AN ANALYSIS OF CONTEMPORARY AND HISTORICAL ECONOMICS ASSOCIATED WITH WATER DEVELOPMENT PROJECTS IN WYOMING

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1990
Technical Report WWRC-90-12

Technical Report

to the

Wyoming Water Research Center
University of Wyoming
Laramie, Wyoming

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March, 1990

FOREWORD

This report presents the Phase I effort to develop a framework for evaluating historical and future water projects in Wyoming. The title of the project is "An Analysis of Contemporary and Historical Economics Associated with Water Development Projects in Wyoming" and was funded by the Wyoming Water Research Center.

The central goal of the Phase I effort was to develop a preliminary methodology for the evaluation of Wyoming water projects. To that end a number of questions required consideration. These questions were:

1. What are the forces and considerations that potentially are and/or will "drive" Wyoming's Water Development Program?
2. What is the appropriateness, for Wyoming's Water Development Program, of traditional project evaluation procedures that were principally developed for federal water projects?
3. What do the citizens of the state of Wyoming desire? What perspectives do they have regarding what is "important" in designing a set of water project evaluation criteria?

4. Finally, how does one, given the above inquiries, incorporate all of the perspectives and considerations into a meaningful decision making framework?

In our attempts to address question I, we found that we must investigate Wyoming's wealth of water resources and the issue of scarcity in other downstream states. Additionally, federal legislation potentially might affect Wyoming's water program as well as might the ever evolving legal and institutional environment. These issues are explored in Appendices A, B, D, and E.

Chapters 2 and 3 present our attempts at addressing question 2. That is, should methods for evaluating Wyoming water projects incorporate considerations beyond those of traditional benefit-cost measures. Our answer was yes, that a more comprehensive analysis is required that goes beyond simply converting all impacts into a dollar metric. Appendix F explains the issue of interpreting a divergent set of impact measures.

Chapters 2, 3, and the appendices provided the groundwork for the administration of a survey to the residents of Wyoming. That is, what are the appropriate evaluation criteria for water project evaluation? Should only strict efficiency measures be utilized or are other considerations of equal or greater importance? We found, as discussed in

Chapter 4, that control of Wyoming's resources is of critical importance even if such control violates traditional benefit-cost efficiency notions. The survey results are presented in Chapter 4 and the actual survey and background results are presented in Appendix C.

Chapter 5 presents the preliminary methodology that we propose to utilize in the evaluation of historical water projects and compare the results to more traditional approaches. The proposed methodology incorporates what we learned from the survey and our other efforts. Chapter 6 offers the outlines of our proposed task structure for Phase II of the research.

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CHAPTER I

INTRODUCTION

1.1 PURPOSE AND SCOPE

This report describes the results of our first year of work on the project entitled "An Analysis of Contemporary and Historical Economics Associated with Water Development Projects in Wyoming."[1] The motivation for the project is the need for a better understanding of the economic ramifications of projects proposed for construction under Wyoming's Water Development Program. This need is summarized aptly in the Request for Proposals issued by the WWRC in May, 1988.

> In more rapidly growing and more populous states in the western United States conflicts among users for limited water supplies are creating the need for far reaching additional water development projects as well as innovative legal means of transferring the water and its rights from one use to another. As Wyoming looks to its future and the potential need for water development, it is critical that a clear understanding of all the economic ramifications of water development projects be understood. This may require that Wyoming not only look at its own water supply and demand picture (both present and the future), but that this picture be couched in a broader context of the water supply and demand activities ongoing in surrounding western states to determine what effect they may have

[1]The project was funded by the Wyoming Water Research Center (WWRC) at the University of Wyoming, Steven L. Gloss, Director.

> on Wyoming water development. While the research conducted must approach the issues from the perspective of Wyoming, it should serve to elevate and articulate reasoned concerns applicable to many western states. (P. 1)

The objective of our first year's research effort was to formulate a preliminary set of economic methods and criteria for evaluating Wyoming water projects. These methods were developed in the context of water needs in surrounding states and the desert southwest that may affect Wyoming's water development possibilities in the future. The methods also attempt to take into consideration the legal framework within which water rights are couched and the institutional framework in which water development decisions are made in the western United States.

Our economic methodology is preliminary in the sense that it has not yet been used to evaluate any specific water projects. The second year of this research project would, however, involve a comparison of traditional benefit-cost approaches with our new methods in the evaluation of historical water projects in Wyoming and surrounding states. Based upon that analysis, refinements would be made to the new methods before they were finalized for use by Wyoming water planners.

1.2 WYOMING'S WATER DEVELOPMENT PROGRAM

The Wyoming Water Development Program was established by the 1975 Legislature in W.S. 41-2-112 (a), which provides in part:

> The program shall encourage development of water facilities for irrigation, for reduction of flood damage, for abatement of pollution, for preservation and development of fish and wildlife resources [and] for protection and improvement of public lands and shall help make available the waters of this state for all beneficial uses, including but not limited to municipal, domestic, agricultural, industrial, instream flows, hydroelectric power, and recreational purposes, conservation of land resources and protection of the health, safety and general welfare of the people of the state of Wyoming.

Wyoming's Water Development Program received no significant funding until 1982, however, when the legislature appropriated over $100 million in general funds for the program and established two mineral severance taxes as ongoing sources- of program revenue. The 1982 Legislature also established the Wyoming Water Development Commission (WWDC) to oversee the program.

Since 1982, the WWDC and its staff have implemented three programs in support of water development in Wyoming:

1. The New Development Program.
2. The Rehabilitation Program.
3. The Water Resource Planning Program.

The purpose of the New Development Program is to develop presently unused and/or unappropriated waters in Wyoming. This program is funded by Water Development Account No. 1,

which to date has received $117,600,000 of General Fund appropriations and revenues from a 1.5 percent excise tax on Wyoming's coal production. New development projects can be proposed by local sponsors such as municipalities and irrigation districts. For a local entity to sponsor a new development project, it must be capable of assuming all of the project's operations and maintenance (0&M) costs and repaying a portion of the project's capital costs. Alternatively, new development projects can be sponsored by the state, with no local commitment for repayment. State projects are typically multipurpose in nature and are often intended to generate a surplus of water above current needs to provide for future economic growth.

The Rehabilitation Program provides funding assistance for improving water projects that were completed and in use prior to 1970. Rehabilitation projects are usually proposed by local sponsors. The Rehabilitation Program is funded by Water Development Account No. 2, which receives revenues from a 0.167 percent severance tax on Wyoming's oil and gas production.

The Water Resource Planning Program involves developing basin wide water plans for the state's major drainages, providing planning assistance to municipalities, and doing research in the areas of instream flows and groundwater availability. Legislative approval must be obtained before funds can be allocated for the study or construction of either

new development or rehabilitation projects. The WWDC is charged with evaluating both sponsored projects and state projects in making recommendations to the legislature with respect to funding. The WWDC currently follows a five-step process in evaluating new development and rehabilitation projects. A brief synopsis of that process is given below:[2]

1. Application Review - The WWDC reviews applications from potential sponsors to insure that the proposed project is consistent with the program's statutory goals and objectives, that the WWDC is the most appropriate source of funds for the project, and that there are no apparent economic, legal, or environmental problems that would prevent project development. If this review is favorable, the WWDC requests funding from the legislature for a Level I study as described below.

2. Level I - Level I studies typically involve an analysis of development options, the identification of project beneficiaries, and a description of the physical, legal, technical, economic, and environmental constraints that may affect project development. Projects are typically recommended for a more detailed. Level II, study if there are no constraints that would prevent project development.

3. Level II. Phase I - Level II, Phase 1 studies involve a detailed engineering analysis of the project; detailed estimates of project construction, operation, and maintenance costs; estimates of direct project benefits; and an analysis of the project sponsor's ability to pay. A determination is made of the project's technical, economic, and legal feasibility at the end of this phase. If a project is deemed to be feasible, and the project sponsor has the willingness and ability to participate in project financing, the project proceeds to Level II, Phase 2, as described below.

4. Level II. Phase 2 - Level II, Phase 2 investigations include the final technical design work for the project, identifying all necessary state and federal

[2]For a more detailed description of the evaluation process, see WWDC [1989].

permits required for the project, conducting an environmental analysis, identifying land acquisition needs, and performing a complete economic analysis of the final design including estimates of both direct and secondary benefits. If a project is still deemed feasible at the end of this phase, it is recommended to the legislature for construction funding.

5. Level III - Level III is the construction phase of the WWDC Water Development Program. During this phase, construction permits and land are acquired, and construction plans and bidding documents are prepared. Level III activities terminate when construction is completed and the project is operational.

Although the five-step evaluation procedure described above includes economic feasibility considerations, no formal economic evaluation criteria or procedures have been promulgated by the WWDC. Instead, the WWDC typically specifies the scope of the economic analysis appropriate for each level of study, but leaves the choice of economic evaluation procedures to the discretion of prospective contractors. The lack of formal economic criteria has been a subject of criticism with respect to the Water Development Program (for example, see Jacobs and Taylor [1989]). One of the primary purposes of this study is to fill that void.

1.3 A FRAMEWORK FOR ECONOMIC EVALUATIONS

There is a dichotomy in the economics profession concerning the appropriate framework for evaluating water projects. Some economists believe that benefit-cost measures alone are the appropriate evaluation tool for water projects, and that projects should not be constructed unless it can be convincingly demonstrated that project benefits will exceed

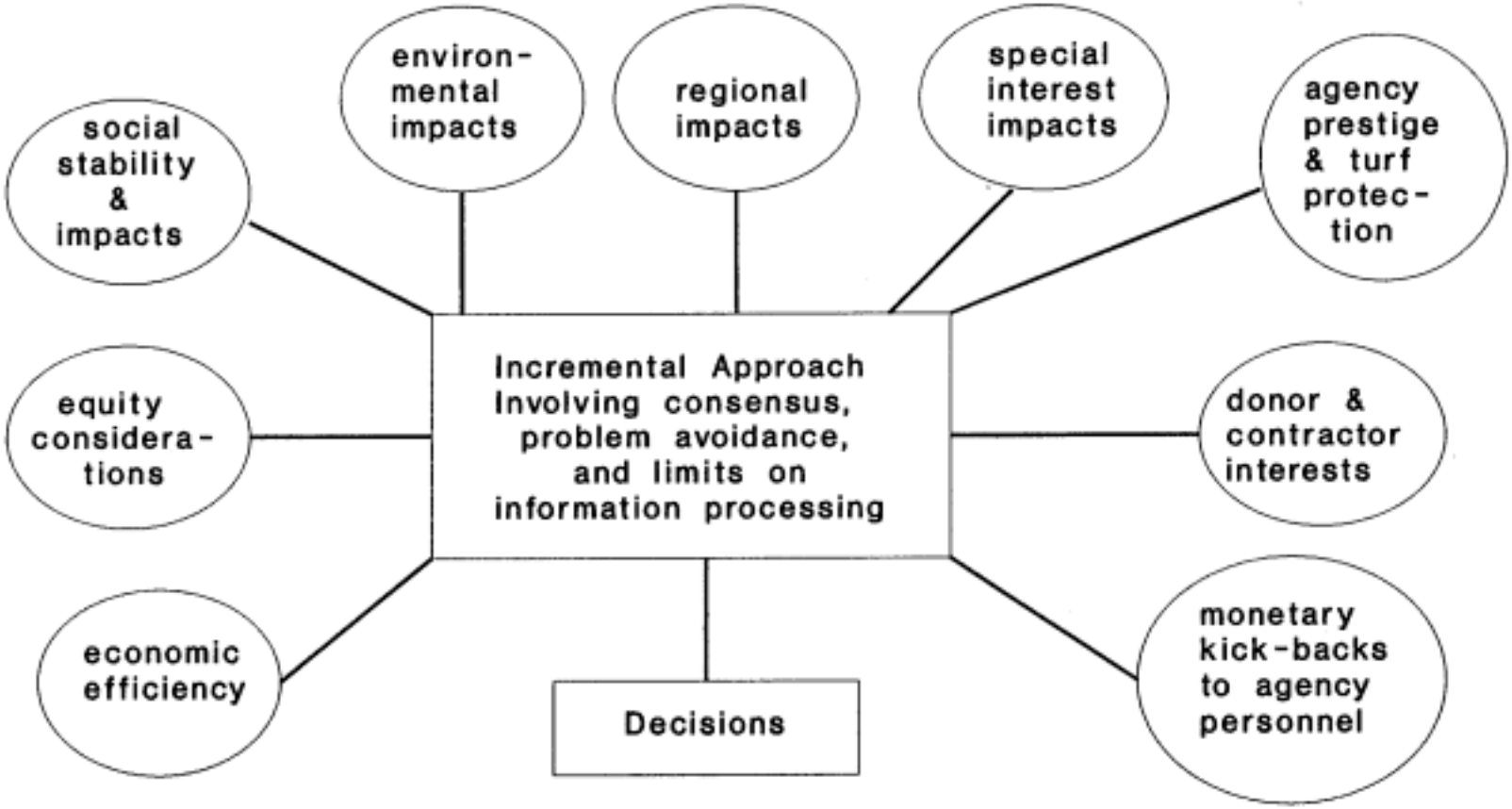
project costs. This view has been argued by Freeman and Haveman [1970] and more recently by Jacobs and Taylor [1989].

Other economists believe that it is often difficult to capture all of the appropriate "pros" and "cons" of a given project in a traditional benefit-cost framework (for example, see Howe [1987]). As a result, benefit-cost measures usually ignore certain project characteristics that may be of interest at the state level. To illustrate this point it is useful to refer to Howe's depletion of the factors influencing water decisions as illustrated in Figure 1.1. The lower left-hand circle, entitled economic efficiency, is the issue addressed by traditional benefit-cost studies. Other economic issues such as equity considerations, social stability, environmental impacts, and regional impacts are traditionally ignored in benefit-cost studies, as are certain special interest considerations.

Howe's argument is that rational decision making with respect to water projects can take place only when all of the factors involved in the decision making process have been identified and the appropriate ones incorporated into project evaluation. Otherwise, the project evaluation process will be subverted or ignored by those with agendas other than economic efficiency. The authors of this report agree with that view.

With respect to the Wyoming Water Development Program, there are several economic issues that are difficult to capture in an economic efficiency framework such as benefit-

Figure 1.1
Factors Influencing Water Decisions



Source: Howe [1987].

cost analysis. We have identified some of those issues in previous work undertaken for the WWDC (see, for example, Watts, Brookshire and Cummings [1989]). Among them are:

1. Wyoming's status as a surplus water state in a region where water resources are becoming increasingly scarce and valuable.

2. The changing role of the federal government with respect to water resources development and management, including increasingly stringent permitting procedures for new projects.

3. Emerging legal trends that add an element of uncertainty to Wyoming's interstate decree and compact water entitlements.

4. The role of water transfers in making water available for new uses in the western United States.

Because economic implications of these factors are difficult to capture in a benefit-cost framework, we believe that the economic criterion used for evaluating Wyoming water projects must extend beyond traditional efficiency considerations. Otherwise, there will be a tendency for the economic evaluation criterion to be subverted or ignored.

With that thought in mind, our goal during the first year of this study has been to:

1. specify how efficiency considerations should be addressed at state levels;

2. identify those non-efficiency considerations of importance to Wyoming's citizens; and

3. incorporate both efficiency and non-efficiency criterion into a meaningful decision making framework.

1.4 RESEARCH APPROACH

The literature addressing the appropriateness of project evaluation procedures is voluminous both in the government "gray literature" as well as in the academic journals.[3] Our research approach was to attempt to stand back from the plethora of writings and attempt to identify a set of central issues that would guide our inquiry. To that end we asked the following three questions:

1. What are the forces and considerations that potentially are and/or will "drive" Wyoming's water development program?

Candidate forces include the legal environment, the interface between the relative abundance of Wyoming ' s water relative to downstream scarcity and/or the possibilities for water transfer schemes. Given these forces, there might be an argument for evaluating Wyoming's water development program utilizing a different framework.

2. What is the appropriateness, for Wyoming's water development program, of traditional project evaluation procedures that were principally developed for Federal water projects?

This is a perspective that might well be termed a "Wyoming eyes" perspective. We are asking whether a Wyoming eyes perspective should be different from the federal or other states perspectives. More specifically, given that federal

[3]Within the government literature one only has to look to documents such as the extensive publications of the Water Resources Council. To a large extent the academic literature can be traced forward from the works of Eckstein [1958] and Maass et al. [1962].

programs "attempt" to choose only efficient projects, should efficiency be the only choice criteria for Wyoming.

3. What do the citizens of the state of Wyoming desire? What perspectives do they have regarding what is "important" in designing a set of water project evaluation criteria?

Thus we were interested in asking the residents of the state whether a pure efficiency criterion is important to them and if there are other non-efficiency considerations that are of importance.

4. Finally, how does one, given the above inquiries, incorporate all of the perspectives and considerations into a meaningful decision making framework?

To this end let us be clear on our goal. We intended to look beyond traditional benefit-cost analysis as it is voluminously detailed in the literature. This is not to say we are disregarding the traditional efficiency framework. We are not. We simply are asking whether the framework for project evaluation should be guided by other considerations than those of strict efficiency tests as well as those that do not fit neatly into the traditional framework.

Chapter 2 of this report presents a discussion of efficiency and non-efficiency considerations with respect to Wyoming's water development program. Benefit-cost measures appropriate for Wyoming water projects are presented in Chapter 3. Chapter 4 presents the results of a survey of Wyoming households concerning the relative importance of various efficiency and non-efficiency criteria. Our

methodological framework greatly hinges on the results of this survey. Chapter 5 presents a preliminary method of integrating efficiency and non-efficiency criteria, and Chapter 6 details plans for additional research. A series of appendices provide much of the background material that was instrumental in designing the preliminary methodology presented in this report.

CHAPTER 2

PERSPECTIVES ON BENEFIT-COST ANALYSIS: EFFICIENCY AND NON-EFFICIENCY CONSIDERATIONS

2.1 INTRODUCTION

The wide and varied history of benefit-cost analysis motivates any attempt to develop a framework for project evaluation to consider the development and limitations of the benefit-cost analysis. In developing such a perspective, we can begin the process by addressing the first question raised in the introduction. That is, what is the appropriateness of benefit-cost analysis and further are there limitations that might require a different Wyoming perspective from that which is traditionally accepted?

As such, Section 2.2 presents the philosophical underpinnings of our analytical approach. Section 2.3 reviews the historical uses of benefit-cost analysis. In developing the outlines of our approach, we consider the notion of efficiency per se in Section 2.4. Finally, in Section 2.5, non-efficiency considerations are discussed and set in perspective regarding non-market considerations.

2.2 PHILOSOPHICAL UNDERPINNINGS OF THE STUDY'S ANALYTICAL APPROACH: BENEFIT-COST ANALYSIS VERSUS BENEFIT-COST MEASURE

Our analytical approach is somewhat different from what has seemingly become the "traditional" approach in benefit-cost studies. We stress the difference between procedures followed in the estimation of a benefit-cost measure, and those relevant for benefit-cost analysis.

The benefit-cost measure is an indicator of the economic efficiency of a project, and includes those beneficial and adverse effects of a project which can be expressed via a dollar metric. Benefit-cost analysis involves the more comprehensive consideration of all effects on welfare which are attributable to the project. Benefit-cost analysis reflects a broadly defined set of multiple objectives of the state, many of which are not quantifiable in dollar terms. Examples include project effects on the distribution of income and economic opportunities, environmental considerations, and the preservation and conservation of the state's rights to unused water resources.

During the early development of benefit-cost analysis as a sub-discipline in welfare economics, the limits of a benefit-cost measure in terms of providing decision makers with a comprehensive analysis of the social and economic impacts of a water project were recognized (see Section 2.4). A comprehensive framework required analyses of socioeconomic impacts beyond those relevant for assessing the economic

efficiency of a project. For instance, Krutilla and Eckstein [1958] stressed the need to look beyond incomes in the efficiency measure to project effects on the distribution of income and the growth in economic opportunities.

Krutilla and Eckstein's argument is that economic analysis cannot "solve" all of the decision makers problems. The efficiency criterion may well involve a conflict with other criteria, and only the decision maker can make the value judgments required to resolve these conflicts (Krutilla and Eckstein [1958], pp. 49-50).

This philosophical position is echoed in three seminal works which appeared in the early 1960s: the 1962 Harvard water study (Maass et al. [1962]); the 1966 report of the Western Resources Conference (Kneese and Smith [1966]); and Bain et al.'s 1966 study of the "anatomy" of a water industry (Bain, Caves, and Margolis [1966]). Maass argued that:

> . . . the objective functions of most government programs are complex; yet benefit-cost analysis has been adapted to only a single objective—economic efficiency. Thus, benefit-cost analysis may be largely irrelevant, or relevant to only a small part of the problem of evaluating public projects and programs (Kneese and Smith [1966], p. 312).[4]

Many economists retreated from the view that project efficiency is but one component in an array of descriptions of

[4] See White [1966] and Davis [1966] for similar arguments.

project impacts.[5] This retreat may be attributable to economist's concern with the potential for nefarious uses of non-efficiency criteria for the simple purpose of justifying inefficient projects:

> . . . we are frankly concerned about the potential effect that the move to multiple objective planning . . . will have on the federal water resources budget. The incentives to cast about for new . . . objectives . . . for a public works program . . . are obvious (Freeman and Haveman [1970], p. 1537).

Further, Kneese, a proponent of multiple objective planning argued in 1968 that:

> What I really fear is that many projects which are both inefficient . . . and poor vehicles for income distribution will be found justifiable on income distribution grounds . . .. Indeed, poverty can become every special-mission-oriented agency's hobbyhorse (Kneese [1968], p. 66).

Others might argue that this retreat reflected the profession's "discovery" of mathematics, and their frustration with their inability to "cram" non-efficiency impacts into the benefit-cost measure (Bromley [1990]). Regardless, benefit-cost analysis in the 1970s and 1980s, as conducted by a large part of the economics profession during this period, involved primary if not sole focus on the development of a benefit-cost measure, with little more than lip service being paid to the non-efficiency aspects of a water development project.

[5]A recent example in this regard is the Jacobs and Taylor [1989] effort which argues that the "income" approach is the only reasoned approach.

Notwithstanding underlying concerns with the misuse of secondary benefits, the apex of this trend is seen in its most developed form in the Water Resources Council's 1973 "Principles and Guidelines." Federal policy became effectively an argument for the supremacy of the benefit-cost measure ("National Economic Development").

The analytical approach we adopted takes up the calls by such authors as Hanke and Walker [1974], Ng [1983], and most recently (and perhaps most eloquently) Bromley [1990], to push the analytical pendulum from benefit-cost measures back in the direction of comprehensive benefit-cost analysis. Concern with the limitations of benefit-cost measures is, of course, not limited to economists. At the 1986 Conference of the Universities Council on Water Resources, the university community exhorted the federal government to reexamine its role in national water and related resources programs to the end of:

1. restating national objectives for water and related resources programs to extend them beyond "national economic development," as NED is expressed by benefit-cost measures, and

2. providing "a revision of project evaluation processes, going beyond the narrow confines of present Benefit/Cost methods [emphasis added] to those that are compatible with expanded planning objectives . . . " (Engineering Foundation and University Council on Water Resources [1986], p. 12).

Our central theme is that legislative and public mandates for water development in Wyoming require considerations and assessments which extend beyond the criterion of economic

efficiency. Benefit-cost analysis, as a comprehensive analyses of diverse and potentially conflicting components, is not problem free.

The result from our approach is an array of information of the form:

1. "This" is the benefit-cost measure;
2. "These" are the impacts on income distribution;
3. "These" are the environmental effects; and
4. "These" are the implications for the security of the states' water rights.

Developing methods for "trading off" these various considerations is quite difficult, however. For instance, trade-offs may involve situations where the benefit-cost measure is "high," but so are adverse environmental effects and/or adverse effects on the distribution of income; or the project substantively contributes to the security of Wyoming's water rights and has desirable effects on the distribution of income, but the benefit-cost measure is "low." (See Appendix F for an illustration of this problem.) Noting the desire for a single integer that might serve as a yes or no indicator, we know of no way that this can be accomplished:

> . . . the selection of appropriate water projects is a political process, no matter how deeply hidden the political choices are beneath the complex analytics of benefit-cost analysis. Benefit-cost analysis may well be a useful administrative tool for organizing and utilizing technical and economic information . . . but it should not be asked to do more than it can reasonably do (Hanke and Walker [1974], p. 907).

2.3 HISTORICAL USE OF BENEFIT-COST MEASURES

Benefit-cost analysis as a new branch of welfare economics was developed in response to the mandates of the 1936 Flood Control Act.[6] The provision of the 1936 Act required analyses of water projects to encompass benefits "to whomsoever they may accrue." This left a great deal of latitude for the consideration of project impacts. During the 1950s and 1960s, benefit-cost measures became increasingly inflated by the dominance of "secondary benefits" (see Burness, et al. [1980]). The inflation of benefit-cost measures via secondary benefits is reasonably attributed to concerns for extra-economic aspects of water projects (see Mann et al. [1987]; North [1977]; and Stoevener and Kraynick [1979]). The result was a growing disenchantment with benefit-cost measures resulting in an impression that benefit-cost measures were little more than a "game" played by the Bureau of Reclamation (Burness et al. [1980]). Martin et al. [1982] describes the role of benefit-cost measures as providing measures of Western water users' "willingness to play. " as opposed to their "willingness to pay" for water projects.

The view that benefit-cost measures were being used to justify projects is reinforced by the manner in which the Bureau of Reclamation has treated "reimbursable" and

[6]We set aside for the moment the conceptual problems which remain at issue in terms of the structure of benefit-cost analyses (see Dasgupta and Pearce [1972], Chapter 1).

"nonreimbursable" costs. Reimbursable costs are project costs which are to be repaid by beneficiaries of reclamation projects. Nonreimbursable costs are attributable to project features which result in "public benefits." Since such costs cannot be assigned to specific, identifiable beneficiaries they accrue to the public at large and are absorbed by the federal government and are therefore "nonreimbursable."[7]

The "game" was not limited to reassignment of capital costs. The Reclamation Act of 1939 provides for subsidies of capital costs to agriculture, based upon agriculture's "ability to pay" (Burness et al. [1980]), and at a minimum water users are expected to pay all operating and management (O&M) costs. Thus, if benefits "promised" in ex-ante benefit-cost measures are related to actual benefits then benefits should cover O&M costs of the project. This simply did not occur.[8]

[7]The "game" which has evolved around the assignment of costs as reimbursable or nonreimbursable is seen in the following. Based on an analysis of 19 Bureau of Reclamation projects in the Upper Colorado and Upper Missouri River Basins, Franklin and Hageman [1984, p. 1048] show that benefit-cost, measures prepared for the purpose of justifying the construction of the projects included costs assigned as reimbursable to irrigated agriculture which amounted to 73.2 percent of total project costs. After the projects were completed, however, costs were reassigned from agriculture, leaving agriculture with reimbursable costs of but 3.8 percent of project costs.

