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AN INVESTIGATION OF THE EMPLOYMENT OF MULTIPLE
OBJECTIVES IN WATER RESOURCES PLANNING

BY

ROBERT REHM WERNER

A Thesis submitted in
partial fulfillment of the requirements for the degree
Doctor of Philosophy,
Major in Agricultural Economics,
South Dakota State University

1968

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AN INVESTIGATION OF THE EMPLOYMENT OF MULTIPLE
OBJECTIVES IN WATER RESOURCES PLANNING

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Doctor of Philosophy, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Chairman,

Head, Economics Department

Date

2661

AN INVESTIGATION OF THE EMPLOYMENT OF MULTIPLE
OBJECTIVES IN WATER RESOURCES PLANNING
Abstract

ROBERT REHM WERNER

Under the supervision of Professor Arthur J. Matson

A number of objectives in water resources development have been identified historically, but planning practice has adhered most closely to economic efficiency. A question of growing concern is whether or not the conscious inclusion of multiple objectives simultaneously in water resources planning can result in the formulation of plans closer to an optimum in the satisfaction of peoples' total desires than does a plan which optimizes the objective of economic efficiency or other single objective.

The purpose of this study was to determine if the explicit employment of multiple objectives in water resources planning represents a strengthening of capability to plan for the accommodation of demands for water among competing interests. This involved determination of (1) the theoretical implications of employing multiple objectives; (2) the degree to which the employment of multiple objectives is compatible with quantitative analysis; and (3) the adequacy of the existing institutional structure to administer multiple objective planning.

Current evaluation procedures were found to support the economic efficiency planning objective, but not consider the income redistributive effects of a resource allocation. Nationally, the aggregate effect is small, but on a project basis the distributional effects can

be significant on the people in the affected area. The effects of water resources development on the environment also appear significant and appropriately evaluated as a dimension of welfare. Income redistribution, environmental quality and other planning objectives were conceived to provide a better approximation of the welfare considerations of a resource allocation than can be gained from a single objective. Together appropriate planning objectives give a breadth of choice in making decisions concerning the water resource.

The contemporary planning efforts in the Susquehanna River Basin Study were reviewed as an attempt to employ a multiple-objective approach to planning through the preparation of separate plans responsive to each of the planning objectives of economic efficiency, environmental quality and regional development. Particular difficulties were noted to be encountered in the identification and quantification of benefits for the objectives other than economic efficiency. Criteria for the selection of features from the individual plans to be recommended as the basin plan by the study coordination group were observed to also be difficult to define. The coordination group had not reached agreement concerning the degree of detail to be presented to policy makers and the public; other institutional barriers were also recognized. In reporting on the attempt by the Susquehanna River Basin Study to formulate plans responsive to several objectives, a dialogue on the practical value of multiple-objective planning has been opened.

This study in applied economics provides a rationale for an advance in approach to water resources planning employing multiple objectives. It places in perspective the alternative objectives of

planning and conceptualizes and rationalizes their inclusion in formal plan formulation. Objectives relate goals of people and the purposes served by water use and development and were found, on theoretical grounds, to provide additional dimensions to welfare. A multiple-objective framework attempts to make costs explicit including the opportunity costs of foreclosed alternatives. Wider range of choice is promoted. This study provides a workable rationale to improve the basis for decision making in water resources planning.

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Errors are my own responsibility.

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CHAPTER I

INTRODUCTION

This study is an attempt to evaluate the effectiveness of planning for public water resources development in which multiple objectives are given explicit consideration. Planning has largely been oriented to resources allocation that would contribute to national income, although a number of historical objectives have been identified in the development of water resources in the United States.

Statement of the Problem

Public water development is in contrast with private water development in the objectives considered in planning. Fox has said, "Unlike private water development in which market considerations have always been uppermost, public development programs have major aims in addition to those of economic efficiency."¹

A concern attracting growing attention is whether or not the simultaneous inclusion of multiple objectives in water resources planning can result in the formulation of plans closer to an optimum in the satisfaction of people's total desires than a plan which optimizes an objective of economic efficiency or other single objective.

¹Irving K. Fox in an address to a joint meeting of the Columbia Basin and Missouri Basin Interagency Committees, June 1963. Resources, No. 16 (May 1964).

Many people are concerned with water and people use water for many purposes. Individuals, industry, states and the federal government, acting broadly for the people under various clauses of the Constitution, have diversified interests in water and seek to achieve numerous objectives through its use. The water problem is sufficiently complicated to make it difficult to determine how the available supplies of water might be utilized to best serve the interests and needs of all the people.

There are many aspects of the water problem. Water is essential to man's life and livelihood. Where water is plentiful in relation to the amount utilized by man, it is often treated as though it were free. More frequently, water is subject to conflicting demands. Legal and economic concepts of ownership of water or the right to use water in this country are complex. Water may be considered wholly or partially in public ownership depending upon the state in which its legal status is being determined. No market has been found adequate for the resolution of the competing interests in water.

Extensive interest, lack of adequate markets and involved ownership and regulation make water problems important. Other aspects intensify the problem. Measures can be taken to alter the flow of water. These measures have significant costs to an individual, an industry, or some unit of government. Some measures, such as dams, are sufficiently long-lived to make marked changes in a landscape, an ecology, and an environment. In any case, measures that are beneficial for some people may have adverse impacts on others.

Water is not a matter of only parochial concern. Removal of water from a stream or serious pollution may present problems to a municipality four hundred miles and twenty days flow time away. Water is transferred from basin to basin and across the Continental Divide.

Water has occupied a prominent position in programs of the federal government. Policies to open new territory and unify parts of a new country utilized the water resource. Later programs to encourage settlement on western lands and more recent efforts to stimulate economic development in certain other regions of the country have considered the water resource. These and other manifestations of public interest have suggested objectives for water resources development.

Because of the geographic extent, and the far-reaching economic, social and environmental consequences of water problem solutions, wide participation is often desirable in the consideration of the problems and the alternative means available for their solution.

The ability to consider water interests and demands, present and projected, and to plan for their accommodation evolves gradually. This study will examine and evaluate steps toward strengthening the capability to plan for the accommodation of demands for water among competing interests.

Objectives

The central objective of this study is to determine if the explicit employment of multiple objectives in water resources planning

represents a strengthening of capability to identify and consider varied interests and to accommodate diverse demands on water resources use.

The objective has not been subjected to rigorous testing in the past or at the present time. And yet the concept of multiple-objective planning appears to have both immediate and continuing value in the water resources field. This study is structured to discover elements of evidence in drawing conclusions regarding the usefulness of the concept. The specific objectives of this study are:

1. To determine under what conditions the use of multiple objectives in water resources planning can be considered valid in terms of economic theory;
2. To determine if use of multiple objectives in water resources planning can be supported by meaningful and adequate analysis;
3. To determine if in terms of the existing structure for water resources planning, the use of multiple objectives is institutionally operable.

Report Procedure

The initial chapter of this report has introduced the extensive nature of the water resources allocation and management problem. The second chapter takes up the context within which major water resources planning takes place. In examining the historical basis for national interest in water resources, emphasis is placed on the role of objectives in planning. The intent here is to relate planning needs to

national and regional goals. An understanding of the part played by objectives in planning is facilitated when the role of the planner is discussed and the model employed in current comprehensive basin planning is described. The chapter is concluded with an appraisal of the significance of planning in resource allocation.

In Chapter III the problem of objectives in planning is explored. Economic theory is examined as it might relate to the concept of employing objectives in planning. The intent is to ascertain the theoretical implications of the concept. The concept is then expanded as it applies to alternatives in resource allocation.

In Chapter IV the various objectives and alternatives employed in planning are discussed. Problems in employing multiple objectives in planning situations are identified and difficulties anticipated.

Chapter V is an in-process review of the Susquehanna Comprehensive River Basin Study. The Susquehanna Study employed a multiple-objective approach to planning. The background for the study, the region and its problems and the organization used for planning are explained. The introduction and evolution of the multiple-objective concept is traced from empirical data. As the employment of multiple objectives is described, the empirical evidence is examined in terms of concepts discussed in Chapter III. One purpose is to determine the degree to which logical and adequate quantitative analysis within the multiple-objective concept is possible. A second purpose is to search for indications regarding the administrative adequacy of the planning structure to accommodate multiple-objective planning. The

concept of multiple objectives in planning is not proven useful unless decision making leading to best use of the water resource for the well-being of all people is facilitated. In this sense, methods of analysis and decision making are examined from the available empirical evidence.

In the final chapter, findings are examined for evidence of the success and failure elements of multiple-objective planning in concept and practice. Conclusions are drawn regarding the value of the concept in strengthening water resources planning capabilities. Appropriate further research is recommended.

CHAPTER II

THE PLANNING CONTEXT

National interest in water resources development has broadened historically from spot interest in harbor improvements to programs for entire river basins. River basin plans can influence resource allocation and affect the development of large regions. This is the planning context in which multiple-objective planning, if useful, would be employed.

Water Resources Development and the National Interest

The value of the water resource became recognized in policy early by the United States.¹ Federal interest was evident when the first Congress enacted the first water resources act for harbor improvement on August 7, 1789.²

The first major planning effort involving water resources use came about in 1807 after several years of contention concerning federal participation and cost sharing in "internal improvements"--specifically the Chesapeake and Delaware Canal and a canal around the falls of the

¹An excellent description of the water resource and its use in a developing hypothetical valley is contained in John Krutilla and Otto Eckstein, Multiple Purpose River Development (Baltimore: The Johns Hopkins Press for Resources for the Future, 1958), pp. 4-8.

²For an excellent short history of congressional activity in water resources legislation see "The Role of Congress in Water Resources Development," paper presented by Senator Spessard Holland before the National Rivers and Harbors Congress, June 1, 1967. The Congressional Record, June 5, 1967, p. S2643.

Ohio River near Louisville. The Senate, on March 2, 1807, passed a resolution authorizing the Secretary of the Treasury, Albert Gallatin, to prepare a study on the development of routes of communication.³ Gallatin's report was a comprehensive plan for canals and improved waterways extending to the Mississippi and Missouri Rivers. The plan cited objectives of economic development and furthering political unity. The plan proposed an economic efficiency justification:

. . . whenever the annual expense of transportation on a certain route in its natural state exceeds the interest on the capital employed in improving the communication, and the annual expense of transportation . . . by the improved route, the difference is an annual additional income to the nation.⁴

The plan was national in scope and sought to develop and exploit the agriculture, industry and commerce of the Midwest by providing means for long-distance bulk commodity transport. One authority has observed that the Waterways Plan was used by the states and the federal government with periodic revision as late as 1907 by the Inland Waterways Commission.⁵ There was no immediate implementation of the plan, however, in part because the basis for federal participation in such work was not well established at that time, partly because the concept

³Ibid.

⁴The "Gallatin Report," as it is usually called, was entitled "The Secretary of the Treasury, in obedience to the resolution of the Senate of the 2d March 1807 respectfully submits the following report on roads and canals . . . " and was presented to the Senate on April 4, 1808.

⁵Henry P. Caulfield, Jr., "The Why and the How of Comprehensive River Basin Planning" (Remarks made before the Annual Convention of the National Reclamation Association, Albuquerque, New Mexico, November 17, 1966), p. 6.

was in advance of its time, and largely, perhaps, because the estimated cost of \$20,000,000 seemed "astronomical."⁶

Many persons believed that waterway improvements were essential to the development of the country. Various canal ventures were undertaken by state and private interests as early as 1784 and possibly even before. Failures were common.⁷ But interest in navigation and inland waterway improvement persisted and was stimulated by the advent of the steamboat.

In a landmark case, involving the assignment of navigation rights by a state to a private party,⁸ the Supreme Court, in reviewing Gibbons v. Ogden, related navigation to transportation which was seen to come under the Commerce Clause of the Federal Constitution.⁹ Rivers were regarded as highways for commerce and, for that purpose, the public property of the nation. Federal interest in inland navigation was established and the federal government had entered the water resources development business. "Navigation improvements" have received annual appropriations since 1824.¹⁰

The objective in this case was the best use of resources--the

⁶"The Role of Congress," op. cit., p. S7643.

⁷George Washington was an investor in the Powtownmack Canal and supervised its construction from 1785 to 1788 when he was elected President. Although the canal was in use for about 30 years, it was not a money making venture. See article by Jean Geddes in The Washington Post, May 9, 1968, p. G10.

⁸Gibbons v. Ogden, 17 Johns. 488 (N.Y. 1820).

⁹Wheat. 1, 197 (U.S. 1824).

¹⁰"The Role of Congress," op. cit., p. S7643.

water resources through navigation improvements--to facilitate national economic development.

The economic growth aspect of federal interest in water resources continued to be evident in the Swamp Lands Acts of 1849 and 1850 when unsold swamp and overflowed lands were granted by Congress to Mississippi River States. The intent was that the states could sell the grants and use the proceeds for drainage, flood control and reclamation. John C. Calhoun, Henry Clay and others had long been pressing for extension of the federal interest in "internal improvements" as such matters were termed. In 1850, also, the first comprehensive study of the Mississippi River was authorized.¹¹

According to Caulfield, development was established as the "central thrust" of national policy for water as well as the other natural resources.¹² Development of all regions of the nation and economic growth were critical to the young nation. This goal has persisted to the present day. Other aims or objectives have also evolved over the years. These aims or objectives refer to what can be achieved or furthered by use of the resource. The Congress, thinking in terms of certain national objectives, has, from time to time, authorized certain types of water resources utilization or development to further those objectives. The manner in which the resource is utilized is generally termed the "purpose," as in project purpose or planning

¹¹ Ibid.

¹² Caulfield, op. cit., p. 1.

purpose. Congressional action is based on some authority assigned to the Congress by the Constitution. It was noted above that inland waterway improvements by the federal government awaited a Supreme Court decision that clarified federal interest and authorities. Clarification of federal interest and authority takes time when Congressional concern is coupled with court action.

Based on a number of court actions the Commerce powers of the federal government were extended, over the years, to federal intervention for flood protection, watershed development and hydropower, although the Proprietary Powers are also involved in the latter case.¹³ For each of these project purposes the prime objective appeared to be economic development through more efficient resource allocation or the avoidance of national income losses from flood damages.

The objective of national defense has been mentioned from time to time in connection with resource allocation. Perhaps the first time the War Powers of the Congress¹⁴ were involved for water resources development was in the case of Wilson Dam at Muscle Shoals on the Tennessee River. The purpose was the development of hydropower, in this instance for nitrate production during World War I.¹⁵ National

¹³U.S., Report of the President's Water Resources Policy Commission, Vol. 3, Water Resources Law (Washington: Government Printing Office, 1950), p. 70.

¹⁴U.S., Constitution, Art. 1, secs. 8 and 9.

¹⁵For further discussion see Frank J. Trelease, "Federal Jurisdiction Over Water in the Eastern United States," Papers delivered at the Water Rights Conference, Cooperative Extension Service, Agricultural Experiment Station, College of Agriculture, Michigan State University (March 1960), pp. 9-10.

defense as an objective does not appear to have been cited frequently, but often appears to be a subsidiary consideration in what may be proposed or in regard to the manner in which a project might be accomplished.

Authority for irrigation as a project purpose stemmed from the Property Clause of the Constitution which gives the federal government exclusive control over federal lands.¹⁶ The objectives of the Congress appear to have been several in the case of the Reclamation Act of 1902. National economic development appears to be one, regional development another, and some concern for income redistribution in favor of a class of people, farmers, may have been another.¹⁷

Other objectives of public investment in water resources have been identified by Fox.¹⁸ He cited stimulation and competition for private industry--as canals to railroads and public to private power--and assistance to depressed areas of the country as in Appalachia. President Lyndon B. Johnson spoke of the quality of the environment as another objective.¹⁹

During a history of nearly two hundred years the federal

¹⁶U.S., Constitution, Art. IV, sec. 3, cl. 2.

¹⁷167 Fed. at 883-884 and 885.

¹⁸Irving K. Fox in an address to a joint meeting of the Columbia and Missouri Basin Interagency Committees, June 1963. Resources, No. 16 (May 1964).

¹⁹U.S., President's Message to the Congress on Natural Beauty, "To Renew a Nation" (March 8, 1968).

government and the states have extended their interests into several aspects of the development and use of the water resource. Certain objectives have been identified. The constitutional basis for federal participation in planning and development became established and statutory authority for federal activity has continued to grow.

"Wise use," "all uses," "best use" and "multiple-purpose" are all terms that have come to be used in connection with the water resource. It became evident that water had value in a number of uses and that there were insufficient quantities of the resource to satisfy the demands of all uses and users.

In the early history of the United States, water appeared as a free good. Anyone seemed able to use all the water he wanted and for almost any purpose without effort or cost and without economic consequence to anyone else. Although there seems to have been a tendency to treat water as a free good through much of United States history--and this tendency might explain a number of water problems at the present stage of development--competing demands gradually changed the resource from one to be exploited to one to be conserved. Historically treating water as a free good explains, in part, the evolution of external effects--the use of water resources in such a manner as to produce an economic effect on other uses without due compensation.

In the early history of this country, external effects, where recognized, were likely to be treated as of lesser order than national growth. Water was a resource to be exploited to facilitate economic

development. One hundred fifty years later, concern for ample supplies of good quality water contributed to the establishment of the Senate Select Committee on Water Resources and stimulated the implementation of its recommendations.²⁰

From the Senate Select Committee recommendations have come the Water Resources Council, which serves as the focal point for the coordination of the federal executive agencies that have been established and authorized to carry out the will of the President and the Congress in the water resources field;²¹ Senate Document 97 which sets forth policies, standards and procedures for federal participation in water resources development;²² and a nationwide coordinated water resources planning program.

A less tangible result of the efforts of the Senate Select Committee and the implementation of their recommendations may have been an increased appreciation of the value of the water resource. Rather than a shortage of supplies of water, the nation may have been in need of better planning for, and management of, water use. In Senate Document 97, "best use" of the water resource for the "well-

²⁰U.S., Report of the Senate Committee on National Water Resources, Report No. 29 (Washington: Government Printing Office, 1961), pp. v, 17-19.

²¹Created under Title I of the Water Resources Planning Act of 1965, 79 Stat. 244.

²²U.S., President's Water Resources Council, Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, printed as Senate Document 97 (Washington: Government Printing Office, 1962).

being of all the people" became the prime criterion in water resources development.²³ Such a criterion seems to be explicit recognition that water planning and use should be responsive to the general welfare of the nation as interpreted at a given time in terms of the ability of the people to conceive, accept and implement proposals. With the multiplicity of objectives, however, it became increasingly difficult to determine what should be done, when, why, what is the best use or how the general welfare is best furthered.

Water Resources Planning

The planning function brings together what is desired, the objectives, and what is possible, the many and varied uses of water. Conventionally, the role of the planner is to measure the resource available; determine the demand schedules over some time period for the various goods and services that may be produced; suggest a scheme or strategy by which resources might best accommodate the various demand schedules; and accomplish this in accordance with objectives, statutory authorizations, constraints, and other guidance.²⁴

The planner has knowledge of the physical nature of the problem. He understands relationships between the land, the atmosphere and water flow. With reasonable precision he can predict how much water a river basin will yield and how the flow will fluctuate. He also

²³Ibid., pp. 1-2.

²⁴Senate Document 97 op. cit. explains many aspects of water resources planning.

estimates the quantity and cost of goods and services to be produced. The array of goods and services that can be produced, expressed in efficient relationships of outputs to inputs, is termed a production function. In this sense the planner specifies the most economical combination of inputs to produce a given output, or the maximum output from a given combination of inputs. The production function can be drawn after simplifying assumptions are made pertaining to what factors are considered fixed and variable. In project design, the engineer assumes a given level of technology; the planner, in looking to the future, anticipates possible changes in the production function as technological innovations are adopted.

In addition to physical production possibilities, there is the problem of economic feasibility. The planner observes the various demands for the goods and services. He estimates the quantity, assortment and schedule of production for goods and services. If a market exists for the products, the estimates are more reliable than if projections are employed to estimate the requirements at several future time horizons.

The water resources planner is given guidance by the President and the Congress in the form of laws, policies and procedures relating to objectives to be achieved. The planner may also be provided with guidance as to availabilities, as the division of water between states or the minimum flows that must be maintained; priorities, as to water rights taking precedence over others or the needs to be satisfied before others are recognized; and constraints, as to water uses that

are not permitted or the geographical area beyond which he may not internalize solutions. With this guidance, the planner can state objectives in terms of an objective function. He can select through comparison of alternative assortments of goods and services the most desirable assortment. The efficient arrangements of goods and services are defined by the production function.

The means by which the planner proposes to supply an optimum mix of goods and services in response to certain demand schedules at various times in the future, guided by an objective function, and constrained by a production function, is a plan.

The planning process is not complete at this stage, however. The plan is likely to undergo scrutiny, and possibly modifications as a result of this scrutiny, by those who employed the planner, those who would be affected by the plan and those who would pay for the implementation of the plan. This series of reviews and modifications is sometimes termed the political or decision-making process.

Descriptive Model for River Basin Planning

Large-scale water resources planning is appropriately accomplished at the level of the river basin. Water problems and solutions come closer to being internalized--fewer elements need be considered external or exogenous to the problem area--in a basin than they do in smaller areas. The basin also permits a systems approach, particularly

to the solution of downstream problems.²⁵ River basin planning is currently practiced in a program of comprehensive water resources studies being accomplished under the aegis of the Water Resources Council.²⁶

The procedure is described in the following paragraphs.

River Basin Planning is a joint effort by the federal agencies with responsibilities in water resources development and the states represented in the particular basins involved.²⁷ The Congress approves a study budget submitted by the study participants and appropriates funds to support the participation by the federal agencies. The extent of state involvement varies with interest, staff capability and funding within the states. The studies are managed through a coordination group with a federal member usually designated as the chairman, and members named by the State Governors and the Secretaries of the federal agencies participating. The coordination group usually meets three or four times a year and the meetings may be open to the

²⁵

Excellent background on the concepts and practice of comprehensive river basin planning is provided by Howard L. Cook, "River Basin Planning as a Fundamental Concept" (Introductory Paper, Session on Stream Basin Planning, Fiftieth Annual Meeting of the American Society of Agricultural Engineers, June 1957); Russell Morgan, "Water Resources Planning in the Delaware River Basin" (Office of Chief of Engineers, U.S. Army, Washington, undated). (Mimeographed.); William A. Green and Richard R. Howes, "Economic Aspects of Comprehensive River Basin Planning," Proceedings of the Tenth Annual Conference on Water for Texas (College Station, Texas: Texas A&M University, 1965); and the remarks of Henry Caulfield previously cited.

