paragraphs 10 and 11.

(b.) *Costs of navigation and flood-control projects* considered as project costs by the Corps of Engineers include both Federal and non-Federal expenditures necessary for the project and may be reduced to the following elements:

(1) Establishment of a project, including investigations and surveys subsequent to adoption of project; lands and rights-of-way; provision of project struc-

tures; provision in some cases of related public and private facilities such as terminals (allowance for terminal costs incurred by private interests is usually made on the benefit side of the ledger, or by consideration of self-liquidating aspects in appropriate cases); damages and relocations of structures and facilities; and remedial measures such as fish ladders. (Deductions from total costs are made to take credit for advance replacement of facilities and to allow for salvage value.)

(2) Operation and maintenance of the project, including replacements; and charges equivalent to tax loss involved in transfer of lands to the Federal Government (a deduction is made for savings in maintenance and operation of projects being displaced).

(3) Other elements of cost not necessarily evaluated in monetary terms, including such items as scenic and historic interest of sites and value of good will and established market.

In addition the Corps of Engineers gives consideration to costs of measures other than project works which contribute toward obtaining full benefits of improvements. Also, the corps recognizes that there may be other costs of an indirect nature which are not accounted for in those elements outlined above.

(c) *Benefit-cost practice.*—The Corps of Engineers evaluates in monetary terms all of the benefits of navigation and flood-control projects set forth in subparagraph (a) above except those from prevention of loss of life, removal of navigation hazards, and the more extended benefits involving general welfare and security. In all economic analyses, the Corps of Engineers takes into account interest and other time factors and uses a limited period for the assumed economic life of projects. In setting up its benefit-cost ratios for flood-control projects the Corps of Engineers deducts all the costs other than project costs from the benefits. This procedure gives net benefits which are compared with project costs only. The procedure followed in the analysis of navigation projects involves the setting up of the cost of transportation by an alternative means as the gross measure of navigation benefits. All costs of transportation by water other than project costs are deducted from this gross measure to arrive at a reduced figure which the Corps of Engineers considers as the net benefit to be compared with the project of waterway cost. Certain costs (referred to in subpar. (b) (3) above) which are either difficult to evaluate in monetary terms because they are intangible in nature or which are not reimbursable under current Federal laws and practices, are excluded from the comparison of benefits and cost in monetary terms. Costs of this type, like benefits from prevention of loss of life and removal of hazards, are considered separately to determine their influence upon the adoption or scope of a project.

9. *Federal Power Commission.*—The current benefit-cost practice of the Federal Power Commission is set forth in Subcommittee statements listed in paragraph 5 above as numbers (6), (10), and (14). The Federal Power Commission is authorized under the Federal Power Act to investigate the utilization of water resources for hydroelectric power development and for other beneficial uses and by flood control and river and harbor legislation to recommend the installation of facilities for power development in War Department projects, upon consideration of the proper utilization and conservation in the public interest of the resources of the region. The Commission's responsibility is therefore to plan for the best possible utilization of hydroelectric power resources for the benefit of the greatest number of people, and it therefore attempts to consider all beneficial effects and costs of projects in its analysis of proposals.

(a) *Benefits of hydroelectric power projects* considered by the Federal Power Commission include power and other benefits which may be summarized as follows:

- (1) Power capacity developed by the project.
- (2) Energy generated by the project.
- (3) Improvement in downstream power output attributable to the project.
- (4) Other benefits resulting to the locality, region and Nation from the availability of abundant low cost power, including national defense aspects. These benefits are not usually evaluated in monetary terms.
- (5) Benefits from functions other than development of hydroelectric power, which are discussed later in paragraphs 10 and 11.

(b) *Costs of hydroelectric power projects.*—The costs of projects to be constructed by the Federal Government are considered by the Federal Power Commission on the basis of investment costs and annual costs. The investment costs of a single-purpose hydroelectric power development or of that portion of a multiple-purpose project allocated to power, consist of the cost of all dams, spillways, waterways, reservoirs, power plants, and other features necessary for

establishment of the hydroelectric development and include the costs of lands, improvements thereon, rights-of-way, supervision, labor, materials, equipment, damages, relocations, remedial measures and allowances for engineering, inspection, legal expenses, and contingencies. In addition to these costs, other costs and losses resulting from the development of the project, including those which are not evaluated in monetary terms, are recognized and given consideration. The annual costs considered by the Federal Power Commission include charges related to the investment as well as operating expenses as follows:

(1) Fixed charges consisting of the interest on and amortization of the investment costs outlined above, cost of replacements, and allowances in lieu of insurance and taxes.

(2) Operating expenses consisting of all expenses for labor and materials for operation and maintenance and administrative and miscellaneous general expenses.

(c) *Benefit-cost practice.*—The Commission determines the economic feasibility of hydroelectric power development at Federal water-resource projects by comparing on an annual basis those benefits and costs summarized above which are evaluated in monetary terms. The power benefits which are evaluated are based upon the cost of capacity and energy from the most economical alternative method of providing equivalent power, usually a steam-electric plant. These costs of equivalent power are considered as power values, and subject to certain adjustments are utilized to give a monetary value to the power benefits. These values are not intended to represent rates at which power will be sold, or to represent the total benefits attributable to the project and to the power available therefrom. The additional benefits are not always evaluated in monetary terms but are taken into consideration in determining the desirability of a power development. The Commission usually accepts and uses the evaluations of the Federal agency responsible for the project when considering benefits and costs of nonpower features of water-resource projects.

10. *Benefit-cost practices of all agencies on multiple-use projects.*—The preceding paragraphs 6 to 9 indicate that each participating Federal agency gives consideration to benefits of functions other than the benefits of project functions with which the agency is primarily concerned. The practices of the agencies with respect to benefits of these multiple-use aspects of their projects were described in supplementary statements (numbers (6) to (10) in par. 5) under the designation "collateral and incidental benefits" and are summarized below.

(a) Federal legislation has resulted in assigning primary responsibility for developing specific water uses on federally constructed projects to Federal agencies participating in this study as follows:

Irrigation—to the Bureau of Reclamation of the Department of the Interior.

Navigation—to the Corps of Engineers of the War Department.

Flood control—to the Corps of Engineers of the War Department insofar as improvement of rivers and other waterways for flood control and allied purposes is concerned, and to the Department of Agriculture insofar as watershed treatment programs involving measures for runoff and waterflow retardation and soil-erosion prevention are concerned.

Hydroelectric power—to the Bureau of Reclamation and the Corps of Engineers for development when feasible in connection with their authorized projects; to the Federal Power Commission for broad national consideration of power resources and specific responsibility for recommendations concerning power features of War Department projects; and to the Department of the Interior for marketing of power from projects of the Bureau of Reclamation and the Corps of Engineers.

(b) In addition there are responsibilities for other functions in accordance with either legislation or administrative assignment. The conservation of soil and forest resources is, by law, a primary responsibility of the Department of Agriculture, and is usually involved in the watersheds-treatment programs mentioned above in connection with flood control. Preservation and improvement of fish and wildlife are a primary responsibility of the Fish and Wildlife Service of the Department of the Interior and legislation provides for carrying out this responsibility in connection with development of dams, reservoirs and waterways. Recreational development at War Department projects is authorized by law. Advice and assistance on recreational development at Federal water-resource projects is provided by the National Park Service of the Department of the Interior. In addition there are other water uses or functions which are considered by all agencies in some degree. These include pollution abatement, salinity control, water supply, and sedimentation control.

(c) Current practice of the participating Federal agencies in considering

benefits other than those of functions with which they are primarily concerned may be summarized as follows:

The Department of Agriculture includes in its estimates of watershed treatment benefits of all types of benefits such as flood control, soil and water conservation, sedimentation control, fish and wildlife, recreation, salinity control, and pollution abatement.