[8]For the 19 projects studied. Franklin and Hageman show that ex ante benefit-cost analyses for these projects were based upon an allocation of 0&M costs whereby 92 percent of such costs were to be reimbursable (69 percent of 0&M costs reimbursable from the agricultural sector); 8 percent of 0&M costs were to be non-reimbursable. After the projects were constructed, the Bureau

(continued...)

However, Franklin and Hageman in noting the divergence between expected and actual project "performance" find justification in the role of water projects:

> water resources have and continue to play a major role in the provision of economic opportunity in western states; the value of this role is seen as extending well beyond economic measures and the ability to pay of direct water users (Franklin and Hageman [1984], pp. 1050-1051).

Thus, water planners, lacking objective measures for broad community objectives related to water reclamation, may view the use in benefit-cost analyses of values higher than those which will likely result- from the project as the only means by which these extra-economic values can be reflected in the benefit-cost measure.

The argument developed above relates directly to our central theme: one should not expect so much from the benefit-cost measure. If water planners recognize and accept the limitations of benefit-cost measures, the benefit-cost measure can be objectively derived. Other project effects, rather than being "crammed" into the benefit-cost measure, are presented as data of equal importance with the benefit-cost measure for the purpose of project evaluation.

Extra-economic impacts can be presented as part of an analysis if one follows the Water Resources Council's

[8](...continued)
of Reclamation reallocated 0&M costs such that only 36 percent of 0&M costs were to be reimbursable (only 6 percent of 0&M costs reimbursable by the agricultural sector), with 64 percent of 0&M costs then allocated as nonreimbursable (Franklin and Hageman [1984], p. 1049).

"Principles and Standards" (38 Fed. Reg.) published in 1973, but are displayed in sections distinct from the derivation of benefit-cost measures. While a number of inconsistencies exist in the rules of the Principles and Standards (see, e.g., Burness et al. [1980]), the comprehensive, multi-objective display of all impacts from a project, wherein the benefit-cost measure was but one datum, is precisely the approach which we argue here is appropriate for analyses of water reclamation projects. Regrettably, however, and reflecting (we posit) a general lack of appreciation of the limits of benefit-cost measures, the perception remains that the benefit-cost measure is somehow more important than the information displayed in other "accounts" of the Principles and Standards analytical framework.

2.4 PROBLEMS WITH EFFICIENCY

This section is focused on how one might define a framework for assessing water projects in Wyoming. We argue that a wide range of social, economic, and political considerations are relevant for the decision making process. The "traditional" benefit-cost measure can provide, and should be expected to provide no more than, a limited amount of information relevant for this process. In arguing this viewpoint, we consider directly the notion of efficiency.

Relevant for the emerging field of benefit-cost analysis, was the focus of welfare theorists on what might be referred to as a "truth rule" or "efficiency rule" which could be used

to distinguish between "good" and "bad" social projects(Hicks [1939], Kaldor [1939], and Scitovsky [1941]).[9]

The stage was then set for the implementation of benefit-cost analysis. Benefits consisted of gains in income or income-equivalents to beneficiaries of a project. Costs would include losses in income or income-equivalents. A project could be judged as "good," and thus was efficient, when benefits were at least as great as costs.

The efficiency objective became viewed as value-free. Moreover, many economists argued that they do not "advocate" any particular policy, but indicate (with the benefit-cost measure) to the decision maker(s) what would be "efficient." Thus, the following dilemma. If the economist's advice is ignored, is the decision maker "inefficient"? Some economists argue that if a choice is then made which ignores the efficient choice, the choice is then obviously a political choice in which distributional issues dominate and the economist remains an objective scientist. Bromley argues that this subtle illusion will not wash:

> To suggest to a decision maker the course of action that would be "efficient" is to load the debate in an unsavory way. No one, not even the much maligned public decision maker, knowingly wishes to be "inefficient"; the problems arise in defining efficiency .... Decision makers . . . understand

[9]A comprehensive discussion of the evolution of contemporary "welfare economics" is found in Bromley [1990]. Also, the potential Pareto improvement test (truth rule) requires that beneficiaries of a project could compensate losers from the project in question, and still be better off than they would have been without the project.

> that most public policy is about either reallocating economic opportunities, or redistributing economic advantage . . . . When the economist suggests that something would be "efficient," it is likely understood by decision makers to be that policy change which will effect a certain reallocation . . . . The economist, of course, means something quite different . . . (Bromley [1990], p. 26).

Clearly, the measure is not value-free. The measure totally abstracts from considerations related to the distribution of income such as who are the gainers and who are the losers, and how are they affected by such gains or losses. Thus, the efficiency test ". . . is optimal (only) with reference to those value judgments that are consistent with the Pareto principle" (Ng [1983], p.30). Furthermore, acceptance of the given distribution of income must be acknowledged.

However, economists have long been concerned with the potential disservice to the public of socioeconomic analyses which are based solely on the efficiency criterion studies which seemingly shroud themselves in the cloak of "scientific objectivity." Such analyses are characterized by Bromley as "Bogus Science, Bad Advice":

> Still uncomprehended, apparently, is that it is a value judgment to claim that economic efficiency ought to be the decision rule for collective action . . . . Economists who have persevered in this tradition seem content to overlook the logical inconsistencies in welfare economics; this obduracy apparently being justified on the grounds that a little economic analysis—even if indefensible on theoretical grounds, and therefore bogus—is better than a political process left to its own devices (Bromley [1990], p. 20).

The limitations of benefit-cost measures, and its appropriate role in the process of project evaluation is argued by Hanke and Walker in the following way.

> Economists have erroneously placed the onus of political bias on government agencies and their application of benefit-cost and have felt that if only benefit-cost could be perfected theoretically and applied impartially, decisions would necessarily improve. This 'incremental' strategy has not borne fruit. Furthermore, it may actually do real harm. . . . The public and its representatives . . . who innocently believe that the single-number ratio represents economic truth are thereby excluded from the actual decision-making process (Hanke and Walker [1974], p. 907).

Thus, benefit-cost measures have important limitations. A wide range of political, social, and economic values are relevant for the analyses of public projects such as water projects. The benefit-cost measure, which includes only those aspects of a proposed project which are amenable to income-like measures, is itself value-based. The value reflects only economic efficiency. Thus, the appropriate use for benefit-cost analysis is that of providing information as to one aspect of a project which can be useful for the political process of project selection. Finally, the appropriate measure of success for a comprehensive socioeconomic analysis of a proposed project is the extent to which the study identifies the relevant range of impacts from a project.

These impacts may extend well beyond those included in the benefit-cost measure into the benefit-cost analysis arena.[10]

2.5 PERSPECTIVES ON NON-EFFICIENCY AND NON-MARKET CONSIDERATIONS

Given our distinction between the benefit-cost measure and the benefit-cost analysis, a comprehensive framework for evaluating Wyoming water projects should be more than the benefit-cost measure. In this section, we want to briefly discuss what this implies and what it does not imply. The discussion is divided into two components: (1) non-efficiency considerations and (2) non-market considerations. Further, in discussing these elements of a benefit-cost analysis, we consider in Appendix F what are the implications for integrating the array of information that constitutes a benefit-cost analysis.

2.5.1 Distributional Considerations

A central aspect of the non-efficiency considerations of benefit-cost analysis pertain to distributional effects. Distributional considerations take the analysis far from the traditional notions of efficiency. In examining the potential distributive effects of a water project, the concern focuses

[10]The substance of such comprehensive analyses is nicely stated by Bromley: "To analyze something is not to reduce all of its components to dollar estimates of surplus, or to changes in net national income. While these measures may clearly be one part of a complete benefit-cost analysis, to analyze a proposed policy is to attempt to understand who the gainers and losers are, and how they regard their new situation in their own terms, and what this means for the full array of beneficial and harmful effects" (Bromley [1990], p. 21).

on the following question: who are the recipients of benefits and who are the people who bear the costs associated with the project?

In general terms, the difference between a project whose benefits accrue primarily to wealthy households and a project whose benefits accrue primarily to low income households may be relevant. Thus, one aspect of the distributional issue is the distribution of benefits and costs relative to income levels. Another distributional consideration might be the spatial distribution of the projects throughout the state. That is, suppose that all of the projects were located in the southeast corner of the state. Clearly, this would potentially lead to a differential in economic activity in the near and long term. Yet, another consideration might be the many possible users of water projects. It might well be relevant to ask if the distribution of the water from an irrigation project goes to a very small number of ranchers or is in fact distributed across a larger group. Finally, the distribution of water uses across all of the water projects might be relevant. That is, will the projects only serve the agricultural sector or will, in fact, the projects provide additional water for a multitude of uses.

In considering non-efficiency notions (distributional impacts), one is raising the possibility that benefits and costs may not be distributed in an "equitable" manner. Further, one might well be creating a situation whereby

efficiency considerations are in "conflict" with non-efficiency considerations. To the extent this issue is important is ultimately dependent upon the views of the citizens of Wyoming regarding the relative importance of distributional effects vis-a-vis other effects or considerations. Thus, our consideration of distributional effects and their relative importance motivates one aspect of the survey (Chapter 3). That is, if given the trade-off between efficiency considerations and non-efficiency distributional considerations, how would the citizens of Wyoming choose?

2.5.2 A Spectrum of Other Impacts

If one were to envision a spectrum of considerations that arguably should go into a benefit-cost analysis, efficiency measures would be at one end of the spectrum and non-efficiency measures such as distributional effects would be towards the other end of the spectrum. The primary differentiation between these two types of measures lies in the ability to place the effects in income or monetary terms.

Between these two ends of the spectrum lies a set of considerations that fall in-between in the sense that some of the considerations can be measured in national income terms while others may not. Typically these are referred to as non-market effects or considerations. For the state of Wyoming these type of effects or impacts are well represented by the array of natural resources that the state is endowed with.

For instance, there is an abundance of wildlife and many rivers and streams that remain in their natural state. Water projects potentially can change the availability of and the nature of these resources.

A significant literature has developed over the years regarding the economics profession's ability to quantify changes in these resources. As this literature is well documented we will not detail the methods at this point. The extent that changes in these resources can be represented in income terms is discussed by Cummings et al. [1986], Mitchell and Carson [1989] and numerous other authors.

This is not to say, however, that the analyst is relieved from best efforts to provide monetary measures for project impacts which are amenable to such measures. For objectives of water projects which are non-market in nature such as the protection of water resources from claims of downstream states, one can take advantage of advances made over the last two decades (see, e.g., Cummings et al. [1986]; Folmer and van Ierland [1989]; and Peterson et al. [1988]).

An example of an application of the contingent valuation method for valuing the protection of Wyoming's water resources from possible future claims of downstream states is seen in a recent assessment of the Sandstone Project in Wyoming (Watts, Brookshire and Cummings [1989]). While, in many cases, the usefulness of values for non-market impacts of a reclamation project may be limited to that of providing

order-of-magnitude insights of relevant values, and may therefore not be meaningfully summed in the benefit-cost measure, their derivation and presentation along with descriptive information of a project impact can provide decision makers with useful insights as to the income implications of the impact in question. If the impacts can not be represented in income terms then other methods will have to be used. For instance, one might represent wildlife impacts through a study of herd size changes.[11]

[11]Appendix F briefly addresses some of the problems of integration of monetary and non-monetary measures. Illustrations of the problem are given.

CHAPTER 3

BENEFIT-COST MEASURES AND CONSIDERATIONS

3.1 INTRODUCTION

In the previous chapter we discussed some of the shortcomings of using benefit-cost analysis alone to assess the economic implications of Wyoming water projects. However, we fully recognize these shortcomings do not preclude the consideration of traditional efficiency measures. That is, the relevance of criteria other than efficiency does not preclude the use of efficiency criteria in project evaluations. As such, in this chapter we consider those aspects of water project evaluation which are "traditional" in the sense of bringing together those quantifiable aspects, in terms of a dollar metric, that are relevant for preparing a benefit-cost measure. This discussion will then lead us to the development of a preliminary methodology (Chapters 4 and 5) which consider both efficiency and non-efficiency measures.

Conceptual and empirical procedures for estimating national economic development (NED) benefits and costs associated with agricultural, municipal/industrial, and recreational water projects are well known and abound in the literature (see, e.g., Eckstein [1958]; Maass et al. [1962]; Mishan [1976]; Howe [1971]; Peskin and Seskin [1975]; Merewitz

and Sosnick [1971]; Dasgupta and Pearce [1972]; and Young and Howe [1988]). There is little to be added to these writings concerning so-called NED benefits and costs. We do not intend to reproduce the details. Thus, our attention will focus upon methodological issues which are generally relevant for the valuation of a Wyoming water project from a Wyoming perspective.

3.2 BASIC PRINCIPLES AND A WYOMING PERSPECTIVE

Any evaluation of a Wyoming water project that incorporates benefit-cost measures, is anchored by the concept of allocative efficiency. The task is to determine, using a rather narrow band of defined and measured benefits and costs, whether the proposed project brings about a net gain to Wyoming as measured by the metric of dollars. Thus, for purposes of an analysis, the benefits are how much Wyoming residents are willing to pay for the project outputs. Costs are the opportunity costs of the foregone opportunities in using Wyoming resources in an alternative manner. Conceptually this is rather straightforward.

There are several reasons for using a Wyoming rather than a federal (NED) perspective for project evaluation. First, projects evaluated from the federal perspective assume that full employment always exists. This is clearly not always the case in Wyoming. Second, the objectives of the residents of Wyoming might well be different than the federal perspective. The survey results presented elsewhere in this report would

appear to support this possibility. Finally, Wyoming is competing with other states for water and will continue to have to do so in the future. The analysis in Appendices A and E support this perspective. Thus, we argue that the rules published by the federal government over the years, which culminated in the Economic and Environmental Principles Guidelines for Water Related Land Resource Implementation Studies (Water Resources Council [1973]), are not appropriate from a Wyoming perspective.

Another reason for a Wyoming water perspective is to enhance Wyoming's competitive position relative to other economic regions. That is, Wyoming is not investing in the west as the federal government has over the years but in Wyoming. In part, this is the central motivation of the Wyoming Water Development Program where money has been explicitly set aside to develop the water resources of the state for economic development purposes. We recognize that this viewpoint explicitly accepts the legislative and administrative structure of the Wyoming Water Development Program. That is, it does not allow for the question that many economists might raise: "How much of the states resources should be devoted to water development and how much to other projects?" It is conceivable that if this were the question then how the array of benefits and costs are established would potentially be different.

The implications of this view are rather straightforward: the Wyoming analyst must consider benefits beyond those traditionally considered for federal projects. In the federal case, only direct benefits to the nation (NED benefits) are considered. For example, consider a project which yields direct and indirect benefits for enterprises in Wyoming and out-of-state. Only the direct and indirect benefits that accrue to the citizens of Wyoming are appropriate if a Wyoming perspective is taken. From the federal perspective, all of the direct and none of the indirect benefits would be considered. The same argument for a Wyoming evaluation would apply "to "ths cost side of the ledger: only the opportunity cost to Wyoming would be included in the analysis. In both cases, double counting should be avoided.

3.3 ESTIMATION OF BENEFITS AND COSTS

There are two central issues regarding the estimation of benefits and costs: (1) what are the types of benefits and costs generated by a project and (2) how does the analyst implement measurement of the benefits and costs in order to achieve a monetary metric? What is appropriately included and what is not included is dependent upon the perspective taken. However, having adopted the Wyoming perspective, our task is rather straightforward. We are only interested in those benefits and costs that are relevant to the citizens of Wyoming. In our discussion, we will limit ourselves, for illustrative purposes, to the benefits and costs from a

traditional water containment facility.[12] We address the issue of secondary effects later in the chapter.

3.3.1 Municipal and Small Industrial Users

Benefits depend upon the user classes. These would include residential, commercial, public and industrial water users. Thus, for any project, the users of the water from the facility would have to be identified. Two methods are traditionally accepted to measure these benefits: (1) the willingness to pay approach as deduced from market measures,[13] and (2) the alternative cost approach as deduced from the cost of the next best alternative source.

Costs would essentially be the cost of developing any new distribution system to deliver the water. Typically, it would be assumed in the analysis that the direct project costs would capture such elements as water rights costs (if any) and the associated capital and operating costs.

3.3.2 Large Industrial Users

For a large industrial user, the benefit stream would consist of: (1) payments received by Wyoming under a purchase and/or lease arrangement for utilization of the containment facilities industrial water yield, (2) the direct income to Wyoming residents, (3) any indirect income generated by the industrial user, and (4) any tax payments to the state or

[12]We follow Howe [1971] and others for the remainder of Section 3.3.

[13]Gibbons [1986] and Jones et al. [1984] for details of how to properly estimate the demand for water.

local governments. Measurement of these categories of benefits are rather straightforward. For instance, the direct payments can be determined based upon the value of water in the region or nationwide. Appendix A is suggestive of the order of magnitude of this type of estimate.

The direct income estimates can be based upon employment projections. The indirect income benefits consist of two components: (1) increased income attributable to the industrial facility, and (2) the associated multiplier effect on the Wyoming economy. Input-output models, while having many shortcomings, can be used in this regard. If the input-output approach is inadequate then the analyst can turn to measures of induced employment where a similar type facility has been constructed.

Costs associated with an industrial facility would depend upon the agreement between the state and the industrial user. In principle, all of the appropriate costs would be identified as in the case of the municipal costing situation.

3.3.3 Agricultural

A principle set of benefits stemming from agriculture would be the increase in moving the land from dry land farming to irrigated land and/or reducing the potential for water shortages. Either or both of these effects might well lead to more intensive cultivation, higher valued crops and expanded acreage. Benefits are typically market measures and represented as net farm income.

The costs would include any infrastructure necessary to deliver the water, and the operating and maintenance of the infrastructure. Ideally, the analyst would determine whether there was, as a result of the project, a net income loss to agriculture in Wyoming and any other costs stemming from surplus stocks. Again market values would be the principle mechanism to estimate the costs.

3.3.4 Recreation

The benefits stemming from recreation would result from increased opportunities for water based recreation. This might include increased flat water recreation as well as fishing. There exists a wide variety of methods for estimating such benefits. In principle these estimates are based upon the notion of willingness to pay. These methods include the travel cost method and the contingent valuation method. For a discussion of these methods, see Cummings, Brookshire and Schuize [1986] and Mitchell and Carson [1989] for the contingent valuation method and McConnell [1985] and Smith and Desvousges [1986] for the travel cost method. Any calculation of recreation benefits would have to take into account the potential for losses in certain types of recreation activities as a result of the containment facility.

3.4 MEASURING BENEFITS AND COSTS: SOME CONCERNS

3.4.1 Concerns About Secondary Benefits and Costs

The use of secondary benefits and costs has lead to criticism of benefit-cost measures. This criticism stems from

the observation that "double counting" might well be the result. However, the issue is not quite so clear when a "Wyoming eyes" perspective is adopted. Central to the argument are assumptions regarding the level of employment. Federal applications assume full employment. As such, secondary benefits and costs are not counted. That is, the state of Wyoming does not have full employment. Further, there are idle resources. As such, the arguments that are set forth vis-a-vis federal project evaluation procedures might or might not apply in a project evaluation in the state of Wyoming.

What then is an appropriate perspective to take? Initially it is important to acknowledge that a project will always generate secondary benefits and costs. A project will effect both input markets and output markets.

For projects in Wyoming, the agricultural and recreation sectors are likely to generate secondary benefits and costs. For example, consider a project which attracts a number of recreational visitors to the project site. The analyst must know whether this is a net increase for the state or simply a "reallocation" of visitors already using recreation facilities in the state. If the visitors are "new" then there might well be a secondary benefit as represented by increased expenditures on fishing tackle. If there is only a reallocation then there would not be any secondary benefits. Thus, our perspective is that the decision will be project

specific as to whether to include or exclude secondary effects.

3.4.2 The Use of Prices for Estimating Benefits

For project inputs and outputs which have market prices, such as agricultural products, construction and 0&M materials, prices are typically used as the appropriate measure for project benefits and costs. Several issues must be considered in the use of prices.

First, the use of market prices for inputs and outputs implies an important assumption: the scale of the project is such that market prices will be unaffected.[14] Such conditions will generally prevail when, in the case of agricultural outputs, the increase in the total production of any one particular crop expected as a result of the project is small relative to the total market of the crop in the relevant market area. When very large projects are under consideration, and substantial increases in the production of any one or more crops are anticipated, the use of prevailing prices can lead to overestimates of project benefits. This follows from the simple notion that substantial increases in the quantity of the crop put on the market will likely depress prices received for the crop. Market studies designed to estimate the likely price response to the increase in crop production are typically non-existent.

[14]One would only use willingness to pay measures for Wyoming residents. For non-residents, expenditures and other multiplier effects are appropriate.

Second, it is common practice to use current (or five year average) prices to value all future costs and benefits over the life of the project. This practice implies the assumption that current prices can serve as "real," inflation-free prices for all future years. More to the point, this assumes that the future rate of inflation relevant for prices used for the costs of the project is the same as the expected future rate of inflation relevant for the costs of the project. Thus, the inflation rates for benefits and costs will cancel, and current prices for benefits and costs are appropriate for the valuation of future benefits and costs.[15]

The use of real prices for benefits and costs has appeal in that it relieves the researcher from the near-impossible task of estimating future prices for items included as benefits and costs. The problem is, however, that historical data tell us that we should know that this practice has invariably resulted in the persistent overestimation of benefits attributed to water development projects, particularly those designed to serve agricultural purposes.[16]

[15]The use of "real," inflation-free measures for benefits and costs implies the need to use "real," inflation-free discount rates.

[16]While most projects are evaluated for 50(and some for 100) year lives, in just the last 25 years (between 1960 and 1985) the Producer Price Index increased by 237 percent for farm products, while increasing by 295 percent and 422 percent for crude materials for construction and construction machinery, respectively (U.S. Department of Commerce [1978a], Tables 786, 793, 768, and 769). Thus, inflation rates for agricultural benefits (in the benefit/cost ratio's numerator have been

(continued...)

Still another indication of such overestimates for agricultural benefits is seen in the Farm Parity Ratio (the ratio between prices received by farms and prices paid by farms). The Farm Parity Ratio has fallen consistently over the past 35 years.[17] Relative to 1950, prices received by farmers in 1985 had increased by only about one half of the rate at which prices paid by farmers had increased. Thus, projects assessed in 1950 which used current prices and costs for benefits and costs expected in the 1980s would have substantially overestimated project net benefits.

Overestimates of project benefits are not corrected by adjustments for productivity gains.[18] Typically, farm production is increased in future years based on past trends in productivity gains. This reflects output changes. At issue then are the net returns associated with output. As is

[16](.. .continued)
substantially lower than the inflation rate relevant for future (for example) operation, maintenance, and rehabilitation (construction-related) costs in the benefit/cost denominator, implying the potential for the overestimation of net benefits when current prices for benefits and costs are used.

[17]

Year	FARM PARITY RATIO (1910-14 = 100)	Year	
1950	101	1970	72
1955	84	1975	76
1960	80	1980	65
1965	76	1985	52

SOURCE: U.S. Department of Commerce [1978a]. Table 1195; [1987b]. Table 1126.

[18]Farm output per acre has increased in the following manner for selected crops over the 1960-85 period: feed grains 193 percent; hay/forage 128 percent; food grains 183 percent (U.S. Department of Commerce [1987b]. Table 1138).

demonstrated (footnote 18) terms of trade have persistently moved against agriculture over time.[19]

In pointing out these problems in using "current" prices for valuing project benefits and costs, our intention is to draw attention to possible biases. Practically, there are few palatable alternatives for the current practice.

3.4.3 The Choice of a Planning Horizon

The "planning horizon," or planning period, refers to the length of time over which expected benefits and/or costs are to be included in project analyses (see Young and Howe [1988], pp. 36-38). For many years, it was common for the Bureau of Reclamation to use the expected physical life of the project as the appropriate planning horizon. For dams and reservoirs, the expected physical life was typically around 100 years. Since around 1973, however, the Bureau's planning horizon for project analyses has been more akin to the economic life of the project, on the order of 50 years. The economic life of a project is generally shorter than the physical life of the project, due to such things as anticipated technological changes and/or market obsolescence, population shifts, changes in government support programs, and shifting patterns in international trade in agricultural commodities.

[19]Over the period 1970-1985, non-real estate (real estate) farm debt has increased by some 400 percent (348 percent) and median family income on farms (between 1975-85) has fallen by some 5 percent (U.S. Department of Commerce [1987b], Tables 1096 and 1112).

Over the last decade or so, it has become common for researchers to use a 50-year horizon but the rationale is seldom stated. Young and Howe [1988] recommend a 50-year planning horizon, and seemingly base their choice on the observation that with discount rates of 5 percent or more, ". . . at least 90% of total present value is accounted for by year 50" (Young and Howe [1988], p. 37).

While certainly no more compelling than the rationale used by Young and Howe, our justification for a planning horizon on the order of 50 (or fewer) years reflects our concerns with biases in estimates of benefits and costs discussed above, which typically become more pronounced the longer the planning horizon. Clearly, the state should use planning horizons longer than those used in private companies, given the broader range of social goals relevant for water development projects. A 50-year horizon would generally balance the need for longer periods of time against which to amortize the investment costs of water development projects and the concern for the uncertainties of benefit/cost estimates in estimates of future values.

3.4.4 Choosing a Discount Rate

As was observed by Baumol:

> . . . few topics in our discipline rival the social rate of discount as a subject exhibiting simultaneously a very considerable degree of knowledge and a very substantial level of ignorance ([1968], p. 788).

In our simplest theories, the choice of a discount rate is straightforward: consumer's rate of time preference would equal the marginal productivity of capital, in which case the market rate of interest is the appropriate rate of discount.

Problems arise from a plethora of sources (for comprehensive overviews see Lind [1990]). Examples are: (1) differences in tax rates applied to consumer rates of interest and those related to returns on private investment give downward biases to consumer rates, (2) new evidence suggests that the "shadow price of capital" may distort measures sought in a social discount rate (Lind [1990]; Lyon [1990]), and (3) recent dramatic changes in the world and U.S. economies, in terms of more integrated international capital markets, make questionable earlier estimates of social discount rates based on the assumption of a closed economy (Lind [1990]; Feldstein [1985]).

