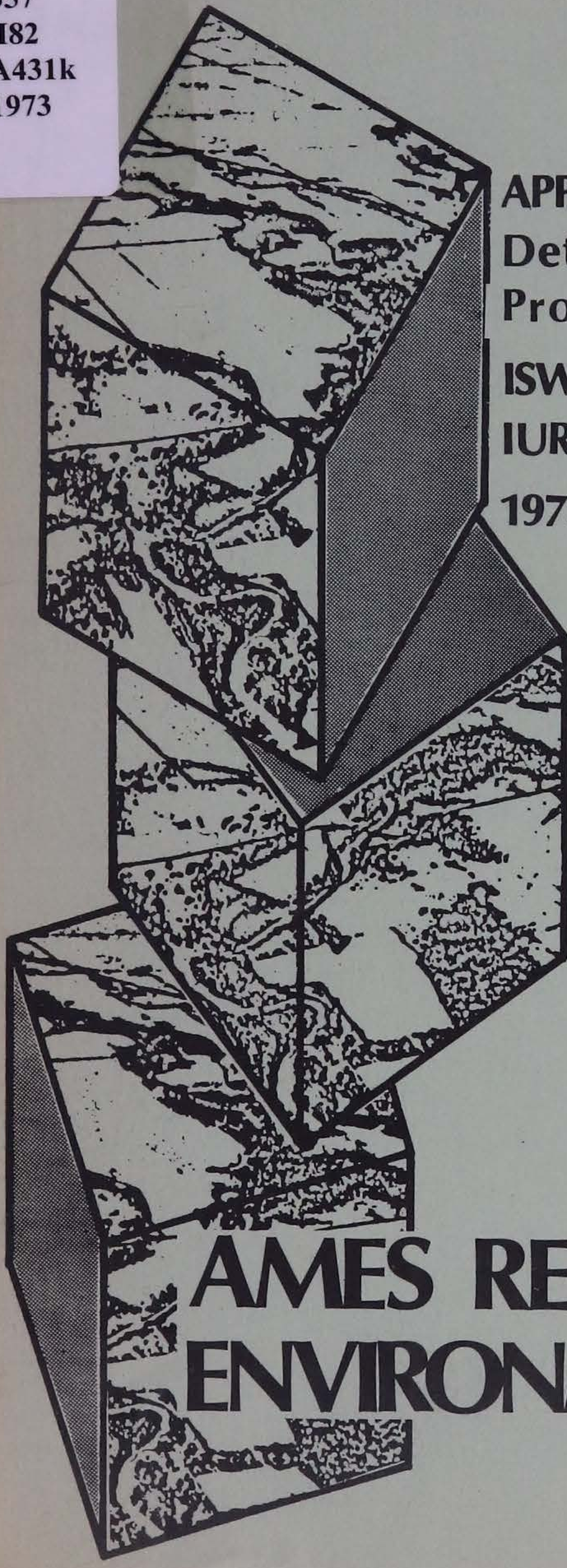

APPENDIX 6
Detailed Economic Review and Project Evaluation

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1973

AMES RESERVOIR ENVIRONMENTAL STUDY

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Appendix 6

Detailed Economic Review and Project Evaluation

GENERAL ACKNOWLEDGEMENTS

Appendix 6 contains the results of a review, analysis, and interpretation of economic aspects of alternative plans of development for the Skunk River between Ames and Story City, Iowa. The studies were conducted by staff and research graduate assistants of The Institute of Urban and Regional Research, the Howard R. Green Company (Consulting Engineers, Cedar Rapids, Iowa), and Dr. Daniel Bromely from the Department of Agricultural Economics, University of Wisconsin, Madison. The above authors were assisted by those in related areas at Iowa State University and the U.S. Army Corps of Engineers, Rock Island District.

The Rock Island District, U.S. Army Corps of Engineers, supported the environmental review study through a research contract, DACW 25-72-C-0033. The purpose of the project review is to provide a comprehensive and authoritative basis for preparation of an adequate environmental impact statement by the Corps of Engineers in compliance with the National Environmental Policy Act of 1969, PL 91-190. The specific objective of the Appendix 6 studies is to review, study, and report on the economic justification and related issues with respect to the authorized Ames project and alternatives.

The studies made as part of this appendix report have received administrative support from several groups at Iowa State University and the University of Iowa. These include at Iowa State University: the Iowa State Water Resources Research Institute, the Engineering Research Institute, Colleges of Agriculture, Engineering, and Sciences and Humanities, the Office of the Vice-President of Research, and other arms of the University support services. University of Iowa coordination was achieved through the Institute of Urban and Regional Research, and the project had the cooperation of the Department of Civil Engineering, the Department of Economics, and the Iowa Institute of Hydraulics Research.

In a review study of this scope, involving completed as well as new research, the assistance of all of these groups is gratefully acknowledged by the authors of each chapter. The efforts of the key individuals involved with coordinating the various studies being conducted were essential to the successful completion of this report. In this regard, the timely assistance of Mr. H. C. Berry of Howard R. Green Company and Dr. Daniel Bromely of the University of Wisconsin is acknowledged.

The District Engineer, Rock Island District, Corps of Engineers appointed the following staff personnel as a coordinating team for this phase of the review study: Robert Hurlbutt, Contract Administrator; Don Johnson, Resources Management; Dave Haumersen, Resources Management; Sam Doak, General Engineering; George Johnson, Water Control Section; and Ray Stearns, Planning and Reports (and Economics). These individuals provided additional project data on request and coordinated in several meetings for discussion of criteria and methods of analysis.

At Iowa State University, Dr. John F. Timmons and Mr. Herbert Schellenberg of the Department of Economics assisted in reviewing the economic analyses and related environmental impact study, in cooperation with Dr. Dueker, category leader for the University of Iowa study group, and Dr. Bromley, economics consultant for the project. Dr. David Palmer, Dr. Howard Johnson, Dr. Wendell Beardsley, and Dr. Merwin Dougal assisted also in final evaluation of the benefits of the reservoir project, and in benefit cost analysis.

AMES RESERVOIR ENVIRONMENTAL STUDY

Appendix 6. Detailed Economic Review and Project Evaluation

Chapter 1

PROJECT IMPACT EVALUATION

Contribution to the
Ames Reservoir Environmental Resources Review Study

Sponsored by
US Army Corps of Engineers Contract DACW25-72-C-0033

by

Daniel Bromley

1973

CONTENTS

Chapter 1

PROJECT IMPACT EVALUATION

Daniel Bromley

In Chapter 2 of Appendix 2 we outlined the evolution of present project evaluation guidelines, and summarized the recent recommendations of the National Water Commission in matters of relevance to the Ames Reservoir Project. In this chapter we will discuss our view of the present dialogue over the proper evaluation guidelines, and the way in which these issues relate to the recommendations of the National Water Commission. We will proceed by first discussing the traditional way in which water resource projects are evaluated, and then turn to how that process might be changed. There are obviously differing views on the nature of such changes, and we will present the dominant candidates. In the course of this latter discussion we will give particular emphasis to the recent concern with greater public participation in the planning and evaluation process.

Traditional Water Resource Project Evaluation

In the discussion that follows, we will be talking about the water development agencies in general, and our comments should not be construed as relating specifically to the Corps of Engineers unless we so state.

The traditional water resource project grows out of a coalition of local interest groups and the local office of a water development agency.

Depending upon the location and the nature of the perceived water-related problems, these groups might be barge-line operators, farmers, private or public utility companies, flood-plain residents, or local businessmen that suffer periodic flood losses. The basic purpose for the banding together is to obtain federal money for the construction of a project. The "local" office of a water development agency has a very real interest in such a coalition--for the obvious reason that such projects tend to guarantee a future workload for the agency.

This local initiative takes the form of informal as well as formal meetings between the agency and the groups most directly interested in a project. Once a general feasibility study shows the project to be "economically viable", it becomes important to move ahead on several fronts: First of all it is imperative to have near unanimity among the Congressional delegation from the state. And, as project authorization is sought, it is often helpful to have testimony from important individuals in the project area. Finally, when it is time for appropriations hearings, the commitment of local entities for cost sharing is crucial.

Throughout this entire process, the agency is faced with an economic justification of the undertaking. As indicated in Chapter 4 of Appendix 2, this consists of assigning values to the different project outputs. The area of project justification has been the subject of numerous papers by economists--critical of the use of economics in certain instances, and incensed at the lack of its use in others. Much of the reason for this criticism is that this process takes on the flavor of project justification instead of project evaluation. That is, once the local "power structure" favors a project, the burden is upon the agency to insure its economic viability.

Criticism of this practice has come from many quarters--economists, conservationists, and politicians. One of the traditional targets for these critics has been the discount rate. Critics have maintained that most any project can be made to look viable with a low enough discount rate, and that the way to interfere with the almost automatic allocation of public works funds to different regions of the country is to raise the rate at which future benefits are converted to present values. While the obvious intent is to make it more difficult for projects to be authorized, the relation to the "water budget" was never very clear. That is, if the "water budget" is taken to be rather stable over time, then bringing about an increase in the discount rate will not affect the amount spent on water resources, but it will influence the nature of projects which are built. Specifically, a low discount rate will bias projects toward high capital intensity, and long life. Put somewhat differently, as the discount rate decreased, the benefit-cost ratio for projects that are very capital intensive increases faster than it does for projects which are less capital intensive, and for projects of similar capital intensity, the benefit-cost ratio rises faster for those projects which are said to create benefits over a 100 year period than those that create benefits for only 50 years.

On the other hand, if the "water budget" is not taken as a parameter--but is instead a function of the number of "viable" projects--then a higher discount rate can have a profound impact on the nature and the scope of the Nation's investment in water resource projects.

In Chapter 2 of Appendix 2, a brief discussion was given which attempted to trace the evolution of project evaluation from the Flood Control Act of 1936 to the present. The Proposed Principles and Standards of the Water Resources Council present a considerable departure from present evaluation methodology and while they may or may not become doctrine, issues are raised therein which merit elaboration. And, in the course of that discussion, it will be possible to introduce our notion of an improved project evaluation approach.

Perhaps the best place to start is with the assertion by the Council (in the Proposed Principles and Standards) that it is the main task of the planner to proceed such that courses of action are formulated which effectively contribute to the attainment of the multiple objectives. As indicated in Appendix 2, the Council has defined these objectives--at various times--to include national economic development, regional development, environmental quality, and social well being. This statement, though innocent enough on the surface, reflects a very basic difference with the view expressed in Public Water Resource Project Planning and Evaluation: Impacts, Incidence, and Institutions (Bromley, et.al., 1971). Below we will attempt to articulate the nature of that philosophical difference.

To us, the planning and evaluation of water resource projects should be consistent with the rationale for initiating such undertakings. And, as seen above, the basic (and most prevalent) rationale is to assist local people solve problems that are directly (or often indirectly) water related. Of course, the implications for national income, regional development, environmental quality, and social well being are very important, but it is not the effective attainment of these "objectives" which is important in the planning process. What is important is that the problems which water resource projects can help solve are effectively dealt with by the project, and that the implications of this solution for the "objectives" of the Water Resource Council are made known, along with the other impacts from projects which may not fit the Council's taxonomic structure.

Given this, it seems reasonable to argue that the planning and evaluation process for water resource projects ought to be structured along the following lines. First, that the process reveal both positive and negative impacts which impinge on various groups of individuals within close proximity of the project (the project region). Secondly, that the process reveal both positive and negative impacts on groups of individuals outside of this immediate area. Thirdly, that the process facilitate discussion and consideration of these impacts at all levels--that is, local and non-local. And, finally, that the process permit the participation in the decision process of those who stand to be "significantly" affected by the project under consideration.

The rationale for the above focus on groups is found in the political philosophy referred to as "analytic pluralism." Basically, the analytic pluralists argue that: (1) society is structured around groups of people that are unified by common values and goals; (2) the more complex a society, the greater the role of these group affiliations; (3) public action results from the balancing of force among opposing groups; (4) groups are successful if they can muster not only numbers, but intensity as well as finesse; (5) political stability results from the exercise of mutual restraint by all groups in a society; and (6) there is no such thing as the public interest. While some of these points are self-evident, several will require explanation.

On the matter of policy resulting from the balance of force among diverse groups, this is of particular relevance to the water resource field since the present approach involves a certain degree of this, and greater public participation would increase this aspect.

On another matter, we are reminded that the factors that are important to the success of a group in the policy arena--in addition to the earlier mentioned numbers, intensity, and technique--include respectability and status, the coincidence between the group's interests and community norms, wealth, time, group confidence and efficacy, unity, and control over information. Finally, Baskin argues that the effectiveness of a group in the policy arena will be a function of its ability to "localize conflict, to keep the issue under control and ensure that the population of participating groups does not expand and dwarf the significance of the interested group's own resources of influence (Baskin, 1970, p. 94)." Before going on it would seem appropriate to elaborate on several of these points of direct relevance to the planning and evaluation process of the federal water resource agencies.

The first item worth elaboration is that of the respectability and status of groups involved in the decision process. Traditionally, those promoting projects have been, quite obviously, local businessmen who saw an opportunity to experience an increase in business--not by investing their own money, but by getting the federal government to spend the money. There can be little doubt that businessmen are "respectable", and hence a credibility of sorts was present when there was ever any local reluctance about the viability of a project in the local area.

Secondly, Baskin tells us that it is important that there be a great deal of agreement between a group's interests and the norms of the community. Given prevailing attitudes in America regarding growth and development, there can be little doubt that those promoting water resource projects have been "in tune" with community norms. Indeed, until recent times, those with the temerity to question growth and development--and the role of water projects in aiding that process--were generally viewed as ingrates, Communists, or both.

Thirdly, we are told that it is important to a group's success to effectively control the generation and dissemination of information regarding the undertaking in question. The agencies were able to take care of this matter in several ways. First of all, project planning and evaluation is a complex and technical task so it is not surprising that few were interested in the fine details. Secondly, the ways in which information on a project was presented to the public was not only highly selective, but often times misleading at worst, and abstruse at best. Since the agency planners had all the information, they had the "power."

Finally, the effectiveness of a group depends--to a great deal--on the extent to which it can confine the conflict to not only small issues, but small areas geographically. For a multipurpose project, there might be a heated debate over the magnitude of the relatively minor wildlife benefits, but with respect to the entire project, the outcome of the debate is not at all crucial to the fate of the undertaking. But, once the debate turns to more substantive issues--or a larger area--the likelihood of success is diminished. The National Environmental Policy Act has been significant in this regard in that it has broadened the geographical area of relevance for environmental impacts. Up until that time, conventional wisdom had it that the "local" people were the only ones responsible for the natural environment (such as a river basin) and if they wanted to dam it up or dig it out (with federal money of course) it was their prerogative. Since NEPA, this view is no longer acceptable.