²⁶

For a description of the program, see U.S., Water Resources Council, Background Material Regarding Comprehensive Planning Program for Use by the Water Resources Council Member Agencies in Preparing Testimony for Appropriations Hearings (Washington, March 1, 1967).

²⁷

Ibid., p. 2.

public. The basin planning studies usually take four to six years to complete and costs of such studies are from one to five million dollars depending on the size and complexity of the basin.

Objectives

Senate Document 97 establishes a broad perspective within which the planning may take place.

The basic objective in the formulation of plans is to provide the best use, or combination of uses of water and related land resources to meet all foreseeable short and long term needs.

.....

Well-being of all of the people shall be the overriding determinant in considering the best use of water and related land resources.²⁸

Development, national and regional, and preservation, proper stewardship of the nation's natural resources, are also cited as objectives in Senate Document 97. In terms of the general objectives, no use of the water and related land resource is excluded in considering needs. All known feasible means of meeting each need may also be considered.

Points of View

The planning is intended to reflect points of view of all interested parties. Senate Document 97 states, "All viewpoints--national, regional, state and local--shall be fully considered and taken into account in planning resource use and development."²⁹

²⁸Senate Document 97, op. cit., pp. 1-2.

²⁹Ibid., p. 3.

National viewpoint is presented by the federal agencies participating in the studies and through review procedures. State viewpoints are presented by the representatives named by the governors on the coordination groups. Local and non-governmental participation is through the state members on the coordination group. Local and non-governmental viewpoints may also be presented directly at open coordination meetings and at public hearings held at the beginning, sometimes during, and at the completion of the studies.

Scope

While the boundary of a river basin for study purposes is that of the watershed, pertinent physical, economic and social factors outside the basin are also to be considered.³⁰ The basin or watershed boundary is selected as convenient for planning because the resource can be treated in a systems approach to the solution of basin problems. The basin is violated in real life activity and care must be taken to avoid unreal assumptions in basin planning. For instance, water is sometimes transferred to or from the basin; economic activity in general is no respecter of the basin boundaries; supply and demand areas may only occasionally coincide with the basin boundaries; state concerns extend beyond the basin.

Planning Detail

Each river basin plan is formulated with intent to provide a general plan of development to meet the needs of the people of the

³⁰Ibid.

basin to the year 2020.³¹ Recommendations for authorization are made for those features included and considered necessary before 1985. Requests for project authorization based on the plan are submitted by the individual action agencies and states.³²

Study Organization

River basin studies follow a common basic organization of the planning effort.³³

Step 1. Physical data relevant to the problem are gathered. Hydrologic projections of water quality and quantity are made; mineral, forest and land resource availability are determined; potential reservoir sites are located; recreation and natural areas of value are identified.

Step 2. A study is made of the economic base of the area. Projections of population and economic development are made for the years 1980, 2000 and 2020.

Step 3. The economic projections are translated into demands, or "needs" as they are often termed in planning, for goods and services related to the water resource. Net needs are then calculated taking

³¹Projections are made for planning horizons of 1980, 2000 and 2020; see U.S., Water Resources Council, Economic and Statistical Analysis and Projections for Comprehensive River Basin Studies (Washington, March 6, 1964).

³²For administrative procedures see U.S., Water Resources Council, Guidelines for Submission and Review of Coordinated Comprehensive (type II) River Basin Reports (Washington, May 17, 1967).

³³For further discussion of the usual planning steps see Caulfield, op. cit., pp. 18-20.

into account needs being met by existing projects or work already authorized.

Step 4. Net needs or demands are considered in terms of the objective function in relation to the availability of the resources as described by the production function, and a plan or plans are formulated. Projects or other solutions are recommended if required in the next ten to fifteen-year period. General approaches or strategies are recommended to meet problems beyond the fifteen-year planning horizon. Alternative solutions may be offered.

Review and Processing

The plan as developed by the coordination group is presented to the people of the basin at a public hearing, and possibly revised as a result of objections and suggestions received. It is also reviewed by the Governor of each state concerned and the head of each interested federal agency. Finally, the plan, with federal comments coordinated by the Water Resources Council, is sent to the President with recommendations that it be passed to the Congress.³⁴ The Congress presumably consults the plan in making decisions with regard to appropriations for features or projects requested within the basin.

The Significance of Water Resources Planning

Plans following a model similar to that described in the

³⁴U.S., Water Resources Council, Guidelines, op. cit.

previous section were prepared for the Delaware and Potomac River Basins.³⁵ In the case of the Delaware Basin, the plan is in process of implementation.

In the case of the Potomac Basin, plans prepared in 1953 and 1963 were opposed by some of the inhabitants of the basin. No plan was implemented. Opposition stemmed in part from a failure to sufficiently explore alternatives for meeting basin needs.³⁶

Plans employing less elaborate models have significantly affected the development of many regions of the country. The canalization of the Ohio River, the Pick-Sloan Plan on the Missouri River, the series of hydro-power dams on the Columbia and the Mississippi River Flood Control Project are but a few. These plans had engineering feasibility in common and they were implemented. Whether all pertinent alternatives were considered or whether these were the best plans that could be devised is problematical.

Other major plans have been delayed because at either the regional or national level support for the resource allocation they proposed was lacking.

In these and other cases, pause is occasioned by the essentially irrevocable commitment of resources that implementation represents.

³⁵U.S., Corps of Engineers, Potomac River Basin Report (U.S. Army Engineer District, Baltimore, February 1963); and U.S., Corps of Engineers, Delaware River Basin Report (U.S. Army Engineer District, Philadelphia, May 1961).

³⁶For discussion, see Robert K. Davis, The Range of Choice in Water Resource Management: A Study of the Potomac Estuary (Washington: Resources for the Future, Inc., 1968).

Dams in a lifespan may be considered permanent. The changes in the ecology wrought by a major impoundment are profound. Not only are natural values changed but cultural changes are made and the way of life for people can be altered.

Approaching the problem from the opposite direction, development in the absence of a plan can result in courses of action that few persons in the basin care to accept were preferences to be polled.³⁷ Resources can be committed inefficiently on a piecemeal basis, as noted by Krutilla.³⁸ One at a time, ten lakes could be committed to general boating use if voted upon separately and the majority ruled. Taken as a system, a majority of people might have preferred to have eight lakes committed to general boating with two reserved for sailboats and canoes only. The illustration serves the point that piecemeal commitment of resources may result in solutions less satisfactory than where alternative courses of action are considered in advance.

One final and practical illustration of unplanned development is that of the Connecticut River. Settled early in the nation's water history, the river is dotted by numerous private power dams that are

³⁷ For example, Alfred Kahn in his article, "The Tyranny of Small Decision: Market Failures, Imperfections, and the Limits of Economics," *Kyklos*, Vol. XIX, Fasc. 1 (1966), p. 24, shows how the consumer can be victimized by the narrowness of the context within which he exercises his sovereignty: if one hundred small decisions (100 x) cause X to occur, the result might have been different had X been presented for direct consideration.

³⁸ John V. Krutilla, "Environmental Effects of Economic Development," *Daedalus* (Fall 1967), p. 1067.

currently operated for peaking power. The river is operated as though controlled by valves opened and closed at various times of the day and shut completely over the weekend. The result is a difficult-to-handle water quality problem and the use of a river below its recreational potential.³⁹

A plan is not the entire solution to the problems of a basin. But a plan appears necessary, even if not sufficient, to determine the best use of the water resource. In the absence of a plan, diverse groups such as municipalities, industry, nature enthusiasts and private speculators, influence water use to meet their own interests. Decisions are made on a piecemeal basis and not necessarily in the interests of all water users. A plan prepared in accordance with a well conceived planning model could be important to the inhabitants of a basin. At a point in time the interests of all those concerned with water in a basin can be focused on planning objectives, alternatives in water use, and relevant costs. Optimum allocation of the water resource in the interests and the well-being of the people of the region becomes a real possibility.

³⁹Notes made by author, Plan Formulation Workshop, Office of Chief of Engineers, U.S. Army, Washington, December 14, 15, 1967.

CHAPTER III

THE ECONOMIC PROBLEM OF OBJECTIVES IN PLANNING

Broad areas of choice remain open to this country regarding how, when and where and in what proportions with other factors of production the water resources will be utilized. The objectives of a nation or an industry or an individual are assumed to dominate behavioral decisions.

Economic Theory and Objectives in Planning

Economic theory has provided the conceptual model that has been the basis for much official guidance for water resources planners.¹ Senate Document 97 as well as earlier guidance was based on concepts of efficient resource allocation taken from welfare economics. Senate Document 97 spoke in terms of "best use" as the basic objective of water resources planning. And "best use" was thought to be determined by the "well-being of all the people."² The terms "best use" and "well-being" were not defined but some observers have contended that in practice planning has tended to be concerned primarily with economic efficiency as an objective--a narrower construct than what might be inferred from the broader though undefined prescriptions of Senate

¹For further explanation, see Allen V. Kneese, "Economic and Related Problems in Contemporary Water Resources Management," Natural Resources Journal (October 1965), p. 3.

²U.S., President's Water Resources Council, Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, printed as Senate Document 97 (Washington: Government Printing Office, 1962), pp. 2-3.

Document 97. The broader views of Senate Document 97 do not seem to be given equal consideration.³

The criticism of single objective planning in spite of the philosophical approval from Senate Document 97 to consider all uses and effects of water has encouraged proposals for the consideration of multiple objectives in planning. Implicit in the proposition that there are a number of objectives that should be considered in water resources planning is that no one objective adequately corresponds to the goal of "best use" or "well-being" or the general welfare. An investigation of economic theory explains the divergence between the intentions expressed in Senate Document 97 and actual planning practice. Economic theory also provides comment about multiple objectives in planning.

Neo-classical Foundations

Water resources development contemplates the best use of the resource to contribute to the well-being of the people or the general welfare. An optimum allocation of resources will maximize welfare. There are two approaches to welfare maximization, each of which has its limitations. Adam Smith saw welfare maximized in the market through the invisible hand of perfect competition.⁴ An equilibrium

³For discussion of Senate Document 97 and planning practice see Gus Norwood, "Public Objectives in Water Resources Development" (Paper presented at the International Conference on Water for Peace, Washington, May 1967), p. 2.

⁴Adam Smith, Wealth of Nations (London: Methuen & Co., 1922), p. 194.

would be reached where it would not be possible to make one man better off without making someone else worse off. The conditions and assumptions under which efficient resource allocation would occur are part of neo-classical economic theory.

Simply, neo-classical theory as it relates to resource allocation consists of three parts. First, it is based on the model of perfect competition. In perfect competition the efficient allocation of resources is accomplished through the market. Detailed assumptions are made regarding consumers, producers, the factors of production and also resources.⁵ Second, factors must be independent, completely divisible and have perfect mobility. These assumptions relate to water resources planning. Third is the optimality of income distribution which may be approximated by the existing static equilibrium. In this case it may be acceptance of the existing distribution of wealth or pertain to income redistribution.

The usefulness of the competitive model is that it provides a basis for a priori evaluation of a proposed rearrangement of the economic system. The consequences of value judgments and ethical overtones may be explored, but are excluded from reasoning. The weakness in this analytical approach is that the assumptions overlook data of significance in real life. The conditions in the real world and assumptions of the model are not always the same. Musgrave saw the difficulty as

⁵An excellent discussion of the market and the competitive model is contained in Otto Eckstein, Water Resources Development (Cambridge: Harvard University Press, 1961), pp. 19-30.

that of applying efficiency criteria to a system that is only partially efficient.⁶ Part of the analysis is to determine the conditions or assumptions not met and the effects on the allocation of resources.

Welfare Theory and Neo-classical Assumptions

The second approach to maximizing welfare is found in that part of economics known as welfare theory. Welfare theory accepts what Adam Smith saw as a result of perfect competition, a point where welfare was at a maximum, and sets about prescribing conditions and actions that might lead to this point. Kenneth Boulding suggested,

What welfare economics really says is that there is a certain norm of exchange opportunities, divergencies from which have to be specially justified. The norm essentially is that everyone should be able to exchange anything for anything else in any quantity at ratios equal to the alternative costs or, more generally, the rate of real transformation of the exchangeables.⁷

The notion of economic welfare is based on an efficient allocation of resources. It contemplates further that in arriving at this efficient allocation, the welfare (or, as it sometimes is assumed in simplification, the real income) of all concerned is improved or the change results in a net improvement. The concern is with resource allocation efficiency and with the effect the allocation has on the welfare of individuals.

This latter concern led to many problems in conceptualization

⁶Richard A. Musgrave, The Theory of Public Finance (New York: McGraw-Hill Book Company, 1959), p. 47.

⁷Kenneth E. Boulding, Economic Analysis, Vol. I: Micro Economics (New York: Harper and Row, 1966), p. 647.

and quantification as the theory evolved, but a number of useful concepts have emerged.

Pigou was one of the first to explore, at any length, the divergence between social or public and private values. Under real world private competition, conditions exist that prevent society from reaping certain benefits or avoiding certain disutilities. Correction of such situations would improve man's welfare. Correction would not automatically take place in response to normal market action and on this basis a case is made for government intervention.⁸ Krutilla traced the development of thought from Pigou through Baumol, Samuelson, Bower, Musgrave, Margolis and Heady. In Krutilla's view, in a competitive economy, the free market

. . . will fail accurately to reflect the social worth of inputs and outputs through the intermediary of prices. Where indivisibilities in production occur, resulting in the least cost scale of output being large in relation to the market, decreasing cost industries occur. In these instances pricing of output at marginal costs will not recover full costs and thus poses problems for efficiency under private management. On the consumption side, indivisibility associated with outputs (e.g. flood damage reservoirs) means that the product or service cannot be discretely packaged and offered separately to each individual subject to payment of a price.

This acts to prevent organization of a conventional market. Krutilla also observed that "where production functions are physically interdependent, external economies and diseconomies arise causing divergencies

⁸A. C. Pigou, The Economics of Welfare (4th ed.; London: Macmillan and Co., Ltd., 1948).

between private and social marginal product and cost."⁹ He contended that these conditions are prevalent in the resource field and development restricted to the private sector would result in inefficiencies and accordingly that public intervention is necessary for the improvement in efficiency. He also pointed out that while public intervention is necessary for an improvement in efficiency, it is not necessarily sufficient to produce an improvement in efficiency.

As Pigou was quoted, and as Krutilla was cited to emphasize, significant divergencies exist between real life conditions and the idealized market conditions contemplated by neo-classical theory. The result is a divergence between social value and private value. In several instances, among them water resources development, a strong argument exists for public intervention into the market.

A neo-classical assumption has been that factors are independent. Where factors are not independent there are external effects. An economic (technological) externality is said to exist when the employment of a factor or the action of individuals has economic consequences not taken into account by the market--uncompensated third party effects. The market does not induce a behavior adjustment as a consequence. Efficient resource allocation is impeded because the real value of the resources at the margin is not reflected in the market price. The market price of a resource is not equal to its opportunity cost, its

⁹John V. Krutilla, "Is Public Intervention in Water Resources Development Conducive to Economic Efficiency," Natural Resources Journal (January 1966), pp. 62-63.

value in its next highest use. When an externality exists, more or less resources are allocated to purposes served than the real production value of the resources would indicate.¹⁰

In the welfare sense, social values may be diminished when externalities cause deviations from optimum resource allocation. In the case of a meat packing plant, for example, untreated wastes may be discharged into the stream causing pollution that results in a loss of recreation values and increased treatment costs for downstream users. It also results in a shifting of a real cost (for waste control treatment) by the meat packer and the production of more meat and less of other goods than the market would have called for had the meat producer been paying the full costs of his production. The result is a loss in social value--social costs--and a less efficient allocation of resources.

The externalities from lack of regulation explain the case cited above, at least in part. Externalities can also result from jurisdictional barriers, institutional arrangements, and other causes. Of particular concern here is that any economic effect of water resource use which is not taken into consideration in plan formulation and evaluation is in reality an external effect producing distortion in factor and resource allocation.

¹⁰A good detailed discussion of external effects is included in Arthur Maass et al., Design of Water Resource Systems (Cambridge: Harvard University Press, 1962), pp. 41-46; and, particularly as these effects relate to pollution, in Allen V. Kneese, The Economics of Regional Water Quality Management (Baltimore: Johns Hopkins Press for Resources for the Future, Inc., 1964), pp. 38-46.

A water resources project could have effects on the environment which if not evaluated could result in an allocation of resources that would not be made if all social costs or opportunity costs were considered. A dam backing water into the Grand Canyon of Arizona is an example.

Similarly, effects on the distribution of income overlooked in planning, when these effects are significant, would be externalities of the project. Were the distributional effects important, and were they considered in planning, the scope of the project or the purposes served might be different or the project might not be built at all.

Another neo-classical assumption concerns the perfect divisibility of factors. The goods and services produced by water resources development--both producers' and consumers' goods--are often not divisible, thus not marketable. For the most part, flood control projects, recreational facilities such as parks, scenic rivers, water quality improvements and other purposes served by water resources projects fall into these categories. These are collective goods and services which if provided for one usually cannot be denied to another person, that is, they are not marketable. Once made available, the goods are for all to use.¹¹ True preferences and value to the individuals are not readily revealed. There is no incentive for private capital to be employed. Collective goods are a result of public intervention, if provided at all. The environmental aspects of water

¹¹ Musgrave uses the term "social wants" in discussing collective goods, Musgrave, op. cit., p. 8.

resources development fall in this category also.

There is the concept of returns to scale. In a public works project, design capacity is sometimes not approached for a long period of time. The scale selected is usually such that marginal costs may be considered to be below average costs as additional use is made of the work. The firm in a competitive situation is encouraged to expand production until marginal costs rise to marginal revenue--marginal costs equal average costs--and a scale of the plant is selected where this can be done efficiently. The situation that is acceptable in a public work would not be profitable for a competitive firm.

Benefit-Cost Analysis as a Welfare Indicator

Political sanction for investment in public works has been sought by various means of showing that gains exceed costs.¹² The intent has been to show that a specific intervention--an adjustment--

¹²Albert Gallatin, in his report of 1808 in which he proposed the development of highways and canals to provide the transportation routes that would accelerate the development of the country, included an evaluation procedure by which such work might be justified. He suggested that the difference between savings in transportation costs and the costs of providing the new facilities could be considered an addition to the national income. This was a type of economic efficiency measurement although it might be noted that, as discussed in Chapter II, the proposal of Gallatin was based on objectives that were far broader than economic efficiency.

Similarly, in 1844, Jules Dupuit, a French engineer, evolved a number of concepts concerning the utility of public works. A concept particularly useful in evaluation was that the utility (benefit) of a public work was the decrease in costs of production which the public work permitted. See Jules Dupuit, "On the Measurement of Utility of Public Works," published originally in Annales de Ponts et Chaussées (1844) and more recently in International Economic Papers #2 (New York: The Macmillan Company, 1956).

would result in a more efficient allocation of resources. Implicit was the idea that thereby man's welfare could be increased. From this over time has grown the custom of justifying economic investments, including resource allocations called water resources projects, in terms of benefits and costs. Economists have refined the methodology over the years until benefit-cost analysis provides, in certain respects, a good approximation of welfare.¹³

To rational economic man, any exchange must result in his being at least as well off as he was before making the exchange. The benefits he obtains from an exchange (a readjustment of the economic system) must be at least equal to what he foregoes. Where there are several opportunities to gain from an exchange or readjustment, ceteris parabus, he would select that from which he would gain the most. This would be an efficient adjustment.

The contribution of welfare economics to benefit-cost analysis evolved from dialogue on one of the central difficulties of welfare theory. Whereas Pigou and others had attempted to broaden classical economics with value judgments concerning welfare, Kaldor took a step toward classical theory.¹⁴ Krutilla described the "production-distribution" or the "efficiency-ethics" dichotomy of the Kaldor-Hicks-

¹³See, for example, Allen V. Kneese, "What We are Learning from Economic Studies of Water Quality" (Colloquium on Environmental Health, Syracuse University, April 18, 1966), p. 2.

¹⁴Nicholas Kaldor, "Welfare Propositions of Economics and Interpersonal Comparisons of Utility," Economic Journal, Vol. XLIX (September 1939), pp. 549-52.

Scitovsky line of development in these terms.

We say that if those who benefit by virtue of the increase in production can overcompensate those who suffer losses (but do not actually make the compensating payments), the 'aggregate real income' has been increased irrespective of its distribution and accordingly of its welfare implications.¹⁵

The Kaldor line side-stepped the interpersonal comparison of utility controversy of welfare economics by placing the analysis on an efficiency basis. In effect, Kaldor said that if a new economic configuration is shown to be more efficient, it should be adopted. The question of compensation is internalized at a higher level--that of society. Society then decides whether and to what degree compensation will be made; this is done through the political process utilizing law and property rights.

Economic efficiency evaluation in water resources is based on the efficiency-ethics dichotomy. Benefit-cost analysis has come to be rationalized on this basis. Krutilla and Eckstein saw the economic changes wrought by a water resources project vis-a-vis the general economy as small and the income redistributional effects, for purposes of measurement, as insignificant.¹⁶ On this basis also, Eckstein stated the derivation of benefit-cost analysis from welfare theory.¹⁷ To the extent that the welfare aspects other than the efficiency

¹⁵ John V. Krutilla, "Welfare Aspects of Benefit-Cost Analysis," The Journal of Political Economy, Vol. LXIX, No. 3 (June 1961), p. 228.