It has generally been accepted that "appropriate" estimates for a social discount rate must focus on opportunity costs resulting from foregone consumption. Thus, mandating a focus on displaced consumption and consumer rates of interest. Results from recent research, however, suggest that such focus may be misleading given that consumers may rationally pay and receive wide ranges of different interest rates as a result of

a lack of self control (Thaler and Shefrin [1981]; Thaler [1985]; and Lind [1990]).[20]

Given the morass of problems surrounding the discount issue, the obvious question arises as to what is currently being done in terms of dealing with these problems, and what approach to discounting might be in the best interests of Wyoming. The U.S. Office of Management and Budget (OMB) [1972] has, for the last 17 years mandated the use of 10 percent as a discount rate; this rate is based upon the pre-tax rate of return on private capital (Lyon [1990]). An exception is made, however, for assessments of water projects. For water projects, the "appropriate" rate is taken to be the Treasury's borrowing rate for instruments with maturity in 15+ years.[21] It is commonly recognized, however, that this rate, as with the 10 percent OMB rate, is a nominal as opposed to a real, discount rate (Lind [1990]; Lyon [1990]). In contrast to the OMB rate, the Government Accounting Office uses discount rates based on the treasury borrowing rate.[22]

In considering the above arguments and recalling the argument that Wyoming's water projects should be viewed from a

[20]An individual may hold IRA's yielding 8 percent while paying 16 percent for a car loan, reflecting the fear that, should he/she sell the IRA's to pay the car loan, he/she would fail to recoup the savings.

[21]The discount rate cannot vary by more than one-quarter percent in any one year.

[22]Typically, the average nominal yield on treasury debt with maturity between one year and the number of years in the life of the project under analysis.

Wyoming eyes perspective, we find that the discount rate should reflect the rate of return on state borrowing. This rate will properly reflect the choice facing the state; to build the project now or later. We have seen no evidence since we last visited this issue (Watts, Brookshire and Cummings [1989]) to change our recommendation of approximately a four percent real discount rate.

3.4.5 Issues of Uncertainty

There are a wide range of sources for uncertainties surrounding important variables in water project assessments. Substantial uncertainties may also be relevant for the legal and institutional environment relevant for water resources planning in Wyoming (Appendices A and E). Here we discuss some of these major sources of uncertainty and means for bringing such uncertainty to bear on project assessments are described.

At the outset of any assessment of a water project, the practice is to estimate future demands (uses) for (of) the outputs of the project. Examples include: (1) increases in agricultural output and crop prices, (2) floods avoided by the project, (3) recreational uses associated with the project, (4) power output and prices, and (5) municipal water uses. Most often, such estimates of future uses of project outputs are based upon first, historical use patterns and secondly, commitments from basin residents for future water contracts.

The record of success for estimates based upon these considerations is poor. Uses "expected" or "predicted" at the time at which a large number of water reclamation projects were being evaluated have often failed to materialize after the project was in place (Franklin and Hageman [1984]).[23] Referring specifically to irrigation, the notion that large irrigation developments will give rise to significant growth in a region's employment levels is belied by a large number of studies.[24]

[23]As a specific example, ex ante estimates for benefits associated with the Baldhill Dam and Lake Ashtabula flood control project in North Dakota were based upon expectations of substantial future growth in municipal and industrial uses; such uses were "predicted" to account for 92 percent of total benefits. Only one other benefit category was included in the ex ante analysis: flood control which was to account for 8 percent of project benefits. (Palanisami and Easter [1984]). Ex post estimates for benefits attributable to the project after 32 years of operation demonstrated that zero benefits had accrued to municipal and industrial water uses—the earlier expectations for municipal and industrial growth had not occurred. On the other hand, flood control benefits had been some 37 times higher than those expected in the ex ante analyses. Moreover, benefits unanticipated at the time of the ex ante analyses—recreation and commercial fishing benefits-were shown in the ex post analyses to account for 28 percent of ex post benefits (Palanisami and Easter [1984]).

[24]For example, an ex post study of employment effects associated with irrigation development in the Northern High Plains was recently conducted. The authors of this study report that their data ". . . fail to support the hypothesis that irrigation development is a major source of regional economic growth in the modern economy. The percentage changes in regional work forces (associated with irrigation development) would not, in fact, be large enough to be distinguished from changes associated with business cycles, or even from statistical 'noise' in employment data" (Mann et al. [1987], p. 1715). Similar conclusions are reported in Cicchetti, Smith and Carson [1975]; Fullerton et al. [1975]; Howe [1976]; Kelso, Martin and Mack [1973]; Stoevener and Kraynick [1979]; and Young [1984].

There are basically three ways by which the uncertainty of projections are treated. The first of these involves the use of "expected values." Thus, if benefits of $500 million may accrue from industrial water uses 10 years in the future, and the probability that such industrial uses will in fact occur is 10 percent, the expected value of the $500 million is $500 million multiplied by 10 percent (and then discounted, of course), or in non-discounted terms, $50 million. An application of this use of expected values is seen in (Watts, Brookshire and Cummings [1989]). The major weakness of the expected value approach is obvious: it is difficult to specify probabilities associated with future water use developments.

A second approach for treating uncertainty is "sensitivity analysis." Critical variables for which values are uncertain are varied (usually, one at a time) in efforts to determine the sensitivity of the benefit-cost measure to changes in the values of the variable being analyzed. Thus, given a $500 million estimate for industrial benefits as in the above example, and considerable uncertainty as to whether or not such benefits will actually accrue to the water development project, the benefit cost measure might be calculated with alternative values assigned to industrial benefits varying, e.g., from zero to $500 million.

The major weakness of this approach is that it does not "treat" uncertainty in the sense of allowing the analyst to

arrive at some objective number which would be assigned (in this example) to industrial benefits. One is really simply asking the question: does the value assigned to industrial benefits "matter" in the sense of effecting substantial changes in the benefit-cost measure? If the value assigned to the variable does matter, the analyst can do little more than attach a caveat to the reported benefit-cost measure.

The third approach is referred to as the analyses of "switching values," and is an extension of the sensitivity analysis approach. The analyst attempts to define the value of the variable in question which results in negative net benefits (a benefit-cost ratio less than unity). Continuing the industrial benefits example, if one were using sensitivity analysis, the benefit-cost ratio might be calculated with the following arbitrarily chosen values for industrial benefits of (resulting benefit-cost ratios are in parentheses): $0 (.60); $100 million (.75); $200 million (.90); $300 million (1.2); $400 million (1.4); and $500 million (2.0). In looking for a switching value, one would search for that value for industrial benefits between $200 million and $300 million which would result in a benefit-cost ratio of I—for example, $245 million. The result of this type of analysis is a statement like the following: if one "believes" or accepts industrial benefits at levels greater or equal to $245 million, the project is efficient; if not, the project is not efficient.

The above examples make obvious the fact that there are no ideal or perfect means for treating the uncertainty of projections. As suggested by Young and Howe [1988], however, "the most important point is that imperfect knowledge of the future should not be ignored" (p. 75). One means for easing the weight of uncertainty on the benefit cost measures is to choose a shorter planning horizon as discussed above.

3.5 CLOSING REMARKS

For the purposes of this Phase I work, we have attempted to set out some of the more important considerations which should be considered in any effort to structure "traditional" measures of the economic efficiency of a project. Missing here are a number of extensions which remain as tasks for Phase II efforts, examples of which include: (1) the development of a manual which provides step-by-step guidance of the preparation of benefit cost measures, (2) extensions and applications of example or situational methods for measuring indirect benefits, and (3) modifications of existing farm budgets which one might use in assessments of agricultural projects.

CHAPTER 4

EVALUATION CRITERIA: A SURVEY OF WYOMING RESIDENTS

4.1 PURPOSE OF THE SURVEY

In Chapter 2 we argued that economic efficiency criteria such as benefit-cost analysis alone do not provide an adequate framework for evaluating Wyoming water projects. This conclusion does not mean that economic efficiency has no place in the evaluation process. To the contrary, in Chapter 3 we argue that the benefit-cost measure is an important evaluation tool that must be supplemented by other criteria. This idea is not new. Multiple evaluation criteria have been utilized and discussed in the economic literature for years under the banner of Multiple Objective Planning (MOP). Federal procedures for water project evaluations have also stressed the need for MOP evaluations to include environmental, social, and regional economic concerns in water project decisions (Howe [1987]).

A practical problem with MOP is that determining the relative importance of various economic objectives is very difficult; so difficult, in fact, that some economists relegate such activities to the political process:

> . . . with weights being assigned to these various objectives in keeping with the decision-makers'

preferences and their interpretation of public desires (Young and Howe [1988]).

The problem with this approach for Wyoming's water development program is that it has implicitly been in place since the program was funded in 1982, and has enjoyed mixed results at best. Some state decision makers have argued for placing heavy weights upon economic efficiency criteria, while others have argued that efficiency considerations are far less important than putting Wyoming's water to beneficial use. As a result, there has been heated debate in the Wyoming legislature about the direction of the Water Development Program and the fate of individual projects, with no objective basis for decision making. Since one of the primary purposes of this research project is to lend some objectivity to that debate, we believe that an attempt must be made to establish the relative importance to Wyoming citizens of various competing economic objectives.

In addressing this issue, we first reviewed the comments of respondents to a recent statewide survey associated with the Sandstone project (Watts, Brookshire and Cummings [1989]). The primary purpose of the survey was to elicit bids as part of a contingent valuation study. Approximately one-third of the 410 respondents, however, volunteered comments about what they liked or disliked about the Sandstone project in particular and Wyoming water development in general. These comments were analyzed, tabulated, and re-analyzed to determine whether there were any recurring issues that might

be important to water project evaluation at the state level. The analysis indicated that the majority of comments could be grouped into one of the following categories:

1. concerns about economic efficiency - a desire to invest Wyoming's resources in projects that will produce a viable return to the state.

2. a desire to retain control of Wyoming's water resources - the need to develop and utilize Wyoming's water resources before downstream states lay claim to the water—"the use it or lose it" philosophy.

3. concerns about environmental impacts - a desire to protect Wyoming's more scenic river systems in their natural state.

4. concerns about the equitable distribution of benefits and costs - a desire for projects that will benefit all Wyoming residents; or, conversely, a desire for project beneficiaries to pay for project costs when only a few would benefit.

There are obvious conflicts among the issues/objectives described above. For example, Wyoming could increase its control over its unappropriated water resources in certain river basins by bringing as much new land under irrigation as possible, thus strengthening its legal entitlement through beneficial use. Such developments may not be economically efficient, however, and may not meet with approval from those who want an equitable distribution of benefits or to preserve river basins in their natural state.

During the Sandstone study. Watts, Brookshire and Cummings [1989] demonstrated that the contingent valuation method (CVM) could be used to place an efficiency value on what would normally be considered a non-efficiency objective, the control of Wyoming's water resources. The results of that

study indicated that Wyoming households are willing to pay a significant sum to enhance Wyoming's control of its water in the Little Snake Basin by early construction of the Sandstone project. Conceptually, the CVM could be used on a recurring basis to resolve conflicting objectives that arise in water project evaluations in the state. As a practical matter, however, this approach has many pitfalls. First, it would require very time-consuming and expensive economic studies for each project that is to be evaluated. Second, repeated use of CVM techniques on the same population can lead to biased estimates for reasons too complex to address here.

As an alternative to suggesting the repeated use of CVM techniques to evaluate state water projects, we decided to conduct a statewide survey of Wyoming households to assess attitudes and opinions about the relative importance of various conflicting objectives. The results of the survey were then incorporated into a framework for evaluating Wyoming water projects (see Chapter 5).

4.2 THE SURVEY INSTRUMENT

A mail format was chosen because of the complex issues involved in the survey. A mail questionnaire allowed us to provide the respondents with the background information necessary to form an opinion, and allowed the respondents adequate time to formulate their responses (a copy of the survey questionnaire is included in Appendix C to this report).

The questionnaire first presents the reader with background information on the Wyoming Water Development Program, and then asks him/her to rate the relative importance of various uses for Wyoming's undeveloped water resources (Question 1). The purpose of these questions was to assess the adequacy of traditional efficiency measures associated with various water uses.

The second set of questions (Question 2) asks the respondent to agree or disagree with four policy statements about the Wyoming Water Development Program. The primary purpose of these questions was to familiarize the reader with the issues involved, and provide backup data concerning their relative importance.

The heart of the survey was a series of three questions (Questions 3 through 5) concerning possible evaluation criteria for Wyoming water projects. Respondents were first presented with the four issues identified from the Sandstone survey, and then asked if there were other issues they believed to be important. If so, they were asked to list those other issues. Respondents were then asked to rank all issues (including their own) as to their relative importance in evaluating Wyoming water projects. The questionnaire concluded with a series of demographic questions.

We approached the survey with some skepticism due to the complexity of Wyoming's Water Development Program. On the other hand, our experience with the Sandstone study led us to

believe that many Wyoming residents are interested in and informed about Wyoming's water issues, and could respond in a meaningful way. It should also be noted that the purpose of this survey is not like that of a political poll, which attempts to elicit the voting preferences of all registered voters about an issue to predict the outcome of an election. Instead, we were primarily interested in the attitudes and opinions of those Wyoming residents who are informed about Wyoming's water issues and the choices the state faces with respect to them.

4.3 SURVEY METHODS

A thorough discussion of survey methods is presented in Appendix C to this report and will not be reproduced here. Briefly, a sample of 800 Wyoming households was selected randomly from telephone listings covering the entire state. The first of three survey mailings was initiated on November 18, 1989. This mailing was followed by a second mailing of the questionnaire on December 9, 1989, followed by a postcard reminder to nonrespondents on December 21, 1989. Survey responses were cut off as of January 15, 1990, with 345 questionnaires returned out of a total of 636 households who received questionnaires, for a response rate of 54.3 percent.[25] We consider this response rate quite good considering the

[25]Of the 800 questionnaires mailed, 164 were returned as undeliverable which is largely attributable to the fact that the most recent telephone books available were almost one year old.

complexity of the issues involved and the amount of time it took to fill out the questionnaire (about one-half hour).

4.4 SURVEY RESULTS

This section presents an overview of some of the more important survey results that are relevant to water project evaluation. A detailed description of the survey results is presented in Appendix C of this report. The statistics in Table 4.1 characterize the most important uses of Wyoming's undeveloped water resources according to survey respondents. The data depict the percentage, of respondents rating each water use as either important or very important on a five-point scale (5 = very important). The results show that providing water supplies for future economic growth is the highest rated use for Wyoming's currently undeveloped water resources. This use is followed in importance by municipal use, preserving wild and scenic rivers, and providing instream flows for fisheries.

Interestingly, additional water for irrigation and industrial use was rated lower among respondents than the two environmental uses, instream flows and preserving wild and scenic rivers. In fact, three of the top four most important uses for Wyoming's undeveloped water resources are uses for which benefits are typically <u>not quantified</u> in traditional benefit-cost studies. Traditional water uses such as hydropower production, recreation, and flood control received relatively low ratings by the survey respondents, being rated

TABLE 4.1

Survey Respondents' Rating of Potential Uses for Wyoming's Undeveloped Water[1]

Potential Uses of Wyoming's Undeveloped Water	Percent Rating Important or Very Important	Importance Rank
Water supplies for future economic growth[2]	78.6	1
Municipal use	72.7	2
Preserving wild and scenic rivers[2]	70.6	3
Instream flows and fisheries[2]	68.1	4
Irrigation	65.3	5
Industrial Use	62.3	6
Hydropower production	46.5	7
Recreational reservoirs	34.2	8
Flood Control	30.8	9

[1] Based upon a sample of 341 Wyoming households that responded to these particular questions.

[2] Benefits attributable to these water uses are typically not quantified in benefit-cost studies.

important or very important by less than half of the sample. This result indicates a need for evaluation criteria that take into account non-traditional water uses.

The next set of questions dealt with a series of statements concerning Wyoming water development policy. Respondents were asked whether they agreed or disagreed with each statement on a scale of one to five (5 = strongly agree). The results are summarized in Table 4.2. Interestingly, the statement that Wyoming must protect some of its rivers from dams and reservoirs received the highest level of agreement, 80.3 percent. The second highest level of agreement was with the statement that Wyoming should develop its water resources before other states take our water, regardless of benefits and costs. Approximately 75 percent of the survey respondents agreed with that statement. Approximately 60 percent of the respondents agreed that projects should be built only if benefits were equitably distributed, but only 43.4 percent believed that benefits should exceed costs before a project is built.

As mentioned previously, the purpose of this series of questions was primarily to familiarize the respondent with the issues, rather than obtain objective data. As noted in Table 4.2 some respondents may have been confused by some of the statements in this section because the percentage of respondents agreeing with both statements 2 and 4 should not logically exceed 100 percent. There is additional evidence

TABLE 4.2

Percentage of Respondents Agreeing
or Strongly Agreeing with
Policy Statements

	Issue Statement	Percent of Respondents Agreeing or Strongly Agreeing
1.	Wyoming must protect some of its rivers from dams and reservoirs to preserve their wild and scenic beauty.	80.3
2.	Wyoming should develop its water resources before other states take our water, regardless of whether project benefits exceed project costs.	75.2
3.	Wyoming water projects should be built only if project benefits will be distributed equitably, i.e., not confined to one small area or group of people.	59.4
4.	Wyoming water projects should be built only if project benefits exceed project costs.	43.4

that some survey respondents were confused at this point because approximately 65 individuals who completed this section of the questionnaire did not proceed with the next section (Questions 3-5). For that reason, the results for survey Question 2 have been used only to amplify and interpret other survey results.

The most important questions in the survey involved a rank ordering of criteria for evaluating Wyoming water projects. Approximately 275 of the 345 survey respondents completed this portion of the survey. The results are summarized in Table 4.3, which shows that increased control over Wyoming's water resources is the respondent's overwhelming choice as the most important evaluation issue. Approximately 50 percent of the sample thought this issue was the most important for evaluating Wyoming water projects. Approximately 20 percent thought preserving a balance between preservation and development of Wyoming's resources was the most important issue, while 13 percent thought a comparison of a project's benefits and costs was. Distributional issues accounted for approximately nine percent of the votes for the most important issue, as did other issues defined by the survey respondents. There was no particular pattern to the other issues identified by respondents.

When respondents were asked to rate the second most important issue, preserving an adequate balance between preservation and development became the respondents' choice.

TABLE 4.3

Survey Respondents' Ranking of Most Important Issue Associated with Building Wyoming Water Projects[1]

Issue	Percent Ranking Issue as the			
	Most Important	Second Most Important	Third Most Important	Fourth Most Important
Will the project increase Wyoming's "control" over it's water resources?	49.3	22.1	15.1	8.1
Will the project disturb the balance between preservation and development of Wyoming's water resources?	19.6	30.1	28.6	15.1
Will the project's benefits be greater than its costs?	13.0	20.6	27.8	30.6
Will the project's benefits be confined to a small group, or be distributed widely across the state?	8.7	18.4	21.1	40.4
Other issues.	9.4	8.8	7.5	5.8
Totals	100.0%	100.0%	100.0%	100.0%

[1] Based upon approximately 275 respondents to this series of questions (see Appendix C for details).

It was also the respondents' choice as the third most important issue, followed by benefit-cost and distributional issues.

It is interesting to note that while the policy statement concerning preservation in Table 4.2 received the highest level of agreement, the preservation issue was rated second as a project evaluation criterion. A careful reading of the questions, however, indicates that while four out of five respondents want to preserve some of the state's rivers from development, a much smaller percentage believes that objective should be the most important issue with respect to project evaluation.

Overall, the data in Table 4.3 indicate that the survey respondents believe that increasing Wyoming's control over its water resources is the most important issue in evaluating state water projects, while the second most important issue is maintaining a balance between development and environmental preservation. Benefit-cost efficiency criteria seem to be more important than distributional issues, but both were rated significantly less important than the first two issues by most survey respondents.

4.5 DEFINITION OF INTEREST GROUPS

A multivariate discriminate analysis was performed on the survey data to relate the demographic characteristics of the survey respondents to their opinions about water development. Table 4.4 presents a list of the eight most important

TABLE 4.4

Most Important Variables in Explaining
Differences in Survey Responses

Variable Number	Variable Description
1	Self-evaluation as developer or preservationist
2	Membership in Wyoming Outdoor Council
3	Years of schooling
4	Contributions to organizations active in water issues
5	Membership in irrigation district
6	Days of annual hiking activity
7	Days of annual bird hunting
8	Size of household

demographic variables that explain differences in the respondents' choices as the most important issue for project evaluation. All of the variables were statistically significant in explaining differences among groups of respondents.

Based upon an analysis of the results, it appears that the survey respondents can be broken into three rough groups for purposes of discussion. The first group consisting of approximately 25 percent of the respondents, is somewhat younger, more highly educated, more oriented to outdoor activities, more likely to belong to an environmental organization, and more likely to have a family at home than the average respondent. They classify themselves as preservationists, not developers, and tended to define the most important issue with respect to water projects as either protecting the balance between preservation and development, or some issue of their own. Interestingly, this group tended to cite the importance of maintaining control over Wyoming's resources as their second most important issue.

The second group consisting of approximately' 50 percent of the survey respondents, were somewhat older than the preservationists, considered themselves developers, not preservationists, and as a group thought that increasing Wyoming's control over its water resources was the most important issue. Interestingly, this group tended to rate

balancing preservation and development as the second most important issue in evaluating water projects.

The third group of Wyoming residents are identified by a lack of desire to balance economic development with preservation. These individuals are much more likely to belong to an irrigation district, and tended to rate either, control, benefit distribution or benefit-cost ratios most important.

4.6 SUMMARY

Succinctly, it appears that the majority of survey respondents wants the state to aggressively develop its water resources and maintain control of its water destiny, but not at the expense of wild and scenic areas of the state. They do not necessarily believe that economic efficiency and distribution issues are unimportant with respect to project evaluation, but that these issues are not as important as the first two objectives.

CHAPTER 5

BRINGING IT TOGETHER: A PRELIMINARY METHODOLOGY

5.1 INTRODUCTION

We have argued "that economic efficiency criteria (benefit-cost measures) should be only one element in an appropriate economic evaluation process for Wyoming water projects. In fact, our survey results indicate that two other issues are significantly more important to Wyoming residents than the issue of economic efficiency. A rank ordering of issues from the survey in terms of their relative importance is given below:

1. will the project enhance Wyoming's control over its water resources by putting water to beneficial use or demonstrating intent to do so;

2. will the project have negative environmental consequences that upset the balance between preservation and development of Wyoming's river basins;

3. will the project generate efficiency benefits to the state in excess of project costs; and

4. will the project's benefits be distributed equitably among the state's residents.

This section of the report presents a preliminary methodology for incorporating all four of these issues into a multiple objective planning (MOP) framework for the evaluation of Wyoming water projects.

5.2 OVERVIEW OF THE METHODOLOGY

To incorporate non-efficiency criteria into the evaluation process, a method must be devised of assigning different values to various projects according to those criteria. For example, values could be assigned on an infinite numerical scale, as is the case with benefit-cost measures. At the other extreme, something as simple as a dichotomous split into "acceptable" and "unacceptable" categories on each project attribute could be employed. With respect to Wyoming water projects, we see no need and many perils to assigning continuous numerical scales to such issues as all of a project's environmental consequences. Doing so would not only be time consuming and expensive, but would tend to obscure the underlying criterion for acceptability on each issue.

In fact, there is relatively little need for a continuous numerical scale with respect to a Wyoming water project's economic efficiency (benefit-cost ratio). As discussed in Chapter 2, benefit-cost measures compute benefit-cost ratios on a continuous scale because the ratio acts as a "trigger" to indicate that funds should be shifted from one sector of the national economy to another. As a practical matter, however, the Wyoming Water Development Program has a fixed source of revenue established by legislation in the form of severance taxes, and a list of projects proposed for funding that would more than exhaust those revenue sources if all were funded.

In that context, the relevant question becomes more one of which projects meet acceptable criteria for construction, as opposed to whether more state money should be diverted for water development.

For that reason, and to avoid overcomplicating our preliminary specification of the methodology, we have employed a dichotomous evaluation criterion for each of the three non-efficiency issues we have identified with respect to Wyoming water projects. That is, we developed preliminary criteria that will be used to categorize a project as "acceptable" or "unacceptable" according to each of the three issues. These dichotomous evaluations were then incorporated into a multi-objective planning (MOP) framework depicted by the decision tree in Figures 5.1 and 5.2. As those figures show, the overriding economic issue concerning water project evaluation is whether the project will enhance Wyoming's control of its water resources. Projects that put water to beneficial use, or store water for foreseeable future beneficial use, have this characteristic. The next most important question is whether the project will have significant negative environmental consequences, followed by the question of whether efficiency benefits exceed costs. The distribution of project benefits becomes the final element in the evaluation process.