The final issue to be discussed concerns the concept of the "public interest." Just as economists argue that there is little one can say about measuring movement toward a social optimum, analytic pluralists deny the existence of anything related to the public interest. However, according to Baskin, the pluralists seem to suggest a procedural conception of the public interest. With a conflict-resolution mechanism whose main recommendation is that each group is free to pursue its interests consistent with the equal right of all other groups to indulge in the same activity, the notion of public interest is derived from a process. That is, if the process is followed properly, the outcome is, by definition, the public interest. While this notion is a bit difficult to accept, it is operationally convenient in many instances, particularly in the area of water resource investments as they are enacted in this country. We now turn to an elaboration of this issue.

While water resource agencies have always pointed to their public hearings when accused of not involving the public in the planning and evaluation process, that defense is no longer admissable--and the agencies know it. A planner for the Corps of Engineers recently outlined how the Corps intends to respond to the insistence for greater public participation. Specifically, he indicated that the Corps would:

> "1) allow the public to establish its own goals and priorities early in the study; 2) let the public clarify and define their own problems; 3) permit public participation in the development and investigation of alternatives; 4) allow open public debate of conflicting views; 5) encourage two-way communication between the planner and the citizenry; 6) demonstrate that public comment had an effect on the proposed action; and 7) above all, keep the public involved from beginning to end (Sellevold, 1972, p. 74)."

As was seen in Chapter 2, if the National Water Commission is followed, authorization for projects would be withheld until agencies report on their public participation programs. Specifically, this report is to show compliance with agency procedures as regards the questions considered, the viewpoints expressed, and supporting information for decisions made on controversial issues.

The exact nature of a public participation program is best described in the context of a particular agency but it is possible to generalize somewhat. Specifically, it would seem that a comprehensive program ought to include at least eight steps. These steps are: (1) problem identification; (2) problem definition; (3) setting of objectives; (4) plan formulation; (5) evaluation of alternatives; (6) selection of alternatives; (7) plan implementation; and (8) monitoring and feedback. We will discuss each in turn.

Our notion of a more comprehensive planning and evaluation process is built around these eight aspects, and none is more important than the first--problem identification. It has traditionally been the case that agency planners, together with a few local citizens, undertook to identify those water-related problems that required attention. However, it is now imperative that the agency identify a broad spectrum of "publics" that merit consultation at this stage. Once these different viewpoints have been identified, it is important that the agency explain the planning process, and solicit notions of local water-related problems. At the same time it is important that these individuals apprise the agency of generally-held community goals, and the relation of water resource projects to these goals.

At the second stage, it becomes important to classify problems by their most likely cause. While the agency might tend to view flood damage as being caused by a river overflowing its banks, conservationists might be inclined to argue that the real cause is that people are living (or working) where a river occasionally needs to flow. Hence, the notion of problem definition is very crucial to the nature of the entire planning process. It is these first two steps which the agencies have traditionally treated as their own private domain. And, it is here that the public at large will need to make a significant input if public participation is to become operational.

At the third stage -- setting of objectives -- it is time to set tentative targets that have some probability of being met with the project. This process must include not only the planners for the agency, but the local "publics" as well. Examples that might surface have to do with the extent of damage from flooding, or the minimum downstream flows during summer months, or maximum downstream temperatures during the summer, etc. Notice that this stage does not consider means (such as dams, levees, etc.) but only objectives. This is crucial since conventional practice is to jump immediately to means for achieving some objectives.

The fourth stage is that of plan formulation. This step derives directly from the preceding one of objective setting. That is, it is first necessary to clearly articulate the project's objectives, and to then consider how they might be met. While plan formulation is a step in the process where it will be felt that the agency possesses the greatest expertise, it should be remembered that we are not only talking about design, but conception. There is no reason why the publics in a local area should not have an input into the process of formulating alternative plans to meet the objectives they helped to specify.

At the stage where alternatives are evaluated, it is important to have a dual input from the planner as well as from the public, More will be said on this below, but for now it is sufficient to note that the first job of the planner is to devise a systematic format for generating and displaying the likely impacts from the contemplated undertaking. Once this is developed, the planner must describe alternatives to the various "publics", explain to each how it will likely be affected by the project, and consider possible changes that are suggested as a result of this dialogue. It is here that the real fundamental conflicts among the interested groups of local people are bound to arise. Up until this time, groups could identify problems, discuss their probable cause, and articulate general objectives. But, when the agency presents a set of plans for solving those problems, groups will have at least two main points of discussion. The first will concern the efficacy of the proposed plan for alleviating the problem identified by that group. The second will be a dissatisfaction with the proposed plan for alleviating the problems identified by some other group. This latter disagreement could arise from either a basic philosophic difference, or from the implications of that alternative to those things the group values.

The last three stages -- selecting alternatives, implementing the plans, and monitoring the results -- are of less direct interest here and will not be discussed.

The preceding discussion focused on the process of planning and evaluating water resource projects, and emphasized the need for all those potentially affected by a project to be apprised of their probable fate. The nature and extent of that informational imperative is the subject of the next section.

Project Impact Analysis: A Brief Overview

Traditional discussions of evaluating public projects focus on either benefit-cost analysis in its more conventional forms, or cost-effectiveness analysis, the latter being distinct from the former by the absence of any requirement to be able to assign monetary values to all project outputs. An extension of cost-effectiveness analysis might be called "impact analysis" (or "tradeoff analysis") where an effort is made to systematically account for all of the monetary and nonmonetary impacts of a project, by proximity to the project, and by group affected. This follows from the above discussion of the stages in the planning and evaluation process. To implement this sort of an approach--which has been spelled out in Public Water Resource Project Planning and Evaluation: Impacts, Incidence, and Institutions (Bromley, et al., 1971)--it is necessary to start from a clear definition of the different types of project impacts.

In the above document it was argued that there should be explicit recognition of two major categories of project impacts: (1) monetary; and (2) nonmonetary. As for the monetary impacts, there are two subcategories, with further definition within each. Specifically, there were said to be two kinds of monetary impacts: (1) those that received their monetary value from workings of the market--called "market-valued"; and (2) those that received their monetary value from other sources-- called "nonmarket-valued." Each of these categories will be discussed in more detail below.

As for the "market-valued" class of project impacts it was argued that there are three possible ways to arrive at estimates of value for project outputs. Where the output is to be used directly in a productive process, it is possible to impute a derived value to the project output based on the market value of the good or service made possible by the project. Irrigation is the standard example here, with water not being priced in a perfect market but constituting an important input into commodities that are. This method of arriving at the value of project output (in this case irrigation water) is referred to as the "intermediate good method."

In those instances where the output of the project is not used directly in a productive process, it is impossible to employ the intermediate good method. Instead, it is necessary to improvise in certain ways. One obvious way is to attempt to determine the value of the project output directly through establishment of a demand curve for the output from which value inferences can be derived. The obvious example of this approach is to be found in the area of recreation demand studies. Here, attempts to determine willingness to pay for a site proceed from the assumption that travel costs to the site portray some estimate of the consumers' subjective evaluation. This approach has been referred to as the "inferences from price-quantity behavior" approach.

The final category of the market-valued monetary impacts is for those situations where the project output is very similar in magnitude and nature to that being produced by the private sector nearby for which market values exist. The "market analogy" approach is where these "comparable" values are employed to draw inferences about the value of a project output. Again, recreation is a good example; private recreation facilities exist and charge for access to the same sort of service (in some cases) as available from a public project.

The second major category of monetary impacts--nonmarket-valued--is where values are placed on project outputs not from the demand side, however indirect that demand relationship may be. Instead, these values arise either from the political process, or from cost estimates for doing similar things in terms of project output in the absence of the federal project.

Taking the latter situation first, the "alternative cost" approach is that method employed to arrive at monetary value for project output using the cost of the "most likely alternative in the absence of the project." The rationale is rather straightforward: if a particular output will be produced anyway without the federal water resource project, then what it would cost to do it by some alternative means provides an estimate of the benefits from doing it with the federal project. That is, this amount represents what was saved by not having to employ the alternative -- and is a "benefit." The emphasis in the above on "will be produced anyway" is central here, and explains why economists are out of sympathy with agency practice in this regard. Specifically, two issues arise. The first is whether or not the particular output would in fact be demanded in the absence of the federal project. The second is the cost savings inherent in joint production. The latter issue is simple and will be discussed first.

If a reservoir is to be constructed for flood control purposes, the incremental cost of including a little "recreation", or a little low-flow augmentation for water-quality improvement downstream, or a little extra capacity for municipal and industrial water supply often is minimal. On the other hand, if an agency gets to count as "benefits" from all of these aspects what it would cost to obtain the same quantity and quality of output in the absence of the project, then the overall economic evaluation of the project is very much biased in favor of high benefits. That is to say that the "most likely alternative" way of providing the above outputs will almost always be more expensive than their inclusion as part of a multipurpose project--thus guaranteeing that the overall benefit-cost evaluation of the project is biased upward.

Of course, if there were an effective demand for the project output in question then the alternative cost approach is perfectly legitimate. However, the extent to which this is true is open to some question. Indeed, almost no effort is expended to determine effective demand for those project purposes evaluated by the alternative cost approach--precisely because demand estimates are so difficult to undertake. Hence, in the absence of very much information about the demand for many project purposes, they are included on the basis of the alternative cost approach, and in the process have a significant impact on the evaluation of the entire project.

The second nonmarket approach to project output evaluation can be referred to as the "administrative fiat" approach. Here, prices (value) of project purposes are established either by the legislative branch, or the executive branch for widespread application. The classic example of this approach--and one mentioned elsewhere in this report--is the valuation of recreation in Supplement #1 to Senate Document 97 entitled: <u>Evaluation Standards for Primary Outdoor Recreation Benefits</u> (Water Resources Council, 1964).

The second category of project impacts--those referred to as nonmonetary--present a slightly different problem in the valuation of project outputs. Here, the problem is not one of determining whether or not market values exist, but of displaying in an accessible fashion those project impacts for which no monetary value exists--nor is one likely to exist. For these types of effects, there is little choice but to articulate them in such physical terms as miles of natural shoreline destroyed, surface acres of a reservoir created, minimum and maximum flows for certain reaches of the river, and minimum and maximum temperatures for both the reservoir and the downstream reaches.

Before turning to a discussion of the generation and display of both monetary and nonmonetary impacts, it would seem appropriate to digress to a specification of the role that groups in a project region might play in planning and evaluation of a project. This discussion can be facilitated by making reference to, say, four possible groups that might become involved. For this example we might consider as relevant groups: (1) farmers; (2) conservationists; (3) businessmen; and (4) local officials.

As indicative of the way in which each might identify a different sort of "water-related" problem, farmers might be inclined to see the problems as that of crops being destroyed, buildings and equipment being flooded, and their fields silted in from upstream erosion. On the other hand, conservationists would likely be concerned about the lack of water for fish and wildlife (both quantity and quality), and erosion. Local businessmen would see water-related problems in terms of buildings and inventories destroyed from floods, and a declining population base to support local business activity at a "desirable" level. Finally, local officials might be concerned that there are no public recreation facilities, and the fact that the tax base of the area is declining.

The above are more than illustrative of how different groups might perceive water-related problems differently. They are an insight into the more substantive difference of problem definition; that is, recognition of the cause of the problem. For instance it is not unreasonable to expect that both farmers and businessmen would view the cause of their flood problems as arising from a river flowing where "it doesn't belong." Likewise, erosion might be viewed by farmers as arising because of "above average rainfall", or as sloppy land use practices by someone upstream--but never themselves. On the other hand, conservationists would be inclined to view flooding as a result of towns and farms having been built in natural flood plains.

Hence, different groups are going to demonstrate considerable disparity in the first two steps of the eight-part planning model described earlier. And, when it comes to the third step--setting of project objectives--this disparity will continue to exist. First of all, it is imperative to make an early distinction between the objectives of a water resource project, and the means whereby those objectives are reached. As possible objectives, the above groups might demonstrate the following: (1) farmers would like crop damages to be reduced to a certain level -- perhaps zero; (2) farmers would like building and equipment damage to be reduced to a certain level -- again perhaps zero; (3) farmers would like to see upstream erosion reduced to a certain fraction of its present level; (4) conservationists would like to see the minimum flow in a certain reach of the river set at some level; (5) conservationists would like to see an upper limit on stream temperature in the summer time for certain reaches of the stream; (6) conservationists would like to see erosion reduced to a fraction of its present level; (7) businessmen would like to see present flood damages reduced or eliminated altogether; (8) businessmen would like to see a viable recreation industry; (9) local officials would like to see more water-based recreation facilities; and (10) local officials would like to see the tax base of the area enhanced in some fashion.

The above are merely examples of how the different groups might articulate their preferred project objectives to the construction agency. Of course the agency itself may have some objectives which may or may not coincide with those it receives from the various publics in the project region. It is at the next stage--plan formulation--that the specific means for reaching these objectives are developed. It is this stage that involves the "means" discussed above. For, dams, levees, recreation facilities, etc. are not rightfully <u>objectives</u>--they are merely <u>means</u>. Here, farmers and businessmen will probably prefer a structure such as a dam, while it is possible that conservationists would view a better alternative as being an insurance program to compensate those who incur flood damage. As regards flow in a reach of the river, conservationists would prefer the prohibition of withdrawals as an effective means. On the other hand, a dam would permit the maintenance of a certain minimum flow during the summer months-- and possibly the maintenance of a certain maximum downstream temperature through reservoir releases from the cooler hypolimnion.

Hence, the impact approach to planning and evaluating water resource projects starts from the premise that the water development agency will desire to implement a project which will meet many of the objectives of those in the immediate proximity of the undertaking. A viable public participation program will facilitate a public input into not only problem identification and problem definition, but also in objective setting, plan formulation and evaluation of alternatives. This latter step will involve the generation and display of relevant information not only for those in the immediate area, but those in contiguous regions that will be affected by the project. In this instance it is important to have many of the traditional indicators of the economic viability of a project, but also additional information of relevance to those who have become involved in the process. The notion of an incidence-based "impact matrix" was introduced in the document: Procedures for Evaluation of Water and Related Land Resource Projects: An Analysis of the Water Resources Council's Task Force Report (Bromley, et al., 1970), and discussed in more detail in a later publication (Bromley, et al., 1971). The concept of an impact matrix is that along the left margin are arrayed the various project alternatives (or purposes of an alternative), and along the top are arrayed the relevant groups in the project region. Then, the monetary impacts--as well as the nonmonetary impacts--of a project are displayed for ready comprehension. Rather than having such impacts either not mentioned at all, or scattered at random through many pages of a project document, the impact matrix facilitates quick access to the more prominent impacts of a water project.