The Bureau of Reclamation considers benefits from power, flood control, navigation, fish and wildlife, recreation, salinity control, pollution abatement, water supply, and sedimentation control. The Bureau's practices with respect to these types of benefits conform generally to those of other Federal agencies which evaluate such benefits, except in the case of power. In determining power benefits, the Bureau uses the gross revenue expected from sales of both firm and non-firm (secondary) energy at the average market rates expected to prevail.

The Corps of Engineers gives consideration to benefits from irrigation, power, drainage, recreation, fish and wildlife, mosquito control, salinity control, sedimentation control, pollution abatement, and water supply. Its practices from a qualitative standpoint, conform in general to those of other Federal agencies which evaluate such benefits.

The Federal Power Commission considers that hydroelectric power projects usually afford favorable opportunity for realization of benefits other than from power and gives consideration to navigation, flood control, water supply for irrigation, domestic and industrial uses, pollution abatement, salinity control, sedimentation control, recreation, fish and wildlife, and mosquito control. The Commission usually relies on estimates of the Federal agency responsible for development of a project for any monetary evaluation of benefits other than from power, but whether evaluated or not, takes them into account in its analyses of projects.

SUMMARY AND COMPARISON OF CURRENT PRACTICES

11. *Perspective and scope of coverage of benefit practices.*—(a) The benefit practices of the several participating agencies are in agreement on perspective. All agencies recognize that benefits should be considered from the broad public viewpoint rather than from a necessarily less comprehensive private standpoint.

(b) The objectives of the agencies are in general agreement with respect to scope of coverage of benefits but there are differences in the extent to which the objective is achieved in practice. All agencies recognize that benefits to whomsoever they may accrue should be considered and that, in addition to the obvious and important direct benefits to individuals directly affected by a project, there are indirect or extended benefits accruing to others in the locality and throughout the region and the nation. There are differences in the extent to which the agencies have considered it appropriate to include various kinds of extended benefits, to recognize the more remote benefits and to place a monetary value on extended benefits.

(c) All agencies give consideration to the possible benefits to other water uses and related purposes in planning and evaluating projects in the primary field of water resources assigned to them by Congress. In defining and using benefits other than those for which the project is primarily authorized and built, each agency conforms generally with the practices of the agency having primary interest in the type of benefit involved. Differences in treatment, however, are noted. In the case of hydroelectric power, the Federal Power Commission and Department of the Interior use somewhat different methods of defining power benefits. The practices of the Bureau of Reclamation and Corps of Engineers in defining and using irrigation benefits also differ in some respects. The practices of the Federal agencies in considering certain benefits, such as recreation and preservation of fish and wildlife, also differ somewhat on a qualitative basis owing to difficulties in developing satisfactory definitions and evaluation methods.

(d) It is apparent that appraisal of the full significance of the differences noted in perspective and scope of benefits will require consideration beyond the qualitative phase of this study.

12. *Perspective and scope of coverage of cost practices.*—(a) The viewpoint of all agencies as to what are the major elements of cost of water resources proj-

ects is essentially similar. The perspective, like that on benefits, is fundamentally from the broad public viewpoint rather than from the private viewpoint. In application of this viewpoint the practices of the agencies are also consistent in the extent to which various types and items of cost are considered, although all agencies have made less progress toward considering costs by whomsoever they may be incurred than they have in considering benefits to whomsoever they may accrue.

(b) Project costs are defined generally as the cost to the Federal Government and to non-Federal public participants of establishing, operating, and maintaining the project. In addition, the Department of Agriculture includes in its project, the farmers' costs such as certain installation costs and increased normal operating expenses which are required in connection with watershed treatment programs. The Corps of Engineers includes in its project costs in some cases, the cost to non-Federal public agencies for terminals necessary for utilization of navigation improvements. Terminal costs incurred by private interests are usually deducted from the benefits. In Bureau of Reclamation practice the costs to water users in an irrigation program are not included in project costs but are assumed to be accounted for on the benefit side of the ledger as discussed in paragraph 13 below. Another variation in practice is that the Bureau of Reclamation includes as part of project costs, the costs of investigations and surveys incurred for a specific project both before and after its adoption as a project whereas all other constructing agencies include in project costs only the cost of investigations and surveys subsequent to adoption of a project.

(c) In connection with costs all agencies consider interest and other factors involving time. On the basis of qualitative considerations alone there are no apparent differences in practices in this respect except that, for the purpose of economic analyses, the Department of Agriculture uses a perpetual maintenance basis for watershed treatment programs whereas all other agencies assume a limited project life.

(d) Costs other than project costs necessary for full realization of the gross (total) benefits of a project are considered by all agencies and, to the extent evaluated, are taken into account as deductions from gross benefits as outlined in paragraph 13 below.

(e) Certain less tangible costs such as the cost of destroying scenic or historic values of property, resettlement costs, and certain indirect costs such as consequential damages to individuals near but not necessarily in the area being acquired for a reservoir or other purposes are given consideration, at least in some degree, by all agencies. Usually such costs are not evaluated except that cost estimates of the Department of Agriculture include an allowance for certain costs for resettling families displaced by its watershed treatment programs.

13. *Methods of comparing benefits and costs.*—(a) In comparing benefits and costs all agencies confine the cost side of the ledger to what they consider project costs and reduce any total benefits on the benefit side of the ledger by the amount of any costs, other than project costs, necessary for full realization of such gross benefits. The alternative approach would be to put all costs on the cost side and all benefits on the benefit side.

(b) All agencies consider some benefits, the realization of which depends in part on the accomplishment of certain measures other than the project works. The methods by which the several agencies make allowance for these additional measures in comparing benefits and costs is illustrated in table 2 on the following page. To simplify the comparison the types of benefits listed for each agency in table 2 are limited to benefits of functions for which the agency has primary responsibility. Similarly the costs shown are intended to represent only the costs chargeable to those functions.

(c) The Bureau of Reclamation does not include on the cost side the farmers' or water-users' costs necessary for realization of increases in gross crop incomes. Instead of actually deducting those costs from gross crop incomes to obtain net direct agricultural benefits, the Bureau has made the assumption that the increase in gross crop income represents the sum of all net direct agricultural benefits and the resulting net indirect benefits creditable to the project. (It should be noted that the Bureau has under consideration new practices which do not include use of the foregoing assumption.)

TABLE 2—Methods of comparing primary purpose benefits and costs

Benefit side of the ledger

Cost side of the ledger

DEPARTMENT OF AGRICULTURE

Off-site benefits (such as flood and sediment damage prevention and increased property utilization) which consist of increases in net income (equivalent to increases in gross income less costs other than project costs) plus on-site benefits which consist of increases in gross incomes resulting from higher production on lands on which the measures are installed and reductions in normal operating expenses on such lands.

Project costs (include the cost of project measures to Governmental agencies and to owners and operators of lands on which the measures are installed, decreases in gross incomes on any such lands and increases in normal operating expenses on such lands).

BUREAU OF RECLAMATION

Increase in gross crop incomes. The Bureau has made the assumption that this item is equivalent to the sum of net direct benefits to agricultural interests (increase in water users' net crop incomes) and the net indirect benefits, to both agricultural and non-agricultural interests, resulting therefrom.

Project costs (include the cost of project measures but do not include farmers' or water users' costs since they are assumed to be accounted for on the benefit side).

CORPS OF ENGINEERS—FLOOD CONTROL

Amount of direct and indirect flood damages prevented. (No costs other than project costs are involved) plus increase in net income resulting from higher utilization of property (equivalent to increase in gross income less costs other than project costs).