Using the approach depicted in Figures 5.1 and 5.2, it is obvious that the "best" Wyoming water projects are those that

Figure 5.1 - Preliminary Evaluation Process for Wyoming Water Projects - Part I

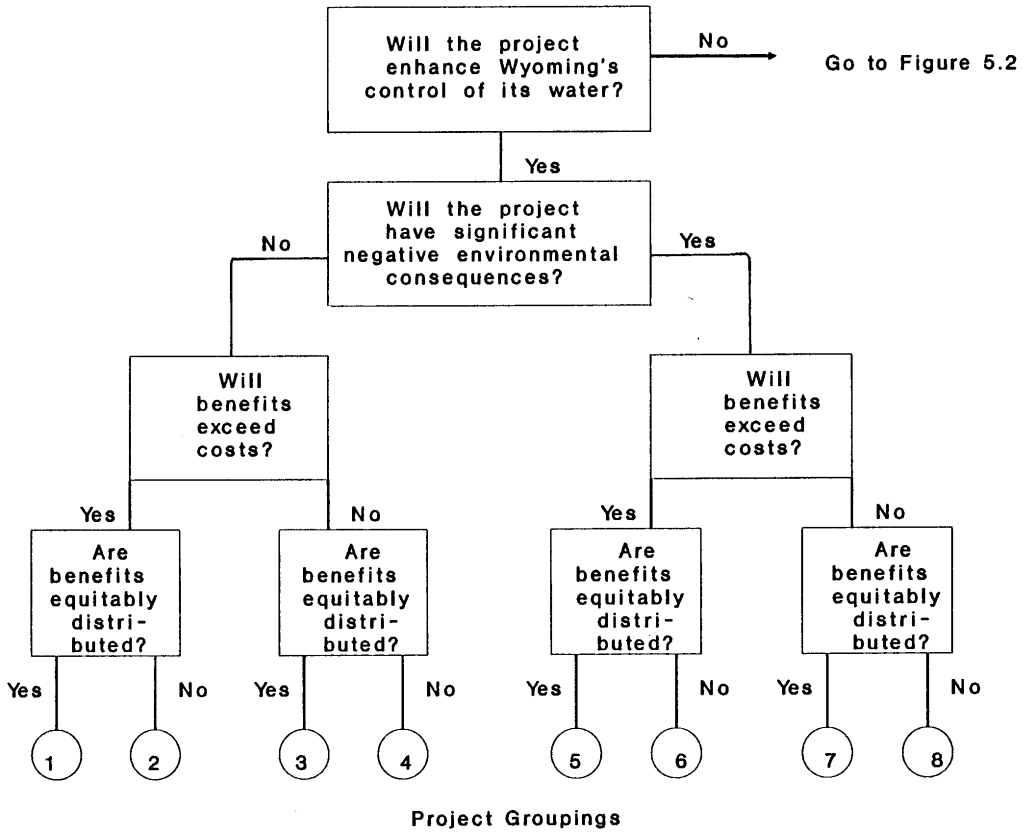
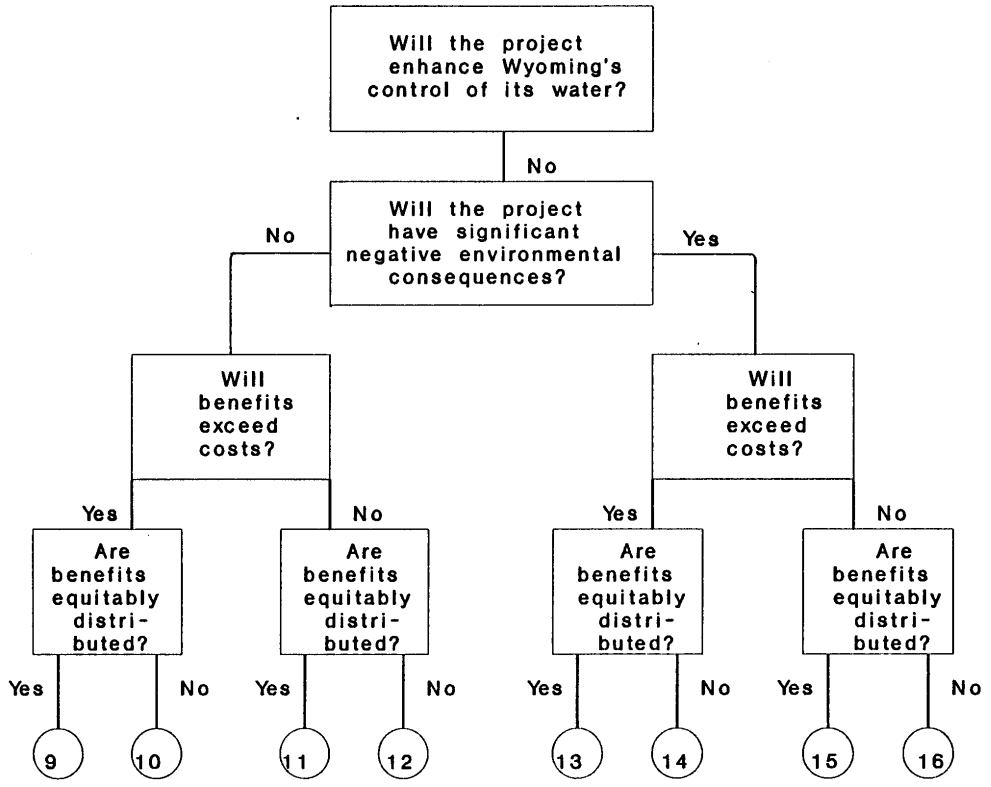


Figure 5.2 - Preliminary Evaluation Process for Wyoming Water Projects - Part II



enhance the state's control of its water resources, do not have significant negative environmental impacts, have benefits in excess of costs, and provide for an equitable distribution of project benefits. Projects that meet these criteria have been labelled as Group 1 projects in Figure 5.1. The next best projects, labelled Group 2, have all of the characteristics of Group 1 projects except that they provide for a less equitable distribution of project benefits. Projects in Groups 3 and 4 have similar characteristics to those in Groups 1 and 2 except that efficiency benefits do not exceed costs for those projects.

Projects in Groups 5 through 8 have characteristics similar to those in Groups 1 through 4 except they have significant negative environmental consequences. Finally, projects in Groups 9 through 16 are similar to projects in Groups 1 through 8, except that they would not significantly enhance Wyoming's control of its water resources.
Before the evaluation procedure depicted in Figure 5.1 can be implemented, a set of criteria must be developed for classifying projects as "acceptable" or "unacceptable" with respect to each issue. That topic is discussed in Section 5.3 below.

5.3 NON-EFFICIENCY CRITERIA

It should be noted that the dividing line between an "acceptable" and "unacceptable" rating will always be subjective, and thus will likely provoke arguments about how a

project should be classified. Such controversy is inevitable with any type of ranking system. The criteria suggested here, although preliminary and subject to revision, should at least help keep debate focused on those issues which are relevant to the decision making process:

- Control — A water project can enhance Wyoming's control over its water resources in one of two ways, or both. First, it can put currently unutilized, unappropriated water to beneficial use, thus enhancing Wyoming's legal entitlements to that water. Alternatively, the project can provide storage for water that will be put to beneficial use at a later date, thus enhancing control by eliminating uncertainty about future permitting requirements and showing intent to put water to beneficial use.[26]

An important aspect of this issue is the ability to put water to beneficial use (or store for future use) at a reasonable cost. In the absence of cost constraints (per acre-foot of developed water), any project could be designed to put water to beneficial use. For this reason, our preliminary methodology specifies a $1,000 per acre-foot cutoff for rating a project "acceptable" in terms of its ability to store and/or put to beneficial use currently unappropriated waters. This $1,000 figure includes the discounted value of both capital and O&M costs over the project's life. Projects which can

[26]It could be argued that projects which put water to immediate beneficial use should receive a higher rating for "control" than projects which store water for future use. In our preliminary methodology, however, we have chosen to make that distinction in terms of efficiency benefits to avoid overcomplicating the approach. That is, projects which put water to immediate beneficial use will tend to have significantly higher benefit-cost ratios than projects which store water for future use, and thus be ranked higher in priority for construction. This issue will be addressed in more detail during our second year of research.

store and/or put water to beneficial use at a cost lower than this will be rated "acceptable," while those that either do not store such water or do so at a higher cost will be rated "unacceptable."

Environmental Balance - Our survey respondents indicated a clear preference for maintaining some of the state's wild and scenic rivers in their natural state. Thus, criteria are needed to evaluate the relative environmental significance of any impacts caused by new water development projects. Our preliminary criteria are that a project will be rated "unacceptable" if the project would result in any of the following occurrences:

- Inundation of a significant[27] amount of Class I fisheries as classified by the Wyoming Game and Fish Department;
- Inundation of a significant amount of irreplaceable big game winter habitat, and habitats for migrating birds and endangered species in the project area;
- Inundation of any significant amount of land that is under consideration for either wild and scenic river status or wilderness status by any federal agency;
- Inundation of significant areas classified as unique and irreplaceable in terms of their natural beauty by other appropriate criteria.

Any projects which do not fall into one or more of the above categories would be classified as "acceptable" from an environmental perspective.

Efficiency – Efficiency refers to a comparison of a project's benefits and costs. For purposes of this preliminary methodology, a project will be rated "acceptable" if the present value of its benefits (estimated using methods outlined in Chapter 3) exceed the present value of its costs.

[27]Obviously the term ". . . a significant amount" is lacking in specificity. It is our intent to quantify such terms during our second study year by analyzing the range of impacts for historical projects and discussing the severity of such impacts with appropriate fish and wildlife experts.

Distribution — Distribution refers to the number of project beneficiaries, their geographic diversity, and their income levels prior to project construction. A project would be classified as "favorable" from a distribution perspective if two or more of the following criteria are met:

- More than 500 Wyoming residents would receive direct benefits attributable to the project;

- Indirect benefits from the project would span more than a one-county area; and

- A portion of the project beneficiaries would be lower income Wyoming residents.

5.4 INTEGRATING THE METHODOLOGY WITH EXISTING PROCEDURES

The Wyoming Water Development Commission (WWDC) currently uses a three-level approach for the evaluation and construction of water projects. Level I studies typically involve an analysis of development options and a description of the physical, legal, technical, economic, and environmental constraints that may affect project development. Level II studies involve a more detailed engineering and economic analysis of the project, and those projects that are deemed feasible at the end of Phase II are recommended for Level III construction funding (see Chapter 1, Section 1.2).

With respect to the evaluation process described in Figures 5.1 and 5.2, a preliminary evaluation of a project's acceptability with respect to the control and environmental issues could be made during Level I studies. A Level I determination that a project would both enhance Wyoming's control of its water resources and not harm environmentally sensitive areas would result in the project being classified

in Groups 1 -through 4 on the ranking scheme depicted in Figure 5.1. Such projects would receive the highest ranking possible for a Level I study, and should be recommended for Level II study.

At the opposite end of the spectrum are projects that would not enhance Wyoming's control of its water resources and would have serious negative environmental consequences. Such projects (Groups 13-16 in Figure 5.2) should seldom, if ever, be recommended for Level II study.

Projects that fall into the middle groupings (Groups 5-12 in Figures 5.1 and 5.2) should be considered for Level II funding only on a case-by-case basis. Some projects in these groups may involve a trade-off between significantly enhancing Wyoming's control of its water resources and at the expense of environmental damage to wild and scenic areas. In such cases, Level II studies may need to weigh these trade-offs using the contingent valuation method or other non-market valuation techniques. In general, however, projects in the middle grouping would not be forwarded for further study unless there is significant uncertainty about their environmental consequences and/or ability to enhance control.

During Level II studies, a determination of efficiency benefits and the distribution of those benefits should be made. Thus, at the completion of Level II studies, a determination should be made concerning whether the project falls in Group 1, Group 2, Group 3, or Group 4, or lower. (A

more detailed evaluation of the project's environmental consequences and its ability to control Wyoming's water resources would also be undertaken during Phase II, and may result in the project being downgraded after further review.)

5.5 SUMMARY

Referring back to Figure 1.1 in Chapter 1, it is obvious that there are so many factors involved in water project evaluations that no set of criteria will ever be accepted by all those involved in the decision making process. Special interest groups will always have their input, which might be quite different from the economic well-being of the state as a whole. Thus, while we do not believe the methodology proposed in this section will end the debate about Wyoming water project evaluations, we believe it will focus that debate on the issues of importance concerning Wyoming's water resources.

The methodology described above is preliminary; i.e., much more needs to be done to define the criteria described in Section 5.3, and the methodology needs to be refined through application to a series of historical projects to determine its usefulness in segregating "acceptable" and "unacceptable" water projects from the Wyoming perspective. That topic is discussed further in Chapter 6 of this report.

CHAPTER 6

PLANS FOR ADDITIONAL RESEARCH: THE NEXT STEPS

6.1 INTRODUCTION

The central theme of this report is that strict efficiency criteria do not capture nor represent the importance of water and water development to the state of Wyoming. We have argued that efficiency is a limited view of the world. This argument is supported by the extant literature addressing benefit-cost issues. We also tested this assertion vis-a-vis Wyoming residents through the administration of a survey. The survey clearly revealed that the preferences of the citizens are not bounded by strict efficiency criteria. That is, while efficiency is an issue, it is not the issue or criterion that solely guides the evaluation of Wyoming's water projects.

As such, we have attempted to develop a conceptual framework that moves beyond the narrow confines of benefit-cost measures and strict efficiency. This approach allows for project evaluation that captures many of the important aspects of water to the state of Wyoming. If the important considerations are indeed captured by our approach then the proposed approach will allow for a more representative

evaluation procedure for choosing which water projects to build.

6.2 FUTURE PLANS

Phase II of this research will have two major thrusts. In reviewing our original proposal regarding Phase II we found that the spirit of our original proposed approach remains unchanged. That is, we must test and compare methodologies and identify critical aspects of water projects that are important to Wyoming. Thus, the focus of Phase II will be upon an evaluation of historical water projects from differing perspectives.

We will compare the robustness of our proposed approach with that of the traditional benefit-cost measure approach. This will involve the analysis of a representative but diverse group of historical water projects in Wyoming. In addition to the comparative approach between methodologies, the evaluation will also be accomplished from an ex-ante and ex-post perspective. Further, we will investigate the question of how important water projects have been and will continue to be to the state of Wyoming. Several steps are required to accomplish this goal.

First, a set of historical water projects for analysis must be identified. A set of criteria for the identification of these projects will be developed. These criteria will attempt to capture dimensions such as alternative types of storage projects, differing levels of "control" of Wyoming's

water resources, differing levels and types of environmental impacts and differing degrees of distributional impacts. The number of projects to be analyzed will be dictated by data availability and budget constraints. We would propose to consult with the WWRC and WWDC in developing our criteria and in selecting the projects for analysis.

Second, the appropriate measures for the non-efficiency criteria would be further developed and refined for defining whether a project is "acceptable" or "unacceptable" as discussed in Section 5.3. For instance, what is an appropriate measure of "control"? Is it the amount of water in a containment facility and/or the amount in a particular basin relative to other basins that have significant downstream scarcities? How many miles of Class I fisheries should we allow to be destroyed before classifying a project as "unacceptable'? We have suggested the outline of these criteria in Chapter 5. However, we argue that these issues remain central to our Phase II effort.

Third, having developed the non-efficiency measures, the necessary primary and secondary data will be obtained. In some cases sufficient data will be available through published documents. In other cases, some primary data gathering may be needed. There is the possibility that another survey will have to be designed and administered for data collection purposes. This might involve visitation with users of the water projects. It should be noted that some aspects of the

assessment methodology may not be amenable to historical testing. In such cases, an attempt will be made to clearly identify the resulting biases.

Fourth, an evaluation will be made as to whether another survey (in addition to the above mentioned possibility) should be administered. The purpose would be to provide a ranking in addition to the rankings derived from the traditional benefit-cost measure approach and our proposed methodology. This would potentially represent a test as to whether our proposed methodology more closely represented the importance of water projects relative to the importance as implied by the benefit-cost measure.

Finally, by taking an ex-post and ex-ante perspective, we will be able to focus on the extent to which the projects succeeded or failed in the generation of benefits and costs anticipated in pro-construction feasibility analyses, and the economic and institutional characteristics of the projects which can be identified as contributing to such success or failures. Attention will focus on the structure of the area economy to determine the extent to which indirect effects were truly associated with the projects' construction and operation. The role of social infrastructure also will be examined ex-ante and ex-post, to determine if the needs and costs for such infrastructure were adequately anticipated in project proposals. Thus, in addition to the overall ranking by the two approaches, the analysis will be a comprehensive

identification of economic and institutional conditions requisite for indirect benefits, costs, and environmental effects, and the relationship between these economic and institutional variables and the magnitude of indirect and environmental effects (in dollars or otherwise).

Based upon the results of the above efforts, the preliminary assessment methodology will be refined and modified. Procedural steps necessary as well as necessary data to implement the methodology will be carefully detailed. It is anticipated that the historical analysis will lead to useful insights into the validity and applicability of the assessment methodology.

APPENDIX A

WYOMING'S WEALTH OF WATER RESOURCES AND SCARCITY ELSEWHERE

A.1 INTRODUCTION

This appendix addresses the following issues: (1) water availability, water use, and water entitlements for Wyoming; and (2) potential scarcity in other states. The motivation for the investigation can be found in our attempt to understand Question 1 in the introduction: What are the forces driving the water development program? As it will hopefully become clear in reading through the appendix, Wyoming has an abundance of water for now and for needs in the near future. However, other states and in particular the downstream basin states, do not have an abundance of excess water now. It was this juxtaposition of abundance and downstream scarcity that interested us. A further motivation for the subject matter of this appendix was to lay the groundwork for the survey of Wyoming residents.

A.2 WYOMING'S WATER AVAILABILITY, WATER USE AND WATER ENTITLEMENTS

Wyoming is separated into four administrative water divisions. The first three of these divisions contain headwaters of the Missouri River. Water Division #l includes the Niobrara River, the North Platte River, and the South Platte River drainages; Water Division #2 includes the Tongue River, the Powder River, the Belle Fourche River, the Little Missouri River, and the Cheyenne River drainages; and Water Division #3 includes the Clarks Fork River, the Bighorn River, and the Little Bighorn River drainages. For the purposes of this appendix, the Yellowstone River and its tributaries are

included in Water Division #3, although their water is not available for use in Wyoming for geographical as well as legal reasons. Finally, Water Division #4 includes headwaters of three river basins: (1) the Little Snake River and the Green River, which run into the Colorado River Basin; (2) the Bear River, which flows into the Great Salt Lake Basin; and (3) the Snake River and the West Teton tributaries, which form part of the headwaters of the Columbia River Basin. (See Figure A.1 for an overview.)

Table A.1 describes water availability and water use by water division. The basis of this table is a similar table in an information leaflet from the Wyoming Water Planning Program (WWPP) from June 1972 (Wyoming State Engineer's Office [1972]). From the WWPP table, we reproduced columns (2), (3), and (4) directly, by simply adding up the figures of those rivers that belong to one water division. This assumes, that natural streamflow volume has not changed significantly since 1968. We also assumed that the total surface area of reservoirs in Wyoming did not change significantly during the same period, as well as all other factors that influence evaporation from reservoirs. Subsequently, we also retrieved the data for column (7) from the WWPP table.

Updating was necessary, though, for columns (5) and (6), which in turn changes the figures in columns (8) and (9). Since the necessary data for this procedure is available only for counties, the first step was, to relate the 23 counties in Wyoming to the four water divisions:

1. Albany, Carbon, Converse, Goshen, Laramie, Natrona, and Platte Counties belong to Water Division #l;

2. Campbell, Crook, Johnson, Niobrara, Sheridan, and Weston Counties belong to Water Division #2;

3. Big Horn, Fremont, Hot Springs, Park, and Washakie Counties belong to Water Division #3;

4. Lincoln, Sublette, Sweetwater, Teton, and Uinta Counties belong to Water Division #4.

Figure A.1

Wyoming's Water Divisions

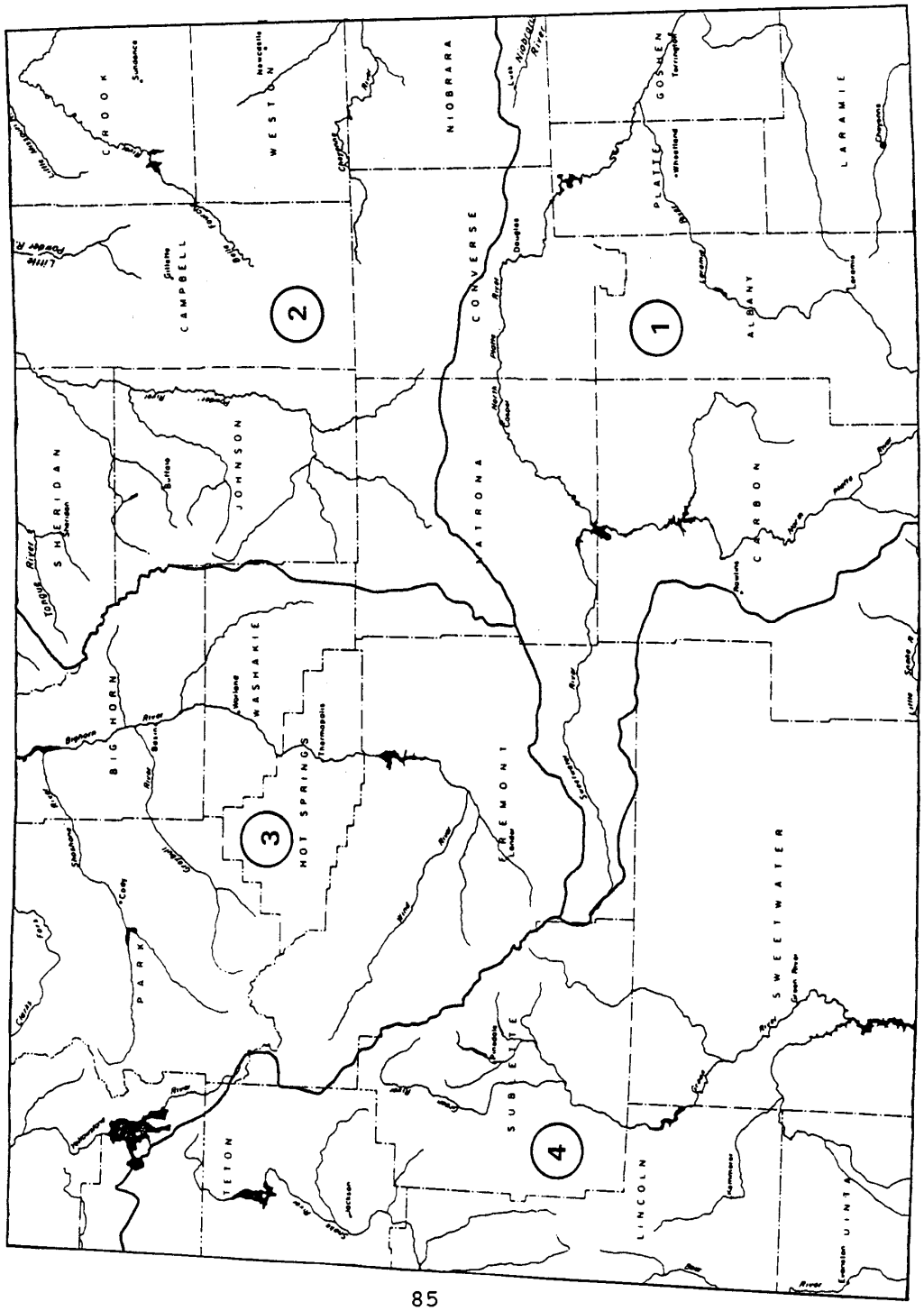


TABLE A.I

Wyoming Average Annual Streamflows and Water Uses
(Streamflow Base Period from 1948 - 1968;
all figures in acre-feet/year)

Water Division (1)	Streamflow into Wyoming From Other States (2)	Water Yield within Wyoming (3)	State Line Outflow under Natural Conditions (4)=(2)+(3)
Div.No.1	530,000	1,240,500	1,770,500
Div.No.2	---	1,019,100	1,019,100
Div.No.3	446,000	6,645,000	7,091,000
Div.No.4	531,000	6,922,700	7,453,700
Wyoming	1,507,000	15,827,300	17,334,300

Man's Water Consumption in Wyoming				Depleted Streamflow Leaving Wyoming
Irrigation (5)	Municipal & Industrial (6)	Reservoir Evaporation (7)	Total (8)	(9)=(4)-(8)
637,600	59,100	180,000	876,700	893,800
140,400	13,900	66,000	220,300	798,800
1,086,700	15,200	106,000	1,207,900	5,883,100
392,000	129,100	38,000	559,100	6,894,300
2,256,700	217,300	390,000	2,864,000	14,470,300

These assignments are naturally arbitrarily, because in most cases political boundaries do not follow watersheds. Therefore, we will only mention the three most significant problems:

1. the Sweetwater River in Fremont County belongs to Water Division #l;

2. the Little Bighorn River in Sheridan County belongs to Water Division #3;

3. the Little Snake River in Carbon County belongs to Water Division #4.

After this preliminary step, the updating of column (5) could begin. Data on the amount of water used for irrigation in each county or water division was not available. But from the U.S. Census of Agriculture (U.S. Bureau of the Census [1972, 1977, 1984]), the irrigated acreage in each county was known for the years 1969, 1974, and 1982. The mean of the data from 1969 and 1974 was taken to represent the irrigated acreage at the time, when the WWPP table was compiled. This enabled us, to compute 1982 water consumption for irrigation for each water division by adding up the irrigated acreage of all counties within one water division and then using the following formula:

$$\frac{\text{1982 irrigated acreage}}{\text{1972 irrigated acreage}} \times \text{1972 water consumption for irrigation} = \text{water consumption for irrigation}$$

The data for 1972 water consumption for irrigation is taken from the WWPP table. The results are shown in column (5).

To update the data for municipal and industrial water consumption two factors must be kept in mind: the growing population and the increasing water consumption per capita. To take care of the change in population, we retrieved data about the population of Wyoming counties in 1970 and 1980 from the Wyoming Data Handbook 1987 (Department of Administration and Fiscal Control [1987]) and transferred the county populations into water division populations, according to the assignment described above.

Adjusting the water consumption per capita was not straightforward. The U.S. Geological Survey (USGS) publishes water use data that includes per-capita use broken down to the state level every five years (Murray [1972]; Solley [1983]). Thus, we had to assume the same per-capita water consumption in all four water divisions. Unfortunately, the USGS breaks down municipal and industrial water use into four categories: (1) public supply, (2) rural domestic and livestock use, (3) thermoelectric power generation, and (4) other self-supplied industrial use. Further, water consumption is given only as total water consumption, containing ground water and saline water as well as fresh surface water, but water withdrawal is broken down into these categories. So, we assumed that the portion of fresh surface water in water consumption is the same than its portion in total water withdrawal. This assumption enabled the calculation of fresh surface water consumption in each of the four water user categories mentioned above. Table A. 2 shows the results of these calculations.

By dividing the numbers in Table A. 2 by the population in 1970 and 1980, respectively, we obtained the fresh surface water consumption per capita:

- for 1970: C_{70} = 84.7 gallons/day
- for 1980: C_{80} = 201.4 gallons/day.

This represents a dramatic increase in water use per capita within a period of only ten years. This might be partly due to an inconsistency in the USGS data about water use for thermoelectric power generation in Wyoming. The water consumption figure jumps from 5.3 to 45 mgd over this ten year period, representing an 850 percent increase. The water withdrawal figure, however, increased only by ten percent during the same period. We had to use these inconsistent figures, because other figures were not available. This might explain a part of the dramatic increase in water consumption per capita. However, the data for public supply and for other

TABLE A.2

Wyoming Surface Water Consumption

Water Use Category	Fresh Surface Water Consumption In million gallons/day (mgd) 1970	1980
Public Supply	6.12	32.20
Rural Domestic and Livestock Use	15.36	10.92
Thermoelectric Power Generation	5.3	45
Other Self-Supplied Industrial Use	1.38	6.47
Total	28.16	94.59

self-supplied industrial use also increase drastically, which indicates that our results are not totally unrealistic.

The final calculation of the municipal and industrial (M&I) water consumption, as it appears in Table A.1, was done according to the following formula:

$$\frac{\text{1980 population} \times C_{80}}{\text{1970 population} \times C_{70}} \times \text{1970 M\&I water consumption} = \text{1980 M\&I water consumption.}$$

The results of this calculation, done for each water division, are shown in column (6).

The rest is straightforward: The updated columns (5) and (6) are added to column (7), which represents reservoir evaporation, which presumably did not change since 1968. These sums are shown in column (8) and represent man's depletion of streamflow. Column (8) subtracted from column (4) yields the depleted streamflow leaving Wyoming.

Table A.1 shows the quantity of water, that is flowing through and out of Wyoming. But not all of this water is available for consumptive use in Wyoming. Interstate compacts and court decrees regulate for most rivers, how much water Wyoming has to allow to cross its stateline. Table A.3 shows, how much more water Wyoming citizens could consume, in addition to the amount they are using now. This table is based on data made available by Donald J. Brosz, Extension Irrigation Engineer at WWRC. The numbers vary a little from those in the corresponding columns in the previous table, which is not surprising, given the randomness of stream flows during the years.