For instance, conservationists could quickly determine the impacts on stream flow and stream temperature from several alternative plan formulations. Farmers could quickly see the possible impacts on net farm income from several alternatives for reducing flooding--likewise for businessmen. Local officials would be able to understand the possible impacts on the local tax base from changes in recreation use in the area, and from possible increased business activity--an impact of obvious interest to businessmen.

In summary, the impact approach to project evaluation calls for a more systematic and complete identification and display of project impacts--on the assumption that those at both the local and non-local level have a right to know what is in store from the allocation of federal money to a water resource project. The recent recommendations of the National Water Commission (detailed in part in Chapter 2 of Appendix 2) call for two very profound institutional changes in traditional water resource project evaluation: (1) more precise cost sharing such that those who benefit from a federal project will pay a great portion of its costs; and (2) greater public participation on the planning and evaluation of such projects. If those who benefit are to be expected to pay a greater share of the costs of an undertaking, then almost by definition the move toward increased cost sharing will result in greater public participation--for who will want to be assessed costs on the basis of claimed "benefits" when those benefits are either incorrect, or inflated?

The impact approach to planning and evaluating projects is derived from the concept of a "derived demand for information" and is well suited to the recent emphasis on different arrangements for planning, evaluating, and paying for water resource projects.

The remainder of this appendix synthesizes project evaluation procedures for the Ames Reservoir situation in a manner which not only respects existing agency practice but also responds to the broader considerations noted above. Organizationally, chapter 2 documents the cost analysis of alternatives and chapter 3 integrates those cost estimates -- together with all monetary impacts as reported throughout earlier appendices -- into traditional benefit-cost calculations. Chapter 4 then introduces environmental impacts and, at least in a suggestive way, indicates broader information displays which purport to serve a more participatory process.

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AMES RESERVOIR ENVIRONMENTAL STUDY

Appendix 6. Detailed Economic Review and Project Evaluation

Chapter 2

REVIEW OF COST ESTIMATES FOR PROPOSED AND ALTERNATIVE DESIGNS AMES RESERVOIR, SKUNK RIVER, IOWA

Contribution to the
Ames Reservoir Environmental Resources Review Study

Sponsored by
US Army Corps of Engineers Contract DACW25-72-C-0033

by

Howard R. Green Co.

1973

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Chapter 2

REVIEW OF COST ESTIMATES FOR PROPOSED AND ALTERNATIVE DESIGNS AMES RESERVOIR, SKUNK RIVER, IOWA

Howard R. Green Co.

Introduction

This chapter consists of a review and update of cost estimates by Howard R. Green Company. This work was authorized by the interdisciplinary study team to compliment the review and updating of benefits for the authorized project and alternatives. The major alternative explored was a reduced scope project wherein the dam and spillway were lowered ten feet below original design elevations. Costs were extended from September 1968 to January 1973, 1975, 1980, and 1990.

The Environmental Resources Review Study of the Authorized Ames Reservoir consists of a detailed assessment of the effect of the proposed reservoir on the environment and its monetary benefits and costs; together these assessments comprise the basis for an Environmental Impact Statement. The cost estimates in this chapter were developed to give appropriate consideration in decision-making of all considerations -- environmental impacts, benefits, and costs -- for the authorized project and alternatives for a current assessment of impact.

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*Consulting Engineers, Cedar Rapids, Iowa.

Some cost items developed by the Corps and updated by Howard R. Green Co. were not used because independent estimates were made by the inter-disciplinary study team. These items include (a) recreation facilities and land (see Appendix 3), and (b) land and damages (see Appendix 2, Part II). In addition, updated estimates of government costs and costs of sub-impoundments were developed by the study and included in the project benefit-cost analysis which is documented in the next chapter.

The two purposes of this study are to (1) review the estimate of cost for the construction of the Ames Reservoir (refer to page 5-a, Exhibit 5, Detailed Estimate of Cost, Design Memorandum No. 1, General Design Memorandum, Ames Reservoir, Skunk River, Iowa - 30 December 1968) and advance these costs for the years 1973, 1975, 1980, and 1990, and (2) evaluate costs as they relate to the impoundment structure and outlet works and spillways if the design elevations are lowered ten feet below the elevations shown in the report. Item (2) changes will be referred to hereinafter as the "Modified Design."

Cost estimates for (1) and (2) will follow a brief resume relative to the Modified Design.

Modified Design

An alternate solution was proposed relative to the extensive costs of relocation and remedial work required to prevent flood damage to specific areas upstream from the impoundment structure. By lowering the control elevations of the main embankment and associated hydraulic structures by ten feet, the possibility of flooding at Story City would be minimized and, therefore, extensive relocation and remedial work at this location as well as others noted in Memo No. 1 could be minimized. In addition land requirements might be substantially reduced and possible savings might be realized in construction of the dam and associated hydraulic structures as well. The effect of reducing the storage volumes contained in the conservation and flood pools on economic benefits accruing to the project will not be analyzed in this report. This evaluation will be conducted by the economics category of the two universities' environmental research team who are studying this project.

The following resume indicates the basic changes resulting from this proposal and the effect of these changes as they related to the increase and decrease in initial costs to specific areas within the project. Variation in the magnitude of flooding downstream from the project has been recognized, but the effects of such variations as to added protective measures required against flooding have not been evaluated in this report.

The crest of the dam, spillway and emergency spillway have been lowered ten feet below the design elevation shown in Design Memorandum No. 1. The outlet works, with the exception of the overall height of the tower, remain unchanged. Comparative elevations and data are included in Tables 6-2-1. and 6-2-2.

Table 6-2-1. Comparative Elevations for Selected Reservoir Features for Proposed and Modified Designs

Feature	Memorandum No. 1 Design	Modified Design
Crest of earth embankment	992.0	982.0
Spillway crest	951.0	941.0
Approach channel spillway	945.0	935.0
Top of roadway, spillway	992.0	982.0
Chute slab at ogee	934.5	924.5
Crest emergency spillway	982.0	972.0
Approach channel, outlet works	906.0	906.0
Stilling basin slab, outlet works	884.0	884.0
Floor, operating house, outlet works	982.0	972.0
Maximum pool, spillway design flood	987.5	977.5
Full flood control pool	976.0	966.0
Conservation pool	950.0	940.0

Table 6-2-2. Comparative Impoundment Data for the Two Designs

	Memorandum No. 1 Design			Modified Design		
		Storage	Surface Area		Storage	Surface Area
Pool Category	Elev.	(acre ft.)	(acres)	Elev.	(acre ft.)	(acres)
Maximum Pool for Spillway Design Flood	987.5	192,000	7,500	977.5	133,000	5,250
Full Flood Control Pool	976.0	125,000	5,000	966.0	80,000	3,600
Conservation Pool	950.0	34,000	2,100	940.0	16,000	1,400

A preliminary investigation was made relative to discharge and storage characteristics for the modified design for standard project and maximum spillway design floods. Method of operation was modified so that comparative pool elevations could be maintained and upstream areas, such as Story City, could be protected from flood damage with a minimum of relocation work.

The proposed method of operation, assuming a full pool elevation of 966.0, is to pass all inflow to 28,700 cfs. (project capacity of the spillway and outlet works). Storage commences for all flows above 28,700 cfs. A maximum of 28,700 cfs. discharge is maintained until the emergency spillway (crest elevation 972.0) is topped, at which time all excess flow will be discharged through this structure.

In the case of the standard project flood, maximum inflow is 44,000 cfs. and the length of time when inflow exceeds 28,700 cfs. is approximately 22 hours. The amount of storage required is less than 17,000 acre feet, while 25,000 acre feet is available with inundation to 972.0. It appears that the maximum discharge through the spillway and outlet works can be limited to slightly less than 25,000 cfs. and the emergency spillway crest elevation will still not be exceeded for a standard project flood.

In the case of occurrence of a maximum spillway design flood, maximum inflow is 87,210 cfs. and the length of time when outflow exceeds 28,700 cfs. and flow is passing over the emergency spillway is approximately 48 hours. This compares to 52 hours noted in Design Memo No. 1 (Plate I-19). Total maximum outflow from the spillway, outlet works and the emergency spillway is 72,700 cfs.

This compares to 61,800 cfs. for Design Memo No. 1. Comparative data are summarized in Table 6-2-3 and the flood routing results are shown in Figure 6-2-1.

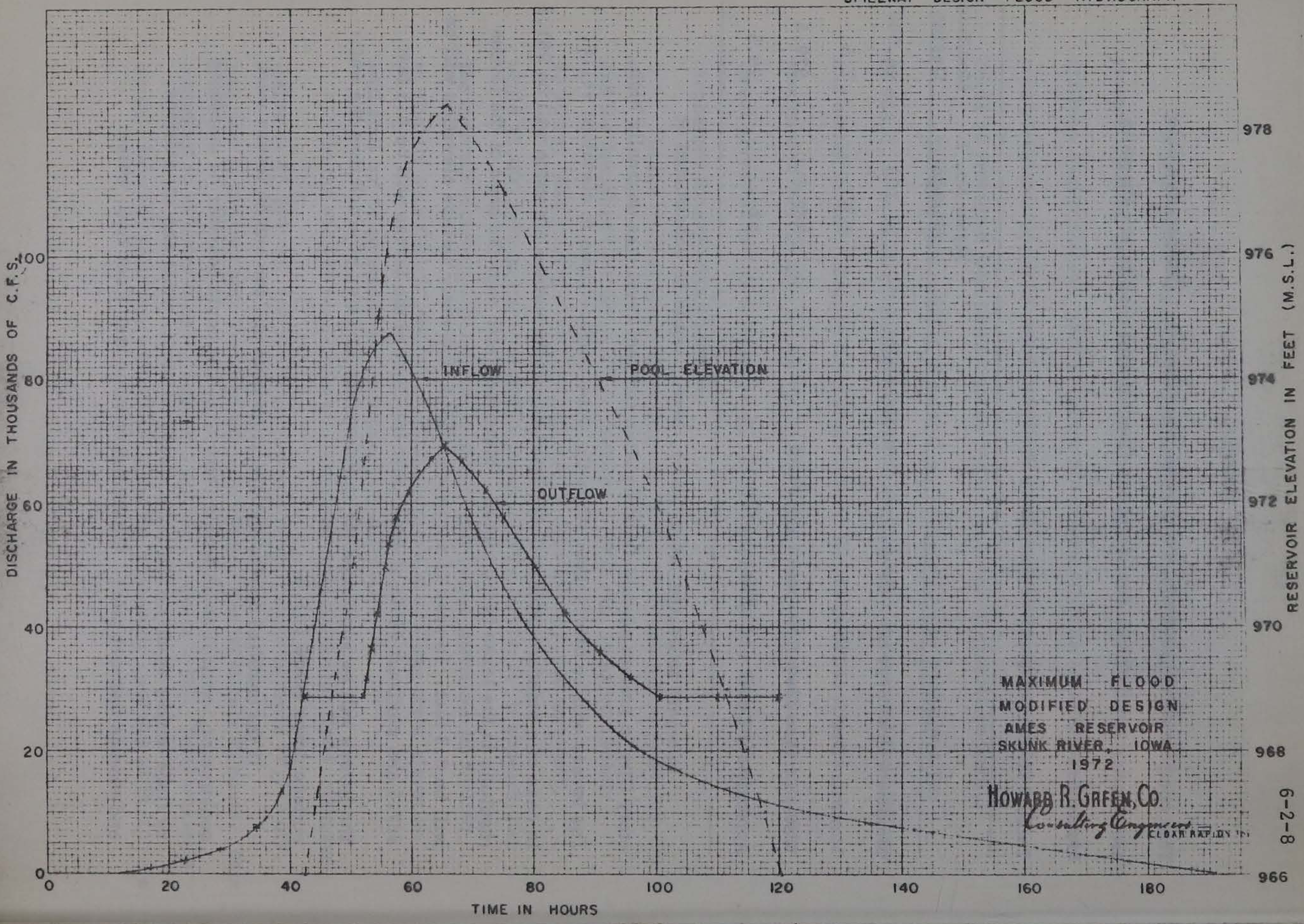
Table 6-2-3. Comparative Emergency Spillway Data

Item	Memo No. 1 Design	Modified Design
Maximum Discharge cfs. (Emergency Spillway Only)	33,100	44,000
Maximum Depth of Flow, Ft.	5.5	7.5
Water Surface Elevation, mean sea level	987.5	979.5
Approximate Depth of Tailwater, Ft.	27	29.5

In regard to Design Memo No. 1, levees would be constructed at Story City to protect against flooding when the pool level was unusually high. The levees will be over-topped when the water surface rises to elevation 981.0. In case of a standard project flood, maximum water surface elevation will be 981.8 resulting in the levee being topped. Maximum depth over the crest of the levees will be 0.8 feet. In case of a maximum flood, the water surface elevation will be 987.5 and maximum depth of water over the crest of the levees will be 6.5 feet. The levees will be submerged for approximately 31 hours at which time the water surface drops below 981.0.

If the modified design and operation were utilized and no levees were constructed, critical areas within Story City that could possibly be inundated by flood waters would be the water treatment plant, wells and lift stations, and sewage tretment plant. Critical elevations are: floor line, water

SPILLWAY DESIGN FLOOD HYDROGRAPH



treatment plant 980.49; city wells A 973.40 and B 977.69; floor line, lift station A 976.56 and B 974.99. Critical floor line elevations at sewage treatment plant appear to be approximately 975.00.

Assuming a modified method of operation, a standard project flood can be controlled so that the emergency spillway crest is not topped when constructed to elevation 972.00. As a result, no critical areas will be inundated, and flooding in Story City will be minimized.

However, the maximum pool level resulting from a maximum spillway design flood will be above the critical elevation at wells and lift stations and they will remain flooded for a period of 13 to 41 hours. In all likelihood these elevations would be exceeded naturally if this magnitude of flood were to occur, whether or not the reservoir existed.

Estimate of Cost

The 1968 Detailed Estimate of Cost (Exhibit 5, page 5a) as noted in Design Memorandum No. 1 has been projected for the years 1973, 1975, 1980 and 1990. The projected costs are as tabulated in Table 6-2-4, Summary of Costs.

In regard to Item (1), the review of unit costs used by the Corps, such costs are realistic and generally conformed to those unit costs being used in our office. The costs were compared with data in Means "Building Construction Cost Data 1972, 30th Annual Edition" as well as unit prices as bid for projects designed by the Howard R. Green Company. Future costs are based upon cost indexes derived from the projection of Engineering News-Record data printed in the March 23, 1972 publication. Special consideration is given to cost index data related to dam construction.