¹⁶ John V. Krutilla and Otto Eckstein, Multiple Purpose River Development (Baltimore: Johns Hopkins Press for RFF, 1958), p. 50.

¹⁷ Eckstein, op. cit., pp. 70-78.

relationship are explained or assumed away, benefit-cost analysis may be a complete approximation of welfare. In its derivation and use, however, benefit-cost analysis has the limitation of being largely efficiency-oriented. It gives a wide but single dimension view of value or welfare.

Welfare economists, however, have taken a broad view of man. Jeremy Bentham was concerned with man's happiness and thought that economics could explain and promote that happiness.¹⁸ The versatility of economics as a science was not sufficient in Bentham's time to handle such a proposition. Welfare economics languished for about one hundred fifty years. Its modern progenitor, Pigou, produced the basic work upon which most modern welfare theory is based.¹⁹ Principles of welfare theory are more broadly accepted than any single definition of economic welfare or any answer to questions asking how economic welfare can be quantified. Pigou saw problems of definition and quantification and they remain to this day.²⁰ Conventional evaluation procedures have tended to assume away all but the efficiency aspect. This is not because man's welfare in the broad sense has not been a concern. Rather, plans with efficiency objectives may be all that can be done

¹⁸For a discussion of the early development of welfare concepts, see I. M. D. Little, A Critique of Welfare Economics (London: Oxford University Press, 1950), pp. 7-10.

¹⁹For a summary of modern welfare theory, see E. J. Mishan, "A Survey of Welfare Economics 1939-59," The Economic Journal (June 1960), p. 203.

²⁰Pigou, op. cit., p. 8.

satisfactorily at this time.

Income Redistribution

Maass, Hufschmidt, Krutilla, McKean, Weisbrod and others have discussed the problem of income redistribution as a real aspect of water resources planning and evaluation.²¹ Redistributive effects appear to be a dimension in the approximation of welfare.

Haveman suggested that

Although both the size of the national income (economic efficiency) and its distribution have been recognized in the literature as the primary determinants of economic welfare, economists have generally proceeded on the assumption that welfare is but a single valued function of only the size of the national income.²²

The questions that arise are whether the redistributive effects are significant enough to be concerned with, and secondly, if they are, can they be included in the conventional economic efficiency calculus.²³ There is also the subsidiary question of whether water resources projects are either appropriate or effective means for accomplishing income redistribution. One answer to the latter question is that there may be better programs for carrying out a national objective of income redistribution. On the other hand, if there were

²¹ See discussion of regional development as a planning objective in the next chapter.

²² Robert H. Haveman, Water Resources Investment and the Public Interest (Nashville: Vanderbilt University Press, 1965), p. 9.

²³ The second question regarding the manner in which distributive effects, if included as a planning objective, might be handled in evaluation will be treated in Chapter IV.

significant redistributive effects of water resources projects, analysis would be incomplete were it not to determine these effects and evaluate them.

The question concerning the significance of the redistributive effects raised above is moot. Krutilla has said that the "redistributive consequences of small changes of the sort encountered in benefit-cost analysis in the United States are negligible."²⁴ He is speaking of consequences in a dynamic, non-cumulative context as for measurement purposes. Consideration of the redistributive effects from water resources projects in relation to national income as a whole would lead to such a conclusion. However, Krutilla discussed the normative status of existing national income distribution. He at least implied that on a project-by-project basis the redistributive effects are not negligible. A study by McKean of the Santa Maria project of the Corps of Engineers and a more extensive study by Haveman of a number of Corps of Engineers projects defend a contention that the distributive effects of projects in their particular areas are not negligible.²⁵

Other Dimensions of Welfare

Welfare theory is not limited solely to the efficiency of the resource readjustment and the effects of the accompanying income

²⁴Krutilla, op. cit., p. 229.

²⁵Roland N. McKean, Efficiency in Government Through Systems Analysis (New York: John Wiley and Sons, Inc., 1958), pp. 214-45 and Haveman, op. cit.

redistribution. Bentham held a broad view of welfare. Pigou confined economic welfare to those effects "which could be brought directly or indirectly into relation with the measuring-rod of money." Pigou explained that the objective was to achieve a quantitative analysis and that this had to be accomplished with the instruments of measurement used by society--money. Pigou contended that the "economic" in economic welfare did not refer to a particular kind of welfare but related to causes or changes in welfare broadly economic in origin.²⁶

Gaffney expressed a similar but broader view.

Economics contrary to common usage begins with the postulate that man is the measure of all things. Direct damage to human health and happiness is more directly 'economic' therefore than damage to property which is simply an intermediate means to health and happiness. Neither do economists regard 'economic' as a synonym for 'pecuniary.' Rather money is but one of many means to ends as well as a useful measure of value. 'Economic damage' therefore includes damages to human function and pleasure. The economist tries to weigh these direct effects on people in the same balance with other costs and benefits to the end of making decisions to maximize net social benefits.²⁷

Such a view is not uncommon in welfare theory. Although accepted for purposes of this discussion, economists do not universally share such a broad view of the realm of economics.

Welfare as a concept in welfare economics, or for guidance of planning federal water resources development, is complex and multi-dimensional. However, the quantitative effects of an economic

²⁶Pigou, op. cit., p. 11.

²⁷Mason Gaffney, "Applying Economic Controls," Bulletin of the Atomic Scientists (June 1965), p. 20.

adjustment are measured more accurately by terms and concepts relating to economic efficiency. It is more feasible (and convenient) to formulate and evaluate plans through analysis handled with comparatively less difficulty. Present concepts and methods of benefit-cost analysis were adopted to aid achievement of economic efficiency as an objective. The relative simplicity of benefit-cost analysis as an efficiency measurement tool has tended to favor the choice of economic efficiency as an objective.

In welfare theory both the analysis and the efficiency objective have been necessary, though not sufficient to reveal all dimensions of economic welfare. Theory does not appear to have as yet provided in usable form a working definition of economic efficiency that includes welfare considerations. The problems of defining viable conditions for optimizing welfare are those of translation into real life terms and of measurement. There have been limitations on economic efficiency as a planning objective. As the ability to define and measure has been improved, more aspects of welfare have been brought into the efficiency calculus.²⁸ Welfare theory has encompassed a more general concept of welfare than can be accommodated by the current working definition of economic efficiency. Maximization of welfare has required the achievement of objectives and criteria in addition to those of economic efficiency. These additional

²⁸This was the case of recreation as a project purpose in planning. The evolution of recreation analysis and what this might mean to environmental quality planning will be discussed in Chapter IV.

objectives, to the extent that they more fully describe welfare, are necessary to improve the analysis of the welfare effects of economic adjustments. Resources allocation in this context has been accepted for discussion of water resources development.

Social Preference Function

A concept from welfare economics helpful in viewing planning procedures is that of the social welfare function or, as it has been termed, the social preference function. For the purposes of the present discussion, the concept is useful because it explains how society chooses opportunities from alternatives offered. The concept becomes important when obstacles exist to attaining a defined welfare optimum through more rigorously quantified analysis. The concept complements the procedures to achieve a welfare optimum discussed in the previous section.

Welfare economics has had a primary concern for the welfare of the community. This has been the generally accepted view although in its early days welfare theory was diverted by discussions about the validity and treatment of interpersonal comparisons of utility.²⁹ The problem of how to derive community preference from individual welfare, or even if it could be done in a manner to withstand the test of rigorous economic logic, is moot and not examined in this study. The community is assumed to order its wants. This ordering is represented by a social preference function and the community,

²⁹See, for example, Mishan, op. cit., p. 199.

thereby, exhibits a social preference.

The social preference function is usually represented graphically in two dimensions (as for society's preference between two goods) as an indifference map--a family of indifference curves. Bergson formulated the concept of social preference function.³⁰ Others investigated welfare problems subsequently in the manner of Bergson's exposition. The important concept was that society, faced with an array of goods and services, would rank the possible combinations in such a way as to be indifferent among certain combinations that would yield society the same total satisfaction of welfare. The family of curves indicates combinations of increasing or decreasing worth to society, however the preferences of society may be determined.

Social welfare, theoretically, is subject to mathematical description and maximization subject to constraints. For any combination of goods and services desired by society there, presumably, also exists a most efficient arrangement for the production of the goods. For fixed resources this can be represented graphically by a possibility curve or surface.³¹ There would also be a corresponding series of indifference curves indicating society's preferences regarding various combinations of quantities of the goods and

³⁰A. Bergson, "A Reformulation of Certain Aspects of Welfare Economics," Quarterly Journal of Economics, Vol. 52 (February 1938), pp. 310-34.

³¹Further explanation may be found in McKean, op. cit., pp. 127-33.

services in question. If, in spite of constraints placed on the two functions, the curves meet, a unique summit position is possible. This is a desirable optimum given the possibilities open to society.

Assuming that communities order bundles of goods and services in accordance with a social preference function, one could expect communities to have expressible preferences regarding the goods and services produced utilizing water resources,³² at any particular place and at any particular time. The various communities would be the locality, the region and the nation. The social preference function would be operative in expressing community response to a proffered array of goods and services. Community decision making regarding specific proposals is usually termed the decision-making process. Though operative when confronted with the requirement to make decisions on actions or policy, the generalized preference system of society is continuous, though at times latent. (An analogy is to the individual's social preference or personal conscience.) General though possibly vague expressions of social preference are federal, state and local legislation concerning water resources policy and use. Enabling legislation, such as for federal investment in flood control, reclamation, pollution abatement, regional development and scenic rivers, as well as legislative and social response to previous decision instances, operate whenever the social preference function is applied in a problem situation

³²Water goods and services are some part of the commodity bundle.

requiring a decision of choice. The procedure by which society determines whether or not an investment will be made has been more clearly prescribed, however, than the procedures by which society chooses among alternative courses of action, as between a scenic river and hydropower development.

Society or the nation can be considered to have taken an action to increase its welfare whenever the social preference is operative. The fewer the constraints on the preference function and the more complete the knowledge is about the choices available to the community, the closer to a welfare optimum an action may be assumed to be. Similarly, an efficient or optimum solution for society is made more likely if society's preference curve is confronted by an efficient possibility curve. In the case of water resources this would be a complete portrayal of the available choices and opportunity costs.

The concept to be operable envisions action by society to increase its satisfaction and welfare. The concept is in contrast from the static approach to welfare maximization also common in welfare theory.

The Concept of Objectives in Planning

The purpose of water resources planning has been the determination of best uses of water to provide for the needs and well-being of the people. This has been assumed to be the same as planning for water use and development to promote economic welfare. Economic welfare is difficult to describe, not only in terms of water

resources planning, but in general economic terms. Aspects of welfare and the economic problem can be seen clearly, however. Mishan saw welfare enhanced by "an expansion of the area of choice."³³ The planner lays out the choices available to society in the uses of the water resource. The role of the economist qua planner, Robbins has suggested, is to show the relationships that exist "between ends and scarce means that have alternative uses."³⁴

In water resources planning, emphasis has been placed on the determination of the "means" by which water serves the purposes of man. Learning about the resource and how to control it is a technological problem. The "ends" appear as important as the "means," however. McKean has said, "whatever the particular problem it is fairly obvious that in choosing among alternative means we need to scan the ends themselves with a critical eye."³⁵ Evidence suggests that ends have not been given the same attention given to means.

The planner is expected to answer questions about what is possible and about costs. Only if he knows what is wanted, can he do this effectively. Gallatin proposed a plan in support of several broad and timely objectives. The problem posed by other proposals has been similar. Gallatin suggested a test for his canal and road

³³Mishan, op. cit., p. 255.

³⁴Lionel Robbins, Essay on the Nature and Significance of Economic Science (2d ed., Toronto: Macmillan and Company, 1935), p. 16.

³⁵McKean, op. cit., p. 25.

proposal in terms of a contribution to national income.³⁶ The test was not unreasonable, but the gap between the test and the objectives was large, and not much was said regarding how to move from the efficiency evaluation to the higher level objectives.

The United States early acquired a predilection for efficiency. An efficient allocation of funds and resources was and is desired. Difficulty was experienced in bridging the gaps between evaluation and objectives and national goals. This difficulty has persisted. A third observation is that there was a lack of consensus on what the nation's objectives were with regard to the use of water resources in promoting the nation's welfare. These observations as they relate to planning today will be examined in reverse order.

Water is only one natural resource. It is important but unlikely to be the major determinant of well-being except in the extreme cases of overabundance and absolute scarcity. Once these cases have been provided for, there is flexibility in how the resource is used.

Water is not independent of other resources. The planning and production of other goods and services is concurrent with water planning and in some cases more dynamic. Often water goods and services are intermediate goods--provide factor inputs in the production of other goods and services; sometimes water provides

³⁶ See discussion in first section of Chapter II.

consumer goods and services as drinking water and recreational boating opportunities. Water transportation is but one mode of an interrelated transportation complex. Hydropower is but one source of even more closely related means of generating electric power. Water-based recreation is but one form of outdoor recreation and that but one outlet for leisure hours and vacations. Water resources planning and development is only a part of a large, decentralized but dynamic resource allocation system.

Water planning objectives are interrelated with objectives of other social programs in support of national goals. National goals such as promoting the general welfare, enunciated in the preamble to the United States Constitution, are clear. National goals as they relate to water resources and other programs are less clear. Water planning objectives, expressed or implied, can conflict with, be indifferent to, or support the objectives of other programs. It is important to "scan the ends themselves with a critical eye" as suggested by McKean.³⁷ Objectives would appear to need careful selection in relation to national goals and other related programs.

An objective also is related to the means available to further the objective. Objectives to be useful are guides to specific action. Criteria relate the objectives to the means. Through the use of criteria, resource combinations can be evaluated and preferred

³⁷McKean, op. cit.

combinations distinguished from less desirable ones.³⁸ Criteria are typically not a full set of specifications, but they do provide guidance, as McKean suggested, concerning "selected effects which are relevant to the comparison of alternative actions."³⁹

The third observation concerns the efficiency of a proposal. Efficiency is a many-faceted concept. The view has been taken that a perfect market gives the best possible or most efficient allocation of goods or resources. In that case it is proper to simulate closely the assumptions and workings of the market to guide factor and resource allocation in water resources planning.

One assumption is that in a perfect market efficiency and welfare are congruent--what is more efficient, enlarges welfare. Welfare and efficiency can be described as being synonymous, but they can also be described as being only related. In the latter, an increase in efficiency would not necessarily increase welfare.

A second assumption is that the market is efficient in the manner in which it evaluates social benefits as well as how it allocates resources in response to signals. Much of the literature concerning benefit evaluation is based on this approach and in general it is useful. It is not without flaws, however. Galbraith

³⁸ For example, one might take promoting of the general welfare as a national goal. Policy makers might decide that this goal should be pursued through water programs by an objective of environmental quality. Criteria would be established to identify, evaluate and rank possible quality features for recommendation and selection.

³⁹ McKean, op. cit., pp. 27-28.

saw the market as unbalanced by the dollars of the more affluent through the law of diminishing marginal utility.⁴⁰ Davidson counseled that market results must be counterbalanced with value judgments.⁴¹ The market may not be completely satisfactory for the allocation of resources.

Reliance on the market raises the issue of why the government has intervened in market allocation in the first place. One explanation was because of the existence of market imperfections such as externalities. Externalities may be the general answer, but McKean suggested that the specific reasons for public intervention be examined before the market is asked for answers.⁴²

Adam Smith envisioned the "invisible hand" of the market working for welfare improvement and allocative efficiency. And yet the failures of the laissez-faire market led to Pigou's treatise on externalities and welfare.⁴³ This effort of Pigou's led to a rehabilitation of welfare theory. It also provided a basis for rationalizing the benefit-cost efficiency evaluation methodology for water resources projects. Welfare theory is viewed as normative economics in that there is an ethical

⁴⁰ John Kenneth Galbraith, The Affluent Society (New York: Houghton Mifflin, 1960), pp. 139-51.

⁴¹ Paul Davidson, "The Valuation of Public Goods" (Paper presented at a conference on the Social Sciences and the Quality of the Environment, Boulder, Colorado, January 31 - February 2, 1967), p. 12.

⁴² McKean, op. cit., pp. 104-07.

⁴³ Pigou, op. cit.

implication regarding implementation of any analysis undertaken. Benefit-cost analysis by this reasoning gives a normative signal. But in its conventional form, benefit-cost analysis is a measure of economic efficiency, and is based in turn on the use of the market for resource allocation. Adam Smith's invisible hand of the market is thereby cast in a normative role in resource allocation. In this role economic efficiency may be an objective for water resources planning in its own right.

Economic efficiency was viewed as necessary, but not sufficient for the approximation of welfare by Kaldor.⁴⁴ Because of the comparative facility with which efficiency benefits may be quantified, planning and project evaluation have tended to rely on the economic efficiency criteria and economic efficiency as a planning objective.⁴⁵

There is one other view of efficiency. This is the manner in which any activity may be considered efficient in its own right. This is the view of efficiency that says for any output there is a minimum combination of inputs and similarly for any given input there is a maximum of outputs. In this sense there can be an

⁴⁴Kaldor, op. cit.

⁴⁵To the degree that other objectives may be explicitly or implicitly recognized, they are generally given less rigorous treatment. Such report text as is devoted to discussion of other objectives is usually limited to paragraphs. Planner value judgments are necessary where definitive guidance is lacking. Where guidance is adequate, consideration for other objectives can take the form of constraints as in the provision of a particular level of flood protection.

efficient solution to an objective given appropriate criteria to qualify the alternatives examined. Both views of efficiency, first that of an objective of planning to assure market efficiency in the allocation of resources, and second that of the efficient allocation of resources in support of other specified objectives through the selection of appropriate criteria, are of consequence in water resources planning.

A number of concepts regarding objectives in planning have been examined. These concepts will be discussed as they relate to planning practice.

CHAPTER IV

THE USE OF MULTIPLE OBJECTIVES IN PLANNING

Best use of water and well-being of the people appears to be achieved in water resources planning through the employment of objectives and criteria that best approximate welfare.

The Use of Multiple Objectives as a Planning Concept

Choice throughout the political process is usually limited by the planning proposals proffered by the planning entity. The choices made in the political process determine significant resource and factor allocation. The decisions, when implemented, cause social and ecological changes that can be irreversible for life spans. It is important, therefore, that the options and opportunity costs be known when decisions are made. A broad base for decision making requires that an array of possibilities proffered should be as broad as feasible. Narrowness in the consideration of alternatives in the formulation of plans can bring about the implementation of a plan that inadequately meets needs or is considered unacceptable or just not implemented. Expensive planning efforts concerning the Potomac River, the Colorado River in Arizona and other river basins have been criticized in this vein.¹

¹Two analyses of water resources planning efforts which raise questions concerning possible alternative solutions are: Robert K. Davis, The Range of Choice in Water Resource Management: A Study of the Potomac Estuary (Washington: Resources for the Future, Inc., 1968), Colorado Choices (Washington: Committee on Water, National Academy of Sciences, forthcoming 1968).

Hufschmidt, after reviewing water resources planning processes as part of the Harvard Water Program, identified one problem as follows:

Examination of recent U.S. planning experience reveals that plans prepared for a single objective . . . often fail to win approval because policy makers evaluate the plans in a broader context involving multiple objectives.

Hufschmidt recommended that "planning to maximize national welfare must deal with multiple objectives and the United States water resources planning process must be revised to this end."²

A board convened by the Secretary of the Army in 1964 to review the Civil Works Program of the Corps of Engineers made the following recommendation:

The Board believes . . . that much more effort is needed to improve . . . policies and practices in plan formulation to obtain:

(a) Optimum solutions to problems rather than mere determination that a project is justified.

(b) Consideration of alternatives other than reservoirs, levees, channels, etc., to achieve objectives.

(c) Consideration of those alternatives that will achieve objectives other than economic efficiency when such other objectives have been recognized or prescribed.

(d) Consideration of alternatives that will meet objectives under possible variations in projected future conditions including major technological, economic and social changes.

(e) Presentation of sufficient data on alternatives in

²Maynard Hufschmidt, "The Water Resources Planning Process: Relation to Corps of Engineers Planning" (Harvard University Graduate School of Public Administration, June 1965), p. I-11. (Mimeographed.)

reports to offer a choice to decision makers at all echelons of review and action.³

The Board in recommendation (c) above made explicit that planning should be responsive to various specified objectives. Senate Document 97 identified as planning objectives, development, preservation, and well-being of people.⁴

Other objectives than those discussed in Senate Document 97 have been noted as having been identified historically with water resources development in this country. Explicit recognition of these objectives in planning has been urged by Kneese and Nobe, Maass, Fox and others.⁵

Woodbury has suggested that the lack of clearly defined national goals for water resources development has not facilitated the definition of objectives to guide water resources planning.⁶

³U.S., Department of the Army, A Report to the Secretary of the Army by the Civil Works Study Board (Washington: Government Printing Office, 1966), p. 8.

⁴U.S., President's Water Resources Council, Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, printed as Senate Document 97 (Washington: Government Printing Office, 1962). p. 1.

⁵See Allen V. Kneese and Kenneth C. Nobe, "The Role of Economic Evaluation in Planning for Water Resource Development," Natural Resources Journal, Vol. 2, No. 3 (December 1962), p. 462; Arthur Maass, "Benefit Cost Analysis: Its Relevance to Public Investment Decisions," Quarterly Journal of Economics (May 1966), p. 2; and Irving K. Fox in an address to a joint meeting of the Columbia and Missouri Basin Inter-agency Committees, June 1963. Resources No. 16 (May 1964), p. 2.

⁶Private communication from Brigadier General H. G. Woodbury, Jr., Director of Civil Works, United States Army, Corps of Engineers, April 18, 1968.

Early concern with "winning the West" and unifying and developing the country have given way to concerns for equitable sharing of national growth by all regions and that the "quality of the environment be protected and enhanced as the nation grows." The National Academy of Science publication quoted, views the number of socially desirable objectives in planning as growing.⁷ Desires and willingness and ability to pay are valid areas to be examined in the process of allocating resources and investment funds.