A.3 POTENTIAL SCARCITY IN OTHER STATES

There are at least two ways that the scarcity issue can be examined: (1) examination of water right prices, and (2)

TABLE A.3

Water Available to Wyoming
(in acre-feet/year)

Stream	Yield + Inflow	Outflow	Consump-tive Use	Legally Available but Unused
Yellowstone River	2,706,000	2,706,000	0	*
Clarks Fork River	716,000	690,000	26,000	424,000
Bighorn River	3,961,000	2,608,000	1,083,000	1,600,000
Little Bighorn R.	119,000	114,000	5,000	**
Tongue River	460,000	376,000	84,000	94,000
Powder River	434,000	338,000	96,000	165,000
Little Missouri R.	35,000	31,000	4,000	**
Belle Fourche R.	86,000	66,000	20,000	7,000
Cheyenne River	79,000	58,000	21,000	**
Niobrara River	7,000	3,000	4,000	***
North Platte River	1,473,000	966,000	777,000	***
South Platte River	20,000	7,000	13,000	***
Little Snake River	404,000	385,000	19,000	)
				) 455,000
Green River	1,882,000	1,536,000	346,000	)
Snake River	4,436,000	4,438,000	88,000	150,000
West Teton Tributaries	360,000	355,000	5,000	*
Bear River	431,000	343,000	88,000	13,000
Total	17,349,000	14,400,000	2,949,000	2,908,000

*The water in the Yellowstone River and in the West Teton Tributaries is generally considered not available for use by Wyoming. Reasons for this are geographical barriers and legal situations. The Yellowstone River leaves the Yellowstone National Park in Montana and the West Teton Tributaries are separated from Wyoming by the Grand Teton National Park.

**For the rivers that are not under compact agreements (the Little Bighorn River, the Little Missouri River, and the Cheyenne River) it is not exactly known how much additional water is available for use in Wyoming.

***Niobrara River, North Platte River and South Platte River are generally considered as fully appropriated.

projected depletions.[28] In what follows two trends become obvious. First, water right prices have been increasing over time and will continue to increase. Second, basins will become depleted from individual state perspectives.

Water right prices have increased rather dramatically in the 1960 to 1980 time period. Table A.4 indicates that the value of water rights in Arizona increased from $708 to $750 per acre-foot in the 1970 to 1980 period. In southwestern Colorado, and in the Colorado Big-Thompson area, however, prices increased from $913 and $310 per acre-foot in the 1960s to over $2,000 and $3,000 per acre-foot, respectively, in the 1980s. The value of water rights in Nevada remained relatively constant during the 1960s and 1970s, but increased more than five-fold between the 1970s and 1980s. Prices for water rights in New Mexico increased from between $427 per acre-foot and $2,661 per acre foot in the 1960s to between $1,000 and $10,000 per acre-foot in the 1980s. Clearly Table A.4 suggests that water values in the western states are increasing significantly.

Water right prices can be expected to increase over time. Table A.5 presents a simple projection based upon the data presented in Table A.4. The estimates are based upon a geometric extrapolation of the increases that occurred in the 1970-1986 time period. While one cannot know the precise values from such a simple forecasting framework, the table does suggest that if the recent past is a predictor of the future that values will increase dramatically. As such, it is not difficult to infer that there will be increasing pressure on downstream states to find "new" water.

Turning to expected water deficits. Table A.6 presents a possible trend through the year 2030. Rapidly growing states

[28]This section draws heavily on investigations previously conducted by the authors (Watts, Brookshire, Cummings [1989]).

TABLE A.4

Water Rights Prices in Selected Western States:
1960s Through 1980s

	$ Per Acre-Foot, 1985 Dollars		
	1960s	1970s	1980s
Arizona	$ NA	$ 708	$ 750
Colorado:			
Southwest	913	1,929	2,102
Big Thompson	310	1,252	3,059
Nevada	320	255	1,394
New Mexico	427-	853-	1,000-

SOURCE: Saliba, Bonnie Colby, David B. Bush, William E. Martin, and Thomas C. Brown, "Do Water Market Prices Appropriately Measure Water Values?" Natural Resources Journal. 27(3) (Summer 1987), pp. 617-652, Table 2.

NA: Not available

TABLE A.5

Water Rights Prices in Selected Western States:
1990s through 2020

		1990s	2000	2020
		($ Per Acre-Foot; 1985 dollars)		
	(1980s)			
AZ	850	784	820	925
CO:				
S.W.	2,102	2,682	3,421	5,605
C-BT	3,059	5,978	11,683	NA
NV	1.394	NA	NA	NA
NM	1,000-10,000	1,172-11,267	1,269-12,694	1,743-16,114

Sources: See Sources given in Table A.4. Estimates for 2000-2020 are extrapolations from mid-1980 values based on geometric increases during the 1970-86 periods.

NA: Not available

TABLE A.6

Expected Water Deficits in Selected Western States

	1990	2000	2010	2020	2030
	(1,000 Acre-Feet)				
AZ	60-500	----	----	27-434	----
CAL	1,010	1,130	----	----	----
COL	2	----	----	9	----
KS	111	93	----	76	64
OK	112	----	----	700	----
TX	64-800	----	----	1,100-2,500	----
UT	----	----	----	----	Starts

Sources: Arizona Water Commission [1977]; State of California, [1983], p. 79; State of Colorado and Bureau of Reclamation [1974], p. 20; State of Kansas [1978], p. 79; Oklahoma Water Resources Board [1980], p. 154, 155; Texas Department of Water Resources [1983], Section 3; and State of Utah [1981], p. 15, for the listed states, respectively.

such as Arizona and California can be expected to experience water deficits in the near future.

A.4 IMPLICATIONS OF WYOMING'S ABUNDANCE AND DOWNSTREAM DEFICITS FOR THE COLORADO BASIN

The implication of the water shortages expected in these states are apparent. If such shortages and high prices, in fact develop, economic activity in those states will potentially decline and the ability to attract new industry will also correspondingly decline. As such, these states may attempt to avoid shortages and attendant high prices by attempting to enhance their supplies from other sources through legal maneuvers. This point is developed from a legal perspective in Appendix E.

It would appear that Wyoming's relative abundance of water juxtaposed with the downstream shortage scenario would suggest that any methodology for evaluation Wyoming's proposed water projects would have to consider "controlling" Wyoming's water. The issue was explored in the specific context of the Watts, Brookshire, and Cummings [1989] report. In broadening the perspective developed in that effort, the survey reported upon in Chapter 4 and Appendix D attempted to broaden the perspective of Wyoming's potential loss of some of its water resources.

APPENDIX B

THE PERMITTING PROCESS FOR WATER PROJECTS

B.1 INTRODUCTION

Wyoming's ability to control the development of its water resources is hindered in several ways by forces over which it has little control. Among the more formidable obstacles facing the state in its attempt to develop new surface water supplies is the maze of federal laws, rules, and regulations that guide the federal permitting process for new dams and reservoirs in the state. These laws, rules, and regulations derive from a series of national environmental concerns that directly affect Wyoming's ability to control its water resources. The more important pieces of federal legislation affecting water development in Wyoming are:

1. The National Environmental Policy Act (NEPA) of 1969, subsequent amendments, and rules and regulations for implementation;
2. The Endangered Species Act of 1973, subsequent amendments, and implementing rules and regulations;
3. The Clean Water Act of 1972, subsequent amendments, and implementing rules and regulations;
4. The Environmental Quality Improvement Act of 1970, subsequent amendments, and rules and regulations for implementation; and
5. The Fish and Wildlife Coordination Act of 1978, subsequent amendments, and rules and regulations for implementation.

These five pieces of federal legislation and their implementing rules and regulations form the cornerstone of federal involvement and control of water resources at the state level. These acts also provide other individuals, organizations, and states with a variety of administrative and

legal tools that can be used to delay or prevent Wyoming and other states from developing water resources as they see fit. Thus, even in situations where a state's legal entitlement to its water resources is unquestioned, rules and regulations stemming from national environmental concerns can be used to thwart the development of those water resources.

This appendix is divided into three sections as follows: Section B.2 provides a brief overview of some of the more important pieces of federal legislation affecting Wyoming's control of its water resources. Section B.3 then presents an overview of the permitting process required for water projects under these federal rules and regulations. Section B.4 summarizes how these rules and regulations can be used to thwart water development efforts at the state level.

B.2 OVERVIEW OF FEDERAL LAWS AND REGULATIONS

B.2.1 The National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) requires all federal agencies to prepare an environmental impact statement (EIS) on environmental consequences of any major federal actions or proposed legislation. Components of the environmental impact statement must include:

- the direct environmental impacts of the proposed action;
- any adverse environmental effects which cannot be avoided should the proposal be implemented;
- alternatives to the proposed action;
- the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

The definition of what constitutes a major federal action, requiring an environmental impact statement, is at the discretion of the federal agency or agencies involved. In

some cases, a less detailed environmental assessment (EA) is conducted prior to making a decision as to whether a full EIS is required. As a generalization, future Wyoming water projects will probably require an EIS because such projects invariably involve the issuance of a Section 404 permit under the Clean Water Act, some changes in use for federal land holdings in the state, or some endangered species considerations. All of these considerations are viewed as major federal actions by federal agencies involved.

B.2.2 The Clean Water Act

The Federal Clean Water Act is administered by the Environmental Protection Agency, and has its objective to ". . . restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to issue permits for the ". . . discharge of dredged or fill materials into the navigable waters at specific disposal sites," after notice and opportunity for public hearings. The Corps is authorized to prohibit, deny or restrict any project involving dredged or fill materials that will have unacceptable adverse effects upon municipal water supplies, fisheries, wildlife, or recreational resources.

As a practical matter, virtually any stream worthy of water development in Wyoming is classified as "navigable," and the issuance of a federal permit under Section 404 of the Clean Water Act is generally regarded as a major federal action requiring a full EIS under NEPA.

B.2.3 The Endangered Species Act

The purpose of the Endangered Species Act is to provide a means of conserving the ecosystems upon which endangered and threatened species depend. Determination of endangered and threatened species is made by the Secretary of the Interior, who also designates critical habitats of these species based upon the best available data. The term "conservation" as defined in the act means the use of all methods and procedures

necessary to bring an endangered or threatened species to the point where such measures are no longer necessary. They include, but are not limited to, research, habitat acquisition and maintenance, propagation, and transplantation.

Before the construction of any project involving the federal government can begin (which is virtually all projects requiring a 404 permit), the lead federal agency must request the Secretary of the Interior for information on whether any species which is listed or proposed to be listed as endangered or threatened may be present in the area of the proposed action. If the Secretary advises that such a species may be present, the federal agency must then conduct a biological assessment for the purpose of identifying any threatened or endangered species which is likely to be affected. Also, any private citizen can petition the Secretary to investigate the presence of threatened or endangered species, or request a judicial review of any decision of the Endangered Species Committee. If the assessment concludes that endangered species are likely to be impacted by the project, the U.S. Fish and Wildlife Service must complete a biological opinion defining project impacts and identifying conservation measures the project proponent must implement to mitigate those impacts.

B.2.4 The Environmental Quality improvement Act

The Environmental Quality Improvement Act of 1970 established the Office of Environmental Quality, a National Council on Environmental Quality, and a professional and administrative staff to support the council. The council on environmental quality acts as an environmental "watch dog," assisting, reviewing, coordinating, analyzing, and overseeing all activities conducted by the federal government which potentially affect the quality of the environment. As a practical matter, the Council on Environmental Quality acts as an administrative body of last resort in resolving conflicts

among various federal agencies regarding the environmental consequences of federal actions.

B.2.5 The Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act defines procedures for handling endangered species considerations with respect to federal actions involving water projects. In particular, the act directs the U.S. Army Corps of Engineers to prepare a biological assessment prior to issuing a dredge and fill permit under Section 404 of the Clean Water Act to determine if any endangered species are affected by such actions. This biological assessment must then be sent to the U.S. Fish and Wildlife Service (USFWS) for review. If both the Corps and the USFWS agree that no endangered species considerations are involved with respect to the project in question, a non-jeopardy opinion is issued, and the U.S. Army Corps of Engineers is free to proceed with other aspects of the permitting process under the Clean Water Act.

If either of the two agencies believe that there is a potential for injury to endangered species, the USFWS then prepares a separate biological opinion under Section 7 of the Endangered Species Act. That biological opinion can result in a recommendation to deny a dredge and fill permit under Section 404 of the Clean Water Act, to issue such a permit, or to issue such a permit with conditions to protect endangered species.

B.3 THE PERMITTING PROCESS

The federal laws and implementing regulations described in the previous section pose an ominous set of hurdles for a state such as Wyoming attempting to develop its water resources for the benefits of its citizens. To better understand the nature of these hurdles, and the uncertainty that they portend for Wyoming's water development program, this section presents a brief overview of the permitting process that has evolved from the federal laws and regulations

described in the previous section. This overview is presented in a series of steps that are somewhat arbitrary by definition, and do not necessarily correspond to steps in the process as defined by federal agencies. They do reflect the major components of the permitting process from a layman's perspective.

B.3.1 Lead Agency Definition

The first step in the permitting process is a determination of whether federal interest is involved in the project, and if so, the definition of a lead federal agency. Virtually any new surface water development project in the state of Wyoming will require federal involvement because of Section 404 of the Clean Water Act. Projects are exempted from this section of the Clean Water Act only if they involve non-navigable water ways on private land, and relatively few perspective projects of interest to the state meet this category.

The lead federal agency in the permitting process is typically the U.S. Forest Service, the Bureau of Land Management, or the U.S. Army Corps of Engineers. The U.S. Forest Service or Bureau of Land Management often take the role of lead agency if the project is located primarily upon lands that they administer; the Corps typically takes the lead if either the U.S. Forest Service or BLM defers lead agency status to the Corps.

B.3.2 Concept Design and Operating Plan

The next step in the permitting process is for the project sponsor (in this case the WWDC) to develop a concept design and operating plan for the project. For Wyoming water development projects, this function is typically carried out by the WWDC with assistance from consultants under contract to the WWDC.

B.3.3 Environmental Review

The third step in the permitting process is for the project sponsor to conduct an environmental review of the potential environmental impacts implied by the concept design and operating plan discussed in Section B.3.2 above, in the case of WWDC projects, this environmental review is typically developed by the Wyoming Game and Fish Department or consulting firms under contract with the WWDC, and submitted to the WWDC for policy review.

B.3.4 Prepare Clean Water Act Section 404 Application

The next step in the permitting process is for the project sponsor to prepare an application to the Corps for a 404 permit and supplement this application with copies of the concept design and operating plan and environmental review as described above.

B.3.5 Memorandum of Agreement

Once in receipt of the Section 404 application and supporting documentation, the Corps then develops a memorandum of agreement with the lead federal agency (if different from the Corps) or cooperating federal agencies concerning the type of environmental assessment that is necessary to evaluate the Section 404 application. Three choices are available to the federal agencies at this point concerning disposition of the applications:

- a determination of no impact could be reached, and the permit could be issued without further study; or
- a determination could be made that environmental impacts would be minor, requiring only a brief environmental assessment (EA) prior to issuing a permit; or
- a determination could be made that environmental impacts might be significant enough to warrant a full environmental impact statement (EIS) to evaluate the permit application.

Because of various provisions of the Endangered Species Act, the National Environmental Policy Act, and the Clean Water Act discussed previously, major WWDC projects are

subject to the full EIS review process. (An example of a WWDC project which required only an environmental assessment was the Lake Adelaide Rehabilitation Project, which is currently nearing completion in the Big Horn National Forest in northern Wyoming.)

B.3.6 The Environmental Assessment Process

Three options exist for the preparation of an environmental impact statement (or environmental assessment). First, the lead federal agency can take responsibility for preparing the EIS; second, the Corps of Engineers can take responsibility for the EIS; or the EIS can be prepared by an independent contractor under so-called "third party agreements." Under third party agreements the project's sponsor pays for EIS preparation and the consultant is responsible to the Corps of Engineers or lead agency.

The recent EIS for the Sandstone project in southeastern Wyoming was prepared under a third party agreement under which funding for the EIS was provided by the WWDC, but direction for preparation of the EIS was provided by the U.S. Corps of Engineers. The EIS for the Deer Creek project, on the other hand, was prepared by the staff of the U.S. Army Corps of Engineers.

The assessment process itself involves the following steps:

1. Conducting a series of scoping meetings by the lead federal agency or third party contractor to elicit public input on the issues and scope of the proposed EIS;
2. Analyzing impacts and preparing a draft EIS for public review;
3. Soliciting public comments on the draft EIS;
4. Lead agency review of public comments resulting in a decision to (a) finalize the EIS with no changes, (b) issue a supplement to the draft EIS, or (c) prepare a revised draft EIS based upon public comment.

If either (b) or (c) above is chosen, the first three steps in the environmental assessment process above are repeated. The draft EIS is finalized when all public comments with respect to the document have been addressed.

B.3.7 The 404 Decision Record

Once the environmental impact statement has been finalized, the Corps makes a decision concerning the issuance of a Section 404 Permit under the Clean Water Act, and makes a record of that decision for review by other federal agencies. Administrative rules and regulations for this decision making process and the supporting decision record are specified in the implementing rules and regulations to the Clean Water Act. These rules and regulations were one basis for a court challenge by Nebraska over the Corps' issuance of a permit to the Wyoming Water Development Commission to build Deer Creek Dam and Reservoir.

The decision record for issuance of the 404 Permit is typically available for review, but is not necessarily published. It is intended primarily as an internal review document.

B.3.8 Special Use Permits

Once a decision has' been made concerning the Section 404 Permit, the project proponent must apply to other federal agencies for any needed special use permits if the project will involve changes in use of federal land holdings. If a project involves Forest Service lands, a special use permit is needed; while if the project involves Bureau of Land Management lands, an easement is needed before the project can proceed. Both the Forest Service and Bureau of Land Management can suggest conditions that should be attached to the Section 404 Permit by the U.S. Corps of Engineers prior to issuing permits or easements.

B.3.9 Environmental Protection Agency Review

Although the U.S. Corps of Engineers has the responsibility for issuing dredge and fill permits under

Section 404 of the Clean Water Act, the U.S. Environmental Protection Agency (EPA) has final authority over the acceptability of such permits and associated conditions. In exercising its review authority, the EPA usually gets involved in the permitting process after the draft EIS has been issued, by requesting a "showing" of the project by the Corps under Section 404B1 of the Clean Water Act. This "showing" is typically a long letter prepared by the sponsor describing the purpose of the project and reviewing alternative sources of water that might be available for the prescribed purposes. The "showing" serves to determine the most cost effective and least environmentally damaging practicable alternative.

In recent years, the EPA has expanded its requirements for the "showing" to include statements of purpose and need for the project. This approach has been adopted by EPA with respect to Wyoming's proposed Sandstone project, where the EPA has raised the question of need as it relates to certain proportions of the planned storage in that reservoir. Wyoming officials view this review of need by EPA as a federal intrusion into Wyoming's rights when it comes to the development of its water resources.

Recently, EPA used its review authority under Section 404 of the Clean Water Act to initiate a veto process over the proposed Two Forks Dam and Reservoir southwest of Denver, Colorado.

B.4 UNCERTAINTY AND THE PERMITTING PROCESS

The previous section described general outlines of the permitting process now required under federal environmental laws and regulations to initiate new water development projects in the state of Wyoming. That discussion highlights two ways in which the state's ability to develop its water resources for its own needs can be thwarted by the permitting process. First, other states, private parties, or other project opponents can initiate lawsuits alleging violations of

the Clean Water Act, the National Environmental Policy Act, the Endangered Species Act, and other federal laws and regulations that form the basis of the permitting process itself. These lawsuits, even if ultimately unsuccessful, can delay project construction for significant periods of time. Such delays can test the resolve of project proponents and certainly affect project budgets.

The prime example of such delays is Wyoming's proposed Deer Creek project, in the North Platte drainage near Casper. Lawsuits initiated by the state of Nebraska with respect to that project have delayed the start of construction by two years.

The second element of uncertainty associated with the federal permitting process is the amount of latitude that federal agencies themselves have over the permitting process. Recent decisions by the EPA with respect to the Two Forks project in Colorado illustrate the amount of latitude that is apparently available under federal law to deny project construction on environmental grounds. Another example is EPA's position that it can potentially deny construction on the basis of a lack of immediate need for some of the water to be developed by a particular project. This latter interpretation of authority by EPA is of great concern to Wyoming Water Development officials and the Wyoming Water Development Program as it directly imposes EPA into the decisionmaking process relative to state water planning.

Although the current federal permitting process for Wyoming water projects leads to a great deal of uncertainty, such planning in the future will probably be subject to even greater uncertainty due to enhanced environmental concerns at the national level. For example, the Bush administration has voiced support for a policy that would result in "no net loss" in wetlands in the United States. To date, the debate has centered on a recently executed Memorandum of Agreement between the Department of the Army and the EPA that supposedly

clarifies the procedures to be used in determining the type and level of mitigation for wetlands necessary to demonstrate compliance with the Clean Water Act. Furthermore, federal wetland legislation is currently under consideration in various committees and subcommittees of Congress. While such policy and legislation may indeed have noble objectives, the latitude currently allowed to the U.S. Corps of Engineers and EPA to determine what constitutes "wetlands" could provide additional hurdles to development of Wyoming's water in the future.

APPENDIX C

SURVEY STATISTICS

C.1 DEMOGRAPHIC ANALYSIS

The survey was mailed to 800 Wyoming households that were randomly selected from telephone listings. Of these 800 surveys, 164 were returned as undeliverable. Thus, we can assume that 636 households received a survey. The percentage of undeliverable surveys (20.5 percent) can be attributed to the following factors: (1) the telephone books used to generate addresses were about one year old, and (2) in 1989 Wyoming lost a substantial part of its population through migration due to the economic conditions in the state.

The original mailing began on November 18, 1989. Those households that did not respond were sent a second survey beginning December 9, 1989. On December 21, a reminder postcard was mailed to those households that still had not responded. Survey responses were cut off as of January 15, 1990, with 345 completed questionnaires returned, which is a 54.25 percent response rate. This response rate is excellent, considering the complexity of the issue and the amount of time it takes to fill out the questionnaire.

The average age of the respondents is 50.71 years; higher than one would expect for the average Wyoming household head. To test for possible bias due to the age of respondents, the sample was divided into two groups: one group contained respondents 50 years or older, and the other group contained those younger than 50 years. Comparing the responses of these two groups to the questions about the importance of different water uses (i.e., Question 1) shows, that the younger group

ranks recreational uses and preservation/conservation higher than the older group. On the other hand, the older group placed a higher value on the "traditional" economic uses of water (see Table C.1).[29]

Seventy-nine percent of those individuals responding for a household were male. The same procedure as described above for different age groups was applied to groups containing male and female responses. The results in Table C.2 show that there are differences in the responses, but no clear pattern is visible.

Tables C.3 through C.10 contain the basic statistic parameters for the background variables asked for in the survey.

C.2 WATER USES AND ISSUES

The first question of the survey asked the respondent to rate the importance of different uses for Wyoming's undeveloped water resources. Between 341 and 331 respondents answered each of these questions, and valued II uses according to their importance on a scale from 5 (very important) to I (not important). Table C.ll shows the means and standard deviations for the answers for different uses.

Similarly, in Question 2, the respondents were asked to evaluate four statements about water policy issues by staling their level of agreement to those statements. Table C.12 shows the statements, the frequencies of different responses, and the median responses.

Respondents were asked to rank the four issues given to them along with any other issues they thought to be important (see Table C.13) Twenty-six respondents ranked issues other

[29]The investigators are aware of the fact that the survey respondents may not be representative of all Wyoming citizens. Rather, those more knowledgeable and more concerned about water development issues probably took the initiative to answer the questionnaire. Thus, it is assumed that the answers to the survey are representative of this group of Wyoming residents.

TABLE C.1

Most Important Water Uses by Respondents' Age Group

Water Use	Average Importance For Respondents With An Age* ≥ 50	Average Importance For Respondents With An Age* < 50	t-value (Significance Level)
Future Supply	4.29	4.04	2.35 (.019)
Municipal Use	4.25	3.89	3.49 (.001)
Irrigation	4.11	3.78	2.61 (.009)
Industrial Use	3.90	3.58	2.38 (.018)
Support High-Unemployment Areas	3.89	3.69	1.63 (.104)
Support My Area	3.87	3.72	1.14 (.256)
Wild-and-Scenic Preservation	3.72	4.26	-4.25 (.000)
Hydroelectric Power Generation	3.71	3.13	4.63 (.000)
Preserving Stream Fisheries	3.68	4.19	-4.36 (.000)
Flood Control	3.18	2.90	2.10 (.037)
Reservoirs for Recreation	2.82	3.12	-2.12 (.035)

* 5 = most important
  1 = least important

TABLE C.2

Most Important Water Uses by Respondents' Sex

Water Use	Average Importance for Responding Who Are*		t-value (Significance Level)
	Female	Male	
Irrigation	4.33	3.48	3.57 (.001)
Future Supply	4.23	4.16	0.55 (.584)
Wild-and-Scenic Preservation	4.20	3.93	1.79 (.076)
Municipal Use	4.03	4.08	-0.38 (.702)
Preserving Stream Fisheries	3.97	3.94	0.21 (.833)
Support High-Unemployment Areas	3.96	3.75	1.48 (.140)
Support My Area	3.96	3.75	1.46 (.147)
Industrial Use	3.68	3.75	-0.42 (.676)
Hydroelectric Power Generation	3.68	3.34	2.24 (.027)
Flood Control	3.28	2.97	1.85 (.067)
Reservoirs for Recreation	2.84	3.03	-1.06 (.294)

* 5 = most important
  1 = least important

TABLE C.3

Background Characteristics of Survey Respondents

Variable	Statistic			
			Range	
	Mean	Standard Deviation	Minimum	Maximum
Respondent's Age	50.71	16.66	0	96
Years of Residency	33.39	21.05	1	91
# of People in Household	2.76	1.60	1	9
Years of Schooling	14.03	3.43	6	20
Days of Fishing on Rivers	5.66	10.99	0	90
Days of Fishing in Lakes	4.63	10.07	0	75
Days of Boating	3.19	9.26	0	90
Days of Water Skiing	1.37	6.62	0	90
Days of Swimming	1.84	7.09	0	90
Days of Camping	6.25	10.82	0	90
Days of Hiking	5.30	17.25	0	200
Days of Picnicking	3.93	8.77	0	90
Days of White Water Rafting	.38	2.66	0	32
Days of Hunting	4.70	10.25	0	100
Days of Hunting Antelope	.65	2.06	0	20
Days of Hunting Elk	1.32	3.09	0	17
Days of Hunting Birds	.67	2.35	0	20
Days of Hunting Deer	1.59	3.91	0	45
Days of Hunting Moose	.12	.88	0	10
Self Evaluation	3.07	1.12	0	5

TABLE C.4

Respondents' Occupations

Occupation	Frequency	Percent
Professionals[1]	155	44.9
Teachers	19	5.6
Craftsmen	6	1.7
Executives	2	0.6
Self-Employed	16	4.6
Technicians	4	1.2
Clerical	7	2.0
Student	6	1.7
Retired	71	20.6
Housewife	8	2.3
Farmer/Rancher	30	8.7
Missing	21	6.1
Total	345	100.0

[1]This category also includes those respondents that were not clearly members of any of the other categories, and thus appears artificially large as a percentage.