Project costs (include the cost of project measures but do not include property users' costs where necessary to realize increased utilization benefits since such costs are deducted on the benefit side).

CORPS OF ENGINEERS—NAVIGATION

Savings due to use of water transportation as compared with alternative methods (equivalent to the total cost of the alternative less all costs by the waterway method other than project costs; e. g., water-carrier costs).

Project costs (include cost of project measures, and costs of public terminals and navigation aids, but does not include water-carrier and private terminal costs which are deducted from benefits).

FEDERAL POWER COMMISSION

Value of hydroelectric capacity and energy from the project (based upon the cost of equivalent power from an alternative source, usually steam electric, with certain adjustments, which allow for any differences in transmission costs and losses).

Project costs (include cost of the hydroelectric development but does not include transmission costs which are accounted for on the benefit side).

SPECIAL PROBLEMS

14. During the progress of its study to date the subcommittee has encountered many special problems in benefit-cost analysis, which involve fundamental principles and have a direct and important bearing upon subsequent phases of the subcommittee's study, or on which interim decisions are needed by Federal agencies to meet current requirements of project analysis. Work is now in progress on most of the following special problems. The results of studies of these problems, and others which may arise during subsequent phases of the subcommittee's study, will be included in part C, analysis of special problems, referred to in paragraph 2 of this summary.

(a) *Classification of benefits and costs.*—Subcommittee studies to date have shown that there should be greater uniformity in the terminology by which the Federal agencies define and classify benefits and costs. This deficiency has been a source of difficulty during the qualitative study of current practice, and it appears that a more uniform system of classification will be useful in later phases of the study leading to mutually acceptable principles of benefit-cost analysis. The subcommittee hopes to develop a practicable system in the near future.

(b) *Inundation of reservoir lands.*—This study includes problems of individual and community displacements and relocations, adverse effects on individual enterprises and on the over-all economy of adjacent areas; effects upon local public services and units of government; and how these problems relate to benefit-cost analysis.

(c) *Downstream power benefits.*—The extent to which prospective downstream power developments should be regarded as benefiting from upstream storage must be considered in benefit-cost analyses.

(d) *Reduction of relief load.*—The problem involved here is the determination of the conditions, if any, under which and the extent to which, the reduction of relief should be considered in the benefit-cost analysis.

(e) *Previous investments in existing facilities.*—When a proposed project includes facilities which will provide the same services as those afforded by an existing facility, and at the same time extend the period during which the service will be performed beyond that which would have resulted from the existing facility, a problem arises as to the adjustment necessary to allow for changes in benefits and costs resulting from the extension of the service period.

(f) *Savings in maintenance and operating costs.*—Savings of this type may result when a new project replaces or supersedes an existing project. The accounting for savings of this kind involves the consideration of whether they should properly be handled on the benefit or cost side of the ledger.

15. Certain other problems of basic importance have been noted by the subcommittee and will be considered at appropriate points in the course of the over-all study, as for example:

(a) *Economics of project formulation.*—This involves the question of whether projects taken singly or collectively in a basin-wide development should be planned to obtain the greatest possible benefit within a benefit-cost ratio of unity, or to produce the highest possible ratio of benefit to cost, or on the basis of some criterion between these two extremes.

(b) *Project life.*—The use of limited project life or a perpetual-maintenance basis for purposes of economic analysis.

(c) *Price levels.*—The selection and use of appropriate estimates of future price levels in benefit-cost analyses.

(d) *Tax changes.*—This covers the tax base and tax revenue changes which result from water resource projects and their relation to economic analysis.

(e) *Compensatory gains.*—Consideration should be given to compensatory gains which accrue to some interests, although losses are incurred by others.

(f) *Evaluation of intangible benefits.*—To what extent can and should the improvement of health, welfare, and security of people; aids to national defense; and prevention of loss of human life be evaluated and measured in monetary terms.

(g) *Land values versus income as a benefit measure.*—This involves a consideration of the extent to which land values, land earnings, and rentals may appropriately be used as measures of benefits as compared with farm and other income.

(h) *Assignment of benefit among several purposes.*—The question involved here is how a benefit should be credited to two or more contributing costs, as for example, when the removal of a flood hazard plus the irrigation of the protected lands are both essential to the realization of the particular benefit in question.

(i) *Evaluation of secondary, extended, or spreading effects.*—This problem embraces the identification and the possibility of evaluating the spreading project effects as they relate to both benefits and costs, and as they radiate outward throughout the locality, region, and Nation.

REMAINING WORK OF THE SUBCOMMITTEE

16. The mutual understanding of the benefit-cost practices of the several Federal agencies, which is essential to the remaining work of the subcommittee, has been advanced materially by exploration of the qualitative aspects of current practices. The subcommittee considers that completion of this study as

outlined in paragraph 2 of this statement is essential for the following reasons:

(a) In its planning of the benefit-cost study as a whole, the subcommittee has been constantly impressed by the fact that although the problem is far-reaching in its effect on Federal project planning and construction policies, there have been no previous studies in the field of benefit-cost analysis that have been pushed to a final conclusion. To a large extent the subcommittee's work is a pioneer effort.

(b) In view of the practical need of the Federal agencies for solutions of the problems involved in benefit-cost analysis, the subcommittee has explored carefully all possibilities for short-cuts and interim solutions. Any such approaches, however, will afford little chance of bringing to light the principles which are necessary as a basis for mutual agreement on benefit-cost practices. If short-cuts were attempted, mutual agreement would have to be based on preponderance of opinion only; and in the opinion of the subcommittee this would not constitute a sound basis for future practice.

(c) The subcommittee concludes that any procedure, other than a comprehensive analysis of current practices and of all appropriate modifications or new approaches, will not achieve results worthy of intensive effort by the Federal agencies; and that the course of study now projected will result in successful accomplishment of the desired objective of formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects.

APPENDIX II

Second Progress Report of the Subcommittee on Benefits and Costs to the Federal Inter-Agency River Basin Committee

1. The Subcommittee on Benefits and Costs, in accordance with instructions of the Federal Inter-Agency River Basin Committee, has been engaged in a comprehensive study of the benefit-cost problem for the purpose of formulating mutually acceptable principles and procedures for determining benefits and costs of water resources projects. The first progress report of the subcommittee covering the period from April 1946 to March 1947 was distributed with the minutes of the thirtieth meeting of the subcommittee and was discussed at the forty-sixth meeting of the Federal Inter-Agency River Basin Committee on November 20, 1947. The first report covered the qualitative aspects of benefit-cost practices. A second progress report covering the measurement aspects of benefit-cost practices, is presented at this time in order to advise the committee as to the status of the work, summarize the results of the past year's work, and indicate the nature and extent of the work remaining for accomplishment of the ultimate objective.

2. *Scope of the comprehensive study.*—The comprehensive study is divided into four major phases with purposes as follows:

Part A. *Analysis of current practices.*—To obtain a mutual understanding of the current practices of each participating Federal agency in preparing its reports and recommendations on water resource projects. This includes a qualitative study of current benefit-cost practices to identify and define the type and nature of benefits and the elements of cost involved, a study of current practices for the quantitative measurement of benefits and costs, and a study of practices used for the allocation of costs.

Part B. *Objective analysis.*—To develop a procedure for benefit-cost analyses not influenced by present practices or current legal and administrative limitations.

Part C. *Analysis of special problems.*—To examine those special problems on which interim answers are desired and problems of an over-all nature which cut across various phases of the complete study.

Part D. *Conclusions and recommendations.*—To compare current practices (pt. A) with the objective analysis (pt. B) in order to develop mutually acceptable principles and procedures for benefit-cost analyses.