Stephen Marglin viewed maximization of the national welfare as the prime goal of public water resources development.⁸ Welfare maximization, though possibly desirable, is difficult to translate into operational criteria. National welfare can be defined as national income. Economic theory has provided fairly effective tools and a rationalization for such a substitution. Economic theory has been less successful in providing commensurable quantitative descriptions for other dimensions of welfare.

Concentration on the efficiency objective fosters a tendency to consider it the ultimate objective. Castle among others has suggested that it is not.⁹ Part of the concern expressed by Hufschmidt

⁷Alternatives in Water Management (Publication 1408. Washington: National Academy of Sciences, National Research Council, 1966), p. 6.

⁸Arthur Maass et al., Design of Water Resource Systems (Cambridge: Harvard University Press, 1962), p. 17.

⁹Emery N. Castle, Economic and Administrative Problems of Water Pollution, Technical Report 7784 (Corvallis: Oregon Agricultural Experiment Station, undated), p. 255.

stems from a preoccupation with efficiency per se as an objective and the ability to quantify efficiency benefits and articulate an objective function. Despite the general breadth of view of Senate Document 97, plans are required to be formulated initially using conventional (economic efficiency) criteria.¹⁰ Gus Norwood, in presenting a paper for the Water for Peace Conference, considered it a serious impediment that the objectives in the early portion of Senate Document 97 were not adequately implemented in the latter sections on detailed mechanics.¹¹

Concentration on the efficiency objective excludes from consideration not only noneconomic dimensions of welfare but also economic dimensions. The efficiency criteria implies that society is indifferent as to the recipient or the distributional effects of the development proposal. Marglin infers that social indifference to the distributional effects "suggests that the marginal social significance of income is the same regardless of who receives it."¹² This has been the case in many of the nation's water resources development proposals. Marglin went on to urge adoption of a dual objective approach to planning to approximate welfare in terms of the economic efficiency contribution and the pattern in which income is redistributed. The dual objective approach is constructive but requires

¹⁰Senate Document 97, op. cit., p. 7.

¹¹Gus Norwood, "Public Objectives in Water Resources Development" (Paper presented at the International Conference on Water for Peace, Washington, May 1967), p. 2.

¹²Maass et al., op. cit., p. 17.

agreement on income redistribution goals.

A limited number of proposals have been advanced that would take into account more than one objective in designing water resource development proposals. Among them have been studies undertaken by the Harvard Water Program. The Harvard approach, to term it that, contemplated a multiple objective function by which, in Marglin's words, "a design criterion [may] choose the system design that performs best in terms of one objective, subject to a specified level of performance in terms of another, which we shall call a constraint." One ranking system selects from among alternatives satisfying the constraint, while a second selects from these the one that performs best in terms of the primary objective.¹³

Marglin suggested three methods to introduce a second objective of income redistribution into the analysis.¹⁴ The first method would contain in the objective function the stipulation or constraint that in maximizing net benefits, a prescribed net income increase be provided to a particular group. The second method would prescribe weighted values to the two effects desired and would formulate designs to maximize the weighted sum of redistribution and efficiency. The third method would be the reverse of the first. Here a redistribution objective function is maximized subject to an efficiency constraint. A number of objectives could be handled in this manner although most

¹³Maass et al., op. cit., p. 18.

¹⁴Ibid., pp. 62-87.

illustrations employ one or another technique of income redistribution. Marglin suggested that national income can be redistributed to a particular group of people, as to an Indian tribe or toward a region by that procedure.¹⁵

A panel of consultants to the Bureau of the Budget proposed a procedure similar to the Harvard approach. In addition, the panel suggested a means by which a selected combination of objectives might be weighted "in accordance with the relative importance that public policy attaches to each objective for the river basin."¹⁶ Each of these methods would be subject to quantitative maximization and to systems analyses employing the digital computer. Weights and the level of the constraints, however, have not been established, and possibly are not establishable in advance of planning.¹⁷ One means of overcoming the difficulty would be an iterative process involving the planners and policy makers and employed until a result--a plan reflecting proper weighting--is produced that is "acceptable." Such a procedure has been suggested by Hufschmidt.¹⁸

¹⁵Stephen A. Marglin, Public Investment Criteria (Cambridge: M.I.T. Press, 1967), p. 21.

¹⁶U.S., Bureau of the Budget, Standards and Criteria for Formulating and Evaluating Federal Water Resource Development, Report of Panel of Consultants to the Bureau of the Budget (Washington, 1961), p. 62.

¹⁷Maass proposes that the weights be established through the legislative process and provided to the planner. See Arthur Maass, "Benefit Cost Analysis: Its Relevance to Public Investment Decisions," Quarterly Journal of Economics (May 1966), pp. 9-10.

¹⁸Maynard Hufschmidt, "Environmental Planning" (Chapel Hill, North Carolina, July 1966), pp. 20-22. (Mimeographed.)

Difficulties are evident in attempting to establish an arbitrary or empirically derived weight or standard. The methods, except that proposed by Hufschmidt, also fix the opportunity costs or trade-offs that are possible among objectives at preselected ratios.¹⁹

Planning Objectives

Objectives explicitly or implicitly operable historically have been identified or suggested for current use. Some of the most commonly used deserve exposition.

Economic Efficiency

Economic efficiency can be considered as an objective in and of itself or it can be considered a test for plans in pursuit of other objectives. In the latter sense, any proposal or plan is desired to be "efficient," whatever its objective. This would construe the idea that there was no other means of accomplishing the same result with less factor input. The "efficiency" in this case is largely a production efficiency.

As an objective, economic efficiency is usually offered as an approximation of one (major) dimension of welfare. This, of course, is the efficiency dimension. Improvement in the efficiency of the allocation of resources makes an economic contribution to the nation. Economic efficiency varies from the concept of national income in that,

¹⁹The difficulties involved in employing these methods will be discussed further in the last section of this chapter. Another method for handling more than one objective in planning will be examined in the case of the Susquehanna Study in Chapter V.

in Marglin's terms, the intent is to increase the size of the economic pie.²⁰

Economic efficiency has been measured in terms of "willingness to pay," another way of describing the demand schedule for the proposed outputs in question. The total value is equal to the area under the demand curve or the sum of the cost (market price) times the quantity plus the "consumers' surplus."²¹ It is generally considered as the amount a beneficiary would (or should) be willing to pay to obtain a given benefit.

Economic efficiency is the traditional objective represented by market demands for water-related goods and services. Major considered economic efficiency to represent "the best allocation of economic resources in market terms." The demands may be in actual market terms or in terms of markets constructed statistically.²²

In practice, during the implementation of planning, economic efficiency is constrained by the statutory authorities of the federal

²⁰ Maass et al., *op. cit.*, p. 20. Marglin also suggested that intuitively it is preferable to produce more electricity, for example, at less cost (larger pie) than a smaller amount at a higher cost which, under conditions of inelastic demand, would result in a larger increment to national income.

²¹ The concept of "consumers' surplus" was introduced by Jules Dupuit, one of the first to explore the efficiency concept with regard to public works. See Jules Dupuit, "On the Measurement of Utility of Public Works," *Annales des Ponts et Chaussées* (1844), more recently published in *International Economic Papers #2* (New York: The Macmillan Co., 1952).

²² David Major, "The Proposed Rationale for Plan Formulation" (North Atlantic Regional Study Group, working paper, U.S. Army Engineer Division, North Atlantic, New York, August 1967), p. 2.

action agencies. Economic efficiency approximates the national interests in water resources development. As an objective, economic efficiency could be viewed as planning from the national viewpoint with each statutory authority an element of national interest.

Economic efficiency, not so constrained, is not limited by the federal viewpoint. Planning participants can make clear to the decision makers the extent to which any evaluation deviates from the current federal norm or in conforming to the current norm, the extent to which the evaluation deviates from economic efficiency.

Environmental Quality

Man's first duty to himself is to insure his survival. Survival chances for a young nation were measured in terms of economic strength. Ciriacy-Wantrup saw adequate justification for exploitation of resources for the benefit of man.²³ Moreover, Lowenthal felt that "to the settlers that vision [manifest destiny] was a challenge requiring action--appreciation of the landscape itself apart from its practical uses was disdained as pointless and effete."²⁴ Man saw his welfare in the land and the uses he could make of it.

The country, its needs and its outlook have changed during its brief history. Economic survival no longer is contingent on resource exploitation. Krutilla concluded that most of our natural resources

²³ S. V. Ciriacy-Wantrup, Resource Conservation, Economics and Policies (Berkeley and Los Angeles: University of California Press, 1952), pp. 15-16.

²⁴ David Lowenthal, "The American Scene," The Geographical Review, Vol. 58, No. 1 (January 1968), p. 72.

appear adequate in supply to meet the needs of the country projected indefinitely into the future.²⁵

There is concern that material well-being has been pursued too efficiently. E. J. Mishan concluded a detailed survey of welfare economics on an apprehensive note. Mishan was impressed with efficiency and progress and felt that welfare concepts were heavily biased toward increasing efficiency through preoccupation with the production of material goods and services. He was concerned whether the increased material returns were in fact bringing a better life.²⁶ He was referring to the quality of man's environment. Reder, another welfare economist, concluded his work with similar reservations. He wondered if this country were not prosperous enough to afford a relaxation from its preoccupation with efficiency for the benefit of the general welfare even if the value could not be quantified.²⁷ The implication is that man has needs that cannot be met solely through improvements in efficiency that increase his income. Reder seemed to feel that man's welfare is broader than the economic realm in which welfare economics is conventionally quantified.

Environmental quality even limited to the water resources planning process is complex. The question is not one of a resource

²⁵John V. Krutilla, "Environmental Effects of Economic Development," Daedalus (Fall 1967), p. 1063.

²⁶E. J. Mishan, "A Survey of Welfare Economics 1939-59," The Economic Journal (June 1960), pp. 255-56.

²⁷Melvin Warren Reder, Studies in the Theory of Welfare Economics (New York: Columbia University Press, 1947). p. 205.

shortage, but, as identified by Herfindahl and Kneese, of a hard-to-define loss in quality of the environment.²⁸ Hans Landsberg stated that "the relationship of people to resources which usually has been expressed in terms of quantity needs to be restated for modern times to emphasize what is happening to the quality of resources."²⁹ The quality of man's environment has come to be a dimension of man's well-being or welfare to be considered and planned. President Johnson threaded this notion throughout his address to the nation on natural resources.³⁰ President Johnson spoke about efforts that should be made to preserve areas of natural beauty in all parts of the country and in reach of all of the population in addition to the designation and preservation of areas of unique natural value. He also advocated reversing the trend that degrades quality whether of the air, water or countryside.

The water-related portion of the quality problem is large. The recent legislative concern is testimony to this. Legislation has been introduced and passed in response to concerns for environmental quality in terms of quality of water, clean rivers and lakes, and the preserving of wild, scenic and pastoral river reaches.³¹ Professor Phillip

²⁸Orris Herfindahl and Allen V. Kneese, Quality of the Environment (Baltimore: The Johns Hopkins Press, 1965), pp. v-vi.

²⁹Hans H. Landsberg, Natural Resources for U.S. Growth (Baltimore: The Johns Hopkins Press for RFF, 1964), p. 13.

³⁰U.S., President's Message to the Congress on Natural Beauty, "To Renew a Nation," March 8, 1968.

³¹For example, in May 1968 there were eight bills before the House of Representatives relating to the designation of scenic rivers.

Lewis of the University of Wisconsin, in a presentation before the Upper Mississippi River Basin Coordinating Committee, indicated that in areas he had studied over 90 per cent of the important natural and cultural features lie in or close by the water and wet land system.³² Water resources planning that overlooked significant natural resources values or proposed work that could not be implemented because of conflicts with other important resource uses is likely inefficient.

The question of maintaining environmental quality is intricate because of the nature of the continuum. Man has been gradually occupying the countryside, making it difficult to find areas where evidences of civilization, including the less attractive, have not encroached. The population of the nation has increased as have man's needs for living and recreational space. Man, acting as an economic being, has also maximized his personal returns to take advantage of the opportunities to increase his satisfactions and economic well-being. His actions are not intrinsically improper. The growth in population and behavior of man do explain, however, another aspect of the problem. Man, in taking advantage of the opportunities--external advantages--legally offered to him, has treated the air, the land and the water as free goods. Man now is confronted with not only the cumulative physical effects of past actions, but an institutionalized economic behavior. In many areas, as Lave has suggested, man's acts have passed the threshold of obtrusiveness and the deleterious effects

³²Upper Mississippi River Comprehensive Basin Study Coordinating Committee, Minutes, 8th Meeting, Des Moines, Iowa, October 1967 (U.S. Army Engineer Division, North Central, Chicago), p. 93.

are problems for public solution.³³

Flood control was not a matter for federal action until increasing damages attracted national attention. The 1927 floods on the Mississippi are often credited with providing the impetus for nationwide federal involvement in flood control measures that came with the 1936 Flood Control Act.³⁴ Pollution is often not thought to be critical until the capacity of a river to handle the pollution load is exceeded. Quality problems for the land are similar.

River basin planning has been concerned not only with the present water-related needs of the basin, but also projected future needs. In the quality continuum, the problem is to provide for the needs or the goals of the future. Environmental quality has become a dimension of the welfare concept. Major expressed environmental quality as a planning objective having the intention "to insure that the effects of water resources development on 'human ecology,' the relation between man and his natural and manufactured environment, are carefully defined and evaluated."³⁵ As an objective, environmental quality contemplates the preservation and enhancement of natural

³³For further discussion of the concept of the threshold, see Lester B. Lave, "Problems Relating to the Management of Pollution" (Paper presented at the American Economics Association Meeting, Washington, December 8, 1967).

³⁴U.S., Report of the President's Water Resources Policy Commission, Vol. 3, Water Resources Law (Washington: Government Printing Office, 1950), pp. 129-31.

³⁵Major, op. cit., p. 3.

values and, in addition, the correction of "misfits."³⁶

Preservation of natural values--natural areas of scenic, cultural or ecological interest--is not a new concept in resources conservation. Preservation, except as a proposal for development in conflict with natural value, has not been regularly taken as a water resources planning consideration, however.

Enhancement, as a newer concept, accepts the idea that man through his efforts can improve on natural areas. Regions with few lakes have been enhanced by the visual contrast and recreational opportunities of reservoirs. Roads have been routed to provide vistas of natural beauty.

"Misfits" may be of two kinds, where either the scale or the form configuration of a feature does not fit the surroundings. Immediate concern of planners is directed toward the removal of eyesores that encroach on and decrease environmental quality. Dilapidated buildings and waterfront structures might be included. Culm piles and strip mine scars in mined areas are considered misfits. Acid mine drainage causes a number of problems in this category. Of equal long-term importance, however, are the anticipated observable impacts of future completed works. This category might include dams and

³⁶ These three aspects of environmental quality were identified in an environmental study of the North Atlantic Region prepared for the North Atlantic Study Group: Study of Visual and Cultural Environment (Research Planning and Design Associates, Inc., Amherst, Massachusetts, November 1967).

impoundments, roads and powerlines.³⁷

According to a National Academy of Science study, the national or regional interest should be in preserving a heritage rather than increasing real income.³⁸ Hufschmidt brought out this point in discussing planning and policy-setting environmental quality standards that advance the "true interest of the public."³⁹ The "merit want" line of reasoning of Musgrave argued that certain wants should be satisfied to correct individual choice.⁴⁰ The emphasis is appropriate although conceptually distinct from the efficiency approach to environmental quality. The environmental objective, together with intangible benefits, could be developed as a project purpose with a benefit function to approximate the marginal willingness-to-pay schedule--the efficiency criteria.

Recreation has been raised from an intangible to an evaluated project purpose. Benefit analysis is still being improved, but as a purpose for evaluation purposes, recreation is established.⁴¹

Views on the utility of quantifying quality or other benefits

³⁷In a private communication, Burton Litton, Resources for the Future, suggested this view of the term misfit.

³⁸Colorado Choices, op. cit.

³⁹Hufschmidt, "Environmental Planning," op. cit.

⁴⁰Richard Musgrave, The Theory of Public Finance (New York: McGraw Hill Book Company, 1959), p. 9.

⁴¹See, for example, Jack L. Knetsch, "Economics of Including Recreation as a Purpose of Water Resources Projects," Journal of Farm Economics (December 1964).

long considered intangible are mixed. The theme of a paper given by Davidson was that the market fails in the case of public goods and that these goods are not reasonably susceptible of evaluation, benefit-cost-wise or otherwise. Davidson said that in the last analysis the evaluation of public goods is a matter of a value judgment on the part of the decision maker.⁴² Fox and Herfindahl tended to agree when they stated that

. . . it would seem desirable not to mislead ourselves by assigning monetary values to benefits when no better values can be developed than are now available for some purposes such as recreation. Instead it would be preferable to develop alternative plans with and without the services in question. The cost of providing the service could then be compared with estimates of the service to be derived expressed in physical terms and a judgment made as to whether the benefits are justified by the cost.⁴³

This recommendation favored the economic efficiency objective and evaluation with analyses employing various constraints. Knetsch, on the other hand, claimed it is necessary that recreation resources be considered as producing economic products. That is, recreation resources produce something for which people are willing to pay and an accounting can be made to determine benefits of resource allocation. Knetsch did not consider the quantitative evaluation as the sole

⁴²Paul Davidson, "The Valuation of Public Goods" (Paper presented at a conference on the Social Sciences and the Quality of the Environment sponsored by the Environmental Science Service Administration of the U.S. Department of Commerce and the University of Colorado at Boulder, Colorado, January 31 - February 2, 1967), p. 39.

⁴³Irving K. Fox and Orris C. Herfindahl, "Attainment of Efficiency in Satisfying Demands for Water," American Economic Review (May 1964), p. 206.

determinant of use as it seldom is with any resource.⁴⁴ Ciriacy-Wantrup acknowledged that decisions by the government concerning resource development are essentially political rather than economic. He continued with another view of the question,

The mere necessity of quantifying makes benefit-cost analysis worth while because of its stimulation effects in expanding scientific understanding of the physical as well as the social problems involved in public resource development.

And again, when speaking of recreational-environmental type benefits, he made the point that even crude and partial measurement is more useful than a disregard for these values.⁴⁵

Much of environmental quality is amenable to partial measurement. There is an element of value in the user-benefiter category that can be evaluated in the willingness-to-pay manner employed on recreation proposals. There may be another element based on the proposition that people would be willing to pay something for the option to avail themselves of the features some time in the future. It is worth something to people to have a particular option--opportunity--kept open to them whether or not they use it. Weisbrod termed this value "option demand."⁴⁶

⁴⁴Jack L. Knetsch, "Outdoor Recreation Demands and Benefits," Land Economics, Vol. XXXIX, No. 4 (November 1963), p. 396.

⁴⁵S. V. Ciriacy-Wantrup, "Benefit Cost Analysis and Public Resource Development," Journal of Farm Economics (November 1955), pp. 676-81.

⁴⁶Burton Weisbrod, "Collective Consumption," Quarterly Journal of Economics (August 1964), p. 472.

A third element of value was suggested by Krutilla.

An option demand may exist therefore not only among persons currently and prospectively active in the market for the object of the demand, but among others who place a value on the mere existence of biological and/or geomorphological variety and its widespread distribution.⁴⁷

Expansion of the element to include imputed values bequeaths a heritage to future generations. Lowenthal made the point that "Americans build for tomorrow, not for today," and he quoted Francis J. Gravel, "They [Americans] do not love the land of their fathers but they are sincerely attached to that which their children are destined to inherit."⁴⁸ Krutilla pursued projecting the value of natural environments into the future. He explained that in contrast to the means of providing fabricated goods and commercial services, the supply of natural environment is virtually inelastic. Supplies currently available may be preserved, but there are significant limitations on reproducing a natural environment in the future should one fail to preserve it. His contention was that "natural environments will represent irreplaceable assets of appreciating value with the passage of time."⁴⁹

Opportunities exist for action proposals relating to environmental quality. Moreover, bases do exist on which to attempt quantitative evaluations of quality benefits.

⁴⁷John V. Krutilla, "Conservation Reconsidered," American Economic Review (September 1967), p. 781.

⁴⁸Lowenthal, op. cit.

⁴⁹Krutilla, "Conservation Reconsidered," op. cit.

Regional Development

Economic efficiency as a planning objective has reflected the national interest in resource development applied generally to all regions of the country and for all project purposes permitted by statute. Regional development as a planning objective has provided opportunity for additional dimensions to be added to the planning perspective in two ways. One has been to permit the introduction of regional viewpoints and regional ambitions regarding allocation and enjoyment of the region's water resources. The second has permitted focus of federal resource-use goals on a particular region or regions.

Senate Document 97 encouraged the infusion of all viewpoints in planning. The people of the basin, the municipalities, the states and private interests have views to be expressed, heard, considered and, to the extent deemed appropriate by the planning group, incorporated in the formulation of plans.

The regional view might consist solely of views concerning proposed federal development. On the other hand, states with active water resource development programs of their own have firm ideas of the state development goals as they relate to a basin or portion of the state in a basin.

State and regional economic viewpoints in planning have had the intent to influence the allocation of resources and factors to accomplish a regional goal. The people of California became convinced that it was essential for state economic well-being and continued growth that water, abundant in the northern portion of the state, be

made available in the major metropolitan complex in Southern California south of the Tehachapee Mountains.⁵⁰ The federal planning and construction contribution has been in accordance with authorities and cost-sharing provisions applicable nation-wide. Federal planning and construction complements the guiding state plan. Non-federal leadership and financing have been internalized at the state level to redistribute state resource wealth. Texas has developed a water plan by a similar method. Vermont, participating in the Connecticut River Basin Study, has introduced the view that the water resources in Vermont should be developed to support and promote the state's recreation industry.⁵¹

The Pacific Southwest has been a fast growing area. Economic growth and activity have been aided by the mining of ground water and the use of federally subsidized irrigation water.⁵² With the advantage of these externalities, irrigated agriculture has flourished. The region envisioned its future dependent on continuing expansion of its agricultural base and additional water supplies from outside the region have been sought.⁵³ A comprehensive regional water resources study,

⁵⁰Chapin D. Clark, "Northwest-Southwest Water Diversion," Willamette Law Journal, Vol. 3, No. 4 (Fall 1965), p. 237.