Table 6-2-4. Summary of Cost Estimates, Ames Reservoir, Skunk River, Iowa

	Sept. 1968	Jan. 1973	Jan. 1975	Jan. 1980	Jan. 19
I. Administration Center	173,000	234,600	265,600	358,800	648,5
II. Overlook Facilities	86,000	117,300	132,800	179,200	324,3
III. Clearing	168,000	228,400	258,500	349,300	631,4
IV. Boundary Survey and Marking	75,000	101,700	115,100	155,500	281,1
V. Recreation-Facilities Development	1,320,000	1,798,600	2,036,600	2,750,800	4,972,0
VI. Dam-Embankment	1,160,000	1,595,600	1,807,700	2,439,400	4,405,3
Spillway	2,090,000	2,840,700	3,233,000	4,365,600	7,893,8
Outlet Works	1,860,000	2,531,600	2,873,200	3,875,700	7,007,8
Operation & Maintenance during construction	72,000	97,900	110,900	149,800	270,7
Total Section I - VI without Land Costs*	7,004,000	9,546,400	10,833,400	14,624,100	26,435,5
Lands and Damage					
Recreational Lands					
Total Section I - VI*					
VII. Relocation					
Story City Streets and Levee	244,000	331,900	375,800	507,600	917,8
Item 1	202,000	274,200	310,000	418,900	757,5
Item 2	49,000	66,600	75,800	102,000	184,7
Item 3	318,000	432,300	489,600	661,000	1,195,1
Item 4	353,000	479,800	543,300	733,600	1,326,3
Item 5	218,000	296,100	335,200	452,800	818,9
Item 6	40,000	53,800	60,800	82,100	148,7
Item 7	527,000	716,500	811,200	1,095,600	1,980,6
Item 8	262,000	355,500	402,700	544,000	983,3
Item 9	297,000	404,500	457,900	618,500	1,118,0
Item 10	41,000	55,900	63,400	85,400	154,7
Item 11	145,000	197,200	223,100	301,600	545,0

Table 6-2-4. Continued

	Sept. 1968	Jan. 1973	Jan. 1975	Jan. 1980	Jan. 1990
[.] Miscellaneous					
Remove Bridges	20,000	27,100	30,800	41,600	75,200
Utilities Relocation	75,000	102,400	116,000	156,300	282,900
Remove Tile Drains	34,000	46,300	52,600	71,000	128,200
Total Sections VII and VIII	2,825,000	3,840,100	4,348,200	5,872,000	10,616,900
Project Total without Land Costs*	9,829,000	13,387,000	15,182,000	20,496,000	37,052,000
Project Total*					
*All cost include the following non-federal portion for the split of Recreational Facility costs	660,000	899,300	1,018,300	1,375,400	2,486,300

Supplemental information for the project was made available from the Corps of Engineers' office, Rock Island, Illinois. Advance design had not been prepared relative to a number of sub-projects. As a result, unit breakdown was not available. In such cases, our estimate is based upon the lump sum prices shown in the report.

Current and future values for "Lands and Damages" and "Recreational Lands" were not available and are, therefore, omitted from the final project costs reported herein. These data are being obtained and evaluated separately by the environmental research groups.

Comparative cost estimates for the modified design have been completed relative to the impoundment structure, outlet works, and spillways. The main areas where cost reduction and/or increase appears most easily defined for (1) the dam, are embankment and riprap, (2) the spillway and outlet works, are earth and rock excavation and concrete, and (3) emergency spillway earth excavation.

Lowering the impoundment structure and related hydraulic structures by 10 feet alters the hydraulic characteristics. For instance, the available gradient between the spillway and the main river channel is lowered. If the tailwater depths are to approximately match the original design and width of the spillway effluent channel must be increased by 28 feet ±. These changes result in a significant increase in the amount of rock and earth to be excavated. With the exception of eliminating ten feet from the overall height of the intake tower the outlet works is relatively unchanged from Memo No. 1.

If the weir length for the emergency spillway is maintained at 800 feet as in Memo No. 1 and the weir crest is lowered ten feet to elevation 972.00, the quantity of earth excavation will be increased by over 400,000 cubic yards. If the basic embankment section (Memo No. 1) is retained this material must be spoiled. If the embankment design is modified and much flatter beach slopes incorporated, the excess excavation can be fully utilized.

Cost reductions or increases resulting from lowering the pool levels as they apply to the construction of the main embankment, spillways and outlet works were computed. Results are listed in Table 6-2-5.

Supplemental Considerations for the Modified Design

As stated previously only construction costs were to be considered in this report to the exclusion of lands and damage, boundary surveys and markets, reservoir clearing and relocation. While only a minimum of pertinent data relative to these items is discussed in Memo No. 1, it is necessary to consider these facets of the project to gain some insight into the total project.

The original taking of land was based upon an elevation of 980. By using elevation 970 in the modified design, surface area of the impoundment is reduced by 27 percent from 5,750 to 4,200 acres. If there is a reasonable correlation between surface area and total land requirements and we assume that the modified design reduces total land and damage by, say 20 percent, the resultant dollar savings could be $1,030,000 based upon 1968 prices.

Table 6-2-5. Changes in Construction Costs for the Modified Design

Cost Reduction	Volume	
Earth, main embankment	127,500 cu. yds.	$ 64,000
Riprap, main embankment	8;300 cu. yds.	41,000
Intake tower, outlet works		23,000
		$128,000
Cost Increase		
Spillway		
Rock excavation-main channel, ogee and bridge section	57,700 cu. yds.	$289,000
Earth excavation*	42,300 cu. yds.	17,000
		$306,000
Emergency spillway		
Earth excavation*	486,750 cu. yds.	195,000
		$501,000

*Excess must be spoiled unless design of dam is modified to beach slopes.

On the same basis, cost of surveys and markers could be reduced by $15,000. In lieu of clearing to elevation 951 as noted in Memo No. 1, extent of clearing would be limited to elevation 941. While limits of clearing are not described, a reduction of 100 acres seems reasonable, resulting in a cost saving of $20,000.

Areas where cost reductions appear to be most easily defined relative to road relocation work are embankment, riprap, surfacing, guardrail and bridges (overall size). While recognizing such related items as stripping, clearing, grubbing and peir work, cost reduction of these items is considered incidental. Reduction in overall road relocation work in the modified design is of major economic consideration and results in a cost reduction of $794,700. Relocation and remedial work at Story City will be minimized if the modified design is adopted, resulting in a cost reduction of $244,000.

This cost reduction is based on flood plain occupancy as it existed in 1968. Story City has since constructed a golf course, associated buildings and facilities in the flood control pool upstream of County Road E 15. Plans are being developed for a community swimming pool in this area. The modified design would leave these new developments essentially unaffected; however, additional relocation costs would have to be assessed against the proposed design of the Corps of Engineers to place the golf course on more upland slopes, and also protect the new swimming pool. These costs have not been evaluated, but could approximate the original acquisition and construction costs of each.

Using the assumptions relative to reduction of costs, the project cost comparison was made based upon 1968 prices. The results are shown as tabulated in Table 6-2-6.

Table 6-2-6. Summary of Cost Estimates Based upon 1968 Prices, Ames Reservoir, Skunk River, Iowa

Item	Design Memo No. 1	Modified Design	Cost Differential
I. Lands and Damages	$ 5,150,000	$ 4,120,000	-$1,030,000
II. Administration Center and Overlook	259,000	259,000	0
III. Clearing	168,000	145,000	- 23,000
IV. Boundary Surveys and Marking	75,000	60,000	- 15,000
V. Recreation Facilities	1,670,000	1,670,000	0
VI. Dam			
a. Embankment & Emergency Spillway	1,160,000	1,250,000	+ 90,000
b. Spillway	2,090,000	2,396,000	+ 306,000
c. Outlet Works	1,860,000	1,837,000	- 23,000
d. Operation & Maintenance During Construction	72,000	72,000	0
c. Subtotal VI	$ 5,182,000	$ 5,555,000	+$ 373,000
VII. Relocations			
Story City Relocations	$ 244,000	0	-$ 244,000
Item 1 (new road over dam)	202,000	202,000	0
Item 2 (local secondary road)	49,000	0	- 49,000
Item 3 (F.A.S. 2173)	318,000	200,300	- 117,700
Item 4 (County Road "A")	353,000	246,500	- 106,500
Item 5 (F.A.S. 2173)	218,000	168,500	- 49,500
Item 6 (new access road)	40,000	40,000	0
Item 7 (Iowa State Hwy. 221)	527,000	407,000	- 120,000
Item 8 (County Road "D")	262,000	0	- 262,000
Item 9 (Interstate 35)	297,000	207,000	- 90,000
Item 10 (new access road)	41,000	41,000	0
Item 11 (F.A.S. 2173)	145,000	145,000	0
Remove bridges on roads to be vacated	20,000	20,000	0
Subtotal VII	$ 2,716,000	$ 1,677,300	-$1,038,700

Table 6-2-6. Continued

Item	Design Memo No. 1	Modified Design	Cost Differential
Utilities	$ 75,000	$ 75,000	0
Tile Drains	34,000	34,000	0
Relocation Total	$ 2,825,000	$ 1,786,300	-$1,038,700
Project Total	$15,329,000	$13,595,300	-$1,733,700

AMES RESERVOIR ENVIRONMENTAL STUDY

Appendix 6. Detailed Economic Review and Project Evaluation

Chapter 3

PROJECT BENEFIT-COST ANALYSIS

Contribution to the
Ames Reservoir Environmental Resources Review Study

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by

Kenneth J. Dueker

1973

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Chapter 3

PROJECT BENEFIT-COST ANALYSIS

Kenneth J. Dueker*

Introduction

The project benefit-cost analysis of the proposed Ames Reservoir Project reviews the original estimate of benefits and costs made by the Corps of Engineers and synthesizes estimates made in the conduct of this environmental assessment. Economic analysis of this type is complex because of the difficulty in re-constructing initial benefits and costs and in estimating current benefit and cost streams for the project. Estimates are subject to error due to the general inflationary costs of construction, land cost, and relocations. Also, new requirements for relocation payments to people displaced by the project have been promulgated since the initial estimates were made. Similarly, new water quality standards promulgated by EPA diminished the original water quality control benefits.

For purposes of this analysis the ARES review team chose not to use Corps of Engineers' guidelines in assessing benefit-cost. The Corps is compelled to evaluate the project using an interest rate of $3\frac{1}{4}\%$,

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*Dr. Dueker is Director of the Institute of Urban and Regional Research at the University of Iowa.

a 100-year project life, and a log-normal flood frequency. The review team desires to evaluate the project for different discount rates, with the major part of the analysis using discount rates of 5½% and 7%, current FY '73 rate and that proposed by the Water Resources Council, respectively. The review team feels 100-year forecasts are too inaccurate and a 50-year horizon is more appropriate. Also, with a higher discount rate, benefits for the period between 50 and 100 years are not valued highly in terms of present worth. Finally, the log-normal method of determining flood frequency is felt to be less satisfactory than the USGS regional method. In evaluating the benefits and costs of water resource projects, the Corps of Engineers is constrained by their established guidelines; whereas the review team is attempting to use criteria having more recently become acceptable to researchers, but not yet institutionalized as governmental directives.

Given this philosophical approach, the present chapter has the form outlined below. First, the original estimates of the Corps are reviewed to determine whether the methodology in effect at the time was employed appropriately. Second, 1973 estimates of cost are provided to furnish a basis of comparison to the estimate of 1973 benefits which has been a focus of this study. Third, the estimates of cost are projected to 1980 and 1990 to illustrate cost implications of delay of construction. Fourth, the 1973 benefits and costs are compared for alternatives. Fifth, the sensitivity of benefits to variations in population, discount rate, flood frequency, flood stage, and crop value are provided. Sixth, associated costs of the project, particularly a regional sewer system and tax loss, are estimated. Finally, a comparison of downstream crop protection to upstream loss of production is provided.

Analysis of Benefits and Costs

Table 6-3-1 summarizes the original estimate of benefits and costs made by the Corps of Engineers in 1968. The first cost estimate of $17,100,000 is converted to annual charges of $866,000 as compared to benefits of $1,390,100 for a benefit-cost ratio of 1.6:1.0. These estimates were revised in 1970 and again in 1972 to reflect re-analysis of requirements and inability to gain assurances of non-Federal participation in recreation facilities. Table 6-3-2 provides a summary of the 1968 benefits and costs with technical corrections deemed appropriate by the ARES review team. These technical corrections are as follows:

1. An interest rate of 4 5/8% should have been employed rather than the $3\frac{1}{4}$% rate. The $3\frac{1}{4}$% rate was in effect when the project was originally authorized by the 89th U.S. Congress and was continued because the project involved local funding as expressed in a Local Interest Participation Letter from the Story County Conservation Board. However, no assurances of a contractual nature to pay the bulk of the non-federal share of project costs were made and the ARES review team does not find satisfactory compliance with rules and regulations (Water Resources Council, 1968).

Table 6-3-1. Summary of Corps Estimate of Benefits and Costs

Estimates of Cost	Original[(a)]	Revised[(b)]
Land and damages	$ 5,150,000	$ 5,220,000
Relocations	2,825,000	3,300,000
Reservoir	243,000	280,000
Dam	5,182,000	6,030,000
Recreation Facilities	2,000,000	491,000[(c)]
Buildings, grounds, and utilities	259,000	275,000
Government Costs		
Engineering & Design	820,000	800,000
Supervision & Administration	621,000	845,000
First Cost	$17,100,000	$17,241,000
Equivalent annual charges, $3\frac{1}{4}$% interest rate, 100 yrs.	866,100[(d)]	734,260[(d)]
Estimates of Annual Benefit		
Flood Control	$ 681,100	681,100
Water Quality Control	325,200	505,538
Fish & Wildlife & Recreation	383,800	88,553
Total Annual Benefits	$ 1,390,100	$ 1,275,191
Benefit-Cost Ratio		
	1.6:1	1.7:1

(a) Corps of Engineers, Ames Reservoir, Design Memorandum No. 1, U.S. Army Engineer District, Rock Island, 30 September 1968, pp. 24, 31.

(b) Corps of Engineers, Supplement No. 1, Project Reformulation and Benefits Analysis to Design Memorandum No. 1, Army Engineer District, Rock Island, 15 July 1970, (Revised 3 November 1970).

(c) Corps of Engineers, Design Memorandum, No. 3A,"Land Requirements Plan: Public Use," Army Engineer District, Rock Island, January, 1972.

(d) Includes interest during construction, annual maintenance, operations, and replacement values.

(e) Includes recreation operations, maintenance, and replacement of $12,900.

Table 6-3-2. Summary of Estimates of 1968 Benefits and Costs with Technical Corrections

Annual Costs		
First Cost	$17,100,000	
Interest during construction ($\frac{1}{2}$ of 4 years @ 4 5/8%)	1,617,700	
Gross Investment	$18,717,700	
Annual Cost (@ 4 5/8% discount rate for 100 year life)		$ 875,300
Operations and maintenance		102,000
Loss of Production[(a)]		0
Total Annual Charges		$ 977,300
Annual Benefits		
Flood Control		$ 537,400[(b)]
Water Quality Control		349,000[(c)]
Fish and Wildlife and Recreation		368,800[(d)]
Total Annual Benefits		$ 1,255,200
Benefit-Cost Ratio		1.3:1

(a) Acquisition cost of agricultural land in reservoir area includes income potential of land for purpose of calculating costs.