3. *Status of the comprehensive study.*—Assignments have been made and studies are proceeding simultaneously under parts A, B, and C of the above outline. The qualitative study of benefit-cost practices under part A was completed and the results were presented with the first progress report as indicated above. Since that time the subcommittee and its staff have made a comprehensive study of the quantitative or measurement aspects of current practices and distributed nine detailed statements on these practices with their minutes. Attached is a summary of measurement aspects of benefit-cost practices currently in use by the participating agencies which is based on these detailed statements. The study of allocation practices is under way, and it is expected that all of the studies under part A will be completed this winter. Studies under part B, the objective analysis, are well advanced and will be covered in a future progress report. Certain special problems which will ultimately be covered in part C were reviewed briefly in paragraphs 14 and 15 of the April 1947 summary and since that time an interim statement on classification of benefits and costs has been issued for discussion purposes. Part D, consisting of final conclusions and recommendations, will be undertaken when parts A, B, and C are substantially completed.

4. *Study of current practices for measurement of benefits and costs.*—The analysis of the measurement practices of the various agencies has occupied the Subcommittee for the last 20 meetings, totaling about 60 hours since the completion of the report on the qualitative aspects in April 1947. During the same period, the staff of the Subcommittee has held 70 additional meetings, totaling 350 hours with an average of about 8 members in attendance. Each agency employing benefit-cost practices has contributed the equivalent of one man's full time to the work of preparing the material for the subcommittee staff.

5. The practices used by the participating agencies for the measurement of benefits and costs are summarized, discussed, and compared in the attached "Measurement aspects of benefit-cost practices" which brings out the important similarities and differences in these practices. The differences result from the various legal and administrative requirements of the several agencies, from differences in objectives, and from complexities and difficulties inherent in the measurement of benefits and costs. The Subcommittee study has made available, for the first time, detailed statements covering the practices currently in use by the participating agencies for the measurement of benefits and costs. These statements have given the subcommittee and the participating agencies a better understanding of current practices, which, with the principles that will be developed in the objective analysis, will provide the basis for the formulation of mutually acceptable procedures.

6. *Remaining work of the subcommittee.*—With respect to the future progress of the over-all study, as outlined in paragraph two of this report, the Subcommittee plans to complete and report upon the objective analysis of benefits and costs within the next year, and then to complete the ultimate objectives of formulating mutually acceptable principles and procedures.

For the Subcommittee on Benefits and Costs:

FRANK L. WEAVER, *Chairman.*

MEMBERSHIP OF SUBCOMMITTEE AND STAFF

SUBCOMMITTEE MEMBERSHIP DURING 1948

Mr. F. L. Weaver-----	Chief, Division of River Basins, Bureau of Power, (Chairman)	Federal Power Commission.
Mr. G. L. Beard-----	Chief, Flood Control Division, Civil Works, Office, Chief of Engineers, Department of the Army.	
Mr. J. W. Dixon-----	Director of Project Planning, Bureau of Reclamation, Department of the Interior.	
Mr. V. Roterus-----	Assistant Chief, Area Development Division, Office of Domestic Commerce, Department of Commerce.	
Mr. E. H. Wiecking-----	Office of the Secretary, Department of Agriculture.	

SUBCOMMITTEE STAFF DURING 1948

Mr. N. A. Back-----	Office of the Secretary, Department of Agriculture.	
Mr. J. R. Brennan-----	Flood Control Division, Civil Works, Office, Chief of Engineers, Department of the Army.	
Mr. O. L. Endler-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.	
Mr. A. R. Johnson-----	Branch of Project Planning, Bureau of Reclamation, Department of the Interior.	
Mr. R. G. Ohlman-----	U. S. Fish and Wildlife Service, Department of the Interior.	
Mr. Carter Page-----	Flood Control Division, Civil Works, Office, Chief of Engineers, Department of the Army.	
Mr. R. A. Prewitt-----	National Park Service, Department of the Interior.	
Mr. R. C. Price-----	Office of the Secretary, Department of the Interior.	
Mr. M. M. Regan-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.	
Mr. K. L. Roberts-----	Division of River Basins, Bureau of Power, Federal Power Commission.	
(Subcommittee Secretary)		
Mr. G. H. Walter-----	Division of Land Economics, Bureau of Agricultural Economics, Department of Agriculture.	
Mr. E. W. Weber-----	Civil Works, Office, Chief of Engineers, Department of the Army.	
Mr. W. M. White-----	U. S. Fish and Wildlife Service, Department of the Interior.	

MEASUREMENT ASPECTS OF BENEFIT-COST PRACTICES

1. *Scope of this statement and its relation to comprehensive report.*—This report is a summary of the measurement aspects of benefit-cost practices currently in use by the participating Federal agencies for the evaluation of benefits and costs necessary for the economic analysis of prospective Federal projects. It is the second progress report of the Subcommittee on Benefits and Costs of the Federal Inter-Agency River Basin Committee and completes the study of current benefit-cost practices. The first report of the Subcommittee covered the qualitative aspects of benefit-cost practices. The remaining work of the subcommittee will include statements covering the cost allocation practices currently used by the participating agencies, an objective analysis to develop a desirable procedure for benefit-cost analyses independent of legal or administrative limitations, a study of special problems on which interim answers are desired, and the conclusions and recommendations for mutually acceptable principles and procedures.

2. *Agencies participating.*—The Federal agencies participating in this study as members of the Subcommittee on Benefits and Costs are: Department of Agriculture, Department of the Interior, Corps of Engineers of the Department of the Army, Federal Power Commission, and Department of Commerce.

3. *Procedure for study of current measurement practices.*—The study of the practices currently being used for measurement of benefits and costs is essential to a mutual understanding of the purposes for such work and the problems involved in project economic analysis and cost allocations. The Subcommittee has issued statements outlining its interpretation of the current practices of the participating Federal agencies, except the Department of Commerce. Although the Department of Commerce is interested in water-resource development and contributes information and services necessary therefor, it is not responsible for the planning or construction of such projects and consequently has not found it necessary to develop specific benefit-cost measurement practices.

4. The attached copies¹ of the detailed statements on the practices currently in use by the participating agencies, as listed in table 1 below, will be of assistance to readers desiring more detailed information than it included in this summary.

TABLE 1.—*List of statements issued by the subcommittee*

Subject	Agency	Date of statement	Issued with minutes of meeting No.
Measurement of benefits of—			
Navigation.....	Corps of Engineers.....	July 8, 1947	31
Flood control.....	do.....	Oct. 21, 1947	34
Hydroelectric power.....	Federal Power Commission.....	Feb. 10, 1948	37
Watershed treatment.....	U. S. Department of Agriculture.....	Apr. 20, 1948	41
Irrigation.....	U. S. Department of the Interior.....	Aug. 3, 1948	47
Measurement of costs of—			
Navigation and flood control.....	Corps of Engineers.....	Mar. 23, 1948	40
Hydroelectric power.....	Federal Power Commission.....	do.....	40
Watershed treatment.....	U. S. Department of Agriculture.....	May 25, 1948	43
Irrigation.....	U. S. Department of the Interior.....	June 15, 1948	44

As used in the statements listed above, and in this summary, terms such as "irrigation project" and "flood control project" indicate the principal purpose for which a project is authorized and built but do not imply that the project is only for the single purpose named.

5. *Contents of this summary.*—The important aspects of the benefit-cost practices have been condensed from the statements listed above and arranged in tabular form in table 2 to facilitate comparisons of similarities and differences. In paragraphs 6 through 20 which follow table 2, the major differences in current measurement practices are discussed in more detail. The purpose of these paragraphs is to stress the significance of the difference observed by the Subcommittee.