⁵¹U.S., Corps of Engineers, Plan of Study, Connecticut River Comprehensive Basin Study (U.S. Army Engineer Division, New England, Waltham, Mass., 1965).

⁵²"Mining" of ground water supplies is a term used to indicate that more of the resource is being used than is being replenished by nature.

⁵³Clark, op. cit., p. 238.

initiated in 1966, may provide additional information concerning relationships between water supply and demand and the growth prospects of the region.⁵⁴ The regional view has come to occupy a growing part of comprehensive planning efforts.

The Missouri River Basin study has represented another comprehensive regional water resources investigation. A regional view in the Missouri Basin has been that efforts must be taken to counter trends showing rural population losses that would appear to jeopardize the rural economic and amenity bases. This regional view has favored exploitation of the region's water and land resources through irrigated agriculture and other programs to counter some of the population trends and hopefully insure future economic viability.⁵⁵

Other instances where regional interest has been identified include the Pacific Northwest, the Tennessee Valley, river basins such as the Wabash and the Potomac and intrastate basin districts, such as the Miami Conservancy District in Ohio and the Pat Harrison Waterways District in Mississippi. In each instance the people in the region have definite views regarding resources. To varying degrees the regions are willing and able to undertake the financial support of plans for resource allocation. Their views have become an integral

⁵⁴For an explanation of the Comprehensive River Basin Program, see League of Women Voters, An Introduction to Comprehensive River Basin Planning: Structure and Strategy (Washington, 1967), p. 4.

⁵⁵See Paul Holm, "Economic Base Study in Relation to Comprehensive Water Resources Planning" (Paper presented before the Missouri Basin Interagency Committee, Bismark, North Dakota, April 14, 1966), pp. 9-12.

part of planning efforts and have provided useful dimensions to the perspectives of welfare relating to the people of the respective regions.

The complementary view of regional development is the federal view. Here, federal programs responsive to national interest and concerned with regional problems are brought to bear. Included in this category have been those programs not authorized or implemented nationally. Resource allocation programs aimed at particular regions have stimulated national development through the establishment of the transcontinental railroad systems, the Homestead Act, and the Reclamation Act among others.⁵⁶ In addition to the Reclamation Act, which has continued to be actively implemented, other federal programs have been initiated where emphasis has been placed on regional resource allocation. These include the Regional Development Commissions, most prominent of which is the Appalachian Regional Commission.⁵⁷ The Reclamation Act was aimed at stimulating settlement, economic activity and regional growth in sparsely settled or underdeveloped regions of the country.⁵⁸ The regional commissions were aimed at some redistribution of national wealth into regions where economic activity has not

⁵⁶The Pacific Railway Act of May 20, 1862, 12 Stat. 392; The Homestead Act of July 2, 1864, Sec 3, 13 Stat. 365; The Reclamation Act of June 17, 1902, 52 Stat. 388, 389, 430 SC 421.

⁵⁷Appalachian Regional Development Act of March 9, 1965, 79 Stat. 5.

⁵⁸For a discussion of the Reclamation Act, see Raymond Moley, What Price Federal Reclamation? (New York: American Enterprise Association, Inc., 1955), p. 6.

kept pace with that of the rest of the country.

Regional development is not synonymous with water resources development. Howe stated that "water resources developments are likely to be poor tools for accelerating regional economic growth if market factor availabilities and other amenities of living are lacking."⁵⁹ What Howe recognized and what was recognized in Section 206(a) of the Appalachian Regional Development Act of 1965 is that water development in proper relationship to other factors can be useful in the efficient economic stimulation of a region. Section 2 of the Appalachian Act referred to the national interest in regional development:

. . . the Appalachian region . . . while abundant in natural resources and rich in potential, lags behind the rest of the nation in its economic growth and . . . its people have not shared properly in the Nation's prosperity, . . .

.

. . . the public investments made in the region under this Act shall be concentrated in areas where there is significant potential for future growth, and where the expected return on public dollars will be the greatest.⁶⁰

The Appalachian Act was at variance with the views of Eckstein and McKean who have indicated that to compensate for all injury would be undesirable because to do so would remove

⁵⁹Charles W. Howe, "Water Resources and Regional Economic Growth in the United States 1950-1960, Southern Economic Journal, Vol. XXXIV, No. 4 (April 1968), p. 28.

⁶⁰Appalachian Regional Development Act, op. cit.

motivations for desirable readjustment.⁶¹ The Act acknowledged impediments to factor mobility and social values involved in maintaining some degree of interregional economic parity.⁶²

Regional development differs from economic efficiency as an objective in river basin planning in several respects. The first of these is that economic efficiency planning contemplates meeting projected economic demand. This demand, or the "needs of the basin" as they are commonly expressed, are calculated on the basis of growth, demographic and economic, based on assumptions for the region in relation to the nation as a whole. One assumption of the projection model is that water will not be a factor to accelerate or retard growth. Another assumption is that regional trends observed in the past will continue to influence regional development and growth. Development goals may differ from the normalized demographic and economic activity projections. If goals are set to achieve higher population targets or economic activity levels, different quantities, qualities, or uses of the water resource may be indicated.

Regional development analysis also seeks to determine favorable factors for growth and the role water development could have to facilitate the growth. The availability of labor, educational and other

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In this case outmigration to regions where labor presumably could be more gainfully and economically employed.

⁶²Otto Eckstein, Water Resources Development: The Economics of Project Evaluation (Cambridge: Harvard University Press, 1961), p. 33; and Roland N. McKean, Efficiency in Government Through Systems Analysis (New York: John Wiley and Sons, Inc., 1958), p. 138.

amenity resources, communication systems, raw materials and markets are properly brought into the analysis. If factors other than water development are essential for growth, plans indicate how they will be provided.

An example is the case of the Salyersville project, the first Appalachian Report project proposed by the Corps of Engineers. The town of Salyersville appeared upon study to have potential for growth. Salyersville had considerable unemployed labor, little industry; it was a center of a depressed rural area; rail and road transportation networks were adequate; and the land was either flood prone or too steep for economical development. Analysis indicated that the prime impediment to growth was lack of land developable by industry. A project system was devised that primarily would protect the flood plain although other project purposes would be served. On bases of present values and conventional economic efficiency project justification, the project would not have been acceptable. The investment package that was proposed, however, was estimated to foster subsequent private investment estimated in a ratio of about six private dollars to one public dollar for the initial project proposal. Additional benefits would be gained from the wages paid by new industry. The water development proposal could not claim all the benefits, but the water factor was considered key to future growth.⁶³

⁶³U.S., Corps of Engineers, Interim Survey Report on Upper Licking Basin, Kentucky, for Water Resource and Related Economic Development (U.S. Army Engineer District, Louisville, July 1967 with revision January 1968).

The Salyersville plan is one type of regional development proposal. Common to all is an approach to project economics somewhat different from that used for other objectives. Wages and property values may not reflect true opportunity costs; secondary expansion effects, not usually counted as of national significance, can loom large in project justification.

The Salyersville plan is an illustration of one approach to considering regional development in water resources planning. Implicitly or explicitly, regional development proposals are income redistributational in purpose.⁶⁴ The Salyersville proposal is part of the water resources development proposed for Appalachia, a national program diverting income to a region. By design, the proposal is aimed, within the region, to divert income to a particular class of people--the un- and underemployed people of the Salyersville area. This was an attempt to maximize returns in an efficient manner to a locality in accordance with criteria established in response to a national goal for a region. The Salyersville proposal is responsive in much the same way that individual water resources project proposals optimize response to point demands in accordance with nationwide water programs. For the locality, it was an attempt to expand the efficiency considerations to a larger view of welfare. To do this generally in a planning effort, it has appeared necessary to

⁶⁴At least to the degree that those that benefit do not pay the costs of a project, any project has income redistributational effects. Haveman, op. cit., has examined a number of aspects of this problem.

make explicit the objective by describing the criteria to be used. Wealth or income (national or regional) redistributive effects could be an important dimension to the overall general welfare objective in water resources development.

Other Pertinent Objectives

Objectives, other than those above, are suggested and incorporated in water resources development plans. These objectives have been less broadly applicable, but merit interpretation.

Acceptability.⁶⁵ Presumably the inauguration of a planning effort presupposes needs served by water resources development may exist. In that the planning effort has a cost in planner time and effort--time and effort that could be expended elsewhere--it is desirable that the work be useful and find a degree of acceptability with the people affected locally, and, through the higher review levels, nationally. The objective of acceptability is implicit in the planning process, but not as an end in itself. Concern for acceptability explains, in part, public hearings and public information efforts throughout the planning process. Concern for acceptability also explains recognition by the planners of the policies, procedures and authorities under which they work.

National Defense. National defense is not likely to be an objective of a regional planning effort. Defense considerations,

⁶⁵ Acceptability was discussed as an objective in U.S., Department of the Army, Susquehanna River Basin Study Plan, A Review of Alternatives (Washington, November 30, 1966), p. 7.

however, may enter into formulation, decision and design procedures. Defense considerations could take the form of discouraging the further concentration of industry, encouraging industry dispersal, concern over the proximity of projects to defense installations, the development of alternative modes or routes of communication and the development of alternate sources of various natural resources.

National Self-Sufficiency.⁶⁶ Such an objective could be controlling for a developing nation, but is unlikely to be critical in a highly developed country. National prestige is probably in the same category. The objective might be a factor in a manner similar to national defense in the planning-decision process.

Equity. While not likely to be an objective at the basin level of planning as such, consideration is likely given to the distribution of projects, benefits and costs. Nationally, at least implicit consideration is given to project distribution in relation to population, geographical spread, per capita income and, from the national perspective, needs.

Neutralizing the Urbanization Trend. Congressmen and President Johnson have expressed concern about the increasing migration and concentration of the population in urban areas.⁶⁷ Should national interest in this problem increase and programs be developed in support

⁶⁶See discussion in Marglin, op. cit., pp. 23-24.

⁶⁷See account of speech given by President Lyndon B. Johnson at Dallastown, Pennsylvania in the New York Times, September 4, 1966, p. 50.

of an objective of making non-urban life relatively more attractive, it is likely that such programs would appear as factors in the regional development objective.

Alternative Means of Attaining Objectives

Between knowledge of the physical availability of the resources and the uses to which the resources may be put lies the technological and economic information that ties these two groups of information together. Technological and economic information establish the relationships between input and output and constitutes a second group of alternatives--alternative means of fulfilling a given objective.⁶⁸

There are engineering alternatives. Water quality in a reach of river can be maintained at a particular standard using dilution from an upstream impoundment, or a higher degree of treatment of sewage effluents or in-stream aeration, or diversion of the sewage outfall to a point where the river can better digest the pollution load, or the sewage might be lagooned until flows became sufficient to handle the load locally. There are additional alternatives.

The National Academy of Sciences has identified management and institutional alternatives. An example of management is the employment of reservoirs for flood control as opposed to flood plain regulation. An example of institutions is the use of alternative political institutions for irrigation development, as the Bureau of

⁶⁸See, for example, U.S., Department of the Army, Susquehanna . . . Alternatives, op. cit., p. A-2.

Reclamation or a Conservancy District. The National Academy of Sciences also has investigated alternatives in timing, size and location.⁶⁹

There are many ways of working toward any objective. The greater the amount of knowledge concerning various means of attaining an end, the more likely an efficient solution will be found.

Parameters as They Relate to Objectives

In water resources development certain assumptions are made and values of derived data arbitrarily selected to facilitate the planning process. These constants or parameters are usually assigned values at the outset or early in the planning effort. They are typically based on standards imposed from outside the context of the study problem or based on experience or on the judgment of the participants. The parameters are important because they are assumptions or have arbitrarily assigned values and sometimes their impact on the planning process is overlooked. At some stage of a study it is advisable to examine the parameters to determine whether proper values have been assigned and what the consequences might be if difference values were used. Sensitivity analysis can determine the effect on overall outcome of an arbitrarily assigned value. Some parameters are established by derived data. An appropriate question is what would happen if the data were not correct, or correct so far as determinable, but with some probability of error.

⁶⁹Alternatives in Water Management, op. cit.

Parameters suggested for further examination in water resources planning include the following:

Economic Projections

Projections used in river basin planning extend planning horizons fifty years into the future. Figures on population and economic activity are used to project water use, industry mix, flood plain occupancy, a whole array of benefits, pollution loads and intermediate figures that have a large bearing on the quantities of goods and services provided at points in time. A degree of accuracy may be assumed that does not exist.

Standards and Failure Criteria

Failure criteria for water supply and stream water quality can have significant impact on the nature and magnitude of plan formulations. The insurance requirement against failure may be fixed by regulation or agreement among planners. Additional insurance--tighter failure criteria--might be sufficiently inexpensive at the margin to show economic advantages. On the other hand, it could be that some lower levels of insurance would be accepted because of the differences in costs. Standards are most common for water quality and those usually used in current planning are those approved by the state under the Federal Water Pollution Control Act.⁷⁰ Often failure criteria are either expressed in absolute terms, as "dissolved oxygen will at

⁷⁰ Federal Water Pollution Control Act of 1965, 75 Stat. 204.

no time be less than 5 mg/l," or are not in a form to be incorporated in the basin planning function, as "not less than 75 per cent saturation during at least 16 hours in any 24-hour period."⁷¹ Stipulation of a standard or a failure criterion eliminates much economic evaluation. The standard or output is achieved through a least cost solution. Pertinent economic questions of what are the costs and benefits, positive and negative, of lower and higher standards and different failure criteria are waived. Without knowledge of the alternatives, the decision maker is in a difficult position for choosing among alternative plans.

Risk and Uncertainty

These are often implicit assumptions. Risk has to do with the probability of a specified event occurring--the likelihood of a flood of a given magnitude occurring at any particular time. The ramifications of taking or avoiding a particular risk may be analyzed. Uncertainty relates to unanticipated changes that may take place in the future. The possibilities of technological advances being made would fall in this category. It is often possible to delay certain decisions until an improved state of knowledge is attained. The urgency of a need may make it necessary to take action regardless of possible future changes. Analyses can be useful in clarifying the effects of various alternative actions.

⁷¹For example, see Commonwealth of Massachusetts, Water Resource Commission, Water Quality Standards (March 6, 1967), p. 58.

Difficulties in Employing Multiple Objectives in Planning

"Best use," "well-being" or "welfare" as goals or overall objectives of a plan for water resources development face severe tests as the planning process moves into its final stages. Implicit in quantitative approaches to welfare theory is that a welfare optimum should be sought. In water resources project or systems design, the desideratum is maximization of net benefits. To the extent that benefit functions and criteria support an objective, maximization is theoretically possible.

Multiple-Objective Planning in Current Literature

In the case of the multiple-objective function suggested by Marglin and extended by Maass, constraints to the efficiency maximum might be established to provide some specified satisfaction of other objectives.⁷² If each objective were complemented adequately by its own benefit functions, quantitative optimization would be possible. The difficulty is in the establishment of appropriate and agreeable weights that set the constraint diverting some "efficiency" to other objectives. The Maass extension suggested that the federal government could establish, in advance of planning, the weights relating to objectives. While such an approach may be feasible, the political decision-making process in water resources development has given little indication of movement in that direction.

Contemplating this problem, Hufschmidt observed that finding

⁷²Marglin, op. cit., and Maass, op. cit.

the right weights was the major limitation of the multiple-objective system-maximization approach. As an alternative, Hufschmidt suggested an iterative approach changing weights and starting over when the outcome was not acceptable to the decision makers.⁷³ It would be a cumbersome approach to quantitative maximization of a system moving from the planner to the decision makers and back again, but it may be a fair approximation of what actually takes place in any event.

Hufschmidt's solution appears to be somewhere between that of Marglin, mentioned above, and that of the National Academy of Sciences (NAS) for the Colorado River. In the NAS method, a broad array of possibilities would be presented to the decision makers and guidance or a course of action sought. An obvious problem in the case of providing decision makers with a very broad array of alternatives is that of the breadth of knowledge required to understand and properly evaluate the many alternatives. Even assuming such knowledge existed or could be imparted, there is also the problem of reaching consensus or voting for one among a number of alternatives. In a second phase, the NAS method would have the planners then concentrate on courses of action based on public and policy-maker response.⁷⁴ The NAS report employs a non-quantified approximation of social welfare optimization through political determination of the social preference function. The welfare value of providing the expanded area of choice was noted

⁷³Hufschmidt, "Environmental Planning," op. cit., pp. 21-23.

⁷⁴Colorado Choices, op. cit.

by Mishan and discussed earlier.

The difficulties of reaching a unique welfare optimum, particularly arrived at quantitatively through a single mathematical objective function, are apparent. As discussed earlier, evidence of social preference does exist, however. In each of the approaches discussed above, the intent is to bring the available possibilities into a confrontation with the wishes of society as expressed by a social preference function for the purposes of an implementable solution.

There are other factors which tend to work against precision in the planning process. Whereas these impediments to arriving at a welfare maximum may be accentuated when multiple objectives are employed in planning, they are present in more conventional planning approaches.

Benefit-Cost Analysis and Multiple Objectives

Benefit-cost analysis, despite the attention to which it has been subject and from which it has benefited in recent decades, still lacks precision.⁷⁵ Direct costs of construction can be estimated with reasonable accuracy and yet the construction agencies are often criticized for underestimation in project costs.⁷⁶ The detail into which an agency can go for cost estimates in the planning stage is one part

⁷⁵An extensive critique of benefit-cost analysis as it evolved and is practiced is contained in R.J. Hammond, Benefit-Cost Analysis and Water Pollution Control (Stanford University, 1960).

⁷⁶See for example "Cost Estimates" (Paper prepared by Jacques Gerin as part of study being undertaken at the University of North Carolina, Chapel Hill, 1968). (Mimeographed.)

of the problem. A larger part of the problem is that from plan formulation to construction there is an elapsed period of from six to fifteen years. Not only do prices tend to rise, but sites are occupied for other purposes and real estate acquisition costs rise particularly fast as a result. And cost estimating is the area where the greatest precision in evaluation may be expected.

Estimation of economic costs or opportunity costs in terms of alternative planned as well as unplanned development, though not new in concept, is not in common practice. For example, the financial cost of acquiring a reservoir site may not fairly approximate the value of the site in terms of environmental quality. In the same sense, acquisition costs of a site for environmental purposes may not consider the impact on the region for future development.

Benefits and benefit functions are similarly imprecise. Primary benefits can be rough approximations and, in cases, arbitrary in selection. The value, pattern, and utility of future flood plain development are conjectural. The damages that might be anticipated by varying levels of flood waters in the dynamic future would be estimated with less certainty. The social value of some assurance of freedom from risk of flood and the availability to a region of developable flood plain land are more difficult to estimate. Benefits for meeting water quality standards are based on least cost alternatives. Benefit methodology for navigation improvements is guided by Congressional statute. Benefit definition for other project purposes is comparably

imprecise.⁷⁷ All of the benefit purposes cited are considered in quantifying the economic efficiency objective.⁷⁸

The economics of environmental quality is in its infancy although from the work of Kneese and others the theoretical rudiments are available for practical application.⁷⁹ Benefit evaluation in the area of regional development has been researched and is being pioneered in practice by the Office of Appalachian Studies for water resources development in Appalachia under the Appalachian Regional Development Act of 1965.⁸⁰ The Salyersville project was discussed earlier. Though regional benefits have been quantified in this case, they are not commensurable at this time with economic efficiency benefits. The lack of benefit commensurability among planning objectives presents another type of problem for quantifying welfare optima in systems. These problems appear amenable to economic research and analysis and continued upgrading of technique and methodology can be anticipated.

Cost Sharing

Another economic problem is institutional in origin. In market

⁷⁷Hammond, op. cit., pp. 17-38.

⁷⁸For a good discussion of the benefit calculation problem as it relates to basin planning, see Davis, op. cit.

⁷⁹Allen V. Kneese, "Economics and the Quality of the Environment--Some Empirical Experiences"(Reprint No. 71. Washington: Resources for the Future, Inc., 1968), reprinted with permission from Maurice E. Garnsey and James N. Hibbs (eds.), Social Science and the Environment (Colorado: University of Colorado Press, 1967).

⁸⁰Appalachian Regional Development Act, op. cit.

terms, resources are efficiently allocated when their values are accurately reflected in the market. No more of a resource is used than its opportunity cost in another use can justify. If the value to a user is other than that reflected by the market, an externality exists and either more or less of the resource is used than would be economically efficient. The user of the resource will use as much of the resource as will bring it into balance with resources for which he must pay market prices. In one form, this is the problem of subsidized water for irrigation leading to inefficient use of the water resource. Efficiency on the part of the irrigator--maximizing his return from water in relation to its cost to him--calls for inefficient resource allocation in market terms. This is a divergence between private and social costs and gains. The advantage given the irrigator could, of course, be the intended consequence of a government policy of supplying water at a particular less-than-market price.

A similar situation pertains when a user or benefiter attempts to maximize his returns when confronted with federal, and probably state, cost-sharing policies.