(b) Corps estimate of $503,300 for crop loss protection factored by 0.52 for revised flood frequency and by 1.7 to reflect revised estimate of yield and price, and $177,800 for property protection factored by 0.52 for revised flood frequency.

(c) The Corps estimate of $325,200 for water quality is assumed to consist of initial investment of $7,760,000 and $266,000 operations and maintenance (15% of investment). Discounted at 4 5/8% yields $83,000 plus $266,000 for operations and maintenance.

(d) Recomputation of recreation benefits at 4 5/8% for 100 years yields $326,000. Fish and wildlife benefits are assumed to remain at $42,800.

> (d) Where construction of a project has been authorized prior to the close of the second session of the 90th Congress, and the appropriate State or local governmental agency or agencies have given prior to December 31, 1969, satisfactory assurances to pay the required non-Federal share of project costs, the discount rate to be used in the computation of benefits and costs for such project shall be the rate in effect immediately prior to the effective date of this section, and that rate shall continue to be used for such project until construction has been completed, unless the Congress otherwise decides.

Only a small part of the non-federal share has been assured, consequently, the project should be re-evaluated using the 4 5/8% discount rate.

However, the Corps has drawn a different interpretation. In the absense of non-Federal agencies that are willing to share the responsibilities of development, administration, and maintenance of recreation, only facilities for public health and safety will be provided (Corps of Engineers, 1972). By deleting recreation facilities for which non-Federal participation was sought, the Corps interpretes no assurances are necessary and the project can continue to be evaluated at the $3\frac{1}{4}$% rate.

2. The loss of production from land in the reservoir area removed from use by permanent or temporary inundation is included in the cost of land acquisition (assuming all land is purchased in fee title). The price paid for an acre purchased from a landowner for reservoir use represents the present worth of the

future stream of annual amounts of net agriculture income he would otherwise have received.

The social cost (to society) of this loss of production (gross production -- costs and returns -- and net income) is reflected in having no more annual benefits in the future from agricultural crop production (land is abandoned for reservoir water areas, open space and other uses). Other benefits -- recreation, fish and wildlife, water supply, and downstream water quality enhancement and flood damage reduction -- must counterbalance this land acquisition cost and all other project construction and ORM costs if a favorable B/C ratio is to exist.

3. Flood control benefits have been revised to reflect use of USGS derived regional flood frequency and 1970 adjusted normalized prices based on national indices.*

The above technical corrections result in a reduction of the benefit-cost ratio from 1.6:1 to 1.3:1.

Table 6-3-3 provides the 1973 estimate of costs with and without the sub-impoundment. The land and damages cost item has been re-estimated to reflect current construction costs, acquisition, and relocation

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*Flood control benefit estimates using 1968 prices were not readily available.

Table 6-3-3. 1973 Estimate of Costs

Cost Item	Cost Without Sub-impoundment	Cost With Sub-impoundment
Land and Damages [a]	$ 6,335,000	$ 6,436,800
Construction and Relocations	11,587,900 [b]	12,036,700 [c]
Government Costs [d]	1,767,500	1,819,300
Recreation	1,798,600 [e]	6,110,100 [f]
First Cost	$21,489,000	$26,402,900

(a) Estimated cost of land acquisition, relocation payments, and appraisal costs.

(b) From Chapter 2, Appendix 6, (excludes estimates of recreation costs).

(c) Subimpoundments were estimated to cost $330,000 in 1968. A factor of 1.36 is used to update to 1973.

(d) Late 1968 estimates of $1,421,000 for engineering and design, and supervision and administration is assumed to increase by 6% per year for 4 years ($1,400,000 assumed for project without sub-impoundments).

(e) From Howard Green Report (see Appendix 6, Chapter 2).

(f) Recreation costs from Appendix 3; less $117,000 for land that is included in Land and Damages.

payments. Construction and structural relocations have been re-estimated by Howard Green Engineers (see Chapter 2, Appendix 6), government costs have been extrapolated from the original estimates of recreation benefits and costs in Appendix 3. Table 6-3-4A provides a summary of the 1973 estimates of benefits and costs for the project with sub-impoundments using $3\frac{1}{4}\%$, $5\frac{1}{2}\%$, and 7% discount rates for a 50-year life. Benefit estimates use Corps criteria for flood frequency and water quality, and are up-dated to reflect current prices, yields, and population estimates (median population projection). Based on these current estimates and Corps criteria the benefit cost ratio is 1.4:1, 0.95:1, and 0.77:1 for $3\frac{1}{4}\%$, $5\frac{1}{2}\%$, and 7%, respectively. Application of current or proposed discount rates results in an economically infeasible project. Table 6-3-4B shows the current benefit-cost situation for the project using U.S.G.S. regional flood frequency and interpretation that EPA water quality standards will require advanced treatment, in addition to low flow augmentation. Using these guidelines benefit-cost ratios of 0.8:1, 0.54:1, and 0.43:1 for $3\frac{1}{4}\%$, $5\frac{1}{2}\%$, and 7%, respectively, are determined which indicate the project is economically infeasible.

Table 6-3-5 summarizes and compares the cost for construction in 1973, 1980, and 1990. This table illustrates additional costs to be incurred if construction were delayed. These costs are based on Howard Green Engineers' estimate of a construction cost index. The benefit streams are not similarly provided, although construction costs have and will likely

Table 6-3-4A. Summary of 1973 Estimates of Benefits and Costs, using Corps of Engineers guidelines and criteria[a]

Annual Costs[b]	@3¼%	@5½%	@7%
First Cost	$26,519,900	$26,519,900	$26,519,900
Interest during Construction (½ of 4 years)	1,684,000	2,997,300	3,842,700
Gross Investment	$28,203,900	$29,517,200	$30,362,500
Annual Cost (Discounted for project life)	$ 1,156,200	$ 1,743,300	$ 2,198,200
Operations & Maintenance[c]	128,800	128,800	128,800
Total Annual Charges	$ 1,285,000	$ 1,872,100	$ 2,327,000
Benefits[b]			
Flood Control[d]	$ 1,033,400	$ 1,033,400	$ 1,033,400
Water Quality[e]	324,000	363,000	387,000
Water Supply[f]	2,200	1,800	1,400
Recreation[f]	414,100	377,400	358,100
Total Benefits	$ 1,773,700	$ 1,774,600	$ 1,779,900
Benefit-Cost Ratio	1.4:1	0.95:1	0.77:1

(a) Using Corps guidelines for analysis of flood frequency and low flow augmentation for water quality benefits.

(b) 50-year project life

(c) Assumed to increase by 6% per year.

(d) Based on Corps log-normal flood frequency estimation with updated prices and yields. See Table 6-3-8.

(e) Difference in cost between normal trickling filter secondary treatment, and activated sludge plus nitrification and phosphorus removal.

(f) See Table 6-3-7.

Table 6-3-4B. Summary of 1973 Estimates of Benefits and Costs, using revised guidelines and criteria of other agencies[(a)]

Annual Costs[(b)]	@$3\frac{1}{4}$%	@$5\frac{1}{2}$%	@7%
First Cost	$26,519,900	$26,519,900	$26,519,900
Interest during Construction ($\frac{1}{2}$ of 4 years)	1,684,000	2,997,300	3,842,700
Gross Investment	$28,203,900	$29,517,200	$30,362,500
Annual Cost (Discounted for project life)	$ 1,156,200	$ 1,743,300	$ 2,198,200
Operation & Maintenance[(c)]	128,800	128,800	128 800
Total Annual Charges	$ 1,285,000	$ 1,872,100	$ 2,327,000
Benefits[(b)]			
Flood Control[(d)]	$ 537,400	$ 537,400	$ 537,400
Water Quality[(e)]	89,000	100,000	105,000
Water Supply[(f)]	2,200	1,800	1,400
Recreation[(f)]	414,100	377,400	385,100
Total Benefits	$ 1,042,700	$ 1,016,600	$ 1,001,900
Benefit-Cost Ratio	0.81:1	0.54:1	0.43:1

(a) Using USGS regional flood frequency and interpretation that EPA water quality standards will require advanced treatment consisting of activated sludge plus nitrification.

(b) 50-year project life.

(c) Assumed to increase by 6% per year.

(d) See Table 6-3-8. Based on USGS regional flood frequency estimation with updated prices and yields.

(e) Difference in cost between activated sludge plus nitrification, and activated sludge plus nitrification and phosphorus removal.

(f) See Table 6-3-7.

Table 6-3-5. Comparison of Costs for Construction in 1973, 1980, and 1990 (due to estimated rates of inflation)

Year Constructed	Cost Item	Cost	Annual Cost[a] $3\frac{1}{4}\%$	$5\frac{1}{2}\%$	7%
1973	Land & Damages	$ 6,436,800	$ 262,492	$ 380,164	$ 466,410
	Construction & Relocations	12,036,700	490,856	710,900	872,179
	Operations & Maintenance		128,775	128,775	128,775
	Government Costs	1,819,300	74,191	107,450	131,826
	Recreation	6,110,100	249,170	360,869	442,738
	TOTAL	$26,402,900	$1,205,484	$1,559,383	$2,041,928
1980	Land & Damages[b]	9,678,565	394,691	571,626	701,308
	Construction & Relocations[c]	18,466,000	753,043	1,090,620	1,338,046
	Operations & Maintenance[b]		193,626	193,626	193,626
	Government Costs[b]	2,735,554	110,942	161,565	198,218
	Recreation[b]	9,187,696	374,674	542,635	665,740
	TOTAL	$40,067,815	$1,826,976	$2,366,446	$3,096,938
1990	Land & Damages[b]	17,332,821	706,832	1,023,694	1,255,936
	Construction & Relocations[d]	33,321,800	1,358,863	1,968,019	2,414,497
	Operations & Maintenance[b]		346,755	346,755	346,755
	Government Costs[b]	4,898,956	199,779	289,337	354,978
	Recreation[b]	16,453,094	670,957	971,736	1,192,191
	TOTAL	$72,006,671	$3,283,186	$4,252,786	$5,564,357

(a) Computed for a 50 year life.

(b) Assumed to increase by 6% per year.

(c) Includes $330,000 for sub-impoundments factored by 2.18.

(d) Includes $330,000 for sub-impoundments factored by 3.75.

continue to increase faster than benefits. This is not to imply a "build now while cheaper" philosophy, however, as benefits may in fact also grow exponentially. Since it is likely that future generations will be richer than present generations, the cost in 1990 may well represent a lower proportion of GNP than at present and, assuming feasibility, society may better afford the project at that time than at present. Furthermore, uncertainties in technology may alter costs, while uncertainties in demand will affect benefits.

Table 6-3-6 provides a comparison of the alternatives on an annual cost and annual benefit basis and illustrates that the alternatives with a lower first cost are generally more favorable from a benefit-cost standpoint. Alternative (6) is a reduced scope project for both flood control and recreation; whereas alternative (2) is a reduced scope project having only the conservation pool for recreation, and alternative (5) is the same as alternative (1), but with minimum recreation development.

Table 6-3-7 shows the sensitivity of recreation, water quality, and water supply benefits to variation in population estimates and discount rates, and Table 6-3-8 illustrates the sensitivity of flood control benefits to variation of flood frequency and stage, and variation in crop value.

Associated Costs and Benefits

The remainder of this chapter discusses costs and benefits that are outside of traditional benefit-cost analysis, but which should be considered. These are separated from the benefit-cost analysis to avoid double counting.

Table 6-3-6 Comparison of Alternatives

Annual Benefit/Cost[a]	Ames Reservoir with Sub-impoundments (1)	Reduced-Scope Recreation Reservoir[b] (2)	Sub-impoundments only (3)	Greenbelt Concept (4)[j]	(4A)	Minimum Recreation Development (5)	Reduced Scope Flood Control Reservoir with Recreation[b] (6)	Status Quo (7)
	ALTERNATIVES							
Cost								
Land & Damages	$ 466,410	$ 341,370	$ 17,200		$148,000	$ 466,410	$ 341,370	
Construction & Relocations	872,180	570,550[c]	32,520[d]			872,180	570,550[c]	
Operations & Maintenance	128,775	128,775	9,000[e]			128,775	128,775	
Government Cost	131,830	96,370[f]	5,530[g]			131,830	96,370[f]	
Recreation	442,740	369,280	176,960	$20,040	$171,000	56,380	369,280	$ 2,000
TOTAL	$2,041,900	$1,506,345	$241,210	$20,040	$319,000	$1,657,570	$1,506,345	$ 2,000
Benefits								
Flood Control	$ 537,400					$ 537,400	$ 453,790[h]	
Water Quality	105,000					105,000	0	
Water Supply	1,400	$ 1,400				1,400	1,400	
Recreation	358,100	360,830	$232,200	$86,340	$308,000	17,630	325,000	$16,000
TOTAL	$1,001,900	$ 362,230	$232,200	$86,340	$308,000	$ 661,400	$ 780,190	$16,000
Benefit-Cost Ratio	0.49:1	0.24:1	0.96:1	4.3:1	0.96:1	0.4:1	0.52:1	8.1:1

(a) 1973 costs and benefits at 7% discount rate for 50 year project life, without interest during construction.
(b) Both alternatives(2) and (6) are assumed to cost an amount equal to that estimated by Howard Green for the Modified Design.
(c) Modified design from Howard Green report, less land damages and recreation updated to 1973 and discounted.
(d) $330,000 updated to 1973, using 1.36 construction cost index from Howard Green Report discounted, equals $448,800.
(e) 20% of $448,800.
(f) 17% of $7,807,300, discounted.
(g) 17% of $448,800, discounted.
(h) Flood control benefits for reduced scope reservoir is estimated to be 85% of full-scale project.
(i) A 10% reduction of benefits from alternative (2) is assumed to reflect a fluctuating water level.
(j) Greenbelt concept provides access points, but does not protect the valley through public acquisition of land.

Table 6-3-7. Sensitivity of Benefits to Variations in Population Estimate and Discount Rate

Discount Rate	$3\frac{1}{4}\%$			$5\frac{1}{2}\%$			7%		
Population Estimate	Low A	Medium	High B	Low A	Medium	High B	Low A	Medium	High B
Benefits - Ames Reservoir with Sub-impoundments									
Water Quality	75,000	89,000	106,000	81,000	100,000	115,000	87,000	105,000	120,000
Water Supply	0	2,200	9,100	0	1,800	7,400	0	1,400	6,100
Recreation	387,400	414,100	N.A.	357,700	377,400	N.A.	341,350	358,100	N.A.