TABLE C.5

Respondents ' Sex

Sex	Frequency	Percent
Female	69	20.0
Male	260	75.4
Missing	16	4.6
Total	345	100.0

TABLE C.6

Respondents' Place of Birth

Place of Birth	Frequency	Percent
Wyoming	133	38.6
Out-of-State	198	57.3
Missing	14	4.1
Total	345	100.0

TABLE C.7

Proportion of Respondents Engaging in Fly Fishing

Fly Fishing	Frequency	Percent
Yes	128	37.1
No	198	57.4
Missing	19	5.5
Totals	345	100.0

TABLE C.8

Proportion of Respondents with
Memberships in Water Related Organizations

Organization	Frequency	Percent
Irrigation District	41	11.9[1]
Outdoor Council	12	3.5
Audubon Society	10	2.9
Rural Water District	20	5.8
Sierra Club	10	2.9
Heritage Society	11	3.2

[1]An unusually high percentage of respondents indicated involvement in these water related organizations and activities—so high that some misunderstanding of the nature of the question must be involved.

TABLE C.9

Respondents' Involvement in Water Development Activities

- 114 respondents (33.0%) contributed money to water development related organizations.[1]
- 79 respondents (22.9%) owned water rights.[1]
- 31 respondents (9.0%) participated in the planning of state water projects.[1]

[1]An unusually high percentage of respondents indicated involvement in these water related organizations and activities—so high that some misunderstanding of the nature of the question must be involved.

TABLE C.10

Respondents' Household Incomes

Income Range	Frequency	Percent
under $10,000	27	7.8
$10,000-$19,999	44	12.1
$20,000-$29,999	75	21.7
$30,000-$39,000	50	14.5
$40,000-$49,000	44	12.8
$50,000-$59,999	33	9.6
$60,000 or more	45	13.0
Missing	27	7.8
Totals	345	100.0

TABLE C.ll

Respondents' Most Important Water Uses

Water Use	Mean	Standard Deviation
Future Economic Growth	4.17	.93
Municipal Use	4.07	.92
Wild-and-Scenic Preservation	3.99	1.18
Irrigation	3.97	1.15
Preserving Stream Fisheries	3.95	1.06
Alleviate High Unemployment Areas[1]	3.80	1.09
Support My Local Area[1]	3.80	1.11
Industrial Use	3.76	1.19
Hydroelectric Power Generation	3.41	1.18
Flood Control	3.06	1.19
Recreational Activities	2.98	1.28

[1]These two uses were excluded from the tabulation in Section 4.0 of the main report for purposes of clarity. They were intended to represent distributional issues, while all other uses did not have this attribute.

TABLE C.12

Respondents' Agreement and Disagreement with Water Policy Statements

Statement	Percentage of Respondents Who: Strongly Agree	Agree	Indifferent	Disagree	Strongly Disagree	Total
Wyoming water projects should be built only if project benefits exceed project costs.	10.7%	32.8%	16.1%	33.0%	7.4%	100.0%
Wyoming should develop its water resources before other states take our water, regardless of whether project benefits exceed costs.	34.5	40.7	7.7	12.1	5.0	100.0
Wyoming water projects should be build only if project benefits will be distributed equitably, i.e., not confined to one small area or group of people.	21.5	37.9	15.3	20.9	4.4	100.0
Wyoming must protect some of its rivers from dams and reservoirs to preserve their wild and scenic beauty.	42.1	38.2	8.8	7.1	3.8	100.0

TABLE C.13

Survey Respondents' Ranking of Most Important Issue Associated with Building Wyoming Water Projects[1]

Issue	Percent Ranking Issue as the Most Important	Second Most Important	Third Most Important	Fourth Most Important
Will the project, increase Wyoming's "control" over its water resources?	49.3	22.1	15.0	8.1
Will the project disturb the balance between preservation and development of Wyoming's water resources?	19.6	30.1	28.6	15.1
Will the project's benefits be greater than its costs?	13.0	20.6	27.8	30.6
Will the project's benefits be confined to a small group, or be distributed widely across the state?	8.7	18.4	21.1	40.4
Other issues.	9.4	8.8	7.5	5.8
Totals	100.0%	100.0%	100.0%	100.0%

[1]Based upon approximately 275 respondents to this series of questions.

than those given by the survey as most important. Of those 26 issues ranked more important than any of those discussed in the survey, eight were concerned with conservation or preservation. The issues mentioned here were wild and scenic views (four times), endangered species, soil and water preservation, and clean drinking water (once each), and one respondent ranked environmental protection in general as the most important issue.

Three respondents ranked specific uses as most important. Agriculture, recreation and tourism, and municipal use were mentioned in this category. Two respondents mentioned issues as most important that are closely related to the question: should Wyoming secure portions of its water today so it can use the water in the future? One respondent wanted to make sure that Wyoming only lets water flow out-of-state that it cannot possibly use itself. The other respondent concerned with this issue wants water to flow out-of-state when it can provide greater benefits to more Americans downstream.

For two other respondents the most important issue was if the project would be necessary or needed, without being more specific about what they mean by that. The remaining 11 issues that were ranked as most important can't be categorized. The following is a list of issues mentioned only by one respondent each:

- will the project have benefits for sure;
- benefits for Indians who have not benefited from previous projects;
- does the project fit into a long-range plan;
- does the project have an economic impact on the state;
- don't build projects, just because influential legislators want that;
- water should not be sold to foreigners, like Japanese;
- provide and secure reserves for times of drought;
- don't build projects just to use up money;

- spend the money currently used for water development for other things, like education or raising the DPASS standard ;
- protect and preserve existing water rights; and
- save water in reservoirs.

C.3 DISCRIMINANT ANALYSIS

Discriminant analysis was used to identify the demographic variables that are important to distinguish among the responses to the questions about the most important issue. The concept underlying discriminant analysis is to form linear combinations of the demographic variables that serve as a basis for distinction between the responses to the most-important-issue question. Such a linear discriminant equation takes the form $D = B_0 + B_1X_1 + \ldots + B_NX_N$,

where: X_i is the value of the ith variable,

B_i is the coefficient for the ith variable, and

D is the discriminant score.

The coefficients were determined so that the resulting equation best explains differences in responses to the question about the most important project evaluation issue. In identifying the most important demographic variables, the coefficients themselves are important. To allow comparison of different variables, standardized coefficients are calculated for the values of the demographic variables being standardized to a mean of 0 and a standard deviation of 1. These standardized coefficients reflect the importance of the variables associated with them for the distinction between the answer to the most-important-issue question.

Eighteen variables were found to be important. Table C.13 shows these variables and the associated Wilk's Lambda. These measure the proportion of the total variance in the discriminant scores not explained by differences among groups. Using the 18 demographic variables in Table C.14 to "predict" responses to the question about the most important issue yields a success rate of 43.11 percent. This means that each

respondents' choice for the most important issue can be predicted about 43.11 percent of the time by using discriminant analysis with the 18 selected demographic variables. Without the demographic information, the expected success rate would be 25 percent (assuming four issues).

C.4 QUESTIONNAIRE SAMPLE

A sample copy of the questionnaire follows Table C.14.

TABLE C.14

Summary of Discriminant Analysis

Variable	Wilk's Lambda[1]
Self Evaluation	.84960
Membership in Outdoor Council	.73007
Years of Schooling	.69641
Contributed Money to Organization	.66924
Membership in Irrigation District	.64098
Days of Hiking	.61577
Days of Hunting Birds	.59578
Number of People in Household	.57673
Respondent's Age	.55834
Membership in Rural Water District	.53957
Respondent's Sex	.52126
Received Benefits	.50396
Membership in Heritage Society	.48942
Days of Hunting Elk	.47659
Participated in Planning	.46525
Membership in Audobon Society	.45311
Membership in Sierra Club	.44253
Fly Fishing	.43288

[1]The Wilk's Lamdas measure the proportion of the total variance in the discriminant scores note explained by differences among groups.

WYOMING'S WATER RESOURCES:

A CITIZEN'S VIEW

A Statewide Survey of an

Important Issue Facing

Wyoming Citizens

This questionnaire should
be completed by one of the
principal wage-earners
in your household.

Western Research Corporation
512 University Avenue
Laramie, Wyoming 82070
(307)742-8295

WYOMING'S WATER RESOORCES: A CITIZEN'S VIEW

HELLO:

This is a survey of the preferences and priorities of Wyoming citizens concerning Wyoming's Water Development Program. The survey consists of only a few questions, but to be able to respond you need to read the following background information.

BACKGROUND INFORMATION

The Wyoming Legislature established the Wyoming Water Development Program in 1979. The purpose of the program is To

> "...foster, promote and encourage the optimal development of the state's human, industrial, mineral, agricultural, water and recreational resources...." Wyoming Statutes, Sec. 41-2-112 (Supp., 1986).

The program is administered by the Wyoming Water Development Commission (WWDC) and is funded by mineral severance taxes.

The Wyoming Water Development Program allows groups of Wyoming citizens (called project sponsors) to propose various types of water projects to the WWDC. Examples of such projects include new dams and reservoirs for irrigation water and recreation, ground water wells for municipal water, and the rehabilitation of existing water supply systems. The WWDC studies proposed projects and recommends certain projects to the Wyoming Legislature for further study and possible construction funding.

Several Wyoming water projects have been built under this program over the past 10 years. Because of limited water development funds, however, not all proposed projects can be built. As a result, the WWDC must attempt to choose the best projects to recommend to the legislature. The purpose of this survey is to help determine what the best water projects are from the perspective of Wyoming's citizens. This question involves two significant issues:

1. What are the best uses for Wyoming's undeveloped water resources?

2. What evaluation criteria should be used to evaluate specific water projects?

This brief survey deals primarily with these two important Issues.

WYOMING'S WATER RESOURCES: A CITIZEN'S VIEW
PART I - WATER USES

1. First, we would like to know what the best uses are for Wyoming's undeveloped water resources. Please CIRCLE the number from 1 (not important), to 5 (very important) which best describes how important each of the following uses is to you. Use the space provided to add any additional water uses you think are important.

		Very Important				Not Important
(a)	additional irrigation water for Wyoming's farmers and ranchers.	5	4	3	2	1
(b)	new reservoirs for fishing, boating, and other recreational activities.	5	4	3	2	1
(c)	additional municipal water for Wyoming's cities and towns.	5	4	3	2	1
(d)	additional industrial water to attract new companies to Wyoming.	5	4	3	2	1
(e)	more flood control protection for Wyoming's cities, towns,and rural areas.	5	4	3	2	1
(f)	preserving instream flows for the fisheries in Wyoming's rivers and streams.	5	4	3	2	1
(g)	additional hydroelectric power for Wyoming's cities, towns, and rural areas.	5	4	3	2	1
(h)	developing adequate water for future economic growth.	5	4	3	2	1
(i)	preserving wild and scenic rivers and streams in their natural state.	5	4	3	2	1

		Very Important				Not Important
(j)	providing new economic opportunities in areas of the state with high unemployment.	5	4	3	2	1
(k)	providing new economic opportunities in <u>your</u> local area.	5	4	3	2	1
(l)	other _____ _____.	5	4	3	2	1
(m)	other _____ _____.	5	4	3	2	1
(n)	other _____ _____.	5	4	3	2	1

Please write on the back page if you need additional space.

PART 2 – EVALUATION CRITERIA

We would like to know how strongly you feel about ways of evaluating Wyoming water projects ("picking the best projects"). To assist you in answering these questions, please carefullyread and consider the following four definitions.

DEFINITION 1 – Project benefits and costs: What are they?

Water project benefits include the incomes and economic opportunities which result when additional water supplies are made available in Wyoming for:

* agricultural uses
* municipal uses
* industrial uses
* recreation
* hydroelectric power
* flood control

Project costs include:

* costs of constructing dams or other water related facilities
* operation and maintenance costs
* any environmental damage associated with the project

The Point:

Some individuals believe that expected project benefits should always exceed project costs if a water project is to be built. Others disagree. One reason for this disagreement is that certain project attributes are difficult to express in benefit-cost terms (see definitions 2, 3, and 4).

DEFINITION 2 – Control of Wyoming's Water Resources: What is the Issue?

Wyoming now has more water than it can use in many parts of the state, but may need this extra water in the future. If water becomes scarce in the future, however, other states may try to keep Wyoming from developing and using this extra water. If Wyoming waits too long to develop this water, other states may try to block Wyoming's water development plans by initiating lawsuits and/or by intervening in the federal environmental permitting process for dams and reservoirs.

The Point:

Wyoming could enhance its control over its water resources by building certain water projects now, even though benefits might be less than costs (Definition 1). Individuals differ as to whether Wyoming should take such measures now to protect its water resources for the future.

DEFINITION 3 – Distribution of project benefits

The distribution of project benefits can vary widely depending upon the location and the nature of a water project. For example, a reservoir designed to provide irrigation water to a few ranchers in a remote part of Wyoming may benefit relatively few individuals. On the other hand, a reservoir designed to provide irrigation water, hydroelectric power, and water based recreation near a large community may benefit many Wyoming residents.

The Point:

If Wyoming does not carefully evaluate the location and nature of future water projects, benefits may not be distributed in an "equitable" manner. That is, citizens who pay the costs for water development may not receive the benefits. Individuals differ as to how important the equitable distribution of benefits is with respect to the Wyoming Water Development Program.

DEFINITION 4 – Preservation and development: What are the concepts?

Preservation means leaving certain Wyoming rivers and streams in their natural state, unaltered by man's activities. Development means altering the river or stream through activities such as dams and reservoirs.

The Point:

As Wyoming develops its water resources, there may be fewer rivers and streams that remain in their "wild and scenic" state. Meanwhile, the number of rivers and streams that are developed will become greater. Individuals in the State differ as to the appropriate balance between the preservation and development of Wyoming's water resources.

2. With the above definitions in mind, please consider each of the following statements separately, and indicate whether you strongly agree, agree, don't know, disagree, or strongly disagree with each statement. (Please circle the appropriate code.)

Statement	Strongly Agree	Agree	Indif-ferent	Disagree	Strongly Disagree
(a) Wyoming water projects should be built only if project benefits exceed projects costs.	SA	A	I	D	SD
(b) Wyoming should develop its water resources before other states take our water, regardless of whether project benefits exceed costs.	SA	A	I	D	SD
(c) Wyoming water projects should be built only if project benefits will be distributed equitably, i.e. not confined to one small area or group of people.	SA	A	I	D	SD
(d) Wyoming must protect some of its rivers form dams and reservoirs to preserve their wild and scenic beauty.	SA	A	I	D	SD

3. The criteria described above can be used to decide which Wyoming water projects should be built and which should not. these criteria can be summarized as follows for one specific water project:

Issue	Description
a.	Will the water project's benefits be greater than its costs?
b.	Will the water project increase Wyoming's "control" over its water resources?
c.	Will the project disturb the balance between preservation and development of Wyoming's water resources?
d.	Will the project's benefits be confined to a small group, or be distributed widely across the state?

Do you believe that there are other issues (not mentioned in a through d above) that should be considered in deciding whether or not to build a Wyoming water project?

_____YES _____NO

4. If your answer to Question 3 is YES, what are these other issues?

Issue	Description
e.	_____
f.	_____
g.	_____
h.	_____

Please feel free to write on the back page if you need more space.

5. Please review issues (a), (b), (c), and (d) in Question 3, along with any additional issues you defined in Question 4. in your opinion, which of these issues are the most important and least important in deciding whether or not to build a Wyoming water project?

MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

NEXT MOST IMPORTANT ISSUE _____.

LEAST IMPORTANT ISSUE _____.

Please check to see that you have ranked all of the issues, including yours.

PART 3 – INFORMATION REGARDING YOU AND YOUR FAMILY

Thank you for your views on the above issues. To completely understand your preferences, we need some additional information. This information will be confidential and analyzed in a manner in which it will be impossible to identify you or your household.

		You	Your Spouse
6.	Occupation	_____	_____
7.	Age	_____	_____
8.	Sex	_____	_____
9.	Born in Wyoming	Yes____ No_____	Yes____ No_____

10. Number of years you have been a resident

	You	Your Spouse
	_____	_____

11. Number of people living in your household _____

12. Your educational background:

You	Your Spouse
_____ Elementary school	_____ Elementary school
_____ High school graduate	_____ High school graduate
_____ Some college	_____ Some college
_____ Bachelor's degree	_____ Bachelor's degree
_____ Graduate work	_____ Graduate work
_____ Advanced degree	_____ Advanced degree

13. How many days of recreational activities have you and your spouse engaged in during the past 12 months? (Please estimate the number of days for each activity below):

You	Your Spouse
_____ Fishing on rivers and streams	_____ Fishing on rivers and streams
_____ Lake or reservoir fishing	_____ Lake or reservoir fishing
_____ Recreational boating on lakes or reservoirs	_____ Recreational boating on lakes or reservoirs
_____ Water skiing on lakes or reservoirs	_____ Water skiing on lakes or reservoirs
_____ Swimming in lakes or reservoirs	_____ Swimming in lakes or reservoirs
_____ Camping	_____ Camping
_____ Hiking	_____ Hiking
_____ Picnicking	_____ Picnicking
_____ White water rafting	_____ White water rafting
_____ Hunting	_____ Hunting
_____ Antelope	_____ Antelope
_____ Elk	_____ Elk
_____ Birds	_____ Birds
_____ Deer	_____ Deer
_____ Moose	_____ Moose

14. Do you fly fish? You Your Spouse

Yes ___ No ___ Yes ___ No ___

15. Do you or your spouse belong to any organizations that are active in water-related issues (either national or statewide)?

Examples might be:

		Please check if you belong
A.	Irrigation districts	_____
B.	Outdoor Council	_____
C.	Audubon Society	_____
D.	Rural water districts	_____
E.	Sierra Club	_____
F.	Heritage Society	_____
G.	Other (please provide the name)	
	_____	_____
	_____	_____
	_____	_____

16. Have you or your spouse ever contributed money to any of these organizations?

_____ Yes _____ No

17. Do you own or lease water rights in Wyoming?

_____ Yes _____ No

18. Have you or your spouse participated in any way in the planning of a state funded water project?

_____ Yes _____ No

19. Have you received benefits (to your knowledge) from a state funded water project?

_____ Yes _____ No

If yes, which project(s)? _____

_____

_____

20. Consider a scale of (1) to (5) where (1) represents a "developer" (i.e., develop as much as possible) of Wyoming's water and (5) represents a preservationist (i.e., leave Wyoming's water resources in their natural state as much as possible).

How would you rank yourself (circle one):

"Developer" "Preservationist"

1 2 3 4 5

21. Approximate combined annual gross income of all members in the household (check 1):

_____ under $10,000
_____ $10,000-$19,999
_____ $20,000-$29,999
_____ $30,000-$39,999
_____ $40,000-$49,999
_____ $50,000-$59,999
_____ $60,000-$69,999

Additional comments?

_____

_____

_____

_____

THANK YOU VERY MUCH FOR YOUR HELP. PLEASE USE THE ENCLOSED POSTAGE PAID ENVELOPE TO MAIL YOUR RESPONSE.

APPENDIX D

A DIGRESSION: AUGMENTING A REGION'S WATER SUPPLIES, TRANSFERS, INCREASED EFFICIENCIES, AND MARKETS

D.1 INTRODUCTION

As Wyoming proceeds in the development of state-wide water plans, scenarios of future water demands in Wyoming's various water basins will almost certainly reveal mixed patterns of water-surplus and water-deficit basins. In its search for sources of water supplies, Wyoming will undoubtedly wish to consider possible interbasin transfers of water, intrabasin changes in patterns of water use, the development of groundwater, and "markets." While these issues take us afield from the principle thrust of this report, they are topics which ultimately will have to be dealt with.

In many ways, assessments of projects involving interbasin water transfers, intrabasin changes in use, and/or groundwater development follow the same principles outlined in other sections of this report for water project assessments. There are, however, a number of assessment issues which are peculiar to projects of this nature, and involve considerations not encountered in other water development projects. The purpose of this appendix is to consider this set of issues. Thus, in Section D.2 we consider the interbasin water transfer; groundwater development is discussed in Section D.3.

The issue will generally arise as to the desirability of allowing greater reliance on water markets as a means for promoting decentralized transfers of water from low to higher valued uses. With the recognition of the contemporary

interest in water markets in western states, this topic is discussed in Section D.4.

D.2 INTERBASIN TRANSFERS OF WATER

A large part of the process of assessing benefits and costs associated with interbasin water transfers would be guided by the principles developed in other chapters of this report. There are three aspects of such projects, however, which introduce analytical problems not typically encountered in other water reclamation projects: (1) the potential "rescue operation" and it's implications, (2) a wider range of opportunity costs than those commonly encountered in water projects, and (3) timing issues, particularly relevant for interbasin water transfers intended to reduce or eliminate the mining of groundwater stocks.

The motivation for a state's interest in a transfer project has been related to what is referred to as a "rescue operation" and is defined as follows:

> The situation envisioned here is a fairly large region that is almost wholly dependent on irrigated agriculture and agricultural processing industries. The physical capital structures of agriculture, related business activities, and social overhead have been established. The region is faced with the loss of some or all of its irrigation water, either because groundwater tables are falling or because of water rights adjudications . . .. Making new supplies available to such regions may be termed a 'rescue operation' (Howe and Easter [1971], p. 28).

Relatively recent examples of proposed transfer projects designed as a rescue operation are seen in the Central Arizona Project in the U.S. (Kelso et al. [1973]), and in Mexico's Northwest Project (PHLINO; see Cummings [1974]). At this time the need for rescue operations is hard to imagine in Wyoming. However, potentially extreme developments regarding the North Platte might well lead to the long term need for a "rescue operation. "

In instances where interbasin water transfers are intended to rescue established local/regional economies threatened with diminished water supplies, one has introduced into the benefit-cost study a key element peculiar to the rescue operation:

> The key element in the evaluation of interbasin water transfers as rescue operations is the immobility of production factors. Labor and capital [social and private infrastructure that is already in place] may be immobile over long periods in some irrigation areas, and net benefits attributable to a water transfer are the incomes that accrue to these otherwise nonproductive resources" (Cummings [1974], p. 4; see also Howe and Easter [1971], pp. 28-30).

Thus, in assessing the benefits associated with an interbasin water transfer of a rescue operation, the following two-step process is required for calculating incomes/returns associated with otherwise displaced, immobile factors of production.

1. Immobile labor and capital resources in importing must be identified as resources which will become unemployed or idle in the absence of the proposed transfer. Most importantly, the length of time over which these resources will remain immobile must be estimated (for examples, see Howe and Easter [1971]; Kelso et al. [1973]; and Cummings, [1974]).

2. Values (incomes to labor resources, returns to capital) are then assigned to all immobile factors over the time during which they remain immobile, and the discounted sum of these values are included as benefits to the proposed water transfer.

There is a flip-side to the benefits associated with the maintained employment of immobile resources in the importing basin: the opportunity cost to factors of production in the exporting basin. There are few instances, where one finds water supplies for an interbasin transfer which could not be put to productive use in the exporting basin—either present uses or potential future uses. Values associated with any use of water in the exporting basin which would be foregone as a

result of the water transfer must be included as a cost to the project.

The key consideration in estimating these costs is the immobility of resources. Thus, for potential future uses of water in the exporting basin, at issue is the extent to which land, labor, or capital is denied employment as a result of the water transfer having alternative employment opportunities elsewhere in the state. Land in the exporting area is obviously immobile, and values associated with well-established future uses of this resource will generally be included as a project cost. To the extent that excess capacity in private and/or social infrastructure has been put in place in anticipation of future expansions which would be affected by the proposed transfer, opportunity costs relevant for project costs will exist.

An analytical problem arises where planned future land values in the exporting region are predicated on expected expansions in infrastructure. The otherwise mobile factor "capital" may, in some instances, require treatment as if it were immobile.

Another analytical issue, unique to the interbasin water transfer, arises in cases where the primary purpose of the proposed transfer is to replace groundwater use. Thus, in agricultural areas dependant upon groundwater, long-term mining of the aquifer (annual pumping at rates which exceed recharge of the aquifer) results in falling water tables, rising pumping costs, aquifer contamination (in areas with layered aquifers, with contaminated layers, or in costal aquifers which can experience the intrusion of sea water), and, eventually, the depletion of groundwater supplies (see Kelso et al. [1973],' and Cummings [1971]). Water imported via the interbasin transfer is then used to displace groundwater use.

All else equal, the benefits and costs associated with the interbasin water transfer would be straightforward.

Agricultural-related benefits and costs would be calculated and compared with project costs. Opportunity costs to the exporting basin, and values associated with otherwise displaced, immobile factors of production in the importing basin would be considered.

In closing our discussions of the interbasin water transfer, we should at least comment on the emotional climate which typically exists in regions which are considering water transfers. When the people of the exporting and the importing region are convinced that their water supplies are threatened, economic assessments which attempt to objectively measure benefits and costs are most likely to be greeted with considerable hostility. Thus, our comments concerning the limitations of benefit-cost measures of water development projects may be of particular relevance in the assessment of interbasin water transfers.

D.3 GROUNDWATER DEVELOPMENT

In the past, economic analyses were rarely used in evaluating whether efforts to open and/or expand groundwater development. Economists became involved in groundwater issues only after the problems associated with groundwater use arose. Presently, economists have had a great deal of experience with the kinds of problems associated with groundwater development which can arise after a number of years. Such problems can now be anticipated, and economic analyses can then provide data and information of direct relevance to alternative groundwater development.

Assessment and policy issues which are particular to groundwater development fall into two major categories which reflect the physical and political characteristics of aquifers: closed aquifers; and open, or tributary, aquifers.

D.3.1 Closed Aquifers

Closed aquifers are groundwater formations which are not linked, or associated, with streams, rivers, or other

aquifers. They can simplistically be viewed as a bathtub (or, as Beatie [1981] would argue, an egg carton) full of water. Recharge to the aquifer, from rainfall at the surface and return flows from irrigation, is typically very small relative to the amount of water which would be extracted for irrigation purposes. Thus, there is essentially a fixed, and non-renewable, supply of water available for use. This raises several issues.