¹ Not available.

TABLE 2.—Comparison of the current practices of the participating agencies in measurement of tangible benefits and costs

Practices to be compared	Corps of engineers' practice on navigation, flood control, and multiple-purpose projects	Department of Agriculture practice on watershed treatment programs	Department of the Interior practice on irrigation and multiple-purpose projects of the Bureau of Reclamation	Federal Power Commission practice on Federal multiple-purpose projects involving power development
(1)	(2)	(3)	(4)	(5)
GENERAL PRACTICES				
1. General basis for measuring and comparing tangible benefits and costs (all agencies give consideration to intangible benefits and costs separately from the tangible benefits and costs which enter into the computed benefit-cost ratio).	Benefits, measured as savings in costs, reductions in losses or increases in income to beneficiaries, all of which are reduced by the amount of any associated costs other than project costs necessary for their realization, are compared with project costs which consist of all Federal and non-Federal costs necessary for establishing, maintaining and operating the project.	Benefits, consisting of increases in gross incomes on lands on which program measures are installed, increases in gross incomes less increased costs of production on other lands, and reductions in costs and losses on all lands, are compared with project costs which include both public and private expenditures for the program installation and operation.	Irrigation benefits as measured by the effects of the project on contribution to national income, plus other types of benefits as measured principally by the value of services rendered, are compared with Federal (project) costs for installation and operation of the project.	Hydroelectric power benefits, including the value of capacity and energy at the project and the improvement in downstream power, plus nonpower benefits as estimated by the agency responsible for the project, all reduced by any nonproject costs required for their realization, are compared with the Federal cost of establishing, maintaining, and operating the project.
2. Period of analysis used in estimating benefits and costs.	Estimated economically useful life, limited to maximum of 50 years in all but exceptional cases.	A perpetual life basis is assumed.	Estimated economically useful life of principal project features or 100 years, whichever is less (see items 25 and 26 for treatment of salvage values).	Estimated economically useful life, limited to maximum of 50 years.
3. Time basis used for expressing monetary amounts of benefits and costs.	All benefits and costs are converted to equivalent average annual amounts for the period of analysis.]	Same as indicated in column 2.	Same as indicated in column 2.	Same as indicated in column 2.
BENEFITS				
4. Price level used in calculating benefits.	Price level prevailing at time of analysis	do	<i>Irrigation.</i> —Estimated average prices during project life—currently, 1939-44 prices are used. <i>Power.</i> —Expected average power rates during project life. <i>Recreation.</i> —Expected average prices during project life. <i>Fish and wildlife.</i> —Sportsman's expenditures based on 1939-44 prices. Commercial fur and fish prices based on local data within 10-year period prior to period of analysis.	Do.

5. Interest rates used for conversion of nonuniform benefits to an equivalent average annual benefit.

6. Method of measuring benefits from preventing flood damage.

7. Method of measuring benefits from increase in value of agricultural production. (Includes such benefits as increased crops resulting from irrigation and the improved farm practices involved in watershed treatment programs and the increased crops possible on land that is drained or protected from floods.)

Average rate of interest payable on money borrowed for long-term private investments in the locality concerned. Rates from 4 to 5 percent are generally used.

Benefits are measured as the amounts of reduction of flood damage, computed on the basis of damage-frequency relations, with damages measured as follows: Damage to land and other property measured by the cost of restoration, when restoration is not possible, damage is measured as reduction in value of the property; damage to agricultural crops measured by market value of crop lost adjusted for any production costs not incurred and replanting possibilities; and damage due to interruption of business, industry, commerce, etc., measured by net loss of income or added costs of operation to the extent such losses or costs cannot be avoided.

Benefit computed as the increase in net farm income. In general, this is the increase in gross farm income minus the increase in cost of production. Effects of increased agricultural production on incomes other than at the farm are usually not measured.

2 percent except as shown for item 8 below.

Same general basis as described in column 2 except that damage due to interruption of business, etc., is usually not measured.

For lands on which the program measures are installed, benefits are measured as the increase in gross farm income with increases in production costs accounted for as a part of program costs. For land downstream (land other than that on which project measures are installed) the benefit is taken as the increase in net farm income. In general, this is the increase in gross farm income minus the increase in cost of production. Effects of increased agricultural production on incomes other than at the farm are usually not measured.

2½ percent-----

Estimates obtained from Corps of Engineers or, when necessary, independent estimates made by similar methods. In either case, adjustments are made to give a price level basis same as for irrigation.

Contributions to national income consisting of:

Effects at the farm (termed "direct benefits")—(a) Increase in difference between gross farm income (farm receipts plus farm privileges) and all farm expenses. (b) Increase in wages paid hired farm laborers. (c) Increase in interest payment on farmers' borrowed capital.

Effects beyond the farm (termed "indirect benefits")—(a) Share of added income resulting from additional volume of agricultural products flowing through industry and trade. (b) Share of added income from increased purchases of goods and services in the project area.

Power benefits are usually measured directly on average annual basis and no conversion is involved.

Estimates obtained from Corps of Engineers or, when necessary, independent estimates made by similar methods.

Estimates obtained from agency responsible for the project concerned.

TABLE 2.—Comparison of the current practices of the participating agencies in measurement of tangible benefits and costs—Continued

Practices to be compared (1)	Corps of engineers' practice on navigation, flood control, and multiple-purpose projects (2)	Department of Agriculture practice on watershed treatment programs (3)	Department of the Interior practice on irrigation and multiple-purpose projects of the Bureau of Reclamation (4)	Federal Power Commission practice on Federal multiple-purpose projects involving power development (5)
BENEFITS—continued				
8. Method for measuring benefits from increased or higher utilization of nonagricultural property.	Any benefits over and above those measured under other items such as 6 and 7 above are measured in terms of increases in earnings expected under average future conditions due to the changes in use made practicable by the project. The annual increases in earnings are determined by applying the current average rate of return associated with the activity concerned to the increase in capital value, except in cases where the increase in earning power can be determined directly.	Any benefits over and above those measured under other items such as 6 and 7 above are measured in terms of increases in property values above the capitalized value of all damage reductions. Estimates of increases in property values are obtained either from studies of values in comparable areas or by capitalizing the anticipated increase in annual land income. These benefits are converted to an average annual basis by use of a selected rate of return; usually between 4½ and 6½ percent.	Benefits of use of land for residential purposes are measured by converting the estimated future increase in market value of such lands to an equivalent average annual value. The standard interest rate of 2½ percent is used.	Estimates obtained from agencies responsible for project.
9. Method for measuring benefits from increasing hydroelectric power production.	Amount of power computed on the same basis used by the Federal Power Commission. Benefit is computed by applying to the above amounts unit values for capacity and energy obtained from the Federal Power Commission.	Usually not evaluated in monetary terms.	Estimated gross revenue to the project from energy sales with adjustment for any gains or losses at downstream plants is measured and termed the "direct benefit." Additional effects of the production of power, termed "indirect benefits" are measured as follows: (a) Share of returns to distributors of project power. (b) Saving to consumers from lower power rates. (c) Benefit attributable to project power in the final production of goods and services.	Hydroelectric power value consisting of: Value at the bus bar of the project for dependable and usable capacity during critical stream-flow period and for usable energy from average stream flow based upon cost of capacity and energy from most economical source, other than hydro, of providing power, usually privately financed, modern, efficient, steam-electric power. Improvements in downstream power values attributable to the project, reduced by any costs incurred by the downstream beneficiaries in order to realize the improved power values.