Federal involvement in water resources planning has expanded over the years as federal interest in water use and federal funds for planning and development have expanded. Each legislative enactment formalizing an additional or modified line of federal interest has been the product of its time and the political climate. Federal support --the federal share of an investment--for development may vary from essentially one hundred per cent for some types of flood protection to

fifty per cent of separable project costs for recreation to none of the allocated costs of water supply. There is no federal financial support of a single purpose recreation reservoir or for a program to preserve sites for future reservoir development. The costs of a dam for flood control are essentially wholly borne by the federal government. Local flood protection requires the recipients to provide land, easements, rights of way and maintenance. Flood plain zoning, flood insurance, and flood proofing shift the financial burden further. A similar spread exists in water quality improvement through dilution as opposed to advanced waste treatment or in-stream aeration.⁸¹

Completely objective planning directed toward the most efficient allocation of resources, natural and capital, by interested parties could hardly be hoped for. Interested parties can be expected to attempt to maximize their returns. In this case, local and state participation might be expected to prefer project proposals or plans that would return the greatest benefit with the least amount of local or state funds invested. Implementation by interested parties of a plan developed by disinterested planners seems hardly more likely. A goal of internalizing the problem at some appropriate level appears but a future possibility. For the present, it appears a clear presentation of the relevant alternatives and costs to those responsible for

⁸¹Current literature offers few comments on the cost-sharing problem. For an analysis of the problem in the Potomac Basin see Davis, op. cit.

decisions and policy may be an interim answer.⁸²

The Discount Rate

A similar institutional problem obtains with regard to the inter-temporal aspects of resource allocation. Too many contributions are found in the literature to attempt more than casual observation in this paper. Resorting to the market for efficient resource allocation would indicate some approach toward selection of an appropriate private discount rate--means of relating the trade-off between present and future consumption. Government intervention in water resources allocation is rationalized on the divergence between social or public and private values. In this case, social purposes may be considered to be served by the diversion of resources from the private to the public sector. How this might be accomplished using objectives and benefit functions has been discussed. This may also be accomplished for desired objectives by using a social rate of time preference that would be arrived at differently than the market or private discount rate. Arrow has observed that selection of the discount rate involves value judgments and that the argument is neither clear nor closed.⁸³

The Role of the Planner vis-a-vis the Policy Makers and the Public

One final complexity to be mentioned is that of the emphasis to

⁸²The problem of cost sharing is currently being studied by the Water Resources Council.

⁸³Kenneth J. Arrow, "Criteria for Social Investment," Water Resources Research, Vol. 1, No. 1 (First Quarter 1965), p. 8.

by placed on values in the objective function. The selection of the objectives themselves, the supporting criteria, and ultimately what constitutes a benefit are significant in determining the nature of the resulting plan. The question might be posed in terms of who should provide the leadership, the policy makers, the planners, or the people?⁸⁴

Planners can attempt to be responsive to the revealed preferences of the people. Planners can also confine themselves to the guidance provided by the policy makers as in statutes and authorizations.

Planners on the other hand could attempt an independent role of their own in planning. As discussed earlier, the social preference function is operative when choices are made. The policy makers, the planners and the public all have important roles to play in the function when it becomes operative in the planning-development situation. It is the role of the policy makers to provide a continuously evolving view of national social interest in water resources allocation. It is the role of the planner to translate general guidance into particular objectives for the study region. In the objectives, the planner synthesizes the preferences of the people and the guidance of the policy makers. In this way the social preference function develops with elements of what the people feel they want for the region, what the policy makers or planners feel would be good for the region--merit wants, perhaps, that the people would want were they better educated

⁸⁴Maynard Hufschmidt discusses some aspects of this question in terms of the objective function in his mimeograph, "Environmental Planning," op. cit., pp. 29-30.

to their needs⁸⁵--and what the policy makers have indicated they would be willing to provide for the region.

Hufschmidt considered the essence of the planning problem to be in working out the significant relationships among variables having political, institutional, economic and technological dimensions.⁸⁶ Too strong a role played by any party may result in an imbalance and an unacceptable solution--an infeasible approximation of the social welfare function.

The concept of employing multiple objectives has been discussed in terms of how water resources planning practice might be expanded to facilitate approximation of a welfare optimum through the planning process. There are factors that work against precision in planning, however, and these may be accentuated when multiple objectives are employed in planning.

⁸⁵Musgrave, op. cit., p. 9.

⁸⁶Hufschmidt, op. cit., p. II-1.

CHAPTER V

THE SUSQUEHANNA CASE

The Susquehanna River Basin study was initiated as a comprehensive water resources study of a major river basin employing the planning model described in Chapter II. Subsequently, explicit consideration was given to multiple planning objectives. The study provides an opportunity to review certain of the concepts discussed in Chapters III and IV as they may be applied in practical experience.

The Susquehanna Study

A major federal program of water studies was initiated in 1962. The program had its origin in a recommendation of the President's Water Resources Policy Commission of 1950 urging comprehensive multiple-purpose and coordinated plans for each of the major river basins of the country.¹ The program was in direct response to the recommendation of the 1961 report of the Senate Select Committee which called for preparation of "plans for comprehensive water development and management for all major river basins in the United States."² The Susquehanna was one of the sixteen river basins selected for detailed comprehensive study.³

¹U.S., Report of the President's Water Resources Policy Commission of 1950, Vol. I, A Water Policy for the American People (Washington: Government Printing Office, 1950), pp. 10-17.

²U.S., Report of the Senate Select Committee on National Water Resources, No. 29 (Washington: Government Printing Office, 1961), p. 17.

³U.S., Water Resources Council, Background Materials Regarding Comprehensive Planning Program for Use by the WRC Member Agencies in Preparing Testimony for Appropriations Hearings (Washington, March 1, 1967).

Funding and organizational efforts for the Susquehanna River study were begun in July of 1962 and the initial meeting of the study coordination group was held in June 1963 in Harrisburg, Pennsylvania. The purpose of the study was to "provide an appraisal of the basin's economic future and of present and future water and related land resources development needs and potentials." This information would provide the basis for development of a general guide to future action programs meeting needs to the year 2020 and, in particular, recommendations for initial implementation of economically feasible projects needed in the ensuing ten to fifteen years.⁴ The total estimated federal cost of the study was close to five million dollars. All on-going and completed studies of the states, federal agencies and others were to be considered. The study was scheduled to be completed in June of 1970.

The Basin and Its Water Problems

The basin is the largest on the Atlantic Seaboard of the United States with a drainage area of 27,500 square miles. The river has its origin in New York State and flows some 450 miles to the Chesapeake Bay. About eighty per cent of the basin drainage is in Pennsylvania and comprises forty-six per cent of the state. Most of the remainder of the basin is in New York with but a small portion in the state of Maryland.⁵

⁴U.S., Corps of Engineers, Plan of Study, Susquehanna River Basin Study (U.S. Army Engineer District, Baltimore, September 1965), p. 4.

⁵Ibid., pp. 2-3.

Maryland, however, counts on water from the Susquehanna as a major source of the water supply of its largest city, Baltimore. The river also has a major but not too well understood effect on Maryland's most important natural resource, the Chesapeake Bay.

A study of the economic base of the Susquehanna and Chesapeake Basins revealed that the Susquehanna Basin as a whole, and to a more pronounced degree the upper basin, could be expected to increase per capita income from below the national average to about equal to the projected level by the year 2020. (See Table 1) The economic base study provided a major input to the projection of water needs for the future. In preparing the study, in addition to the usual assumptions of no major nuclear conflict or prolonged periods of high level unemployment or inflation, it was also assumed that the "quantity and quality of available water will not be a factor in limiting economic and population growth in the basin areas."⁶ The projections showed the changes that could occur with an adequate supply of water provided; they did not indicate the nature of the changes were water in one or another of its uses to be available, but either in short supply or in greater abundance.

The basin included developed areas exhibiting vigorous economic growth and other areas where various combinations of conditions resulted

⁶ The study was made by the National Planning Association of Washington. It was published and made available for public use in February, 1968. The study will appear as an appendix, "Summary, Economic Base Study, Chesapeake Bay Drainage Basins," to the Susquehanna River Basin report, p. 1.

TABLE 1

SUSQUEHANNA RIVER BASIN STUDY
SUMMARY OF CERTAIN PLANNING PARAMETERS FROM THE
ECONOMIC BASE STUDY

	<u>Population^a</u>		<u>Civilian Employment^a</u>		<u>Per Capita Income^b</u>	
	<u>1960</u>	<u>2020</u>	<u>1960</u>	<u>2020</u>	<u>1960</u>	<u>2020</u>
Nation	180	460	66.7	174.1	2,217	10,539
Susquehanna Basin	3.5	9.5	1.2	3.8	1,952	10,398
Subregions I, II, III	1.46	4.3	.5	1.8	1,820	10,290

^a millions.

^b dollars.

in a depressed economy. About eighty per cent of the basin was in Appalachia as defined in the Appalachian Regional Development Act. Waters of the region varied in quality from Lake Otsego where Coopers-town, New York drew its water supply untreated, to streams such as the Lackawanna where acid mine drainage made the water unfit for use in municipal or industrial water supply without special treatment or by fish or wildlife. Some reaches of the stream had the more common quality problems caused by inadequately treated municipal and industrial wastes. Some coal mining areas exhibited the visual blight of large smoking culm piles adjacent to towns and scars of strip mining operations. There were natural values in the basin of considerable regional importance and two major stretches of the river had been recommended for consideration as designation as national scenic rivers. There did not appear to be any use to which the water resource might be put that would not be considered in developing a plan for the basin.

Organization for Planning

The study, although organized under federal initiative, was intended to be a partnership effort with the states concerned. To that end a coordination group was formed as the Susquehanna River Basin Study Coordinating Committee under the chairmanship of the District Engineer, Baltimore. The Secretaries of the Departments of Agriculture, Commerce, Health Education and Welfare and Interior and the heads of the independent federal agencies of Housing and Home Finance (now the Department of Housing and Urban Development) and the

Federal Power Commission named representatives to the committee. The Department of the Army was represented by the Corps of Engineers through the permanent committee chairman. The governors of each of the states of New York, Pennsylvania and Maryland also named representatives to the committee. The purposes of the committee were to provide the broad guidance and general direction of the study effort, provide the means of introducing and considering the views and needs of the participants, and coordinate the portions of work carried out by the individual states and federal agencies. The committee was assisted by various subcommittees and work groups staffed by the states and agencies participating in the study.⁷

The general approach to planning adhered to the river basin planning model (described earlier in this paper) with a major exception in regard to the treatment of alternatives in planning. The Susquehanna River Basin Study has been singled out for review because it is a major study in which explicit attention was given multiple objectives in planning.

Evolution of Multiple-Objective Planning for the Susquehanna Study

In September 1966, the Secretary of the Army directed the Chief of Engineers to form a task force to review the Susquehanna River Basin Study to determine if the standards recommended by the Civil Works Study Board were being met with respect to the treatment of planning

⁷U.S., Corps of Engineers, Plan of Study, Susquehanna . . ., op. cit., p. 4.

alternatives.⁸ These recommendations were discussed earlier in this paper.⁹ The task force after much discussion concluded that the then current plan of study of the Susquehanna Study would not adequately treat planning alternatives as envisioned by the Civil Works Study Board. The Susquehanna plan of study assured "mainly the formulation of an economic efficiency plan modified by consideration of the objectives of the three states involved, including some consideration of equity and acceptability." The task force also concluded that study objectives, identified in the plan of study, of regional development, economic efficiency and preservation appeared "to be sufficiently varied and fundamentally different to offer an adequate basis for discussion and choice" provided plans were developed in pursuit of each objective that were in equal detail.

Another conclusion of the task force was that a listing of second level alternatives--alternative means of meeting various water-related problems--should be developed, expanded upon and considered when the means for solving the various water problems identified in the study were treated in formulating the plan.¹⁰

⁸ U.S., Department of the Army, Memorandum from the Special Assistant to the Secretary of the Army for Civil Functions to the Chief of Engineers, September 28, 1966.

⁹ U.S., Department of the Army, A Report to the Secretary of the Army by the Civil Works Study Board (Washington: Government Printing Office, 1966), p. 8.

¹⁰ U.S., Department of the Army, Susquehanna River Basin Study Plan, A Review of Alternatives (Washington, November 30, 1966), p. 8.

The task force report was completed in November 1966 and revised in April 1967. The findings of the task force were first presented to the Susquehanna Study Coordinating Committee on April 17, 1967.¹¹ By letter in July of 1967 the chairman of the coordinating committee proposed to each of the study participants that the task force finding with regard to the treatment of alternatives be adopted by the committee for the Susquehanna study. The letter proposed formulation of a demonstration or base plan for the basin--this would be a least-cost, but conventionally formulated plan to meet the study-developed needs of the basin. Further, it was proposed that the base plan would be modified to meet each of the three objectives of economic efficiency, regional development and what was then termed environmental control. A separate plan would be developed in support of each of the three defined objectives. The concluding step in plan formulation would be selection by the coordinating committee of a plan formulated from features of the three single objective plans and presented in the final study report in its relationship to the other three plans.¹² The letter of the District Engineer also proposed schedule and work

¹¹ Susquehanna River Basin Study Coordinating Committee, Minutes, meeting, Williamsport, Pa., April 17, 1967. The Office of Record for papers relating to the Susquehanna River Basin Study is the office of the chairman of the coordinating committee, U.S. Army Engineer District, Baltimore; hereinafter papers cited as "Susquehanna River Basin Study."

¹² No mention was made of criteria by which the features for the coordinating committee plan would be selected from the three single objective plans.

plan modifications that would accommodate the proposal.¹³ Response to the letter was inconclusive.

At the next coordinating committee meeting, the chairman pressed for adoption of the study approach proposed in the letter of July 7. There was considerable discussion and differences of opinion among the committee members. One question raised was whether it was worth while spending time developing three plans when only one, that of regional development, was likely to be acceptable in the basin. Another point made was that a broad array of alternatives could be confusing to the public and disruptive when it came time to seek support of a recommended course of action. Consensus was finally reached that the three-plan approach would be applied to three sub-basins. It was agreed that when the plans had been formulated the coordinating committee would review the work of the plan formulation work group and consider, at that time, the extension of the approach to the entire basin.¹⁴

Baltimore District of the Corps of Engineers, and later the other study participants, working during the winter and spring of 1968 developed tentative criteria in support of the objectives and separate plans for each of three sub-basins. The plans were presented to the coordinating committee on May 16, 1968 in general terms, stressing the criteria and objectives rather than the details of the plans that were supported in rather sketchy detail. Considerable discussion ensued and

¹³Letter dated July 7, 1967, from the District Engineer, U.S. Army Engineer District, Baltimore, to each study participant.

¹⁴Susquehanna River Basin Coordinating Committee, memorandum, meeting, Baltimore, September 21, 1967.

the points raised earlier brought up again. Objection was made to identifying the proposals in support of each of the planning objectives when it was contended they were not plans that could be implemented. Response to this point was mixed. Feeling had generally shifted toward accepting the three-objective approach as a planning tool. There was still objection to the presentation of the three plans in the final study report. It was accepted as consensus, however, that the plan formulation group could continue the three-plan approach and in addition develop, for presentation to the coordinating committee, a proposal for a combined plan incorporating some preferred features of each. No method or criteria for formulating the combined plan was specified. Decision on the manner of presentation of the combined plan was deferred.¹⁵ It was clear that the novel approach was acceptable at least for plan formulation purposes. It was also clear that the dialogue would continue as the study progressed.

Susquehanna Multiple-Objective Planning Model

Objectives and Criteria for the Susquehanna Study

The Susquehanna Study Group at Baltimore District with some outside assistance defined the objectives for the multiple-objective approach to planning proposed for use in the Susquehanna River Basin study. The definitions of the objectives were working definitions and assumed to be subject to modification in the course of the study.

¹⁵ Notes made by author, Susquehanna River Basin Coordinating Committee meeting, Baltimore, May 16, 1968.

Criteria in support of the objectives, as defined, were also prepared. The material was developed for the information of the coordinating committee and use at the committee meeting of May 17, 1968. The coordinating committee did not take definitive action on the multiple-objective approach to planning at the meeting. The material developed was accepted for use as guidance for the plan formulation work group that was assigned the responsibility for completing the three objective-three plan planning approach.

Economic Efficiency Planning

The economic efficiency objective was defined for the coordinating committee: "Return the maximum in social and economic satisfaction through investment in water resource restoration and development from the viewpoint of the nation as a whole."¹⁶ Other documents amplified the definition. The plan was to attempt to maximize net national benefits.¹⁷ "The plan will constitute a benchmark against which other plans . . . can be evaluated."¹⁸ The plan might include some features of plans in support of other objectives to the extent that such features were considered to be a national objective or in the

¹⁶"Planning Objectives," Susquehanna River Basin Study, working paper, May 16, 1968.

¹⁷U.S., Corps of Engineers, memorandum, meeting to discuss Plan Formulations and Data, NANEN-B, March 26, 1968, U.S. Army Engineer District, Baltimore.

¹⁸U.S., Department of the Army, Susquehanna . . . Alternatives, op. cit., p. 6.

national interest. In deciding what should be included or excluded, value judgments would have to be made by the planners.

The quantitative economic criteria set forth in Senate Document 97 would apply as they do to all comprehensive plans:

- (a) Tangible benefits exceed project economic costs.
- (b) Each separable unit or purpose provides benefits at least equal to its costs.
- (c) The scope of development is such as to provide the maximum net benefits.
- (d) There is no more economical means evaluated on a comparable basis of accomplishing the same purpose or purposes which would be precluded from development if the plan were undertaken. The limitation refers only to those alternative possibilities that would be physically displaced or economically precluded from development if the project is undertaken.¹⁹

Although the provisions of all portions of Senate Document 97 were expected to apply to all comprehensive studies, the Susquehanna approach to planning reflected the viewpoint that the objectives of Senate Document 97 could best be met by separating the specific objectives for working purposes. The final plan, to which the economic efficiency plan would contribute, would comply generally with Senate Document 97 objectives.

General criteria for economic efficiency plan formulation by purposes were as follows:

General - Provide for the year 2020 water-based requirements with net national benefits at a maximum.

¹⁹U.S., President's Water Resources Council, Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources, printed as Senate Document 97 (Washington: Government Printing Office, 1962), p. 7.

Water Supply - Select the most economical means within a system to reduce failure of supply to one 7-day period in 25 years.

Water Quality - Select the most economical means within a system to maintain a quality standard of 5 mg/l of dissolved oxygen with one 30-day period of failure in 20 years.

Mine drainage disturbances - Select the most economical corrective measures to the limit of economic justification within a disturbed watershed.

Outdoor recreation - Select the most economical means within a sub-basin system, without specific regard to location.

Flood control - Select the optimum means within a system to reduce recurring flood damage.²⁰

The water-based "requirements" referred to in the "General" paragraph of the criteria refer to commonly termed planning "needs." The failure criterion for water supply and the failure criterion and standard for water quality were stated to largely remove them from economic consideration. Davis in his work on the Potomac River investigated several water quality standards for costs and concluded that such analysis provided a useful basis for making decisions.²¹ Terms such as "limit of economic justification" and "optimum means" were indicative of intent but were inadequate for quantitative evaluation without further definition or the application of judgment by the planner.

²⁰"General Criteria for Plan Formulation," Susquehanna River Basin Study, working paper, May 17, 1968.

²¹Robert K. Davis, The Range of Choice in Water Resource Management: A Study of the Potomac Estuary (Washington: Resources for the Future, Inc., 1968).

Only the criterion for meeting outdoor recreation needs was, in fact, expressed in definitive economic terms.

Regional Development Planning

Regional development as a planning objective was defined:

"Return the maximum in social and economic satisfaction through investment in water resource restoration and development from the viewpoint of the Susquehanna River Basin."²²

The general criteria for plan formulation are similar to those for the economic efficiency objective but with significant modifications:

General - Provide for the year 2020 water-based requirements with net total benefits at a maximum.

Water Supply - Select the most economical means in a system to reduce failure of supply to one 7-day period in 25 years, but with greater flexibility and reliability at the growth centers.

Water Quality - Select the most economical means in a system to maintain a quality standard of 5 mg/l of dissolved oxygen. One 30-day period of failure in 20 years, but with greater flexibility and reliability at the growth centers.

Mine drainage disturbances - Select the most economical and effective measures to restore adequate water quality at growth centers and potential recreation complexes within a watershed.

Outdoor recreation - Select the most economical means within a sub-basin system with particular attention to location of growth centers and recreation complexes.

Flood control - Select the optimum means within a system

²²"Planning Objectives," op. cit.

to reduce recurring flood damages with particular attention to growth complexes.²³

Regional development as an objective was intended to be defined by the regional study participants to be responsive to what were believed to be regional needs and aspirations.²⁴ At coordinating committee meetings, New York State representatives promoted development of the southern tier of the state and, in any particular project, maximum physical utilization made of any storage site selected. Pennsylvania representatives promoted recreational development of the state's northern tier. The state objective appeared to be to make this region an attractive recreation area that would be utilized by persons from other parts of the state and adjacent states and by so doing stimulate economic growth in the region. In neither case was there discussion of the degree to which projects would be supported by state funds beyond the point that was found to be economically efficient. Maryland was known to have concern for the Chesapeake Bay and a desire for development of the Susquehanna River that would preserve and enhance the resources--sport and commercial fishing, scenic attractiveness, and the like--of the bay. These views had never been formalized, and at the May 17 meeting of the coordinating committee, the chairman requested formal statements of state regional interest be prepared. It was evident, however, from the

²³"General Criteria," op. cit.

²⁴U.S., Department of the Army, Susquehanna . . . Alternatives, op. cit., p. 4.

discussion that interest was strong in applying whatever criteria were developed for use elsewhere in Appalachia to water resources projects in the Susquehanna Basin.²⁵

The criteria for regional development planning did reflect the Appalachian influence. There was evident concern with what were considered growth centers and the desirability of facilitating growth at those points by water development. The term "total benefits" included both regional and national benefits. No method of assessing benefits had been adopted by the coordinating committee. The Salyersville project which was considered a prototype for the use of expansion benefits had not yet been acted upon by the Congress.²⁶ An approach similar to that employed in evaluating the potential benefits for the Salyersville area was being developed by Baltimore District and would apparently form the basis for the approach to the regional objective.

Earlier discussions of the objectives differentiated between regional development, which was considered to focus on long-term improvements in regional economics, and income redistribution. Income redistribution was considered to be a more equitable distribution of national income through the evaluation of regional benefits as national,

²⁵Notes made by author, Susquehanna River Basin Coordination Committee Meeting, Baltimore, July 16, 1968.

²⁶U.S., Corps of Engineers, Interim Survey Report on Upper Licking Basin, Kentucky for Water Resources and Related Economic Development (U.S. Army Engineer District, Louisville, July 1967 and revised January 1968). Hereinafter cited as "Salyersville."

or favorable cost-sharing policies, but with more immediate or short-range effects predominant.²⁷ The criteria again were indicative of intent, but gave vague economic directions and required further definition for rigorous application. The use of terms such as "greater flexibility and reliability" and "particular attention to growth centers" was desirable guidance but difficult to quantify.