Table 6-3-8. Sensitivity of Flood Control Benefits to Variations in Flood Frequency, Crop Value, and Flood Stage

(1) Variation Description	(2) Flood Frequency Factor	(3) Flood State Factor	(4) Combined Frequency-Stage Factor	(5) Factor from Column (4) times Corps Estimate for Property Damage[a]	(6) Crop Value Factor	(7) Combined Frequency-stage-Crop Value Factor	(8) Factor from Column (7) times Corps Estimate for Crop Loss[b]	(9) Total Flood Control Benefit
Minimum Damage Estimate with Corps Crop Value	0.52	0.77	0.40	$ 71,100	1.0	0.40	$201,300	$ 272,400
Minimum Damage Estimate with Current Crop Value	0.52	0.77	0.40	$ 71,100	1.7	0.68	$342,200	$ 413,300
Medium Damage Estimate with reduced frequency and Current Crop Value	0.52	1.0	0.52	$ 92,500	1.7	0.884	$444,900	$ 537,400
Maximum Damage Estimate with Current Crop Value	1.0	1.0	1.0	$177,800	1.7	1.7	$855,600	$1,033,400

(a) Corps estimate for property damage is $177,800.

(b) Corps estimate for crop loss is $503,300.

Table 6-3-9 estimates some of the associated benefits and costs of the reservoir. Analysis in Chapter 7, Appendix 5, indicates a regional sewer system will be necessary, which will divert outflow from Story City to Ames and sewerage from developing land in the western portion of the reservoir area. Also approximations of tax loss from land removed from tax rolls by the impoundment is compared to approximations of increases in valuation due to residential development in the vicinity of the reservoir, and increases in property values downstream due to the flood protection.

Increased valuation of land in the reservoir area is a function of proximity to the reservoir and the regional sewer systems. For purpose of this analysis that portion of the increase, which is attributable to the reservoir and regional sewer system, should be considered as offsetting the tax loss from lands removed from the tax roll. It is assumed that approximately 2,000 acres in the reservoir area will double in value (from $800 to $1,600) at the time the regional sewer system is constructed. One-third of that increase would probably occur without the reservoir because of general northerly developmental pressure from Ames. It is also assumed that 20 houses per year will be constructed in the area for 50 years, and that one-half of those are attributable to the reservoir and regional sewer system. This process is assumed to begin in 1976. This cumulative effect of taxable improvements is converted to a present worth of $45,600,000 and an annual taxable income of $103,000. The impact of the construction alone is estimated to be $245,000 annually.

Table 6-3-9. Estimate of Associated Benefits and Costs for Ames Reservoir with Sub-impoundments

	Benefits/(Costs)		
Item	Capital	Annual	Operations and Maintenance
Regional Sewer System[(a)]	$ 1,310,000	$ (94,900)[(b)]	$131,000[(c)]
Tax Loss	4,729,100[(d)]	(134,000)[(e)]	
Increased Valuation of Land in Reservoir Area	870,000[(f)]	27,000[(g)]	
Increased Valuation of Improvements in Reservoir Area	45,600,000[(h)]	3,310,000[(i)] 103,000[(j)]	
Residential Construction[(k)]	3,380,000	245,000	
Sand & Gravel Royalties	345,000	(25,000)	

(a) From Chapter 7, Appendix 5.

(b) 7% discount rate for 50 year life.

(c) Assumed to be 10% of capital cost.

(d) Acquisition cost estimate for land and improvements.

(e) Annual estimate of tax from acquired property at 27% valuation and 105 mills rate of tax (average for Frankland, Milford, Lafayette, and Howard Township plus 3%).

(f) Due to reservoir and regional sewer system. Assumed to increase in 1976 by 100%, $800 to $1,600 for developable land, for 2,000 acres, converted to present worth.

(g) Annual estimate of additional tax from appreciated, developable land; assessed at 27% of value at 115 mills.

(h) Present worth of increased valuation based on uniform investment of 10 houses per year being constructed at $30,000 each for 50 years at 7%, beginning in 1976. Cummulative increase in taxable improvements.

(i) Uniform equivalent series for arithmetic gradient described in (h) above

Table 6-3-9. Continued

(j) Annual estimate of additional tax from improvments, at 27% assessed valuation at 115 mill rate.

(k) Present worth of construction activity for 10 houses per year as described in (h) above.

Another associated cost of the Ames Reservoir project is the loss of access to sand and gravel resources. The amount of sand and gravel in the reservoir area is estimated in Chapter 2 of Appendix 1. This loss of access becomes of importance _if_ the cost of sand and gravel increases due to the forced use of more remote quarries due to inundation of these reserves. Whether or not sand and gravel costs in Story County will increase has not been estimated, but a loss of royalties of $25,000 per year is estimated from existing gravel quarries in the reservoir area. This is based on 100,000 tons per year at 25¢ per ton. At 7% for 50 years this amounts to $345,000.

The annual loss of tax income in the total reservoir area is estimated to be $134,000. This is nearly offset by an increased tax income of $130,000, which occurs primarily in Franklin Township. The tax loss occurs nearly equally in four townships with the increase occurring in only one. Additional costs to service this rural non-farm population have not been estimated but should be considered. In addition, it should be recognized that growth in the reservoir area is not bringing new growth to the county, but is a redistribution of growth which would otherwise occur, probably in Ames.

No increase in property valuation downstream is attributable to flood protection. Land values in the downstream flood plain do not reflect a serious flood problem at the present time. Because major flooding has not occurred in recent years that would be comparable to 1944 and 1947 floods, land values in the flood plain are considered to be inflated and buyers are not presently perceiving any real threat of flood. If a serious flood would occur in the near future, land values would probably decline until the flood threat perception would again be forgotten or ignored. Consequently, those agencies constructing flood control projects should guard against people perceiving complete or a greater level of protection than will actually occur.

Table 6-3-10 illustrates the effects of the Ames Reservoir in crop production within the take line. If all land within the take line is removed from production, the annual value of that production is $448,761. However, the cost of production is $217,236. If land above the maximum flood pool remains in production the annual value of production removed is $328,189 ($448,761 - $120,570) and the cost of production for that amount is $148,598 ($217,236 - $68,638). These data can be interpreted in a variety of ways. First, if one assumes that land within the flood pool were to be cropped, when possible, $151,719 in production is estimated to be lost to operation of the flood pool. The difference $297,042 ($448,761 - $151,719) can be viewed as a cost to society for converting the land from growing crops to recreation and open space use. The second interpretation is to compare the value of production upstream to annual crop loss protection downstream, which is $444,900 (from Table 6-3-8). This crop loss protection value implicitly contains production costs, however, by inclusion of replanting costs. Consequently, it should be compared to the net value of protection upstream, $231,525 ($448,761 - $217,236). Third, the annual value of production in the reservoir area can be viewed from the perspective of local business who will lose sales of goods and services to produce those crops and

Table 6-3-10. Annual Effects on Crop Production in Reservoir Area[(a)]

Elevation	Annual Value of Production	Production Costs(b)	Crop Loss due to Reservoir Operation(c)
Below 950	$117,285	$ 53,580	$117,285
950 - 955	31,630	12,825	14,361
955 - 960	35,318	15,362	8,935
960 - 965	38,821	17,423	6,095
965 - 970	45,741	21,358	2,966
970 - 975	59,396	28,050	2,077
975 - 983	120,570	68,638	0
	$448,761	$217,236	$151,719

(a) Data derived from Figures 4-1-7 and 4-1-8.

(b) Corn: $65 per acre production costs, $28 per acre harvest cost, and $2 per acre weed control.

Soybeans: $41 per acre production costs, $14 per acre harvest cost, and $1 per acre weed control.

Oats: $15 per acre production costs, $20 per acre harvest cost, and $1 per acre weed control.

Hay: $42 per acre per year production and harvesting costs.

Non-Crop: $3 per acre production costs.

Note: Harvest costs not included for percent of years when crop lost due to flooding

(c) Assuming land within take line would be cropped when reservoir operation permits. Also assumes no replanting, but does not include trash and weed problems associated with flooding.

sustain the farmers. This indirect impact of taking land out of production is a loss to the local area and is offset by protection and increased production downstream.

Concluding Remarks

This benefit-cost analysis of the proposed Ames Reservoir Project provides the ARES review team calculation of benefits and costs using conventional methodology, and displays the estimate of benefits and costs for the various alternatives. However, it should be pointed out that benefit-cost analysis has substantial deficiencies in incorporating social costs and non-monetary effects. Consequently, the benefit-cost analysis is insufficient and assessment of a broader range of effects is provided in the next chapter.

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AMES RESERVOIR ENVIRONMENTAL STUDY

Appendix 6. Detailed Economic Review and Project Evaluation

Chapter 4

BROADER EVALUATION CONSIDERATIONS

Contribution to the
Ames Reservoir Environmental Resources Review Study

Sponsored by
US Army Corps of Engineers Contract DACW25-72-C-0033

by

Joseph S. Drake, Kenneth J. Dueker, and
John F. Hultquist

1973

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TABLE

Chapter 4

BROADER EVALUATION CONSIDERATIONS

Joseph S. Drake, Kenneth J. Dueker, and
John F. Hultquist

Introduction

While the previous chapter has attempted to summarize the economic evaluation of alternative plans for water-resource development in the upper Skunk River basin, a central point of this study is that less rigid techniques are necessary to provide balanced consideration of noneconomic impacts. Whereas the calculations in the previous chapter relate exclusively to the objective of economic efficiency or national income, each alternative also will lead to a variety of physical, social, and political impacts. Quite apart from misgivings regarding the use of certain dollar values in Chapter 3, many of these impacts cannot be valued legitimately in monetary terms. Rather, the "weights" of relative importance for such impacts might be elicited through a broader strategy of participatory public evaluation.

To facilitate such a process, Chapter 3 of Appendix 2 fashioned taxonomical constructs to organize the technical analysis and to assemble and display pertinent impact information. Two distinct constructs were advocated, one being a mechanism-based and the other

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an incidence-based classification. The mechanism-based construct (recall Table 2-3-4) is relatively technical in substance and serves as an organization vehicle for the impact analysis itself. The incidence-based construct (Table 2-3-5) is intended to organize impact information in terms which are most readily understood by various interest-group participants in a public evaluation forum. This chapter synthesizes the results of technical efforts concerned with investigation and documenting impacts of alternatives in terms of both taxonomical paradigms, and offers illustrative guidelines for implementing broader tradeoff evaluations in terms of this information.

The chapter is organized as follows. The next section reviews the specific project alternatives which receive substantive consideration in this chapter. Then, to the extent possible, information on prospective impacts for each of these alternatives is assembled in two forms. First, physical, social, and political impacts are recapitulated in terms of the mechanism-based paradigm. Second, these impact estimates and the economic considerations of the previous chapter are integrated and transformed into an incidence-based tabulation for each project alternative. Subsequent discussion highlights the more important tradeoffs implied by this information.

Project Alternatives

The National Environmental Policy Act of 1969 (Section 102(2)) requires that an environmental impact statement consider alternatives to a given course of action which is advocated by an agency. Beyond this requirement, any effective manifestation of tradeoff evaluations between economic and environmental objectives requires that a variety of different project configurations, emphasizing different kinds of impacts, be analyzed and presented for public review. With both of these motives in mind, this study has given substantive attention to several project alternatives which merit brief review at this juncture.

Such a recapitulation is germane not only because the preoccupation of this chapter is with the broader comparative evaluation of those alternatives, but also because there are some variations in the specific alternatives considered within different appendices of this report. As a consequence, the impact information available on these various alternatives is not identical in all instances. Lest further confusion arise, then, clarification of these variations is essential before proceeding with evaluative strategy.

The original definition of alternative project configurations for the study was first documented in a project memorandum, distributed in July 1972, entitled "Physical Alternatives for Conservation and Flood Control Pools." That memorandum defined six structural alternatives for water-resources develo pment of the upper Skunk River basin, plus one "do-nothing" alternative. The later project was meant to constitute a benchmark for "with project - without project" comparisons. Configurations defined by that memorandum dealing with minor refinements to the original impoundment design were not analyzed by the study in favor of covering more basic variations in project function and design. The specific alternatives listed in that memorandum, given the aforementioned deletion, are as follows:

Alternative 1. Ames Reservoir, as planned by Corps of Engineers, with two subimpoundments (per Design Memo No. 1)

a. Ames Reservoir

conservation pool	elev 950 ft (MSL)
flood pool	976

b. Bear Creek subimpoundment

conservation pool	970
flood pool	979

c. Dam site subimpoundment

conservation pool	1000

Alternative 2. Ames Reservoir, as planned by Corps of Engineers, with no subimpoundments

conservation pool	elev 950 ft (MSL)
flood pool	976

Alternative 3. Ames Reservoir, minimum conservation pool for recreation only (no water quality or flood control storage)

conservation pool	940

<u>Alternative 4</u>. Reduced-scope Ames Reservoir (limited flood control storage of 3.6"), minimum conservation pool with subimpoundments

a. Ames Reservoir

conservation pool	940
flood pool (reduced)	965

b. Bear Creek subimpoundment

conservation pool	970
flood pool	979

c. Dam site subimpoundment

conservation pool	1000

<u>Alternative 5</u>. Tributary recreation lake development only; no reservoir conservation or flood control storage

a. Bear Creek impoundment

conservation pool	970
flood pool	979

b. Dam site impoundment

conservation pool	1000

<u>Alternative 6</u>. Status quo, for recreation and open-space use with scenic river in natural state; no capital improvements

The analysis of inundation-related environmental impacts throughout Appendix 1 addressed these alternatives or a subset thereof. On the other hand, the alternatives studied in Appendix 3 for purposes of recreation and open space use involved some departures from those defined above. Based on a concern for those configurations which are "especially relevant to outdoor recreation and open space use," that analysis did not explicitly consider either the no-subimpoundments alternative or the reduced-scope configuration. However, it introduced a formal plan for greenbelt development (alternative 4 in chapter 3-2), and an alternative proposing the Reservoir as planned by the Corps, but with only minimum recreation facilities for public health and safety (alternative 5 in chapter 3-2). The latter proposal assumes no local cost-sharing commitment for recreation development.

For the record, the alternatives for which impact information is presented in this chapter are the following:

Alternative 1. Ames Reservoir with subimpoundments as planned by Corps (per Design Memo # 1).

Alternative 1A. Ames Reservoir as planned by Corps, with optimum recreation facilities, but without Bear Creek subimpoundment.

Alternative 2. Ames Reservoir, minimum conservation pool for recreation only (no water quality or flood control storage).

Alternative 3. Tributary recreation lake development only (no reservoir).

Alternative 4. Greenbelt plan under continuation of private ownership.

Alternative 4A. Greenbelt plan with public land acquisition.

Alternative 5. Ames Reservoir with dam site subimpoundment as planned by Corps, but with minimum recreation development.