10. Method for measuring navigation benefits.	Savings to shippers measured as the difference between cost of transportation by cheapest available alternative and cost of transportation by waterway; savings in water-carrier time and operating costs on an improved waterway when it will supersede an existing waterway; estimated recreational value of harbors and waterways to small boat traffic. More extended or secondary effects such as stimulation of business activity are not usually measured.	do	Estimates obtained from Corps of Engineers or, when necessary, independent estimates made by similar methods. In either case, adjustments are made to give a price level basis same as for irrigation.	Estimates obtained from Corps of Engineers or, when necessary, independent estimates made by similar methods.
11. Method for measuring domestic and industrial water supply benefits.	Measured by the cost of providing the most economical alternative means of obtaining the needed water. Where there is no other practical alternative means, the benefit is measured by determining the value of the additional water to the consumer, sometimes in terms of ability to pay.	Reduction in water supply treatment costs (usually computed as a sedimentation control benefit).	Same practice as that described in column 2.	Estimates obtained from agency responsible for project or, when necessary, independent estimates made by similar methods.
12. Method for measuring sedimentation control benefits.	Value of damage prevented (similar to flood control), reduction in cost of services provided, or value of avoidance of impairment of a useful function.	Value of damage prevented, reduction in cost or increase in value of services provided, or value of extended life of facilities.	Same practice as that described in column 3.	Estimates obtained from agencies responsible for project.
13. Method for measuring benefits from pollution abatement.	Measured by the cost of providing the most economical alternative methods of waste treatment or disposal, or reduction in maintenance and operating costs where alternative methods of pollution abatement are not economical.	Usually not evaluated in monetary terms.	Same practice as that described in column 2.	Estimates obtained from agency responsible for project or, when necessary, independent estimates made by similar methods.
14. Method for measuring salinity control benefits.	Value of damage prevented, increased use made possible, or maintenance costs avoided—determined in manner similar to that for flood control (item 6 above).	do	Same practice as that described for Corps of Engineers.	Estimates obtained from agencies responsible for project.
15. Method for measuring recreational benefits.	Except as covered in item 10, usually not included in benefit estimates but in order to permit consideration outside of monetary benefit-cost comparison, benefits are evaluated in general monetary and nonmonetary terms after consultation with National Park Service.	do	Recreational benefits estimated by the National Park Service based on expected expenditures by persons visiting the area plus general benefits to surrounding areas (consideration is currently being given to revision of this practice).	Do.

TABLE 2.—*Comparison of the current practices of the participating agencies in measurement of tangible benefits and costs—Continued*

Practices to be compared (1)	Corps of engineers' practice on navigation, flood control, and multiple-purpose projects (2)	Department of Agriculture practice on watershed treatment programs (3)	Department of the Interior practice on irrigation and multiple-purpose projects of the Bureau of Reclamation (4)	Federal Power Commission practice on Federal multiple-purpose projects involving power development (5)
BENEFITS—continued				
16. Method for measuring fish and wildlife benefits.	Standard procedures for estimating fish and wildlife benefits have not been adopted. Often not included in monetary benefit-cost comparison, but when included both qualitative and quantitative data are based upon estimates made by the U. S. Fish and Wildlife Service.	-----do-----	Increased value of annual yields estimated by the Fish and Wildlife Service based on expenditures of sportsmen for fishing and hunting and on gross market value of fish and fur taken for commercial purposes.	Do.
17. Method for measuring benefits from increased employment.	Not measured because during normal times increased employment is assumed to be essentially a diversion from other equally profitable sources of employment. During periods of depression the possibility of increased employment is considered to be a factor which is outside the project economics but which may be given consideration in selecting the project for construction.	Not measured for the same reasons listed in column 2.	Part of labor's share of added income measured as part of the benefits from agricultural production and from power. (See items 7 and 9.)	Recognized but not measured or evaluated.
18. Method for measuring benefits from increased use of capital.	Not measured because it is assumed that other equally profitable methods of using capital could be employed and that, therefore, there is no increased return from the use of capital on the project.	-----do-----	Part of capital's share of added income measured as part of the benefits from agricultural production and from power. (See items 7 and 9.)	Not measured or evaluated.

COSTS

General cost practices

19. Price level used in calculating costs.	Price level prevailing at the time of the analysis.	Same as indicated in column 2....	Prices prevailing at the time of analysis for construction costs. Expected future prices for operation and maintenance (currently, future prices for irrigation based on 1939-44 average and on power, based on special investigations).	Same as indicated in column 2.
20. Interest rate used for converting nonuniform costs to an equivalent average annual cost.	3 percent for Federal and 3½ percent for non-Federal cost.	2 percent for all costs.....	2½ percent for Federal costs. Non-Federal costs are taken into account under Benefits. (See item 7.)	2½ percent for all costs.
<i>Investment costs</i>				
21. Types of costs included in initial investment costs. (Differences in measurement practices for similar types are described in items 22 to 26 below.)	All costs, subsequent to authorization of the project by Congress, for labor, materials, and equipment necessary to design and construct a project; lands and rights-of-way for construction and operation; damage compensations; structural and utility relocations, remedial measures, legal expenses, overhead costs, and all other costs incurred in establishing the project, including interest during construction and allowances for contingencies and for salvage value of land.	All Federal and private costs, subsequent to authorization of the project by Congress, of establishing program measures including labor, materials, equipment, lands and rights-of-way, engineering plans and designs, technical assistance and supervision, and allowances for contingencies and for guidance and assistance in relocating displaced families.	Same types included as those indicated in Column 2 except that an allowance is made for salvage as determined by remaining use value of major structures.	All costs for labor, materials, equipment, lands, rights-of-way, damage compensations, structural and utility relocations and remedial measures required to establish the project, plus 25 to 35 percent of the total amount of such costs to cover such additional costs as engineering, inspection, legal expense, administrative and miscellaneous general expense, interest during construction, and an allowance for contingencies.
22. Allowance made for interest during construction.	Included for ½ of the construction period at 3 percent for Federal investment and 3½ percent for non-Federal investment.	Not included because benefits either begin to accrue as expenditures are made or are discounted to the time of the expenditures.	Included for one-half of construction period as 2½ percent.	Same practice as that described in column 4.
23. Allowance made in estimates for contingencies.	Included in various portions of the estimate in amounts appropriate to the degree of refinement and accuracy inherent in the estimates of physical quantities and unit price data.	Same practice as that described in column 2.	Included as a percentage of total construction cost as estimated to fit the conditions for each project.	Included in total investment cost. (See item 21.)
24. Allowance made for consequential damages.	Not included in monetary estimate of cost.	Allowance is made for the cost of financial and guidance assistance expected to be provided to persons displaced by land acquisition.	Not included in monetary estimate of cost.	Not included in monetary estimate of cost.