First, is the fact that estimates for benefits and costs associated with aquifer development must reflect the fact that pumping costs will increase as water tables are drawn down. Secondly, but related to increased pumping costs, the analyst faces the question: What level of development should be allowed? This question is tantamount to the question as to what useful, economic life of the aquifer should be established. Thus, once groundwater development has been initiated, a major policy concern (vis-a-vis the issuance of further rights to pump) must be that of protecting existing rights. For instance, Wyoming might decide water rights should be protected by allowing only one pumper. This would extend the life of the aquifer as the exhaustion of water supplies would be pushed far into the future. However, if Wyoming places a high value on the generation of incomes in the near term, an unlimited number of pumpers might be allowed to take water from the aquifer. Each pumper's "rights" are then limited to the amount of water that he/she can take from the aquifer before the supply of water is exhausted (Cummings [1969]). The exhaustion of water would then occur in a relatively short time.

Examples of the extremes exist in several of Wyoming's sister states. New Mexico has severely limited the expansion of pumping with administrative rules based on a planned aquifer "life" of 50 to 100 years. In western Colorado, limits to groundwater development were based upon a much shorter, 25 year expected aquifer life.

At issue here is the notion that Wyoming's interests may not be best served by groundwater development and management policies at either end of this management spectrum. That is, Wyoming may well wish to attempt to identify the hydrological and socioeconomic trade-offs relevant for policies which would be consistent with development strategies between these extremes. The assessment process would involve the following:

1. identify social and economic criteria relevant to the state in present and future years (as examples, incomes, health/safety, environmental considerations, providing for future generations, etc.).

2. for each groundwater basin, conduct hydrological studies required to determine key aquifer parameters: specific yield characteristics; recoverable storage; the identification of any perverse geochemical characteristics;

3. conduct trade-off analyses to identify desireable time horizons for aquifer exhaustion.

A final consideration relevant for the closed aquifer relates to our discussions of "rescue operations" within the context of interbasin water transfers. Given that groundwater development serves to support the growth of an extensive economy in an area, such growth will be accompanied by large investments of state funds for social infrastructure (streets, roads, schools, utilities, etc.), as well as private infrastructure). The social costs and distortions associated with a later decline in the area's economy, which must inevitably attend the exhaustion of the groundwater supplies, can be substantial. As the aquifer nears exhaustion, strong pressures will exist for the "rescue" offered by the interbasin water transfer.

D.3.2 The Tributary Aquifer

The tributary aquifer is one which is directly related to streams and rivers in that it receives recharge from, and recharges to, the river (DuMars et al. [1986]). The key feature of the tributary aquifer as it is relevant for the assessment process is that, regardless of the amount of water

in storage, each acre foot of water pumped from the aquifer will eventually reduce streamflow in the river to which it is tributary by an acre foot (Brown et al. [1989]). The length of time between pumping and reduced river flows can be quite long, and depends upon such things as aquifer characteristics and the proximity of pumping to the river. But whether within ten or fifty years, groundwater withdrawals will ultimately be reflected in reduced stream flows.

The tributary aquifer represents a planning dilemma. The value of water stored in the aquifer derives from putting such water to use. Such economic activity may extend over a period of 50 or more years before river flows begin to be affected. Eventually, declines in economic activity based on the direct use of surface water will offset the gains achieved through groundwater development. Pumpers are effectively pumping from the river. Thus, the trade-off facing the analyst is an extended period of significantly enhanced economic activity in an area, and the later (often, much later) economic decline and the legal morass of problems related to the infringement on surface users water rights by pumpers.[30]

D.3.3 Intrabasin Changes in Water Use

Two issues must be confronted in any consideration of plans and programs to promote intrabasin changes in water use. The first, centers on the mechanisms to be used for

[30] Problems which may arise when the tributary aquifer extends over two or more states are described in (Burke et al. [1984]). The problems which the state can encounter if it fails to consider the diminished flow effects on streams are seen in the litigation between the states of Texas and New Mexico. New Mexico allowed extensive development of water use from groundwater in the Pecos River basin, beginning some 60 or 70 years ago. As has been determined by the Supreme Court, New Mexico's pumping from the tributary aquifer has reduced streamflows in the Pecos river by some 10,000 acre feet per year. The result is New Mexico's debt to Texas of about 300,000 acre feet of water, to compensate the state of Texas for shortages in New Mexico's compact deliveries of water to Texas over the last 30 years.

facilitating such transfers in water rights. When all waters of an area are appropriated, property rights of one form or another are, of course, vested in the current users of water. Owners of water rights will then require compensation for any rights which are to be transferred to other users.

A second issue concerns water stored in federal projects. By federal statute, "appurtenance requirements" apply to water in most federal projects; i.e., such waters cannot be transferred for uses in areas or on lands which are not appurtenant to those in established irrigation districts. The result is described by DuMars and Ell is as a "two-tiered" water market (DuMars and Ellis [1978]); non-federal water is traded in a relatively open, state-wide market; federal water can be traded only within the boundaries of established irrigation districts.[31] This then suggests that Wyoming may wish to consider the advisability of looking to changes in federal law concerning appurtenance requirements imposed on federal water projects. Absent such requirements, substantial quantities of water, now used in many instances for very low valued crops, could become available for other uses in the state's water basins.

The removal of appurtenance requirements would not necessarily be a panacea for Wyoming's future water problems. First, the removal of appurtenance requirements from federal project water would have the effect of substantially increasing the amount of water available for transfer in many areas, which could result in severe depressions in the prices for water rights. Individuals who had earlier purchased land with water rights would have paid land prices which included the capitalized value of included water rights. With sharp

[31]As an example, non-federal water in the state of New Mexico trades at prices between $1,500 and $10,000 per acre foot, while, within the federally-established Elephant Butte Irrigation District, water can be exchanged between farmers at prices ranging between $200 and $500 per acre foot.

drops in the value of water, the value of their property would decline proportionally. Secondly, and related to our earlier discussions of interstate competition for water, the "new" availability of large supplies of water, resulting from the removal of appurtenance requirements, could draw strong interest by Wyoming's sister states in Wyoming's expanded "wealth" of water resources.

D.3.4 Promoting Water Markets As a Means for Achieving More Efficient Patterns of Water Use

If well functioning (perfectly competitive) markets for water rights existed, it could be argued that the state would have few problems in terms of allocations of water between low and high valued uses, or in interbasin inequities of water supplies (Anderson [1983, 1985]). Prices for water would be determined by the forces of demand and supply, and water would be allocated across the state in the most efficient manner: water would flow "uphill" to dollars. Thus, an issue which will surely gain increasing attention in Wyoming in upcoming years concerns greater reliance on markets as a means for promoting greater efficiency in Wyoming's water use.

There are many aspects of water markets which have considerable appeal such as water allocations being decentralized. However, a number of pitfalls are potentially associated with reliance on markets to achieve state goals related to water use. These pitfalls include: (1) the absence of basic prerequisites for a functioning market in water rights, (2) the existence of externalities, and (3) potential conflicts with the state's position vis-a-vis commerce clause litigations.

Basic to the competitive market paradigm is the existence of the following conditions: (1) there are many buyers and sellers (under certain conditions); (2) there exists perfect information; (3) the resource to be traded is perfectly, and costlessly, mobile; and (4) property rights to the resource are well defined. The lesser the extent to which these

conditions exist, the less effective will be water markets, and less likely is the possibility that the state might achieve it's goals for water reallocations via the market mechanism.

In what follows, we comment on the existence of these conditions in Wyoming, or, indeed, in any western state.

The need for many buyers and sellers for a well functioning market is obvious. The more individuals there are on each side of the market, the less market power any one individual will have. However, few areas in the west exist where such conditions hold, particularly in terms of many buyers. Growing demands for water are typically found in a city or metropolitan area. Generally, then, the city will be the principal, if not sole, buyer for water rights in a water basin. Examples in this regard are seen in Colorado (Denver), New Mexico (Albuquerque), and Arizona (Phoenix and Tucson). A move to greater reliance on markets under conditions where one or a few urban entities can effectively set the price for water can then have effects which are contrary to those sought by the water planning agency.

It is typically the case in western states that institutions do not exist which makes readily available to all potential buyers and sellers of water rights the conditions of all offers to buy and sell. This problem could be eliminated by Wyoming relatively easy, however, by the establishment of a clearinghouse for all offers to buy and/or sell rights within the state.

The "perfect mobility" condition relates to the need for a minimum of impediments to trades between individuals for markets to operate effectively. Litigation and hearings costs associated with third party challenges to proposed water rights transfers would seem to impose a substantial impediment to such transfers in most western states (Farrah [1989]). The effects of such challenges has been not only to impose large

costs on water transfers, but also to increase the uncertainties surrounding successful water sales.

Related to the litigation costs associated with the mobility assumption of the competitive paradigm, the extent to which there exists "well established" property rights for water resources is questionable. This follows from the confusion which exists in many areas between rights based on diversion and rights to consumptive use. Recent court cases have held that rights holders may sell only that part of their water right which is consumed. Litigation costs, therefore, are required to establish an individual's saleable water right. The result is further impediments to well functioning markets.

The point of these discussions, of course, is that the one cannot assume out of hand that water markets will work effectively in the state. One must focus on the implications of the divergence between conditions required for well functioning markets and those which actually exist in the state for markets to achieve the ends sought.

APPENDIX E

LEGAL AND INSTITUTIONAL ASPECTS RELEVANT FOR MULTIPLE OBJECTIVE PLANNING

E.1 INTRODUCTION

In Appendix B we examined the present structure of federal laws and regulations which are relevant for Wyoming's construction and management of water resources. In this section, we consider the legal environment relevant for water resources planning in the state. An important objective for the state must be the protection and conservation of its water resources base. As demonstrated, in Appendix A, the growing scarcity of water resources in Wyoming's sister states will surely create incentives for challenging future plans by Wyoming to develop water resources. An understanding of the positions taken by courts in resolving interstate conflicts over water then adds two important dimensions:

1. the evolution of court decisions concerning state's development, management, and regulation of its water resources may define an important "benefit" associated with alternative water development plans, viz., the vulnerability of unappropriated or undeveloped waters in various basins; and

2. the areas of water law which must be continually tracked if the state's MOP process is to be responsive to important changes in the environment for water planning.

This appendix is organized in the following manner. Section E.2 offers a brief historical sketch of the sequence of court cases which have lead to the modern frontier of federalism as it applies to constitutional restrictions on a state's ability to regulate and tax its natural resources.

Section E.3 turns to a parallel series of court decisions which focus directly on interstate competition for water. Concern is with property rights for water as they are relevant for the "certainty" with which a state can claim rights to the water resources within its boundaries.

E.2 CONTEMPORARY FEDERALISM: A STATE'S ABILITY TO CONTROL, REGULATE, AND TAX ITS NATURAL RESOURCES

Limitations on a state's ability to control, regulate, and levy taxes on the natural resources within its boundaries is determined, in large part, by Article I, Section 8 (the "Commerce Clause") of the U.S. Constitution which provides that Congress has the power "to regulate Commerce with foreign Nations, and among the several states, and with the Indian Tribes" (U.S. Constitution). The negative implication of the phrase ". . . regulate Commerce . . . among the several States . . ." i.e., that states may not enter that province, has been the source for considerable debate almost from the time of its adoption:

> ". . . the history of commerce clause adjudication is a history of the search for that balance of federal-state power that best serves the society's needs at a particular time" (Browde et al. [1981], p. 11).

The somewhat polar limits of that search are seen in the opinions of Justices Frankfurter and Jackson:

> The interpretations of modern society have not wiped out state lines. It is not for us to make inroads upon our federal system either by indifference to its maintenance or excessive regard for the unifying forces of modern technology" (Polish National Alliance v. NLRB).

> Our system, fostered by the Commerce Clause, is that every farmer and every craftsman shall be encouraged to produce by the certainty that he will have free access to every market in the Nation, that no home embargoes will withhold his exports, and no foreign state will by customs duties or regulations exclude them" (H.P. Hood & Sons v. DuMond).

In these interpretations of the commerce clause as it bears on state's rights to impose control over its natural resources, the Supreme Court has taken many twists and turns. In the early 1800s, the Court's strong federalist positions, as seen in the 1824 Gibbons v. Ogden decision, firmly established the theory of the exclusivity of federal power over commerce. One then sees a period over which the Court is seemingly attempting to define what a state might, and might not do, i.e., to properly define federal and state powers. At the outset, these attempts took the direction of distinguishing between a state's legitimate exercise of its police power and the regulation of commerce. In Brown v. Maryland the Court distinguished between the power to direct (regulate) the removal (extraction) of gunpowder, a legitimate exercise of police power, and the licensing of wholesalers of imported gunpowder, an unlawful disruption of interstate commerce. This notion then evolved into a distinction between actions which were "local" and "national" in nature. The Court was then to look beyond the subject of a state regulation to the examination of the effect of the regulation on the flow of commerce (e.g., Cooley v. Board of Wardens).

The "local v. national" focus of the Court in the late 1800s and early 1900s is important in that state regulations are allowed on its natural resources even if some burden on commerce resulted. A state's regulation was allowed so long as the burden on commerce was deemed by the Court to be "only indirectly, incidentally, and remotely" (Smith v. Alabama). The stage was then set for a period of judicially supported laissez faire economics, wherein, in the "Heisler trilogy" (Browde et al. [1981], p. 18), the Court took the position that taxes and/or regulations applied to the act of severance or production, which preceded the flow of commerce, were not subject to commerce clause constraints (see Heisler v. Thomas Colliery Co., Hope Natural Gas Co. v. Hall. and Oliver Iron Mining Co. v. Lord). Thus, in Heisler v. Thomas Colliery Co.,

the state of Pennsylvania imposed a tax on a type of anthracite coal shipped to other states, states which were prohibited to use other coals of higher sulphur content. Notwithstanding the resulting, essentially monopolistic, position of Pennsylvania, the Court reasoned that a tax levied when coal has been mined and prepared for shipment precedes the time at which the coal is governed and protected by the commerce clause (Heisler v. Thomas Colliery Co. at 260-61).

Thus, the basis for state's confidence in their "ownership" of natural resources within its boundaries, certainly as respect to its ability to exercise regulatory and tax powers as it chose, is readily apparent. So long as a specific activity was not "in" commerce, such as the activity involved in the extraction of resources (e.g., groundwater, coal, etc.), regulatory and or tax actions by the state were simple, and allowable, applications of its police powers, commerce clause constraints did not apply. This was the setting for state regulation and control of intrastate natural resources through the 1960s.

Beginning in 1970 with Pike v. Bruce Church, Inc., however, the Supreme Court moved sharply away from the "local" v. "national" criterion underlying the principles of the Heisler trilogy. In looking for ways to balance the conflicting claims of state and national power, in Pike the Court established a test for the determination of whether or not a state tax or regulation was in violation of the commerce clause. A regulation on natural resource use within a state to be allowable vis-a-vis the commerce clause, was judged on the basis of (1) evenhandedness, (2) the legitimacy of local public interest, (3) the burden imposed on commerce in relation to local benefits, and (4) least intrusive means. The "evenhandedness" criterion, of course, relates directly to discriminatory effects of a regulation vis-a-vis citizens of other states (see, e.g., Exxon Corp. v. Governor of MD). The "legitimacy of local public interest" essentially involves the

Court's assessment of a hierarchy of interests. At one end of the hierarchy, regulations whose primary effects are to protect economic well-being would most likely be judged illegitimate on their face. Alternatively, regulations whose major effects are to protect public health and safety would most likely be viewed as legitimate exercises of police power. The "legitimacy" of regulations, the major effects of which lie in between these extremes, is an open question (see, e.g., City of Philadelphia v. New Jersey). The "burden on commerce in relation to local benefit" criterion requires the Court's balancing benefits claimed for a regulation, even health/safety benefits, against effects on interstate commerce (see Bibb v. Naval o Freight Lines. Inc. and Southern Pacific v. Arizona). Finally, even if the Court finds burdens on commerce to be acceptable vis-a-vis local benefits, the regulation is not permissible in cases where there exists alternative, less intrusive (in terms of commerce effects) means for achieving the same objective (see Hughes v. Oklahoma).

In virtually all modern resources cases, however, the Court has consistently struck down state regulation schemes which have the effect of placing the state in a position of economic isolationism, or which tend toward "economic Balkanization" (City of Philadelphia v. New Jersey; Pennsylvania v. West Virginia; West v. Kansas Natural Gas Co.).

Looking next to taxes, the Court moved from the principles of the Heisler trilogy in the late 1970s with their decisions in Complete Auto Transit. Inc. v. Brady, Department of Revenue v. Association of Washington Stevedoring Cos., and Michelin Tire Corp. v. Wages. Beginning with Complete Auto Transit, the Court established, essentially, a four-pronged test for determining whether or not a state tax on natural resources violates the commerce clause. Thus, a state tax does not violate the commerce clause when it: (1) is applied

to an activity with a substantial nexus with the taxing state, (2) is fairly apportioned, (3) does not discriminate against interstate commerce, and (4) is fairly related to the services provided by the state (see Japan Line. Ltd. v. County of Los Angeles).

Hopefully, these discussions serve to make clear the substantial changes which have occurred over the last decade in terms of range over which states may impose taxes on, and/or regulations for, the use of natural resources within their boundaries. Until the 1970s, the Heisler trilogy guided the Court, and the extraction, diversion, or use of natural resources were, in the main, insulated from commerce clause challenge, activities involving the extraction or gathering of resources per se did not involve commerce. Beginning in the 1970s, however, the "local v. national" distinction no longer held, and any tax or regulation on resources use became subject to the Court's scrutiny as to its effect on commerce. The implications of this general observation for water resources in particular are developed in the following section.

E.3 PROPERTY RIGHTS AND THE STATES' CONTROL OVER WATER RESOURCES: THE RATIONALE FOR UNCERTAINTY AS A COMPONENT RELEVANT FOR WATER PLANNING

Narrowing our focus now to water resources, there are three distinct lines of development in the positions taken by the Court which are of primary importance for our discussions of the relevance of evolving legal institutions for water planning. The first of these concerns commerce clauses challenges to a states' right to control water, particularly groundwater, within its borders, and therefore relates discussions in the preceding section directly to water resources. The second line of legal developments to be discussed concerns the dramatic shifts in the criteria used by the Court in deciding "equitable apportionment" suits involving interstate claims on water in interstate streams and

rivers. Central to these discussions is the apparent trend whereby intrastate water rights based upon the prior appropriation doctrine are seemingly being replaced by comparisons of interstate efficiency in water use. Finally, we examine Court decisions which relate to the bastion of state control over water resources—the interstate compact.

E.3.1 Water Rights and The Commerce Clause

Prior to 1982, western states had every reason to be confident in their absolute control over groundwater resources within their boundaries. Their control over surface waters, for interstate streams, were typically constrained only by limits imposed by adjudicated equitable apportionments or by interstate compact. Given our discussions above, commerce clause considerations were viewed as totally irrelevant; after all, the extraction of groundwater was a "local" matter, and involved an extraction process which preceded commerce. In irrigated agriculture, the extraction of water was a local activity which provided an input to the process which produced articles in commerce (agricultural products). The state's control over its groundwater resources was viewed as absolute, and extended to laws and/or regulations which prohibited the out-of-state export of water resources.

Paralleling the general shift in the Court's position vis-a-vis the regulation and taxation of resources noted above, the nature of a state's control over groundwater resources shifted markedly in 1982 with the Court's decision in Sporhase v. Nebraska. In Nebraska, like most western states, groundwater was considered to be "owned" by the state, and therefore subject to state control over its use. In particular, Nebraska laws prohibited the export of groundwater to other states unless the importing state had a reciprocal agreement for groundwater imports to Nebraska. While recognizing the need by state's for planning and management of groundwater resources, the Court rejected the notion that a state can "own" its groundwater resources, such "ownership"

was held to be a "legal fiction." Further, using the line of reasoning that, since more than 80 percent of water supplies are used for agricultural purposes and agricultural markets are worldwide, the Court ruled that a state's interference with interstate exports of groundwater would be in violation of the Commerce Clause of the U.S. Constitution.

> In expressly overruling (Greer v. Connecticut) three years ago, this Court traced the demise of the public ownership theory and definitively recast it as 'but a fiction expressive in legal shorthand of the importance to its people that a State have power to preserve and regulate the exploitation of an important resources (citing Hughes v. Oklahoma [Complete Auto Transit. Inc. v. Brady]).

"Appellee's argument is still based on the legal fiction of state ownership" (Sporhase v. Nebraska at 3461).

Recall that in the post-Heisler trilogy Court, scrutiny of regulations on natural resource, looked to the "burden on commerce in relation to local benefit" criterion, wherein the Court balances benefits claimed for a regulation, even health/safety benefits, against effects on interstate commerce. In Sporhase, the Court looked to balance the local benefits of managing water for health and safety against the burdens on interstate commerce resulting, not from the local extraction of water, but on the agricultural commodities which used water as an input.

> Appellee . . . [has] convincingly demonstrated the desirability of state and local management of groundwater. But the States' interests clearly have an interstate dimension. Although water is indeed essential for human survival, studies indicate that over 80% of our water supplies is used for agricultural purposes . . . [and] . . . agricultural markets supplied by irrigated farms are worldwide (Sporhase v. Nebraska at 3462).
>
> . . . appellee's claim that Nebraska ground water is not an article of commerce goes too far: it would not only exempt Nebraska ground water regulation from burden-on-commerce analysis, it would also curtail the affirmative power of Congress to implement its own policies concerning such regulation . . . . If Congress chooses to legislate

> in this area under its conmierce power, its regulation need not be more limited in Nebraska than in Texas and States with similar property laws" (Sporhase v. Nebraska at 3463).

The notion that groundwater is an article in commerce, and thus subject to Commerce Clause protection is later reaffirmed in South-Central Timber v. Winnicke. For example,

> For a state regulation to be removed from the reach of the dormant Commerce Clause, congressional intent must be unmistakable clear . . . (requiring states to prove that Congress affirmatively contemplated a waiver of the commerce power) . . . reduces significantly the risk that unrepresented interests will be adversely affected by restraints on commerce" (South-Central Timber v. Winnicke at 2238).

These extensions of commerce clause applications to groundwater over the last few years have implications which go well beyond groundwater per se, and include surface waters supposedly protected by adjudicated equitable apportionments as well as compacts. In El Paso v. Reynolds the City of El Paso had applied to New Mexico's State Engineer for permits to pump some 250,000 a.f. per year from the Mesilla Bolson in New Mexico, about 20 miles to the south of the City. The Mesilla Bolson is a tributary aquifer to the Rio Grande whose waters are divided between New Mexico and Texas (as well as Colorado and Mexico) by the Rio Grande Compact. If allowed, El Paso's pumping would then unquestionably reduce flows in the Rio Grande after some period of time, thereby impairing the compact-established water rights in the Rio Grande. The District Court seemingly stepped around the effects of El Paso's pumping on compacted surface water rights, and focused solely on New Mexico's law which prohibited water exports and, following the example of Sporhase, ruled the law unconstitutional on commerce clause grounds.

This then leaves unanswered the issue as to whether the Supreme Court will consider pumping effects from tributary aquifers on surface water rights established by prior

appropriation or compact in their considerations of "local" benefits claimed by states.

E.3.2 Equitable Apportionment and Water Markets: The Demise of The Prior Appropriation Doctrine

In most western states, water rights were established by an individual's putting water to beneficial use, and the priority of such rights was governed by the prior appropriation doctrine: "first in use, first in right." Prior to 1921, it was generally thought that prior appropriation would rule absolutely throughout the course of a stream, notwithstanding state boundaries. The "absoluteness" of the prior appropriation doctrine was modified by the courts in 1921, however, when, in Wyoming v. Colorado it ruled that prior appropriation based on annual flows of a river was not the basis for quantifying rights; rather, it was the amount of water which could be available with the construction of appropriate facilities for water storage. Wyoming's claim that they should not be required to build storage facilities to facilitate Colorado's needs for greater water supplies was rejected by the Court:

> The question here is not what one State should do for the other, but how each should exercise her relative rights in the waters of this interstate stream. Both are interested in the stream and both have great need for water. Both subscribe to the doctrine of appropriation, and by that doctrine rights to water are measured by what is reasonably required and applied. Both States recognize that conservation within practicable limits is essential in order that needless waste may be prevented and the largest feasible use may be secured . . . . We think that doctrine lays on each of these States a duty to exercise her right reasonably and in a manner calculated to conserve the common supply (Wyoming v. Colorado at 484).

The prior appropriation doctrine, as it relates to the state's rights to surface water flows, was further weakened in the Court's 1945 decision in Nebraska v. Wyoming. In this case, the Court held that water claims of a state based on prior appropriation must be considered within a context that

includes physical and economic factors. Most importantly, the Court holds that prior appropriation must give way in instances where its recognition would result in harm to existing economies.

> That (claims for the just and equitable results realized with the prior appropriation doctrine) does not mean that there must be a literal application of the priority rule . . . in determining whether one State is using, or threatening to use, more than its equitable share of the benefits of a stream, all the factors which create equities in favor of one State or the other must be weighted as of the date when the controversy is mooted. . . . But if an allocation between appropriation States is to be just and equitable, strict adherence to the priority rule may not be possible. For example, the economy of a region may have been established on the basis of junior appropriations. So far as possible these established uses should be protected though strict application of the priority rule might jeopardize them. . . . But physical and climatic conditions, the consumptive use of water in the several sections of the river . . . the extent of established uses . . . the practical effect of wasteful uses on downstream areas, the damage to upstream areas as compared to the benefits to downstream areas if a limitation is imposed on the former--these are all relevant factors. . . . They indicate the nature of the problem of apportionment and the delicate adjustment of interests which must be made (Nebraska v. Wyoming at 618).

By the 1980s, however, the Court's focus on commerce and, implicitly, markets and efficiency noted in resource regulation and tax cases was seemingly carried over into equitable apportionment considerations. In the Court's 1982 decision in Colorado v. New Mexico, the Court held that water rights claims based upon prior appropriation considerations are subject to the extent to which diligence in the exercise of the rights can be shown, but most importantly, could be forfeited in instances wherein junior claims could be shown to be more efficient (or valuable). That is, relative benefits and costs were the yardstick to be used in deciding whether to protect senior rights based on prior appropriation against

challenges by junior users. The dictum of the Court, selections of which follow, raises serious questions as to the extent to which prior appropriation can still serve as a means for establishing certain rights in a state's surface waters.