Alternative 6. Reduced-scope Ames Reservoir (limited flood control storage of 3.6), minimum conservation pool with subimpoundments, and

Alternative 7. Status quo, for recreation and open space use; no capital improvements.

Except for Alternative 1A, these configurations, by number and character, are identical to those considered in the economic analysis of the previous chapter.

Summary of Noneconomic Impacts Within the Mechanism-Based Paradigm

For each of these alternatives, this section summarizes various impact estimates which are documented throughout earlier appendices. Chapter 3 summarized pertinent economic impacts representing all direct efforts and indirect economic impacts within the mechanism-based classification. The concern of this section is with "environmental" impacts, including those identified as physical, social, and political in character. Also, brief attention is given to third-order institutional impacts.

Table 6-4-1 through 6-4-9 summarize such impact estimates for each of the project alternatives defined in the previous section. The expressional form of the entries in these tabulations range from strictly quantitative measures to more qualitative verbal statements. Indeed, for landscape impacts the only effective form of expression is through the sketches contained in Appendix 1, not reproduced herein. These tables are not exhaustive accounts of all conceivable impacts, either because some impacts necessarily were ignored by the technical analysis or because of oversights in this compilation of results from all previous appendices. Also, as explained in the previous section, not all alternatives have been analyzed with equal thoroughness. However, it is believed that these tabulations capture the major effects and tradeoffs which should be highlighted eventually in a public evaluation of alternatives.

For guidance in reading these tabular summaries, several general observations regarding the categorization of impacts may be useful. Impacts upon the physical environment by virtue of project production refer to reductions in upstream resources due to inundation, if any takes place. Consumption-related physical impacts generally refer to equilibrium levels of reservoir/stream water quality and creation of mudflat areas, which may be influenced by the strategy of reservoir/stream operation and management. Production-related social impacts include upstream dislocation of households and disruption of such interactions as local transportation patterns. Consumption-related social impacts are concerned with patterns of residential development and recreational usage. Political impacts are many and diverse. Production-related effects include losses in the local tax base because of federal land and improvements purchases and increased local government budgets for transporting road building materials from more distant sources. Consumption-related impacts in the political sector include the fiscal responsibility for local recreational development and the responsibility, also generally requiring monetary inputs, for urban wastewater treatment. This latter issue involves a possible controversy concerning reclassification of various segments of the river, particularly that reach between the dam site north of Ames and Colfax to the south.

Third-order institutional impacts are somewhat distinct from those of production and consumption. Such third-order impacts occur because of broad cultural and political forces, formally or informally institutionalized, particularly with the role and style of government. Public or quasi-public processes may be reinforced or altered by the development of a particular project, or, in fact, even the project evaluation process. For example, the development of Alternative 2, with the full recreational potential of the area, may provide an increased impetus for local political conflict between those having a development ethic and environmentalists. A major project, of course, would make developments north of Ames more attractive for many uses and increase the intensity of development pressure while simultaneously lessening the tenaciousness of the environmentalists with respect to this particular area.

The extent and nature of the impacts vary for each alternative. The most impactful alternative is the project with both subimpoundments and optimal recreational development (Alternative 1). The "do-nothing" alternative, with its implied continuation of present trends, will appear to be the least impactful to most observers. This is probably a false view, and Alternative 4A is a more reasonable alternative for maintenance of the valley in its present environment in the long run.

With these introductory comments, Tables 6-4-1 through 6-4-9 are presented for inspection and evaluation without further elaboration.

Table 6-4-1. Mechanism-Based Paradigm: Alternative 1

Alternative 1	PHYSICAL					SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 1 Chapter 1-1 Inundates 3700 acres of prime agricultural soils	373 acres Oak-Hickory forest remaining 244 acres mixed flood plain forest remaining	50% decrease in terrestrial wildlife Loss of approximately 206,000 individuals of various wildlife species.	Massive ecosystem simplification in reservoir (ten residual species)		Total destruction of 23 sites Partial/total destruction of 13 sites Possible endangerment of 7 sites within acquisition arch. Another 8 sites possibly affected by development of easement or peripheral zone.	Project dislocates 300 persons and disrupts 125. Removes 768 acres of cropland from production for conservation pool (below elev. 960) 1420 acres of cropland between elev 960 and 983 (take line)			Resource requirements to provide non-federal participation in recreation facilities.		Temporary loss of tax base. Temporary loss of school enrollment and school tax base.
CONSUMPTION RELATED		Extensive mudflat area likely. At maximum flood pool 15% of present county's woodland is inundated	Massive ecosystem simplification (loss of small mammals and their predators) in flood-pool zone. Two-fold increase in wood duck and other waterfowl.	Extensive photoplankton blooms in reservoir. Low flow augmentation for aesthetic and water quality.	Reservoir recharges shallow aquifer to support shallow well system, avoids future dependence on deep bedrock wells to meet water demand in Ames.	At least 5 sites could be developed as part of an interpretive program.	crop protection downstream Longer but less severe periods of inundation, both upstream & downstream. Operation and use of reservoir will have external effects upon 90 existing residents. Increase in water-related recreation opportunities on reservoir and sub-impoundments. Loss of passive recreation opportunities and open space.	lake access housing lot opportunities	Extensive west-side residential development.	Continuing commitment of resources for the operations, maintenance, and replacement of recreation facilities.	Maintenance and clean-up of roads in flood pool.	Land enhancement for development, long-term growth in tax base Requires regional sewer system.

Table 6-4-2. Mechanism-Based Paradigm: Alternative 1A

Alternative 1A	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 2 Chapter 1-1 Inundates 3700 acres of prime agricultural soils	392 acres Oak - Hickory forest remaining 244 acres mixed flood plain forest remaining	Approximately 202,000 individuals of various wildlife species lost.			Total destruction of 21 sites Partial/total destruction of 13 sites. Possible endangerment of 9 Possibly destroyed within easement or peripheral zone 8.	Project dislocates 200 persons and disrupts 113. Removes 768 acres of cropland from production for conservation pool (below elev. 960) 1420 acres of cropland between elev. 960 and 983 (take line)			Resource requirements to provide non-federal participation in recreation facilities.		Temporary loss of tax base. Temporary loss of school enrollment and school tax base.
CONSUMPTION RELATED		Extensive mudflat area likely, particularly in Bear Creek and Dry Creek tributaries. At maximum flood pool 15% of present county's woodland is inundated.	Proportionately the same as Alternative #1.		Reservoir recharges shallow aquifer to support shallow well system, avoids future dependence on deep bedrock wells to meet water demand in Ames.	At least 5 sites could be developed as part of an interpretive program.	crop protection downstream Longer but less severe periods of inundation, both upstream & downstream. Operation and use of reservoir will have external effects upon 90 existing residents. Increase in water-related recreation opportunities in conjunction with reservoir, but without Beak Creek sub-impoundments. Loss of passive recreation opportunities and open space.	lake access housing lot opportunities	Extensive west-side residential development.	Continuing commitment of resources for the operations, maintenance, and replacement of recreation facilities. Without Bear Creek sub-impoundment, recreationists will attempt to modify reservoir operation to minimize fluctuations of water level.	Maintenance and clean-up of roads in flood pool.	Land enhancement for development, long-term growth in tax base. Requires regional sewer system.

Table 6-4-3. Mechanism-Based Paradigm: Alternative 2

Alternative 2	PHYSICAL: Landscape	PHYSICAL: Flora	PHYSICAL: Fauna	PHYSICAL: Aquatic	PHYSICAL: Geological	SOCIAL: Archaeological	SOCIAL: Rural Farm	SOCIAL: Rural Non-Farm	SOCIAL: Urban	POLITICAL: State	POLITICAL: County	POLITICAL: Local
PRODUCTION RELATED	See Sketch 3 Chapter 1-1	702 acres Oak - Hickory forest remaining. 560 acres mixed flood plain forest remaining.	Loss of approximately 85,000 individuals of various wildlife species.			Total destruction of 23 sites. Possible endangerment within acquisition of 11 sites. Endangerment by peripheral development 5.	Project dislocates 60 persons and disrupts 250. Removes 580 of cropland from production (below elev. 950)			High rate of financial participation to provide non-federal share of recreation facilities. Low rate of cost sharing with Federal Government w/o flood control benefits.		
CONSUMPTION RELATED	Less visible change than fluctuating reservoir (less wood land inundation and no bathtub ring).	Minimal mudflat area likely. Leaves timber edge at perimeter of pool.	Proportionately the same as Alternative #1.	Less low flow augmentation	Reservoir recharges shallow aquifer to support shallow well system, avoids future dependence on deep bedrock wells to meet water demand in Ames.	At least 5 sites could be developed as part of an interpretive program.	No crop protection downstream. Might require extensive agricultural levee system downstream. Operation and use of reservoir will have external effects upon 158 existing residents.	No flood hazard protection downstream.		Continuing commitment of resources for the OMR of recreation facilities.		Requires additional treatment of waste water at Ames.

Table 6-4-4. Mechanism-Based Paradigm: Alternative 3

Alternative 3	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 5 Chapter 1-1	722 acres Oak - Hickory forest remaining 924 acres mixed flood plain forest remaining Corridor of bottom land timber would remain.	Loss of approximately 13,000 individuals of various wildlife species.			Total destruction of 2 sites. Total destruction of 16 Possible destruction of 4 sites Peripheral endangerment of 2	Project dislocates 20 persons and disrupts 20.			Sizeable investment of state and county funds to provide recreation impoundments.		Little impact on tax base.
CONSUMPTION RELATED		Negligible mud-flat area likely.	Proportionately the same as Alternative #1.	No low flow augmentation.		At least 3 sites could be developed for interpretive program.	No crop protection downstream. Might require extensive agricultural levee system downstream. Operation and use of reservoir will have external effects upon 20 existing residents.	No flood hazard protection downstream.		Continuing commitment of financial resources for OMR of recreation facilities.	Requires land use controls in valley to retain land in open space and agriculture.	Requires additional treatment of waste water at Ames.

Table 6-4-5. Mechanism-Based Paradigm: Alternative 4

Alternative 4	PHYSICAL: Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	SOCIAL: Rural Farm	Ruran Non-Farm	Urban	POLITICAL: State	County	Local
PRODUCTION RELATED	See Sketch 6 Chapter 1-1	789 acres Oak - Hickory forest remaining 929 acres mixed flood plain forest remaining.	No loss of wild-life - possibly an increase in many species.			All sites preserved Trails and access roads might affect some sites.	Minimal dislocation and disruption				Relatively small investment re-quirements for open space and rec-reational facilities.	
CONSUMPTION RELATED		Natural shoreline diversity pre-served.	No loss of wild-life - possibly an increase in many species.			Site development and interpretation could (should) still be under-taken.	Gradual encroachment of rural non-farm and urban development on agricultural and open space. No crop protection downstream Might require ex-tensive agricul-tural levee system downstream. Provision of access points invites additional recreation use of private land and increases potential for conflict between owners and users.		No flood hazard protection down-stream.		Continued developmental pressures for rezoning and public services and land use conflicts. Would require flood plain zoning upstream and downstream.	

Table 6-4-6. Mechanism-Based Paradigm: Alternative 4A

Alternative 4A	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 6 Chapter 1-1	789 acres Oak - Hickory forest remaining 929 acres mixed flood plain forest remaining	No loss of wildlife - possibly even greater increase in wildlife.			All sites preserved. Trails and access roads might affect some sites.	Little dislocation and disruption.			Extensive investment requirements to provide recreation facilities.		Requires passage of strict land use controls.
CONSUMPTION RELATED		Natural shoreline diversity preserved. Would increase timber cover in county.	No loss of wildlife - possibly even greater increase in wildlife.			Site development and interpretation could (should) still be undertaken.	No crop protection downstream. Might require extensive agricultural levee system downstream. Operation and use of reservoir will have external effects upon 330 existing residents. Would increase public access and views of existing landscape.	No flood hazard protection downstream.		Continuing commitment of financial resources for OMR of recreation facilities.	Continuing pressure to allow residential development.	

Table 6-4-7. Mechanism-Based Paradigm: Alternative 5

Alternative 5	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 1 Chapter 1-1	373 acres Oak - Hickory forest remaining. 244 acres mixed flood plain forest remaining.	Possibly some less loss than in Alternative #1.			Total destruction of 23 sites. Partial/total destruction of 13 sites. Possible endangerment of 7 sites within acquisition arch. Another 8 sites possibly affected by development of easement or peripheral zone.	Project dislocates 280 persons and disrupts 113. Removes 768 acres of cropland from production for conservation pool (below elev. 960) 1420 acres of cropland between elev. 960 and 983 (take line).			Requires minimal non-federal participation in recreation facilities initially.		Temporary loss of tax base. Temporary loss of school enrollment and school tax base.
CONSUMPTION RELATED		Extensive mudflat area likely At maximum flood pool 15% of present county's woodland is inundated.	Massive ecosystem simplification (loss of small mammals and their predators) in flood-pool zone. Proportionately the same as in Alternative #1.	Extensive photoplankton blooms in reservoir. Low flow augmentation for aesthetic and water quality.	Reservoir recharges shallow aquifer to support shallow well system, avoids future dependence on deep bedrock wells to meet water demand in Ames.	At least 5 sites could be developed as part of an interpretive program.	crop protection downstream. Longer but less severe periods of inundation, both upstream & downstream. Increase in water area suitable for recreation, but inadequate land facilities to support likely use. Operation and use of reservoir will have external effects upon 75 existing residents. Increase in water-related recreation opportunities on reservoir and sub-impoundments. Loss of passive recreation opportunities and open space.	lake access housing lot opportunities	Extensive west-side residential development.	Dissatisfaction with minimal recreation facilities; pressure to provide adequate recreation facilities.	Maintenance and clean-up of roads in flood pool.	Land enhancement for development, long-term growth in tax base. Requires regional sewer system.

Table 6-4-8. Mechanism-Based Paradigm: Alternative 6

Alternative 6	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 4 Chapter 1-1	483 acres Oak - Hickory forest remaining 342 acres mixed flood plain forest remaining	Loss of approximately 167,000 individuals of various wildlife species.			Total destruction of 19 sites. Partial/total destruction of 12 sites. Possible endangerment within acquisition zone of 7 Possible endangerment by peripheral development of 8 sites.	Project dislocates 120 persons and disrupts 170. Removes 580 acres of cropland from production (below elev. 950) 1002 acres of cropland between elev. 950 and 965).			Resource requirements to provide non-federal participation in recreation facilities.		Reduced-scope multiple-purpose project reduces impact on tax base and school enrollments.
CONSUMPTION RELATED		Moderate mudflat area likely.	Proportionately the same as in Alternative #1.		Reservoir recharges shallow aquifer to support shallow well system, avoids future dependence on deep bedrock wells to meet water demand in Ames.	At least 5 sites could be developed as part of an interpretive program.	Less efficient crop protection downstream than full-scale project. Operation and use of reservoir will have external effects upon 80 existing residents. Increase in water-related recreation opportunities with less loss of woodland.	Lake access housing lot opportunities.	Extensive west-side residential development.	Continuing commitment of resources for the operations, maintenance, and replacement of recreation facilities.	Maintenance and clean-up of roads in flood pool.	Land enhancement for development, long-term growth in tax base. Requies regional sewer system.