TABLE 2.—Comparison of the current practices of the participating agencies in measurement of tangible benefits and costs—Continued

Practices to be compared (1)	Corps of engineers' practice on navigation, flood control, and multiple-purpose projects (2)	Department of Agriculture practice on watershed treatment programs (3)	Department of the Interior practice on irrigation and multiple-purpose projects of the Bureau of Reclamation (4)	Federal Power Commission practice on Federal multiple-purpose projects involving power development (5)
costs—continued				
<i>Investment costs—Continued</i>				
25. Method of allowing for salvage value of land.	Investment to be amortized is reduced by the estimated future value of land at end of a period of analysis (net result same as Interior method).	Not applicable because of assumption of perpetual life for the program.	Initial investment reduced by present worth of estimated future value of land at end of period of analysis (net result same as Corps of Engineers' method).	No allowance made for salvage values of land.
26. Method of allowing for salvage value of major structures.	Usually no allowance made for salvage values of major structures.	Not applicable because of the assumption of perpetual life for the program.	Initial investment reduced by present worth of remaining use value, at end of period of analysis, of major structures on straight line depreciation basis over the life of the structures, not to exceed 150 years. (See item 28.)	No allowance made for salvage values of major structures.
<i>Annual costs</i>				
(Items 27 to 32 below include all factors considered by these agencies in expressing costs on annual basis)				
27. Allowance made for interest on initial investment.	Interest on initial investment cost without any deduction for salvage value of land or major structures is included in annual cost over the period of analysis at interest rates of 3 percent for Federal and 3½ percent for non-Federal investments.	Interest on initial investment cost without any deduction for salvage value of land or major structures is included in annual cost in perpetuity at an interest rate of 2 percent.	Interest is included in the annual cost over the period of analysis on the initial investment cost reduced by present worth of salvage or remaining use value of land and major structures at an interest rate of 2½ percent.	Same practice as that described in column 2 except that interest rate of 2½ percent is used.
28. Allowance made for amortization of the initial investment cost.	An amount is included in the annual cost over the period of analysis to amortize the initial investment cost reduced by salvage value of land (see item 25) using interest rates of 3 percent for Federal and 3½ percent for non-Federal investments.	Amortization is not included because of the assumption of perpetual life.	An amount is included in the annual cost over the period of analysis to amortize the initial investment cost reduced by the present worth of the salvage values for land and for major structures (see items 25 and 26) using interest rate of 2½ percent.	An amount of 1.03 percent of total investment cost is included in annual fixed charges to amortize this investment cost in full over the period of analysis, using an interest rate of 2½ percent.

29. Allowance made for replacement costs.	Minor replacement costs are estimated as part of maintenance and operation costs. Major replacement costs are converted to present worth values upon which interest and amortization are charged over the full period of analysis. No salvage credit is taken for the remaining value of the last major replacement the life of which may extend beyond the life of the project.	Included as part of maintenance costs and computed by dividing the initial cost by the life of the item.	Same as indicated in column 2 except that the present worth of the replacement costs are reduced by the present worth of any remaining use value of replaceable items on a straight line depreciation basis where the life of the replaceable items extends beyond the life of the project, but no such remaining use values are considered beyond 150 years.	Average annual replacement cost usually estimated as about 0.60 percent of total investment cost on the basis that this allowance is approximately equivalent to providing annually during the entire period of analysis for a charge for each replaceable item which, on a 2.5 percent sinking fund basis over the life of the item, will provide for the cost of replacing the item.
30. Allowance made for insurance costs.	Not included.	Not included.	Not included.	Included in annual fixed charges over the period of analysis as 0.12 percent of total investment cost.
31. Allowance made in lieu of taxes.	Loss of taxes to local taxing agencies as a result of transfer of lands and property to Federal ownership is included as an annual charge against the project over the period of analysis. This charge may be offset by increased revenue to local taxing agencies from reservoir land rentals in accordance with sec. 7 of the 1941 Flood Control Act and subsequent Acts.	No allowance made because it is assumed that increases and decreases in taxes offset each other.	Same practice as that described in column 3.	An amount averaging about 1.40 percent of total investment cost is included in annual fixed charge over the period of analysis as an allowance in lieu of state and local taxes that would be paid if the project were privately owned.
32. Allowance made for operation and maintenance costs.	Includes all costs, other than those accounted for in the initial investment, which are expected to be incurred, during the period of analysis in order to maintain and operate it for the intended purposes.	All costs, Federal or private, necessary to operate the programs and to maintain the program investments for perpetual life including increases in production costs on lands on which project measures are installed.	Same practice as that described in column 2.	Annual operating expense includes all costs for labor and materials for maintenance and operation of hydroelectric power development as well as for administrative and miscellaneous general expense over the period of analysis.

6. *General basis for comparing benefits and costs.*—In their economic analyses of prospective Federal projects all of the participating Federal agencies compare benefits, reduced by any nonproject costs required for their realization, with project costs. Differences in concepts with respect to benefits and costs exist, however, as discussed in subsequent paragraphs. The study of current practices by the subcommittee has been primarily concerned with these benefit-cost analyses, and has not been concerned with the separate problem of repayment analyses which are made for other purposes, as for example by the Department of the Interior in compliance with reclamation law. In general, the benefit-cost analysis involve the measurement of certain physical and economic factors under conditions expected to prevail without the project and under conditions expected to prevail if the project is built. Although the subcommittee's previous summary on the qualitative aspects of benefit-cost practices brought out the fact that all the participating agencies recognize that benefits and costs should be considered from a public viewpoint, including benefits to whomsoever they may accrue and costs by whomsoever incurred, the subcommittee's study of current measurement practices indicates that there are important fundamental differences in the application of this principle in the measurement phase. These differences include variations in the concept of what economic effects should be measured as benefits and as costs, differences in methods of measurement, and differences in the extent to which costs are measured as compared with benefits. The details involved in these differences are to be found in the statements describing the practices of each agency, and some of the important aspects of the differences in these practices are discussed and compared in the following paragraphs of this summary.

7. *General basis for measuring benefits.*—There is wide variation in the benefit measurement practices of the several agencies. The benefits measured range from the more direct benefits accruing to individuals who utilize the products or services of the project to the more extended effects of the projects on the local, regional, and national economy. Variations in the amount of benefits measured for comparison with project costs also result because of differences in definitions of project costs and differences in deductions made from benefits to allow for costs other than project costs.

8. *Extent to which remote benefits are measured.*—There is a considerable range in the extent to which the several agencies measure the more remote benefits. Federal Power Commission estimates of power benefits are based on the cost of the most economical alternative source of power and, accordingly, account for none of the more extended effects of power production on the economy, Corps of Engineers navigation benefit estimates are also based essentially on the value of the most economical alternative, and, except for some recreational benefits of small boat harbors, reflect none of the more extended economic effects of the waterway improvements. On flood control, the Corps of Engineers and the Department of Agriculture measure a limited number of the more extended effects. The Department of the Interior on Bureau of Reclamation projects measures irrigation benefits in terms of contributions to national income, and power benefits in terms of direct and indirect effects. These procedures of the Department of the Interior have the effect of including many more of the indirect or extended effects of projects than are measured in the practice of other agencies.

9. *Deductions from benefits.*—Realization of many of the benefits of Federal water resource projects involve costs other than project costs. The variations in definition of project costs are discussed in paragraph 12. All costs other than project costs necessary for the realization of the benefits of a project are deducted from the gross benefits by all agencies except that Interior's practice of measuring irrigation benefits in terms of contributions to national income involves including as benefits a part of the wages, interest, and other income received by all persons whose activities are associated with or dependent on the completed project. However, in the practice of the other agencies such items are not considered as benefits, but when involved, are treated only as part of the nonproject costs all of which are deducted from the gross benefits. The reduction of benefits by any nonproject costs required for their realization is based on the assumption that the labor and capital involved in nonproject costs could and would be employed elsewhere if not employed as a result of the development of the project, and in this other employment would realize gross benefits at least equal to these costs. When nonproject costs which are required for the realization of benefits are not subtracted from these benefits, the effect is the same as assuming that the labor and capital involved in these costs would be unemployed if the project were not developed.