> . . . will protect only those rights to water that are 'reasonably required and applied' . . . 'there must be no waste . . . of the treasure of a river. . . . Only diligence and good faith will keep the privilege alive' . . .. Thus, wasteful or inefficient uses will not be protected. . . . Similarly, concededly senior water rights will be deemed forfeited or substantially diminished [emphasis added] where the rights have not been exercised or asserted with reasonable diligence (Colorado v. New Mexico at 184).
>
> . . . we have held that . . . it is proper to weigh the harms and benefits to competing States . . . we held water rights . . . which under state law were senior, had to yield to the 'countervailing equities' of an established economy . . . even though it was based on junior appropriations. . . . We noted that the rule of priority should not be strictly applied where it 'would work more hardship' on the junior user 'than it would bestow benefits' on the senior user. . . . The same principle is applicable in balancing the benefits of a diversion for proposed uses against the possible harms to existing uses (Colorado v. New Mexico at 186, 187).

E.3.3 Providing Security For a State's Water Rights: The Interstate Compact

The ultimate bastion for the protection of a state's water rights has always been viewed as the interstate compact, surely a state's water supplies allocated under compact must be secure from acquisition by other states. But even here, with interstate compacts, uncertainties as to the state's ability to use its compact waters in whatever ways she wishes was challenged in 1983. In the Court's 1983 decision in Intake Water Company v. Yellowstone River Compact, the Court held that a state's compact allocation of water was immune to the Commerce Clause. A state might prohibit the interstate export of its compact water supplies only if the language of

the Compact approved by Congress explicitly prohibits such transfers:

> Just as Congress may itself enact a law that interferes with interstate commerce, it may also give its approval to a state law interfering with interstate commerce and thereby immunize the law from challenge under the Commerce Clause . . . the issue is whether Congress in fact approved the state law . . . Congress's approval of the Yellowstone River Compact in 1951 may be considered the express statement of intent to immunize the Compact from attack that the Court found lacking in Sporhase (Intake Water Company v. Yellowstone River Compact at 296).

While states, like Wyoming, who are parties to the Colorado River Compact (which does contain such "express statement(s) of intent") might seek comfort in the Court's decision in the Intake case, many legal scholars would view such comfort as sanguine. As demonstrated above, the persistent movement of the Court toward the position that waters, interstate and intrastate, should be used wherever the needs and benefits are greatest--essentially, that water resources should be subject to the forces of free, interstate markets--there exists (in the minds of many legal writers) considerable uncertainty as to the ultimate protection offered a state by their participation in compacts.

> Under the Court's interpretation of the tenth amendment it would seem that compacts create state-held proprietary interests not subject to any limitation derived from the dormant commerce clause. . . . (however, in Sporhase, the) . . . court has placed into the matrix a countervailing need-the need in our federal system for water to flow to its highest economic use in the interstate water system. . . . While the argument that congressional approval of compacts creates exclusive state apportionments of water seems clear on its face, there is sufficient uncertainty to suggest that there are circumstances in which the protection might not be absolute (Rodgers [1986], p. 373).

> My guess is that the Court, in the absence of explicit territorial limitations [in a compact] will tend to be unfavorably disposed to state restrictions which interfere with providing water to

expanding population centers and it will not construe compacts as placing territorial limitations on water use that avoid commerce clause scrutiny. The Court will be more inclined to solve the population problems than to read the intent of state legislatures into federal law (Simms [1985]).

APPENDIX F

THE QUESTION OF INTEGRATION

F.1 INTRODUCTION

The question as to how one might effectively integrate measures/descriptions of impacts associated with water projects has long been of concern to analysts. Problems of integration stem primarily from the fact that impacts associated with the various objectives are, and we have argued should be, presented in different units. In this appendix, we explore this issue. Our purpose is to draw attention to the past debates regarding integration and alert the reader of some of the problems of a broad benefit-cost analysis.

F.2 AN EXAMPLE OF INTEGRATION PROBLEMS

Impacts on income-related items (included in the benefit-cost measure) are summed and are expressed in dollars. Distributive impacts are typically given by an (unsummed) array such as the percentage distribution of households in various income groups in the areas affected by different water reclamation projects. Environmental and or ecological impacts may be described by such measures as income or acres of wildlife habitat preserved, an affected biological species, and/or numbers of encounters (relevant for "congestion" in a wilderness experience).

The impacts associated with two projects under consideration might be represented as follows:

	PROJECT A	PROJECT B
Benefit/ Cost Measure:	(a) .89 Benefits: $20.2 mill. Costs: $22.7 mill. (b) benefits and costs are certain.	(a) 1.2 Benefits: $27.8 mill. Costs: $23.2 mill. (b) a good part of Project benefits are uncertain.
Distribution:	75% of affected Population “poor”; 90% of project incomes (benefits) accrue to the poor.	15% of affected population “poor”; 10% of project incomes (benefits) accrue to the poor.
Environmental Impacts:	No wilderness areas are affected	Half of the lands in a 10 million acre

The trade-offs involved with these two projects are obvious: the greater, but uncertain, economic efficiency of Project B, as seen in the benefit/cost ratio of 1.2, may be traded off with the more certain, smaller income related benefits, greater effects of improving income distributions, and the protection of established wilderness areas affected by Project B. Alternatively, if Project A was being considered in isolation, the relevant trade-off to be considered is that between the objective of improving the incomes and social well-being of low income households in the state, with investing in "efficient" projects.

Thus, integration may involve nothing more than a presentation of the array of project-related impacts as exemplified above for projects A and B. Indeed, this mode of "integration" is the one implied by the arguments of Bromley and others described above. However, "integration" implies to many the need to bring together the diverse impacts of a project in one common unit (i.e., dollars) such that the impacts can be summed, and the net beneficial effects of the project can then be expressed as single integer. Then that integer can be compared with those derived for other projects

to the end of comparing the relative desirability of projects. As an example, if we were to be told that each dollar of income had a "social weight" of 1 (for the purpose of this example, we ignore uncertainties), each dollar of income which accrues to low income families had a social weight of 1.25, and that each acre preserved in wilderness areas had a social value/weight of 1.5, the impacts of projects A and B could be expressed as an integer reflecting "social values" as follows:

Project A: (1) ($20.2 million - $22.7 million) + (1.25)
(90% of $20.2 million, or $18.2 million)
= - $2.5 million + $22.8 million
= $20.3 million

Project B: (1) ($27.8 million - $23.2 million) + (1.25)
(10% of $27.8 million, or $2.8 million)
+ (1.5) (- $5 million)
= $4.6 million + $3.5 million
- $7.5 million
= $0.6 million

Here, Wyoming's concern with the problems of the poor, environmental concerns, etc., are viewed as being adequately expressed in the weights 1.25 and 1.5, respectively. Intra-project trade-offs disappear, and the comparison of interest is $20.3 million with $.6 million and Project A is obviously superior. The obvious problem with this approach, of course, is with: where does one find these crucial weights? The answer to this question is equally obvious: you don't; at least, to date we know of no one's success in this regard.

F.3 THE PAST DEBATE AND OUR THOUGHTS

During the late 1960s and early 1970s, a great deal of effort was expended by economists and systems engineers with this approach (as examples, see Major [1969] and the critique by Freeman and Haveman, [1970]; Flack and Summers [1971]; Miller and Byers [1973]; and Seneca [1969]). Of course, while analysts could provide any number of numeric algorithms for "integrating" benefits and costs of multi-objective projects, applications of these models were persistently stymied by the

lack of information as to appropriate weights which might be assigned to non-monetary objectives:

> Unless weights (values) can be specified or there is a political process for choosing among projects, the social optimum cannot be defined, and nothing further can be said about the choice of projects (Freeman and Haveman [1970], p. 1534).

In his treatise of efficiency in government through systems analysis, McKean acknowledges that:

> In order for such opportunities (to use operations research methods for project analyses) to exist, there must be . . . meaningful quantitative indicators (weights) of gains and losses ([1966], p. 16).

Of course, the search for weights runs counter to Bromley's earlier noted admonition that everything is subject to conversion to a single integer. At issue in the "weights" problem is the well-known Arrow Impossibilities Theorem, which in homey terms, demonstrates the impossibility of acquiring meaningful social weights for these diverse impacts (Arrow [1963]). Our view is that this admonition is well made, and that "integration" must be taken to describe no more than, but certainly no less than, the process of bringing together, in a comprehensive manner, the full array of relevant beneficial and adverse effects of a project.

REFERENCES

Anderson, T. (Ed.), Water Rights: Scarce Resource Allocation, Bureaucracy, and the Environment, 1983.

Anderson, T., "The Market Alternative for Hawaiian Water", Natural Resources Journal, 25(4) (October 1985), pp. 893-910.

Arizona Water Commission, "Arizona State Water Plan: Alternative Futures," Phase II, Phoenix, AZ (February 1977).

Arrow, K. J., Social Choice and Individual Values, 2nd ed.,(New York), 1963.

Bain, Joe S., Richard E. Caves, and Julius Margolis, Northern California's Water Industry (Baltimore, MD: Johns Hopkins Press), 1966.

Baumol, W. J., "On the Social Rate of Discount," American Economic Review, 58 (1968), pp. 788-802.

Beatie, Bruce, "Irrigated Agriculture and the Great Plains: Problems and Policy Alternatives", Western Journal of Agricultural Economics, 6(2) (1981), pp. 289-299.

Bibb v. Naval o Freight Lines, Inc., 359 U.S. 520 (1959).

Bromley, Daniel W.,"The Ideology of Efficiency: Searching for a Theory of Policy Analysis," Journal of Environmental Economics and Management, forthcoming (1990).

Browde, Michael B., and Charles T. Dumars, "State Taxation of Natural Resource Extraction and the Commerce Clause: Federalism's Modern Frontier," Oregon Law Review, 60(1 and 2) (1981).

Brown v. Maryland, 25 U.S. (12 Wheat.) 262 (1827).

Brown, F. Lee, Ronald G. Cummings, and Susan C. Nunn, Efficiency, Equity, and Sovereignty in Groundwater Management: A Case Study on a Tributary Aquifer," (Canary Islands: Universidad de Laguna Press), 1989.

Brosz, Donald J., Extension Irrigation Engineer, Wyoming Water Research Center, private conversation, 1989.

Burke, K. J., R. G. Cunmiings, and J. C. Mays, Interstate Allocation and Management of Non-tributary Groundwater, Western Governors Association, Denver, CO (May 1984).

Burness, H. S., R. G. Cummings, W. D. Gorman, and R. R. Lansford, "United States Reclamation Policy and Indian Water Rights," Natural Resources Journal, 20 (1980), pp. 807-826.

Cicchetti, Charles, V. Kerry Smith, and John Carson, "An Economic Analysis of Water ResourceInvestment and Regional Economic Growth," Water Resources Research, 11(1) (1975), pp. 1-6.

City of Philadelphia v. New Jersey, 437 U.S. 617 (1978).

Colorado v. New Mexico (Vermejo I), 459 U.S. 176 (1982).

Colorado v. New Mexico (Vermejo II), 467 U.S. 310 (1984).

Complete Auto Transit, Inc., v. Brady, 430 U.S. 274 (1977).

Cooley v. Board of Wardens, 53 U.S. (12 How.) 299 (1851).

Cummings, Ronald G., "Some Extensions of the Economic Theory of Exhaustible Resources," Western Economic Journal, 8(3) (September 1969), pp. 209-220.

Cummings, Ronald G., "Optimum Exploitation of Groundwater Reserves with Saltwater Intrusion," Water Resources Research, 8(6) (December 1971), pp. 1414-1424.

Cummings, Ronald G.,Interbasin Water Transfers; A Case Study in Mexico (Baltimore, MD: Johns Hopkins Press), 1974.

Cummings, Ronald G., David S.Brookshire, and William D. Schuize (eds.), Valuing Environmental Goods: An Assessment of the Contingent Valuation Method (Totowa, NJ: Rowman & Allanheld Publishers), 1986.

Dasgupta, A. K. and D.W. Pearce, Cost-Benefit Analysis: Theory and Practice (New York, NY: Harper & Row Publishers), 1972.

Davis, Robert K., "Planning a Water Quality Management System: The Case of the Potomac Estuary," in Alien V. Kneese and Stephen C. Smith (eds.), Water Research, (Baltimore, MD: John Hopkins Press), 1966, pp. 99-124.

Department of Administration and Fiscal Control, Division of Research and Statistics, Wyoming Data Handbook 1987, 8th Edition, Cheyenne, WY (1987).

Department of Revenue v. Association of Washington Stevedoring Cos., 435 U.S. 734 (1978).

DuMars,Charles T. and William Ellis, "The Two-Tiered Market for Western Water," Nebraska Law Review, 57 (1978), pp. 333.

DuMars, Charles T., et al., "State Appropriation of Unappropriated Groundwater: A Strategy for Insuring New Mexico a Water Future",New Mexico Water Resources Research Institute, Las Cruces, NM (January 1986).

Eckstein, Otto, Water-Resource Development: The Economics of Project Evaluation (Cambridge: Harvard University Press), 1958.

El Paso v. Reynolds, 563 F. Supp. 379, D.N.M. (1983).

Engineering Foundation and Universities Council on Water Resources, Water Resources Planning and Management in the United States Federal System, Proceedings, New England College, Henniker, NH, July 6-11, (1986).

Exxon Corp. v. Governor of Md., 437 U.S. 117 (1978).

Farrah, Philip, "An Evaluation of Market Preferences in New Mexico Water Rights Transfer," Unpublished Ph.D. Dissertation, University of New Mexico, Albuquerque, NM (1989).

Feldstein, M.S., "International Trade, Budget Deficits,and the Interest Rate," Journal of Economic Education, 16(3), (1985), pp. 189-193.

Flack, J. Ernest and David A. Summers, "Computer-Aided Conflict Resolution in Water Resources Planning: An Illustration," Water Resources Research, 7(6) (December 1971), pp. 1410-1414.

Folmer, H. and E. van Ierland (eds), Valuation Methods and Policy Making in Environmental Economics, (New York, NY: Elsevier Press), 1989.

Franklin, Douglas R. and Ronda K. Hageman, "Cost Sharing With Irrigated Agriculture: Promise Versus Performance," Water Resources Research, 20(8) (August 1984), pp. 1047-1052.

Freeman, A. Myrick and Robert H. Haveman, "Benefit-Cost Analysis and Multiple Objectives: Current Issues in Water Resources Planning," Water Resources Research. 6(6) (December 1970), pp. 1553-1539.

Fullerton, H. H., W. C. Lewis, J. C. Anderson, J. Keith, and R. Willis, "Regional Development: An Econometrics Study of the Rose of Water Development in Effectuating Population and Income Changes," Report PRRBE089-1, Utah Water Resources Laboratory, Utah State University, Logan, UT (June 1975).

Gibbons, Diana, The Economic Value of Water (New York, NY: Johns Hopkins University Press for Resources for the Future), 1986.

Gibbons v. Ogden, 22 U.S. (9 Wheat) 1 (1824).

Greer v. Connecticut, 161 U.S. 519 (1896).

H.P. Hood & Sons v. DuMond, 336 U.S. 525, 539, (1949).

Hicks, John, "Foundations of Welfare Economics," Economics Journal, 49 (1939), pp. 696-712.

Hanke, S. H. and R. A. Walker, "Benefit-Cost Analysis Reconsidered: An Evaluation of the Mid-State Project," Water Resources Research, 10(5) (1974), pp. 898-908.

Heisler v. Thomas Colliery Co., 260 U.S. 245 (1922).

Hope Natural Gas Co. v. Hall, 274 U.S. 284 (1927).

Howe, C. W., "Effects of Water Resource Development on Economic Growth: The Conditions for Success," Natural Resources Journal, 6 (1976), pp. 939-956.

Howe, Charles W., "Obstacles to the Use of Social Science Analysis in Water Decision Making or Where's the Demand for Social Science Input?" in Duane D. Baumann and Yacov Y. Haimes (eds.), The Role of Social and Behavioral Sciences in Water Resources Planning and Management (New York, NY: American Society of Civil Engineers), 1987.

Howe, Charles W. and K. William Easter, Interbasin Transfers of Water: Economic Issues and Impacts (Baltimore, MD: Johns Hopkins Press), 1971.

Hughes v. Oklahoma, 441 U.S. 322 (1979).

Intake Water Company v. Yellowstone River Compact, 590 F.Supp.293 (1983).

Jacobs, J. J. and D. T. Taylor, "The Increasing Role of States in Water Management: The Wyoming Experience," Western Journal of Agricultural Economics, 14(2) (1989), pp. 261-267.

Japan Line,Ltd. v. County of Los Angeles, 441 U.S. 434 (1979).

Jones, C. Vaughan, John J. Boland, James E. Crews, C. Frederick Dekay and J. R. Morris, Municipal Water Demand: Statistical and Management Issues (Boulder, CO: Westview Press), 1984.

Kaldor, N.,"Welfare Prepositions of Economics and Interpersonal Comparisons of Utility," Economics Journal 49 (1939), pp. 549-552.

Kelso, Maurice M., William E. Martin, and Lawrence E. Mack, Water Supplies and Economic Growth in an Arid Environment: An Arizona Case Study (Tucson, AZ: University of Arizona Press), 1973.

Kneese, Alien V., "The Use of Shadow Prices: Comment," in Samuel B. Chase (ed.), Problems in Public Expenditure Analysis,(Washington, D.C.: Brookings Institution), 1968.

Kneese, Alien V. and Stephen C. Smith. Eds., Water Research (Baltimore, MD: John Hopkins Press), 1966.

Krutilla, John V. and Otto Eckstein, Multiple Purpose River Development (Baltimore, MD: Johns Hopkins Press), 1958.

Lind, Robert C., "Reassessing the Government's Discount Rate Policy in Light of New Theory and Data in a World Economy With a High Degree of Capital Mobility," Journal of Environmental Economics and Management, forthcoming, March 1990.

Lyon, Randolph M., "Federal Discount Rate Policy, The Shadow Price of Capital, and Challenges for Reforms," Journal of Environmental Economics and Management, forthcoming, March 1990.

Maass, Arthur, "Benefit-Cost Analysis: Its Relevance to Public Investment Decisions," in Alien V. Kneese and Stephen C. Smith (eds.), Water Research (Baltimore, MD: Johns Hopkins Press), 1966, pp. 311-330.

Maass, Arthur, Maynard M. Hufschmidt, Robert Dorfman, Harold A. Thomas, Jr., Stephen A. Marglin, and Gordon Maskew Fair, Design of Water Resource Systems (Cambridge: Harvard University Press), 1962.

Major, David C., "Benefit-Cost Ratios for Projects in Multiple Objective Investment Programs," Water Resources Research, 5(6) (1969), pp. 1174-1178.

Mann, Roger, Edward Sparling, and Robert A. Young, "Regional Economic Growth From Irrigation Development: Evidence From Northern High-Plains Ogallala Ground Water Resource," Water Resources Research, 23(9) (September 1987), pp. 1711-1716.

Martin, W. E., H. Ingram, and N. K. Laney, "A Willingness to Play: Analysis of Water Resources Development," Western Journal of Agricultural Economics, 7(1) (1982), pp. 133-139.

McConnell, Kenneth, "The Economics of Outdoor Recreation," in A. Kneese and J. Sweeney (eds.) Handbook of Natural Resource and Energy Economics, Volume 1 (New York, NY: Elsevier-North Holland), Chapter 15, 1985.

McKean, Roland N., Efficiency in Government Through Systems Analysis (London: John Wiley & Sons), 1966.

Merewitz, Leonhard and Stephen H. Sosnick, The Budget's New Clothes; A Critique of Planning-Programming-Budgetinq and Benefit-Cost Analysis (Chicago, IL: Markham Pub. Co.), 1971.

Michelin Tire Corp. v. Wages, 423 U.S. 276 (1976).

Miller, W. L. and D. M. Byers, "Development and Display of Multiple-Objective Project Impacts," Water Resources Research, 9(1) (February 1973), pp. 11-20.

Mishan, Edward J., Cost-Benefit Analysis (New York, NY: Praeger), 1976.

Mitchell, Robert C. and Richard T. Carson, Using Surveys to Value Public Goods: The Contingent Valuation Method (New York, NY: Johns Hopkins University Press for Resources for the Future), 1989.

Murray, C. R. and E. B. Reeves, Estimated Use of Water in the United States in 1970, U.S. Geological Survey, Circular 676, Washington, DC (1972).

Nebraska v. Wyoming, 325 U.S. 589, 672 (1944).

Ng, Yew-Kwang, Welfare Economics (London: MacMillan), 1983.

North, R. M. and W. P. Neely, "A Model for Achieving Consistency for Cost Sharing in Water Resource Programs," Water Resources Bulletin, 13(5) (1977), pp. 995-1005.

Oklahoma Water Resources Board, "Oklahoma Comprehensive Water Plan," Publ. No.94, Oklahoma City, OK (April 1, 1980), pp. 154-155.

Oliver Iron Mining Co. v. Lord, 262 U.S. 172, 178 (1923).

Palanisami, K. and K. William Easter, "Ex Post Evaluation of Flood Control Investments: A Case Study in North Dakota," Water Resources Research. 20(12)(December 1984), pp. 1785-1790.

Pennsylvania v. West Virginia, 262 U.S. 553 (1923).

Peskin, Henry M. and Eugene. P. Seskin, Eds., Cost Benefit Analysis and Water Pollution Policy (Washington, DC: The Urban Institute), 1975.

Peterson, George L., B. L. Driver, and Robin Gregory (eds.), Amenity Resource Valuation: Integrating Economics With Other Disciplines (State College, PA: Venture Publishing, Inc.), 1988.

Pike v. Bruce Church. Inc., 397 U.S. 137 (1970).

Polish National Alliance v. NLRB, 322 U.S. 643, 650 (1944).

Rodgers, Ann Berkley, "The Limits of State Activity in the Interstate Water Market," Land and Water Law Review, XXI(1) (1986), pp. 357-380.

Saliba, Bonnie C., David B. Bush, William E. Martin, and Thomas C. Brown, "Do Water Market Prices Appropriately Measure Water Values?" Natural Resources Journal, 27(3) (Summer 1987), pp. 617-654.

Scitovsky, T., "A Note on Welfare Prepositions in Economics" Review of Economics and Statistics, 9 (1941), pp. 77-88.

Seneca, Joseph J.,"Water Recreation, Demand, and Supply," Water Resources Research, 5(6) (December 1969), pp. 1179-1185.

Simms, R., untitled paper presented at Rocky Mountain Legal Foundation Seminar, June, 1985, available from the author. (See cite in Rodgers, 1986).

Smith v. Alabama, 124 U.S. 465, 482 (1888).

Smith, V. Kerry and W. H. Desvousges, Measuring Water Quality Benefits (Kluwer-Nijhoff Publishing), 1986.

Solley, W. B., E. B. Chase, and W. B. Mann, Estimated Use of Water in the United States in 1980, U.S. Geological Survey, Circular 1001 (1983).

South-Central Timber v. Winnicke, 104 S.Ct. 2237, 2242 (1984).

Southern Pacific v. Arizona, 325 U.S. 761 (1945).

Sporhase v. Nebraska, 458 U.S. 941 (1982).

State of California, "The California State Water Plan," Department of Water Resources, Bulletin 160-83, Sacramento, CA (December 1983), p. 79.

State of Colorado and Bureau of Reclamation, "Water for Tomorrow: Colorado State Water Plan, Phase 1 Appraisal Report," U.S. Department of the Interior, Washington, DC (Februrary 1974), p. 20.

State of Kansas, "Kansas Water Supply and Demand," Background Paper #39, State Water Plan, Topeka, KS (April 1978), p. 79.

State of Utah, "State of Utah Water-1980," Division of Water Resources, Utah Department of Natural Resources, Salt Lake City, UT (January 1981), p. 15.

Stoevener, Herbert H. and Roger G. Kraynick, "On Augmenting Community Economic Performance by New or Continuing Irrigation Developments," American Journal of Agricultural Economics, 61(5) (December 1979), pp. 1115-1123.

Texas Department of Water Resources, "Water for Texas: Planning for the Future," Austin, TX (February 1983), Section 3.

Thaler, R., "Mental Accounting and Consumer Choice," Marketing Science, 4 (1985), pp. 199-214.

Thaler, R. and H. M. Shefrin, "An Economic Theory of Self-Control," Journal of Political Economy, 89(1981), pp. 201-207.

The Clean Water Act of 1972, 33 U.S.C. §§1251 et seq.

The Endangered Species Act of 1973, 16 U.S.C. §§1531 et seq.

The Environmental Quality Improvement Act of 1970, 42 U.S.C. §§4371 et seq.

The Fish and Wildlife Coordination Act of 1978, 16 U.S.C. §§661 et seq.

The Flood Control Act of 1936, 33 USC §§ 701 et seq.

The National Environmental Policy Act (NEPA) of 1969, 42 U.S.C. §§4321 et seq.

The Reclamation Act of 1939, 43 USC §§ 371 et seq.

U.S. Bureau of the Census, Census of Agriculture 1969, Vol. 1: Area Reports, Part 40: Wyoming (Washington, DC: U.S. Government Printing Office), 1972.

U.S. Bureau of the Census, Census of Agriculture 1974, Vol. V: State Reports, Part 50: Wyoming (Washington, DC: U.S. Government Printing Office), 1977.

U.S. Bureau of the Census, Census of Agriculture 1982, Vol. 1: Geographic Area Series, Part 50: Wyoming (Washington, DC: U.S. Government Printing Office), 1984.

U.S. Constitution, Article I, Section 8, Clause 3.

U.S. Department of Commerce, Statistical Abstract of the U.S., Washington, DC (1978a and 1987b).

U.S. Office of Management and Budget, Circular No. A-94, Revised (March 27, 1972).

Water Resources Council, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, 38 Fed. Reg. 24, 777 (Washington, DC: U.S. Government Printing Office), 1973.

Watts, G. L., D. S. Brookshire and R. G. Cummings, An Economic Analysis of Sandstone Dam and Reservoir, submitted by Western Research Corporation to the Wyoming Water Development Commission (1989).

West v. Kansas Natural Gas Co., 221 U.S. 229 (1911).

White, Gilbert F., "Optimal Flood Damage Management: Retrospect and Prospect," in Allen V. Kneese and Stephen C. Smith (eds.), Water Research (Baltimore, MD: John Hopkins Press), 1966, pp. 251-270.

Wyoming v. Colorado, 259 U.S. 419, 497 (1921).

Wyoming State Engineer's Office, Wyoming's Surface Water Supplies, Information Leaflet from the Wyoming Water Planning Program (1972).

Wyoming Statute 42-2-112 (a) (1975, 1982).

Wyoming Water Development Commission, Draft Program Description and Program Priorities, as transmitted by John W. Jackson, Deputy Administration, Planning, December 22, 1989.

Young, R. A., "Direct and Regional Economic Impacts of Competition for Irrigation," in E. A. Englebert and A. F. Scheuring (eds.), Water Scarcity Impacts of Western Agriculture (University of California Press), 1984.

Young, Robert A. and Charles W. Howe,"Handbook for the Economic Evaluation of Application for Appropriation of Surface and Groundwater in the State of Idaho," Idaho Water Resources Institute, University of Idaho, Moscow, ID (February 1988).