Environmental Quality Planning

Environmental quality was defined: "return the maximum in social and economic satisfaction through investment in water resources restoration and development, with emphasis on minimum disturbance of the natural environment and on restoration and enhancement of environmental and aesthetic values."²⁸

The general criteria again were based on those for economic efficiency, but with emphasis on not encroaching on what might be considered natural values:

General - Provide for the year 2020 water-based requirements without loss of important cultural scenic values, and with net improvement to the existing environment.

Water Supply - Select the most compatible means in a system to reduce failure of supply to one 7-day period in 25 years. Emphasis on groundwater and pipelines.

Water Quality - Select the most compatible means in a system to maintain a quality standard of 5 mg/l of dissolved oxygen with one 30-day period of failure in 20 years.

²⁷U.S., Department of the Army, Susquehanna . . . Alternatives, op. cit., p. 7.

²⁸"Planning Objectives," op. cit.

Emphasis on advanced waste treatment together with flow augmentation.

Mine drainage disturbances - Select the most economical and effective means of restoring all waters of the basin, as well as disturbed surface areas, to an acceptable quality standard.

Outdoor recreation - Select only those measures that are compatible with the objective statement with particular emphasis on use of existing recreation resources within their capability.

Flood control - Select the optimum means compatible with the objective statement, with particular emphasis on local programs and improved flood plain management.²⁹

Additional criteria were used in actually formulating draft quality plans for the first three sub-basins.

a) Water Supply - needs will be met by use of ground water or pipeline; streamflow will be augmented only if storage is compatible.

b) Water Quality - needs will be met by advanced waste treatment; interceptor sewers only if distance is short and discharge is into much larger stream; flow augmentation only if storage is compatible.

c) Recreation - emphasis on use of existing streams for water-oriented recreation facilities through improved access, fibre dams and flow augmentation; provide storage only where compatible.

d) Mine drainage - treat drainage sources adequately to restore streams to state quality standards.

e) Flood control - storage only as part of a compatible reservoir; local flood protection if compatible; no high levees or flood walls that reduce scenic values; no paved channels; reliance on headwater efforts and flood plain management measures primarily.

²⁹ "General Criteria," op. cit.

f) Reservoir compatibility criteria - no conflict with wild or scenic rivers; no trout or other high natural value streams lost; minimize agricultural impact and loss of other cultural values; location of storage should augment flow for recreation, fishing, scenic uses, pollution abatement.³⁰

The criteria were primarily concerned with how certain stipulated needs were to be met. The notion of saying just what were the natural values not to be encroached upon or identifying specific areas of notable value had not yet entered the criteria. Nor had the idea of ranking projects according to merit been introduced.

In an effort to obtain a better grasp of the environmental question in the basin, the National Park Service of the Department of the Interior had initiated studies covering historical values of the basin. A member of the Susquehanna Planning Group was working to synthesize the findings of the various studies made for the Park Service and develop better understanding of the basin's environmental values.³¹

Multiple-Objective Plan Formulation

Plan Formulation Rationale

In the formulation of each of the objective-related plans for the Susquehanna River sub-basin, the same study-developed basin "needs" for water-related goods and services were taken as "given." Using the

³⁰ Notes made by author, Plan Formulation Workshop Meeting, March 14, 1968, Baltimore District Office, Corps of Engineers.

³¹ Paul Danis, U.S. Army Engineer District, Baltimore, produced a working paper, "Environmental Quality," and was in the process of developing an inventory of environmental quality features.

criteria associated with the three selected objectives, each plan was developed to meet, to some degree, this single set of basin needs. One advantage was that a common basis for comparison was available among the three plans. A common basis for comparison could become quite important as plan formulation rapidly became complicated, particularly as the basin or sub-basin was operated as a system. A simple sub-basin with many potential storage sites, each with a non-linear storage-cost function being evaluated for perhaps five purposes, rapidly would become too difficult for man or machine to manage without simplifying assumptions. Another advantage of having each plan treat a certain set of basin needs, was that the plans also met a concern expressed by the coordinating committee regarding implementability. Each plan proposed, if implemented, could be said to have met the (given) needs of the basin with regard to water use to some greater or lesser degree.

There were disadvantages to this procedure also. One was the assumption of validity of the particular standard or need. Basin needs were developed from a series of studies, and calculations and each successive study usually had its own explicit or implicit assumptions. The disadvantage of having all plans on a common base was that the basic structural derivation of needs was not questioned. This was not to imply that the structure was necessarily invalid, but it was an approach, a model, and not the only approach or model that might be used. A second disadvantage was that within each plan a number of compromises or trade-offs would have already been made before the single objective plan was brought before the coordinating committee. For instance, in

formulating the environmental quality plan, decisions would necessarily have been made regarding preservation versus development. At the planning staff level, decisions would have been made with regard to preserving a valley or proposing a reservoir or the selection of ground water as a water supply source. The rationalization of these trade-offs--the valley versus the reservoir--could have been explicit and in compliance with agreed-upon criteria, or in response to subjective judgments made at the working staff level. The value judgments and opportunity costs in formulating each plan could thus have been hidden.

"Needs" were developed in the same manner as in conventional planning. The needs at particular planning horizons--say the years 1980, 2000 and 2020 for the usual comprehensive study--indicated projected damage or water requirements. The need projections, conventionally, have been exclusive of economic justification. The needs have indicated solely projected quantities, such as water use. Economic justification for provision of quantities of water or levels of protection must ultimately be analyzed on a project-by-project basis. Need figures for flood control could be average annual damage figures by river reach. For water supply, the need could be a requirement based on current water use and extrapolated in some manner to reflect projected population. While the price of water affects demand, water pricing policies vary widely and possible changes are not usually taken into consideration in the calculation of needs. In the case of water quality, the need might be the storage required to provide flows that would insure sufficient dilution of water-borne wastes--assuming

secondary treatment by municipalities and industry--to meet certain in-stream water quality standards. The need figures are not taken from a demand schedule, but could be assumed to provide one or more points for construction of such a schedule.

Some assumptions are then made with regard to fulfillment of the needs. In the case of water supply and water quality, a failure criteria is established, perhaps arbitrarily. A plan will attempt to meet 100 per cent of the need as qualified by the failure criterion. In the case of flood control or recreation--say flat water boating acres--the need would be met to some degree initially determined by an estimated economic justification. The foregoing is a simplified explanation of "needs," but partially clarifies the intended approach to plan formulation.³²

Analysis and Evaluation of Plans

Demonstration plans were formulated for each of the three upper sub-basins of the Susquehanna River, each approaching the same needs as discussed above. The plans were prepared by the interagency working staff--the plan formulation work group. Each plan was developed in response to its objective function and criteria and reflected the judgment, technical background and knowledge of the planners about the basin. The plans discussed were tentative working plans for the

³²The general approach to various development "needs" can be found in U.S., Department of the Army, Seminar on River Basin Planning (Washington, May 1963). For a more sophisticated statement of the problem see Maass et al., op. cit.

Susquehanna Study; figures were subject to change and, as planning continued, features could be expected to be added or deleted.³³

Economic Efficiency Plans. These plans were formulated to provide the most economic solutions to the identified needs of the basin to the year 2020.³⁴ Solutions were also screened for probable economic justification. The summarized plans are shown in Table 2. The flood plain zoning was that which might be expected with current emphasis on flood plain regulation. Some continuation of development of the flood plain could be expected with consequent increases in flood damages incurred. The inclusion of ground-water well fields, water supply pipe lines and advanced waste treatment facilities gave evidence of a broader approach to economic efficiency than could be supported by existing authorizations of the participating federal construction agencies. Features were included that federal agencies were not authorized to construct. The plans, as presented, were not devoid of consideration for what might have been politically unacceptable or undesirable from the standpoint of quality. In this sense possible

³³All figures and other data used are from Susquehanna River Basin Study Plan Formulation Work Group working papers or meeting notes dated May 15, 1968 or earlier, and previously cited unless otherwise identified.

³⁴It is usual in planning efforts where several planning horizons are employed--the years 1980, 2000 and 2020 in this case--to plan for meeting the needs of the most distant horizon first. Once the longest range needs and ultimate development are known, the shorter-range needs can be phased in at times that appear appropriate from both need and construction and budgetary capability considerations.

TABLE 2

SUSQUEHANNA RIVER BASIN STUDY
SUMMARY FOR PLANS FOR SUB-BASINS I, II AND III^a

Project Type	Economic Efficiency Plan		Regional Development Plan		Environmental Quality Plan	
	Number of Projects	Cost ^b	Number of Projects	Cost ^b	Number of Projects	Cost ^b
Reservoirs (Major) ^c	9	7,805	14	16,820	5	8,040
Reservoirs (Minor)	49	3,900	94	5,180	57	2,635
Ground-water well fields	5	1,465	3	565	7	2,340
Diversion Pipelines	1	2,420	1	2,420	1	2,420
Diversion Sewer lines	--		--		--	
Advanced waste treatment	4	540	3	290	6	770
Mine Drainage Watersheds	2	610	3	5,310	3	7,260
Land Treatment (acres) ^d						
Agricultural	995	2,370	995	2,370	995	2,370
Forest	735	775	735	775	735	775
Pastureland	630	2,210	630	2,210	630	2,210
Reclamation	21	1,055	21	1,055	21	1,055
Bank Stabilization	--		--		--	
Local Flood Protection	--		4	125	1	100
Flood Plain Management	moderate		low to moderate		moderate to intense	
Low (channel) dam use	--		moderate in one sub-basin		moderate to substantial	
Small Urban Recreation	--		--		30	(+)
Total Cost		22,750		37,120		29,975

^aAll figures are tentative.

^bCosts are in thousands of dollars yearly.

^cMajor and minor refer to the size of watershed served.

^dAcres figure in thousands.

damsites in areas where opposition had already been indicated were considered, but not necessarily included. Two major main stem reservoirs which appeared to have possible justification were also not included because they would flood out scenic areas in stretches of river already designated for consideration as national scenic rivers in bills before Congress.³⁵ In one case a possible water demand for out-of-basin use was not considered, nor was possible out-of-sub-basin use for acid mine waste dilution. A summary of basin needs met by each set of plans is shown in Table 3.

A possible "plan" that was discussed but which did not materialize was the zero plan--the situation where no water resource development was undertaken. The development of such a plan or, more accurately, the appraisal of regional effects in the absence of any development plan, would have provided an interesting basis for discussing alternative schemes of development. In the absence of such an approach, the economic efficiency plan appeared as the neutral plan--the plan that would provide the water and water controls assumed in the economic base study projections.

The economic efficiency plan would then provide the basic plan for the development of the river basin. There was some deviation from strict economic efficiency, willingness-to-pay benefit evaluation, but the willingness-to-pay concept is the basis for current federal benefit

³⁵In May 1968, at least eight scenic river bills were being considered by the House of Representatives.

TABLE 3

SUSQUEHANNA RIVER BASIN STUDY
ESTIMATE OF PER CENT OF CERTAIN NEEDS MET BY
PLANS FOR SUB-BASINS I, II & III

	<u>Economic Efficiency Plan</u>	<u>Regional Development Plan</u>	<u>Environmental Quality Plan</u>
Water Quality ^a	100	100	100
Water Supply	100	100	100
Flood Damage Reduction	20	.30	10
Mine Drainage Problems (Reduction to Arbitrary Standard)			
Sub-basin II	40	100	100
Sub-basin III	5	65	100
Recreational Boating	60	100+	35

^aWater Quality and Water Supply needs are met 100 per cent subject to stipulated failure criteria.

estimation practice. The designation of pipelines, ground-water development and advanced waste treatment facilities reflected analysis indicating that these facilities could be provided at a cost less than that of an impoundment. Benefits in these cases would adhere closely to the willingness-to-pay concept as the municipalities face the needs as they arise. The meeting of water quality standards was currently more of a quality than economic efficiency feature. An economic justification for meeting quality standards was not required by current procedures.

The economic efficiency plan was aimed at allocating resources in such a manner as to provide the necessary water for the needs of the future by the most efficient means possible. This was the plan that would provide the adequate supplies and quality of water that were assumed in making the demographic and economic projection for the region.

The means shown in the plans at this stage were comparatively conventional and none of the more esoteric proposals of meeting needs had yet come into play.³⁶ This failure to employ less conventional means to meet needs might be explained at least in part by the paucity of information developed by the planners on costs and effectiveness of these means. More information and possibly more use of other means

³⁶Water quality problems may be approached, for instance, by withholding sewage effluent from the stream during low flows by lagoon-ing, and improving dissolved oxygen levels by mechanical aeration or the introduction of gaseous oxygen among other measures. (See section on Alternative Means of Attaining Objectives in Chapter IV.)

might be forthcoming before plans are finalized.

Mine drainage treatment economically justifiable was included in the efficiency plan. Mine drainage treatment included such work as dilution of acid mine drainage, treatment of the mines themselves to seal off effluent or prevent water intrusion, reclaiming strip mined areas, and culm pile removal. Each of these investments tended to improve environmental quality, but also could provide stream flows more acceptable in quality for industry, municipalities and recreation. Treatment of the mine drainage problem was experimental and costly.

Regional Development Plans. These plans were formulated with the intent to stimulate and facilitate increased regional economic activity. Projects were selected with the intention of providing additional safe reaches in the flood plains for industrial use where additional flood protection appeared potentially helpful in facilitating more rapid economic growth. (In some cases, what was assumed to be normal intensification of flood plain regulation was proposed to be relaxed.) Regional benefits were counted in these plans. As a result, projects became feasible that had been submarginal with only conventional national primary benefits counted. More effort was placed in acid mine drainage rehabilitation to promote economic redevelopment of communities in coal mining areas. Facilities for recreational boating were considered a stimulus to regional economic growth and additional reservoirs were added to provide the ability to meet one hundred per cent of the projected recreation needs of the region (see Table 3).

The regional development plan concentrated on two approaches to facilitate development. Better protection of the flood plain and a relaxation in flood plain zoning were seen to create external effects that would provide more jobs, more income to the region, and higher per capita regional income. In the Salyersville report, good public management of the external effects created was cited as being important to insure the benefits are captured by the region and not appropriated by speculators or as a windfall by industry.³⁷ For maximum usefulness to the region, the flood plain area provided must both be needed for developable land and complemented by unutilized capital or labor factors or by other programs deemed to provide the necessary components for more rapid development. The studies supporting estimates of expansion benefits should attempt to provide this information.

Should the combination of available labor, the transportation system, amenity resources, and available land prove attractive to industry considering the relative (interregional) marginal productivity of capital, the local gainers would include the underemployed labor. The increased earnings and broader employment base would benefit the entire community and the region generally. Although an approach such as this has been fostered under the Appalachian Regional Development Act, some critics questioned whether this was the most efficient means of stimulating regional economic growth. However, with federal and state interest in proceeding on this course, a water program for

³⁷"Salyersville," op. cit., p. 67.

regional assistance was likely to continue until there was legislative indication to the contrary.

The second important approach in the regional development plan was to provide a basis for a recreation industry in Northern Pennsylvania. The area was attractive with many hills but few lakes. The addition of flat water might enhance landscape quality, but would also provide increased recreational opportunities in the region. The plan assumed complementary activity on the part of other programs to improve road transportation and provide amenities to make the area attractive and competitive with other major recreation regions in the East.

As a single plan, the regional development plan appeared to be most carefully formulated in response to the interests of the people in the region. The region (almost all of the three sub-basins were in Appalachia) was considered to be depressed and in need of outside assistance to stimulate economic activity to bring it on a par with other parts of the country. The representatives of the States of New York and Pennsylvania reaffirmed the desirability of stimulating regional economic growth at planning meetings. The states have been aware that the rationale existed for more intensive development--increased diversion of federal funds to the region. The states appeared desirous of capitalizing on the opportunity afforded. Basic cost sharing policies might not be changed, but more liberal repayment terms could enhance the attractiveness of the increased federal

activity.³⁸

The regional development plan supplied some income redistributive perspective to the basin plan. The plans and criteria reflected the absence of general income redistributive goals for water resources programs except as might be imputed to the federal interest in the various water resources development purposes themselves. To the extent of implicit federal interest in income redistribution through the authorization of various project purposes, it was reflected in the economic efficiency planning. Evaluation of the redistributive effects of the projects had not been attempted.

The regional development plans did reflect, however, the particular income redistributive objectives of the federal government with regard to the specific region of Appalachia.³⁹ While planning for this objective did not add a dimension perspective to each project considered, it did add a dimension to the basin planning as a whole. No planning criteria or evaluation standards had been agreed to as yet at the national level and benefit counting and evaluation were tentative. Nevertheless, the higher level of investment in water resources development provided some basis for conjecture. Assuming some validity to the dependency relationship between water resources investment and regional growth as defined for regional development formulation,

³⁸In the Salyersville Report, it was recommended that the non-federal contribution be deferred up to ten years interest free and then repaid over a fifty-year period.

³⁹Over eighty per cent of the Susquehanna Basin is in the Appalachian Region.

conditions assumed for the economic projections would be changed. Economic activity would be greater in the growth and recreation centers. Gross income would be greater than projected. The population increase would probably be greater also. The value of these problematic results would, of course, have to be weighed against the costs of the financial investment and the environmental quality opportunity costs.

Specific state objectives with regard to the region were hazy as noted earlier. Better defined state objectives and criteria would have permitted the planners to be more responsive to this concern in plan formulation.

Environmental Quality Plans. These plans attempted the least disturbance of the countryside--permitted the greatest preservation of natural values. Although all water supply and quality requirements were met, greater reliance was placed on ground water and advanced waste treatment. The flood damage problem was approached through more intensive flood plain regulation, more local flood protection in lieu of impoundment and less damage reduction. With fewer impoundments, less of the recreational boating needs were met although provision was made for increased use of low mainstem fibre-type dams that in raising the water level a few feet would provide additional flat water boating opportunity. Visual blight and water stream quality were considerations in the increased treatment of the mine drainage problem.

The relative benefits of the quality plan were difficult to define. The region as a whole was not densely populated and areas of some natural value were plentiful. However, only a few natural features might have been considered of national or even regional significance. While preservation of natural values generally is considered desirable, it is typically difficult to sell the idea to the inhabitants. The benefits would accrue largely to future inhabitants of the region (or other regions). If the cost of the quality plan were to be counted in terms of (foregone opportunities for) regional development, decision-making at the regional level might be made clearer. This might be particularly true if the costs of development in terms of natural values were made apparent in comparison with the quantity of natural values available.

No means of objective definition of quality features had yet been developed. Quality per se is intangible and susceptible only to subjective evaluation. Environmental features associated with quality, however, could probably be identified. Definitive criteria would be necessary to rank the quality features and develop benefit functions in support of this objective. A basic environmental quality plan might be free of any requirement for meeting other than quality needs. Were this done, it would be possible to develop a complete quality evaluation of the basin. It is necessary to know what is important in a relative, ordinal, scale of value to know the opportunity costs in terms of quality of an alternate proposal for resource use. Until this were done, the development of a quality dimension to the general goal of

best use would be incomplete.

The environmental quality criteria cited earlier were largely preservation-oriented and would fill part of the general criterion needs. The criteria used did not require identification of quality features per se. An obvious lack was the failure to identify or designate stretches of river as scenic rivers in the terms of several bills pending before the Congress. This might imply that there were no river stretches of even regional scenic value, in the eyes of the planners at least, or that the planners did not feel qualified to make a judgment. Neither seemed likely. Few knew the basin with its opportunities and needs as well as the current planners. In absence of recommendations on their part, actions and recommendations for scenic rivers and other natural value features would have to be made by others and decisions made on a fragmentary and piecemeal basis, far from the comprehensive approach to meeting basin needs intended in this study. In addition, as Lewis observed, perhaps ninety per cent or more of the natural values of the basin might be water-related.⁴⁰ Identification of these values that would constitute a possible use or alternative use of the resource was lacking. Should this lack of identification of an important use of the water resource be continued into the final plan, an important welfare dimension to the basin water resource plan would be slighted.

⁴⁰ Upper Mississippi River Comprehensive Basin Study Coordinating Committee, Minutes, 8th Meeting, Des Moines, Iowa, October 1967 (U.S. Army Engineer Division, North Central, Chicago), p. 93.

These cited aspects of the quality plan were being studied and the absence may have been in process of correction. The problem of evaluation criteria was the more difficult in that no method was currently tested and available. The experimental use of any procedure would have value for other planning efforts.

With features identified and a method of evaluation, a more complete environmental plan could have been developed for the basin. The data provided permitted little conjecture beyond the fact that there would be fewer reservoirs and that unit water costs would probably be higher.

The Plans Summarized

The three plans were not formulated with the intent one would be selected and recommended by the coordinating committee. The plans, or trial formulations with a particular objective in mind, were intended to provide choice for the formulation of a plan that the coordinating committee would recommend for the basin. The three plans were to provide the input for that final formulation.

In Table 4 a comparison is made of certain costs and effects of the three plans. While the costs of the efficiency plan and the quality plan are roughly the same for the features compared, the opportunity costs of the quality treatment are lessened flood damage reduction and fewer acres for recreation. In making choices, the related benefits and costs of the alternative actions could be weighed. If the increase in environmental quality could be shown to exceed the anticipated

TABLE 4

SUSQUEHANNA RIVER BASIN STUDY
COMPARISON OF CERTAIN ESTIMATED COSTS AND PER CENT
OF CERTAIN NEEDS MET FOR PLANS FOR SUB-BASINS I, II AND III^a

	<u>Economic Efficiency Plan</u>	<u>Environmental Quality Plan</u>	<u>Regional Development Plan</u>
Costs ^b	13,710	13,885	22,980
Costs net of Efficiency Plan		+175	+9,270
Per Cent Needs Met ^c			
Flood Damage Reduction	20	10	30
Recreational Boating	60	35	100+

^aAll figures are tentative.

^bCosts are in thousands of dollars annually. Costs do not include mine drainage problems or features common to all plans.