10. *Comparison of results of benefit measurement practices.*—This comparison of results under benefit measurement practices of the participating agencies is confined to those benefits which constitute the major portion of the benefits measured; namely, benefits from the prevention of loss and from the increase in production made possible by a project, measured directly on an average annual monetary basis. The comparison does not include consideration of the effects of differences in treatment of deferred benefits and of other differences, all of which have various effects on total benefit estimates. Consideration of these effects would unnecessarily complicate the illustration of the differences which are usually most important. Exclusive of these complicating factors, the effect of the differing practices of the participating agencies as applied to the average annual benefits may be summarized as follows:

(a) In the measurement of benefits from the prevention of flood damage and from watershed improvement programs, the practices followed by all participating agencies except the Department of the Interior give essentially similar results. The practice of the Department of the Interior because of the use of a base price level which is currently about one-half of the 1948 price level, results in a calculated benefit approximately one-half that of the other agencies.

(b) Benefits from irrigation usually are measured only by the Department of the Interior and the Corps of Engineers. The practice of the Department of the Interior in measuring direct and indirect benefits in terms of contributions to national income results in benefit estimates which would be appreciably greater than estimates of the Corps of Engineers if computed on the same price basis.

(c) Power benefits are measured by all agencies except the Department of Agriculture. The practices of the Federal Power Commission and the Corps of Engineers give substantially the same results. The practice of the Department of the Interior of including more of the remote effects of increased power production results in estimates currently about two-thirds greater than those of other agencies.

(d) Benefits to navigation are usually measured only by the Corps of Engineers.

(e) The relatively minor differences in the measurement practices for other benefits, such as water supply, sedimentation control, pollution abatement, etc., do not usually result in appreciable differences in project benefit estimates.

11. *General basis for measuring costs.*—There is less variation in the practices of the participating agencies for measuring costs than in the practices for measuring benefits. The project costs measured by each agency include, in general, all expenditures by the Federal government and by other agencies and individuals participating in the establishment, maintenance and operation of the project. All agencies express these costs on an average annual basis to permit comparison with benefits expressed on that basis. Since each agency includes substantially the same items in its estimates of initial project cost and uses current price levels in making the estimates, there is relatively little difference in the results of the respective practices on initial cost estimates. Important differences result, however, from the practices used for expressing costs on an average annual basis as discussed in paragraphs 14 to 20 below.

12. The costs other than project costs necessary for realization of project benefits are accounted for by all agencies by deduction from total benefits. As explained in paragraph 9 above, the Department of the Interior practice of including the wages, interest, and other income components of nonproject cost items in total benefits results in appreciable differences in benefit estimates but does not affect the estimates of project costs.

13. The project costs measured by all agencies as described above include relatively few of the more remote or indirect costs which may result from the project as, for example, the loss of scenic or historic values, resettlement costs and other costs usually designated as "consequential damages." In general as stated in the qualitative report the agencies have made less progress toward considering costs by whomsoever they may be incurred than they have in considering benefits to whomsoever they may accrue.

14. *Period of analysis for calculating annual costs.*—All agencies consider that the period of analysis to be used for calculating the annual costs of a project should be not greater than the estimated economic life of the project, but there are significant differences in the period of analysis selected by the several agencies under this fundamental concept. The Corps of Engineers and the Federal Power Commission have placed a maximum limit of 50 years on the period of analysis. These agencies recognize that the projects involved may endure physically and, in many cases, economically beyond 50 years, but they apply the

limit as a means of allowing for the uncertainty of predicting future conditions and events including possible changes in technology beyond a period of 50 years. The Department of the Interior places a maximum limit on the period of analysis of 100 years and, in cases where the expected life is longer, makes allowance for salvage or remaining use value beyond a hundred years up to a maximum of 150 years total life. The Department of Agriculture uses a perpetual life basis on the assumption that the future requirements for watershed treatment programs will increase and that there is need for maintaining each program in perpetuity.

15. *Annual charges for interest and amortization.*—All agencies include in the estimate of annual costs an item for interest on the initial investment. The rates used vary from 2 to 3 percent on Federal investments. Each agency uses the same rate on Federal and non-Federal investments except that the Corps of Engineers uses a rate of 3½ percent on the non-Federal investment in its projects. These interest rates and the different periods of analysis selected by the several agencies result in wide variations in the annual charges for interest and amortization. These charges are illustrated for certain conditions in table 3 following paragraph 20. For the Department of Agriculture, the total charge is the interest charge of 2 percent since there is no sinking fund charge on the assumed perpetual life basis. The charge for interest and amortization of the Federal investment on Corps of Engineers projects amounts to 3.89 percent. These charges for the Department of the Interior (2.73 percent) and the Federal Power Commission (3.53 percent) lie between the two extremes.

16. *Effect of salvage allowances on costs.*—The amount of annual charges for interest and amortization is also affected by the respective agency practices on allowance for salvage or estimated remaining useful life as of the end of the selected period of analysis. Such allowances are not applicable under the Department of Agriculture's perpetual life assumption. The Federal Power Commission makes no allowance for salvage or remaining useful life. The Corps of Engineers usually makes no allowance insofar as structures are concerned but assumes that the land could revert to its original uses and charges interest but does not amortize the investment in land. The Department of the Interior allows for salvage value of land by a different method which gives the same result as obtained by the Corps of Engineers and, in addition, allows in some cases for as much as 50 years remaining useful life of equipment and structures beyond the maximum 100-year period of analysis. The effect of the differences in salvage allowances on total annual charges is relatively small.

17. *Operation and maintenance costs.*—Operation and maintenance charges as estimated by the several agencies are difficult to compare. In general, they appear to be on consistent bases but in amount they vary over a wide range due to the great variation in project conditions encountered. The only major point of difference in current practice is that the Department of the Interior uses a selected historical base level of prices in estimating its operation and maintenance costs whereas all other agencies use prices prevailing at the time of the analysis.

18. *Costs for major replacements.*—The methods used by the several agencies for calculating annual charges to cover the cost of major replacement varies considerably but the net results obtained by the several methods do not affect total annual charges appreciably.

19. *Miscellaneous costs.*—Only two agencies include items other than those listed above in their estimates of annual charges. The Corps of Engineers makes an allowance, usually small in relation to total annual charges, for the net loss of taxes to local taxing agencies due to the transfer of lands to Federal ownership. The Federal Power Commission, however, makes an appreciable allowance (averaging about 1.52 percent of the investment costs) in its annual charges in lieu of insurance and state and local taxes that would be paid if the project were privately owned.

20. *Summary of annual charges.*—The effect of the foregoing procedures is illustrated in table 3 below for a hypothetical project condition which is similar for all agencies.

TABLE 3.—*Annual charges for a given hypothetical project condition*

Amounts may be read either as percentages or as dollars with relation to an initial Federal investment of 100]

Item	Corps of Engineers	Department of Agriculture	Department of the Interior	Federal Power Commission
Investment in land.....	30	30	30	30
Investment in project works.....	70	70	70	70
Total initial investment ¹	100	100	100	100
Period of analysis in years (maximum for each agency is used).....	50	(²)	100	50
Annual charges other than operation and maintenance: ³				
Interest.....	3.00	2.00	2.50	2.50
Sinking fund charge.....	.89	0	.23	1.03
Major replacements.....	.48	1.01	.52	.60
Miscellaneous.....	Small	None	None	1.52
Gross annual charges (excluding operation and maintenance) ⁴	4.37	3.01	3.25	5.65
Deductions to allow for remaining use value:				
(a) Land.....	.22	0	.07	0
(b) Project works.....	0	0	.05	0
Net annual charges (excluding operation and maintenance) ⁴	4.15	3.01	3.13	5.65

¹ Differences in items which would be included in the initial investment by the several agencies and differences in allowances for interest during construction are assumed to be minor and have been neglected.

² Operation and maintenance charges vary widely for the various types of projects under the jurisdiction of the several agencies and have, therefore, not been included.

³ Perpetuity.

⁴ Maximum allowance of 50 years beyond period of analysis assumed. (See par. 16.)