^cAll plans meet one hundred per cent of projected water supply and water quality needs. Figures are from Table 3.

benefits of more flood control and more recreation, decisions involving these two alternative plans would be facilitated.

A similar comparison could be made between the regional development plan and the efficiency plan. At greater annual financial cost, more flood control and more recreation are possible. The question to be answered is, would the gains to the region be worth the costs in dollars (investment opportunity) and in quality?

Table 4 does not show benefits that relate to the costs and that would provide more information for making decisions among the alternatives. Benefit data were incomplete for the efficiency plan. Benefit functions for the development and quality plans were under study.⁴¹

While each of the three plans met stipulated water supply and water quality criteria, other needs were met to varying degrees. Together the three plans illustrated some measure of the choices open to the people of the basin and the governmental policy and decision makers.

In general, there was most reservoir storage in the regional development plan, less in the efficiency plan and least in the quality plan. Storage costs allocated for each of the project purposes of flood control, water quality, water supply and recreation would be expected to decrease from the regional to the efficiency to the

⁴¹It is possible that when expansion and quality benefit functions are developed, there will be no common basis for comparing the benefits. A method possibly to be used for plan comparison when benefits have been estimated, but are not commensurable, is discussed later in this chapter.

quality plans, similarly. However, the proportion of the storage for any purpose varies from plan to plan. In the larger reservoirs, flood control storage approached half of the capacity, while in many of the smaller reservoirs, flood control was lacking as a project purpose and recreational use was paramount. The conservation pool, or pool exclusive of flood control storage, would be operated in a system that would attempt to maximize benefits accruing to water quality, water supply and recreation considering both the value of the water in the stream and in the reservoir at various times of the year. As reservoir size increased, economies of scale generally caused the marginal cost of reservoir storage to decrease. This explained in part the increased reliance on ground water and advanced waste treatment in the efficiency and quality plans over that in the regional development plan.

Conventional (economic efficiency) benefit-cost ratios would have been highest, perhaps in the 1.2 to 1.5 range, in the efficiency plan; lower in the quality plan where restrictive criteria were imposed; and perhaps marginal in the regional plan. Where expansion benefits were added, the regional plan would probably show highest total benefits as project selection was based to a large extent on the possible project effects on regional economic activity. The quality plan would have the least beneficial effects on economic activity. While the plans contemplated the existence of quality benefits, benefit functions for quality features had not made their appearance in formulation.

Methods of Analysis

For the Susquehanna multiple-objective planning model to be most useful, a workable analysis and evaluation methodology is necessary. Economic efficiency system planning was provided for through the use of conventional benefit counting practices and the use of high flow and low flow system operation programs. The high or flood flow pool regulation program was in common use by the Army Corps of Engineers. The low flow program was developed by Leo R. Beard of the Hydrologic Engineering Center in California, based in part on contributions of the Harvard Water Program studies on the Lehigh River and planning experience in other basin studies as the Potomac Basin.⁴²

The regional development expansion benefit methodology was developmental in nature. It was based on the Appalachian Program approach studied by the Office of Appalachian Studies in Cincinnati. Following the general guidance of the system developed for the Salyersville project,⁴³ the Susquehanna Study planning staff developed a tentative methodology for Susquehanna Study use.⁴⁴ The unique feature was counting the regional expansion benefits. The national primary benefits could be counted in the conventional manner and the proposals

⁴²U.S., Corps of Engineers, Computer Program 23-J2-L253, Economic Evaluation of Multi-Reservoir Operation, Special Projects Memo. No. 152 (The Hydrologic Engineering Center, Sausalito, California, undated).

⁴³"Salyersville," op. cit.

⁴⁴U.S., Corps of Engineers, "A Method for Determining Expansion Benefits and Associated Investment" (draft) (U.S. Army Engineer District, Baltimore, April 1968).

operated and evaluated as part of a system using the high and low flow models. The problem of comparing national or economic efficiency benefits with regional or total benefits, of course, existed.

Quality benefits presented another problem. In the plan, as it was developed, there was no benefit counting system developed to balance the costs of meeting needs beyond what was in conventional practice. Awkwardness developed when there was no offsetting benefit that corresponded to the possibly more costly solution to meeting needs that was shown in the efficiency plan. For instance, in the quality plan rather than create an impoundment for water supply purposes, the criteria might have indicated the development of ground water at greater cost. There was no means of evaluating the loss in quality that was presumed to take place by creating the impoundment. What rationale existed was subjective--value judgments not yet generally accepted in conventional practice. Several consultants retained for the Susquehanna Study had offered views on desirability or disutility of impoundments at various potential reservoir sites. The work was a first step, but only that.

There was also the broader problem of developing and evaluating a plan for environmental quality. Environmental quality has been considered intangible by many planners and economists. Possible approaches to the economics of environmental quality were discussed in Chapter IV. Kneese has recently encouraged general hope that a quality benefit evaluation methodology may not be far in

the future.⁴⁵

It appeared likely that some effort to evaluate and count quality benefits would have to be made prior to the completion of the Susquehanna study.

Decision Making

Continuing for the moment on the subject of analysis, other significant problems arise when, as a major step in decision making, the coordinating committee plan is formulated. This is the plan to be developed after consideration of the single objective plans and which is supposed to represent the best use of the resources to provide for the well-being of the people. The plan would be formulated from features identified in the single objective plans. No objective function was developed for this plan and no criteria had yet been established to aid in decision making--selecting features from the three single-objective plans. A mathematically exact objective function, moreover, could not have been specified because of the nebulous nature of the input. An objective function even with weak ordering criteria would be helpful and likely will be necessary. Establishment of some defensible rationale for formulation of the single plan to be recommended would appear unavoidable.

One bit of information useful in decision making at both the

⁴⁵Allen V. Kneese, "Economics and the Quality of the Environment - Some Empirical Experiences" (Reprint No. 71, Washington: Resources for the Future, Inc., 1968), reprinted with permission from Maurice E. Garnsey and James N. Hibbs (eds.), Social Science and the Environment (Colorado: University of Colorado Press, 1967).

planner and review levels, would be the opportunity costs of the various proposals. For the purposes of the planning effort, the project opportunity costs in terms of alternative use of capital, except as indicated by whatever discount rate might be prescribed, may be overlooked at this level. The opportunity costs in terms of other federal non-water-related program benefits may also be overlooked at this planning level. These may be considered problems for the Bureau of the Budget and the Congress. Water resources planners would necessarily be responsive to guidance from these policy makers. The planners do need to concern themselves with the opportunity costs of alternative uses of the resources considered within the planning effort. The planner-decision makers are expected to know the costs of any efficiency proposal and the whole program in terms of regional development and environmental quality. To make a rational decision concerning an impoundment with certain known benefits and certain construction and real property acquisition costs, it is important to know what the real or opportunity costs are. Real costs can differ from the financial costs. The cost of the impoundment in terms of environmental quality could be greater or less than the financial cost. The opportunity costs of a dam which would flood the Grand Canyon would presumably be quite high. The Lake of the Ozarks is often considered to have greatly benefited the natural values of that area and its opportunity cost in terms of environmental quality could have been quite low or negative.

One way to compare programs with the intent to determine what

trade-offs should be made between objectives is through the use of the production possibility curve.⁴⁶ If the benefits of the two proposals or programs are known, the net benefits may be shown on the major axes and a curve constructed that relates the 'decrease in benefits to one purpose to the increase in benefits to another when there is a conflict in resource use. Marglin has worked with such curves as they relate to the distribution of trade between a nation as a whole and one of its regions.⁴⁷ McKean gives a pertinent illustration of a production possibility curve in his book on government systems analysis.⁴⁸

With knowledge regarding what will be foregone in terms of regional development and environmental quality by the selection of an economic efficiency proposal, the planner is in a better position to employ his judgment, particularly in the event he is not guided by strong selection criteria.

Mention has been made of the planner's role as decision maker. The planner is an important decision maker although the importance of this role may often be overlooked. The planner makes decisions about what he will recommend to the higher level decision makers and the public. Such is the strength of his recommendations that what he

⁴⁶ For further explanation of production possibility curves see Kenneth E. Boulding, Economic Analysis, Vol. 1: Micro-Economics (4th ed., New York: Harper and Son, 1966), pp. 603-8.

⁴⁷ Stephen A. Marglin, Public Investment Criteria (Cambridge: M.I.T. Press, 1967), pp. 26-39.

⁴⁸ Roland N. McKean, Efficiency in Government through Systems Analysis (New York: John Wiley and Sons, Inc., 1958), pp. 127-33.

proposes is, at times, accepted without change by other higher level decision makers. Sometimes, what he proposes is rejected. Possibly less often, a material change is made in his proposal by the decision makers. It is the weight of the planner's decision making role that may have prompted recommendations that the planner only develop the technical possibilities available for presentation to the decision makers.⁴⁹ As discussed earlier, such a procedure would place a difficult burden on the decision makers and much of the value of the experience and expertise of the planner could be lost. An alternative would be for the planner to present the array of possibilities available along with his recommendations and justification. A less satisfactory solution, based on earlier discussion, would be to have the planner make a recommendation based on his study even if all the possibilities examined were not presented as part of the study. In this latter case, and it is mentioned because it is the procedure that has occasioned criticism of planners in the past and still remains a possible course of action for the Susquehanna planners,⁵⁰ it is important, in the welfare sense, that a full range of (resource allocation) possibilities be developed, and as much supporting data be made available as possible, to provide a broad base for the development of the planner's recommendation.

⁴⁹See Colorado Choices, op. cit.

⁵⁰No decision had been reached by the Susquehanna Coordinating Committee regarding the detail of presentation of study results.

Cost Sharing

Cost sharing has been mentioned as an impediment to efficient resource allocation. The interests of the public, the states, the agencies and the federal government impinge at this point. It is unlikely that planning can take place in an atmosphere of complete altruistic objectivity--at least not by interested parties. The incentive for the individual, the locality or the state to consider not only project cost, but who pays, cannot be overlooked. Economic man is said to maximize his returns. It may be expected, therefore, for the individuals, the locality or the state to prefer solutions for which their contributions would be minimized. Where this is institutionally possible, resource allocation can be distorted. The resource allocation distortion is the degree to which any planning participant attempting to minimize his costs is able to influence group decisions away from the most economically efficient solutions. One of the problems of those who benefit not paying is that the resource is then not valued at its proper market exchange value and more of the resource is used than would otherwise have been, with a trail of effects on the economy. The importance of the effects, of course, varies with the magnitude of the distortion produced.

Using cost-sharing policies for the economic efficiency plan as a norm, the proportional contribution in any investment by the federal government might be expected to be greater for the regional development plan where the national interest might be in redistributing national wealth to favor a region. The return on the state dollar invested

could be high. State pressure for a solution in this sector would be understandable were the investment return attractive to the state even if the return on the federal investment were marginal. Were environmental quality costs largely to be borne by the region, considerable political pressure within the region might be necessary to counter a development investment that might be foregone.

An intermediate range solution to the problem is revised federal policies concerning cost-sharing and this has been under more or less continuous study by the federal government since 1962 or before.⁵¹ A shorter range solution would be to set forth clearly the basis upon which planning decisions and recommendations are made. Where the mechanics and ramifications of the planner's decisions are open for all to see, objectivity appears most likely to be served.

The problem of project selection and cost sharing rests not only with the planners. The legislative history surrounding federal participation in water resources development gives evidence that the federal government has instituted many programs to assist regions and encourage the use of resources for certain purposes. It would be self-defeating, nationally, to promote market-oriented objectivity that would negate legitimate program authorizations. The political process, the interaction between decision makers and public, balances the role of the

⁵¹The problem was highlighted in the Report of the Senate Select Committee in 1961 and treated in part by Senate Document 97 in 1962. The subject was studied by the ad hoc Water Resources Council and is now under study by the Water Resources Council.

planners.

The evolution of the Susquehanna River Basin Study approach to multiple-objective water resources planning was examined in this chapter. The usual planning difficulties appeared to be encountered and, in addition, problems of definition and evaluation were evident both for the single objective plans and in the formulation of a final plan to be recommended by the coordinating committee. Manifestations of institutionalism were also evident.

CHAPTER VI

CONCLUSION

The investigation reported in this study represents an effort to determine the usefulness of employing multiple objectives in water resources planning. The study involved establishing a theoretical and conceptual basis to guide employment of more than one objective in planning. To supplement the theoretical and conceptual investigation, an in-process review was made of work currently being accomplished in the Susquehanna River Basin. This basin study was selected because it represented an attempt to explicitly recognize the desirability of looking at alternative uses for the water resource through multiple-objective planning.

Summary and Evaluation of Findings

The survey of experience with river basin planning gave evidence of a divergence between planning practice and planning theory. Senate Document 97 encouraged planning for "best use" and the "well-being of all people," guidance not fully followed in practice. The gap was a result of planning too narrow to provide as broad a view of welfare as was possible. Pertinent alternative uses of the water resource often were not considered. The area for choice by decision makers and the public was limited.

The economic foundations of public investment in water resources development were examined. Public intervention in resource allocation was justified by another divergence--that of the private market and

public interest. Welfare theory highlighted this separation and also provided insight into efficient allocation in the welfare sense. A welfare optimum consists not only of efficient resource allocation in market terms, but allocation leaving all concerned as well or better off in a broader but more difficult-to-define context.

Welfare includes the redistribution of wealth resulting from an economic adjustment such as resource allocation. Redistribution effects exist whether there is policy regarding on whom the effects should fall or there is analysis that merely describes effects for the benefit of the policy makers. Wealth is more than money. Other dimensions to wealth can be measured in economic terms. Environmental quality was identified as one. Efficiency, distribution, environmental and possibly other economic effects of water resource investments can be evaluated in terms of welfare improvement. A welfare optimum through quantitative analysis alone was found to be unlikely. Welfare improvement by a social preference function operative through the political process and supported by measurable analyses appeared more realistic.

Current evaluation procedures have concentrated on market efficiency and have accepted economic efficiency as an objective for planning. Other aspects of welfare were slighted. Although conventional economic efficiency planning is capable of expansion to accommodate more aspects of welfare than is done at present, other aspects of welfare are presently more satisfactorily described by the use of additional planning objectives.

Theory explained the empirical problem of optimizing welfare. One answer was found in the selection of objectives. Objectives could

be selected and defined that would provide a clearer and more complete basis upon which to make judgments concerning the best use of resources for the well-being of the people--to improve welfare.

A planning objective was found to be functional if effectively related to benefit identification and evaluation. This relationship is established through criteria and definition of the objective function. To be meaningful, an objective should relate to higher level objectives or goals. When so structured, an objective is relevant of peoples' desires.

Both practice and theory appeared sufficient to define objectives that assist in welfare improvement. Welfare was also enhanced by broadening the area of choice in resource allocation. Planning practice could be improved by the selection of several objectives that could lead to this broader area of choice.

Objectives, beyond that of market efficiency, were found to present problems of evaluation procedure. These objectives, though conceptually definable, were not used in practice--operational definitions proved difficult. To work quantitatively with several objectives in a single planning effort appeared possible but involved. Proposals in current literature for use of a multiple-term objective function were not obviously practical for present use.

Difficulties that beset conventional water resources planning were accentuated when multiple objectives were employed. Cost estimating is less precise than desirable. Benefit estimating is even less precise. Benefit functions for the economic efficiency criterion might be considerably broadened. Benefit estimating for non-efficiency

objectives is embryonic. Federal cost-sharing policies are sufficiently inconsistent to invite aberrations in resource allocation in respect of economic efficiency. Local and state self-interest logically tend toward solutions that would maximize regional gains for any regional cost. In present practice and knowledge, there appeared to be significant obstacles in achievement of a quantified welfare optimum.

A current river basin study in which a multiple-objective approach to planning was being attempted was examined. Attitudes of study participants did not clearly support the novel approach to river basin planning. Response to the multiple-objective proposal varied. There was concern expressed over the additional time, effort and funds entailed. The association between review of alternative resource uses and a broader area for choice was recognized, however. But certain study participants had concern over the deviation and dissipation of effort from the prime concerns of the study in the basin. Benefits and total costs, as well as the share of costs to come from the region, would vary considerably from plan to plan.

The multiple objectives selected did provide a better approximation of welfare considerations than otherwise might have occurred. Objectives were nevertheless difficult to define and difficult to support with benefit estimating functions. Objectives did provide a broader view of welfare subject to improvement through resource allocation. The basis for choice was improved--there was some basis upon which planning decisions involving best use and well-being of all the

people of the basin could be made.

Objective functions and, as a result, benefit functions lacked rigor and precision. This confirmed an observation made when the concept was explored. Arbitrarily selected parameters were imposed on the various plans. Although sensitivity to parameters was not analyzed, basin needs were not satisfied to the same degree in each of the demonstration plans.

Criteria had not been developed that would provide guidance for the selection of the single plan that would be recommended for the basin. Beyond preference or judgment, no basis for selection had been provided. This was analogous to the conceptual problem and guidance appeared necessary. In addition, the question had not been resolved regarding the degree to which the alternative solutions to the basin problems would be made public or provided to decision makers. The importance attached to providing policy makers and public information on which recommendations are based increases with the vagueness of the formulation criterion.

Conclusions

Present planning for future water resources programs will have major impacts on resource allocation for generations of users. Planning under these programs is guided by Senate Document 97, but subject to at least three weaknesses in practice identified in this study. Alternative uses for resources are not invariably considered. Choices submitted by planners to decision makers are typically limited. Welfare implications of resource allocations are not fully assessed.

This study in applied economics provides a rationale for an advance in approach to water resources planning employing multiple objectives. The rationale is based on a synthesis of views on economic theory and resource allocation. The need for additional objectives other than economic efficiency to evaluate welfare implications of resource allocation was demonstrated on theoretical grounds. Planning objectives relate goals to purposes served by water use and provide additional dimensions to welfare. In reporting on the attempt by the Susquehanna River Basin Study to formulate plans responsive to several objectives, a dialogue on the practical value of multiple-objective planning has been opened.

Simplifying assumptions have previously limited economic efficiency, as a planning objective, to evaluation of changes in net national income. The omitted distributional effects of economic adjustments can be provided by employing an objective of regional development. National and local views for particular areas can be explicitly considered in this manner. The objective of environmental quality can provide additional dimension to welfare while further expanding the area of choice.

Multiple-objective planning has the important function of making explicit both the range of choice and the value considerations that different people have in looking at water resources allocation. A major obstacle has been that welfare economists have not felt satisfied with their ability to deal with human satisfactions. There is no generally acceptable way of measuring improvements in welfare of individ-

uals or groups. However, paralyzing perfectionism that requires certainty for decision making is intolerable. Planning must continue.

Use of a multiple-objective framework tries to make costs explicit, including the opportunity costs of foreclosed alternatives. Where there is no accepted practice value judgments are unavoidable. These value judgments generate debate from which conventions on rankings and practices emerge. An incomplete rationale is helpful where none existed before. This study provides a workable rationale to improve the basis for decision making in planning where decisions must be good, but cannot be perfect.

Limitations of the Study

This investigation chose for empirical example a river basin study currently under way. The selection was deemed appropriate because the Susquehanna Study was a major river basin planning effort in which an attempt was being made to formulate plans in furtherance of each of three meaningful objectives. The demonstration plans were to provide a broad base for the formulation of a final plan to be recommended by the study coordination group. The plan was intended to be responsive to higher level objectives of best use of the resource and well-being of all people. The difficulties of dealing with a novel approach to planning slowed progress of the study. The production of benefit and costs data on the demonstration plans fell behind schedule.

Possible policy implications stimulated this investigation in

multiple-objective planning and the in-process examination of the Susquehanna study. An investigation along similar lines after completion of the study would be of value also. More complete empirical evidence would be available, and evaluation, though less timely in regard to providing guidance for other river basin studies underway, more complete. Sufficient data would be available to make possible a more complete analysis of the benefits and costs of alternative resource allocations. Institutional problems of the structure for planning could be examined ex poste to determine capability to administer the planning approach. Institutional obstacles could be evaluated in their influence on the resource allocation from the recommended plan and the review procedures. Each of these lines of investigation was limited in this study report because complete data were not available.

Need for Further Research

Objectives should be related meaningfully to higher level objectives and goals and functionally by evaluation criteria to actual water uses. In the cases of regional development and environmental quality, the goals are not at all clear. "Best use" and "well-being of all people" are sufficient guidance to endeavor to lay out the possible choices as broadly as possible, but the relative degrees to which the objectives should be emphasized are not clearly set.

One area for further study is that of providing a basis for planning policy in each of these objective areas. Some indication of what the national interest is in income redistribution may be pieced

from the Appalachian Regional Development Act and other welfare legislation. An economic relationship between what might be imputed to be federal policy and what is feasible in water resources development might be established. A similar problem exists with regard to environmental quality. Each of these objectives requires better definition for useful employment in water resources planning.

A second area for further study is an adjunct to the first. Once the objective is defined, the criterion must be established. What can be done with the water resource is much better known than how these water uses relate beneficially to objectives such as regional development. It should be possible to identify features, evaluate them, assign benefits and rank them within the objective. The techniques are refined in the case of economic efficiency; they are in experimental form with regard to regional development and hardly conceptualized in the case of environmental quality.

A third area for study follows the second. Once it is possible to rank and evaluate features in support of several objectives, it becomes desirable to compare the various proposals. The use of opportunity costs was suggested earlier. Ability to relate the various proposals to a common measurement base for purposes of comparison would facilitate rational plan formulation.

Research directed specifically toward these areas is desirable. The employment of multiple objectives, however, would be of immediate usefulness in river basin planning if only to broaden choice for planner and other decision makers. Weaknesses in guidance and analysis act as

obstacles to attainment of maximum usefulness of the multiple-objective approach, but not as a bar to its employment. However, empirically derived practices or measurements are useful where no means of closing gaps using theory have been found practical. The searching and trying that are part of a real-life planning effort also constitute research. The definition of objectives in terms that are significant to a region and attempts to overcome guidance and analytical obstacles as by-products of planning efforts, should be encouraged as a matter of policy. This form of research is also desirable and represents practical steps toward improved planning.

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