Table 6-4-9. Mechanism-Based Paradigm: Alternative 7

Alternative 7	PHYSICAL						SOCIAL			POLITICAL		
	Landscape	Flora	Fauna	Aquatic	Geological	Archaeological	Rural Farm	Rural Non-Farm	Urban	State	County	Local
PRODUCTION RELATED	See Sketch 6 Chapter 1-1	789 acres Oak - Hickory forest remaining 929 acres mixed flood plain forest remaining	No loss of wild-life.			All sites preserved (but vulnerable to residential development) and gravel quarrying activities and farming practices such as contour farming.	No initial dislocation or disruption. No loss of production.			Little initial financial resources required.		
CONSUMPTION RELATED		Natural diversity preserved.	No loss of wild-life.			Site development interpretation could (should) still be undertaken.	Gradual encroachment of rural non-farm and urban development on agricultural and open space. No crop protection downstream.				Continued developmental pressures for rezoning and public services and land use conflicts. Would require flood plain zoning upstream and downstream.	

The Incidence Approach

To further elucidate the nature of the impacts of the Ames Lake Project, an incidence approach is discussed in this section. The technique has been used in other instances and has been discussed in Chapter 3 of Appendix 2. The essence of this approach is that special interest groups are identified, and the amount and incidence of benefits and costs are articulated for each group. This can be done for alternatives, but no attempt is made to weigh the costs to one person or group against the benefits to others to arrive at an optimum solution. The incidence approach presents information that is necessary to reduce doubt and uncertainty regarding consequences of alternative decisions. The information, when based on sound research, is relevant for planning decision; but it does not usurp the responsibilities of policymakers. The incidence approach recognizes that significant resource development decisions are multifaceted problems and that it would be irresponsible to accept a course of action based on criteria restricted to a single domain of human interest.

Each person viewing the incidence matrix can trace a vertical column and determine the detrimental or beneficial impacts of various alternatives with regard to that particular interest. Were the person able to restrict interest to one column only, then the ranking of alternatives might be an easy task. As one's interests diverge, so too does the variety of impacts which enter into the decision process; and, consequently, the choice of alternatives becomes more difficult.

Having viewed the matrix of impacts based on one's own interests, each person is then exhorted to view the incidence of effects of the preferred alternative on other interest groups. This is done by following a horizontal row from one side to another. Thus, one can quite easily see the effect on others from actions one would take for one's own greatest personal gain. In so doing, it is possible to determine from which group or groups to expect support for, or opposition to, a particular project.

Table 2 - 3 - 5 (Appendix 2, p. 2 - 3 - 38) shows the configuration of an incidence matrix with interest groups as column headings and alternatives as row headings. One aspect of the incidence approach is that impacts must be anticipated. Those best able to perceive an impending impact on a group is that interest group itself. Thus, in this section the presentation of the paradigm is somewhat different than in the abstract terminology of Chapter 3, Appendix 2. Rather than attempt to enumerate each and every interest group, and attempt to anticipate relevant impacts on each, two groups only are chosen for presentation. The authorized project is being justified to the greatest extent through the positive effect on two groups, namely agricultural interests and recreationists. Thus, in this section these two groups are to exemplify how an interest group might use the incidence approach. The results are presented in condensed textual form for ease of presentation, rather than in a tabular format.

AGRICULTURAL INTERESTS IMPACTS

General

Over the years landowners have initiated projects and made substantial investments of their own funds in improving the Skunk River flood plain for agricultural production. Land between the mouth of the reach of the Skunk River and Ames is the reach most affected by floods, and this damage occurs predominantly in rural areas.

Alternative 1

The project as presently authorized has flood storage equal to 5.2 inches of runoff in the basin above the dam site. The chief beneficiaries of the flood storage are persons residing or doing business in the flood plain between Ames and Colfax. Similarly, those most adversely affected through dislocation are those persons residing or doing business with those residing in the reservoir area upstream from the dam site.

If all land within the take-line of the reservoir is removed from production, the annual value of tha production is estimated to be $448,800, less a cost of production of $217,200, which compares to a value of annual crops less protection downstream of $444,900.

Reservoir operating policies must try to satisfy both agricultural interests and recreation users of reservoirs. Rarely is either group satisfied. Reservoir operation experience in Iowa indicates the flood protection downstream is partially offset by sloughing of river banks because of rapid changes in release rates and longer periods of high flow rates when drawing down the reservoir. Less cropland may be flooded, but some crop- and pastureland may be flooded for longer durations.

Firms serving agriculture will be affected differentially depending on the location of their clientele. Those serving farms in the reservoir area will be impacted as soon as acquisition and construction begin, and it will be a permanent loss, while those serving farms downstream will be assured a more consistent market with fewer and less severe floods.

Alternative 1A

This project will have essentially the same impact on agricultural interests as Alternative 1.

Alternative 2

This alternative is a reduced-scope recreation only lake and provides no flood protection downstream. It does, however, have a lower elevation conservation pool and requires less land for the reservoir. Also there is no flood pool which subjects agricultural land to damaging fluctuations.

Alternative 3

The tributary lake development provides no flood protection, but takes very little land. Total surface area for both are 155 acres for Bear Creek and 30 acres for dam site impoundment. Minimal additional lands would be required for access.

This alternative provides no assurance against encroachment of agricultural lands in the reservoir area by urban development northward from Ames, nor does it prevent further quarrying activity.

Alternative 4A

The comprehensive greenbelt concept removes land from agricultural use between Ames and Story City but does not offset this loss with protection downstream. Much of the best cropland is left intact, however. Provision of a significant amount of open space, however, may remove some of the pressure from private lands and reduce trespassing by recreationists.

Alternative 5

This alternative is essentially the same as Alternative 1 and 1A, except that the minimum recreation development may remove some of the pressure from the Corps to operate the reservoir as a recreation lake.

Alternative 6

This alternative is a reduced-scope multiple-purpose reservoir which provides a lesser amount of flood protection. This lower level reservoir has a conservation pool of 1410 acres as compared to 2100 in Alternative 1, and a maximum flood pool acreage of 3620 acres as compared to 5000 acres. Alternative 6 provides flood storage for 3.6 inches of runoff in the basin above the dam, as compared to 5.2 inches for Alternative 1. This project is estimated to be about 85 percent as beneficial to downstream agricultural interests, as is the first full-scale project. Agricultural landtaking in the reservoir area is reduced from 2780 acres to 580 acres of cropland.

Alternative 7

The "present trends" status quo alternative implies continual private ownership of most lands along the Skunk, both upstream and downstream of the dam site. The reservoir area will receive increasing pressures for urban-type development, and the downstream flood plain will continue to be subjected to flooding.

RECREATION INTERESTS IMPACTS

General

The choice seems to be between a diverse and nature-oriented experience in a river greenbelt and a water-oriented experience with a reservoir. The total amount of recreation clearly would increase with the construction of one of the reservoir or recreation lake alternatives.

Alternative 1

This alternative produces the greatest projected recreation use and devotes 665 land acres for recreation to serve the 2100-acre conservation pool, the 155-acre Bear Creek subimpoundment, and the 30-acre dam site subimpoundment.

This alternative is expected to generate recreation benefits of $4,941,700 and costs of $6,227,100, using a discount rate of 7 percent and a project life of 50 years. This is based on an estimate of approximately 290,000 annual visitations initially to nearly 480,000 in 2020, with each visit valued at $1.25.

The chief difficulty in implementing this alternative is in obtaining nonfederal participation in the development and operations of recreation facilities. Design Memo No. 1 called for $1,140,000 for nonfederal cost sharing, principally for recreation facilities. There has been insufficient commitment to and priority for the Ames project at both state and local levels to obtain assurances for cost sharing. Consequently, the Corps is now directing its attention to Alternative 5, which calls for minimum recreation development.

The mere presence of the large body of water as proposed in Alternative 1, even in the face of questionable water quality and management problems, will intensify recreation use of the area.

Operation of the reservoir for flood control poses conflict with recreationists. A fluctuating pool creates unsightly mud flats when the level is low, and debris and difficulty of access when the level is high. Alternative 1 calls for a conservation pool elevation of 950 and a flood pool elevation of 976.

The nature-oriented recreationists lose the natural valley to the reservoir, which serves more active water-oriented recreationists.

Alternative 1A

This alternative is based on a re-analysis by the Corps in 1972, which deletes the Bear Creek subimpoundment, but otherwise plans for optimum recreation development. According to the Corps' 1972 estimate, $2,715,000 is subject to cost sharing. Again, the nonfederal assurances to share these recreation costs were not obtained.

Deletion of the constant-level Bear Creek subimpoundment is a significant loss to recreationists; and Bear Creek without a subimpoundment will not be particularly attractive to recreationists, as it will have extensive mud flats. Otherwise Alternative 1A is similar to Alternative 1.

Alternative 2

Alternative 2 is a reduced-scope dam with a constant level pool for recreation alone. There would be no flood pool and, consequently, no mud flats. The constant level 1410-acre pool would be ideal for boating. This alternative is expected to generate recreation benefits of $4,979,700 and costs of $4,719,200, using a discount rate of 7 percent and a project life of 50 years. This is based on an estimate of approximately 250,000 annual visitations initially to over 400,000 in 2020, with each visit valued at $1.50.

Operation of the dam for recreation only may pose water quality problems, both in the lake and downstream. In periods of low inflow the lake may become stagnant, which, in turn, will cause low or no outflow and create water quality problems downstream, whereas the multiple-purpose reservoirs augment low flow from reservoir storage.

It is extremely doubtful that the Corps of Engineers would participate in a recreation only development, given the guidelines under which they operate.

Alternative 3

This alternative provides two recreation subimpoundments -- Bear Creek and dam site -- with 155 and 30 water acres, and 200 and 50 recreation land acres, respectively. The main valley is left in private ownership, as are all existing public parks and access points. These small water areas would not serve the power boaters but would add to the recreation inventory of Story County. This alternative attempts to serve some water-contact sports and fishing, while at the same time not removing the nature-oriented recreation sites.

This alternative is expected to generate recreation benefits of \$3,204,500 and costs of \$2,442,200, using a discount rate of 7 percent and a project life of 50 years. This is based on an estimate of approximately 120,000 annual visitations initially to nearly 200,000 in 2020, with each visit valued at \$2.00.

Continued encroachment by rural residential developments can be expected unless stringent land use controls are instituted. This alternative also requires considerable local commitment of financial resources. It is unlikely that the Corps of Engineers would participate in the recreation only development unless it became part of a comprehensive basin-wide water management program.

Alternative 4

This alternative utilizes only the stream system in a greenbelt program of modest scope. It assumes that most of the vegetation -- timber, shrubs, pastures, and other open space areas -- would be preserved and managed by private landowners. One hundred and eight acres of land would be purchased for public use and access to the river.

This alternative is expected to generate recreation benefits of \$1,191,500 and costs of \$276,500, using a 7 percent discount rate and a 50-year project life. This is based on an estimate of approximately $4,000 annual visitations initially to nearly 75,000 in 2020, with each visit valued at $2.00.

Again, it is questionable whether existing land use controls can stand the residential development pressures. Also, this alternative would require local financing, development, and operations. State and federal interests would not be ground by this alternative.

Alternative 4A

Much more land acquisition is required in this alternative, compared to Alternative 4. The stream channel and a strip of land on each side would be purchased from Story City to the Hallett gravel pit area. Additional wooded tracts, specific areas of ecological value, and required lands would be controlled through rental and easement agreements.

Approximately 1,420 acres of land are included in the immediate or short-term acquisition phase, and 2,350 acres are placed in a rental or easement category. As willing sellers offered their lands, from the rental or easement category, then additional purchases could be made. A strong measure of land use control and positive zoning is required to keep the west side of the valley in a wooded, lightly used concept for optimum visual aesthetics of the natural valley.

This alternative is expected to generate recreation benefits of $4,251,500 and costs of $4,410,300, using a discount rate of 7 percent and a project life of 50 years. This is based on an estimate of approximately 150,000 annual visitations initially to 260,000 in 2020, with each visit valued at $2.00.

Achievement of this alternative would require substantial local commitment of resources. The initial cost of Alternative 4A is $1,590,600. If financed by a bond issue at 5 percent for 20 years with equal payments of $129,000 annually, this would require a millage rate of 0.81, based on the estimated 1973 assessed valuation of Story County at $160,500,000. Operations, maintenance, replacement and land rental is estimated to cost $204,000 annually, which would require an additional 1.26 mills. However, Iowa statute limits millage for county conservation boards to 1 mill, and Story County levied 0.60 in 1972, 0.659 in 1971, and 0.915 in 1970.

Alternative 5

This alternative is probably least attractive to recreationists. It is the same structurally as Alternative 1A -- the flood control reservoir with dam site impoundment -- but with minimum recreation development. Not only are the existing recreation opportunities in the valley lost, but they are replaced by inadequate facilities in number and quality.

The ARES Review Team estimates approximately 25,000-40,000 annual visitations would occur because of the minimum facilities.

This alternative is expected to generate recreation benefits of $314,800 and costs of $926,700, using a discount rate of 7 percent and a project life of 50 years.

Alternative 6

This alternative is a reduced-scope multiple-purpose reservoir, which reduces the conservation pool from 2100 acres to 1410, and the maximum flood pool from 5000 acres to 3620, compared to Alternative 1. The conservation pool would be the same size as in Alternative 2, but operation of the flood pool would result in mud flats and other conflicts between recreation-oriented use and flood control objectives. This alternative represents a compromise to lessen project impacts on natural habitat, dislocation of farms and residents, and flooding of Story City.

Alternative 7

The "present trends" alternative implies continued private ownership of lands and present uses in the reservoir area. Continued and increasing pressure for residential development will be felt, and it is uncertain whether the area can be retained in its present state without more stringent land use controls. Recreationists would continue to place pressure on the few public sites and rely on the good will of private landowners for access along the stream valley.

This alternative is expected to generate recreation benefits of $223,000 and costs of $27,600, using a discount rate of 7 percent and a project life of 50 years. This is based on an estimate of approximately 11,000 annual visitations initially to nearly 20,000 in 2020, with each visit valued at $1.50.

Summary

As the preceding section demonstrates, the incidence paradigm can be quite valuable for the interpretation and evaluation of a resource project. The previous section may not have been all inclusive in terms of the impact on the interest groups considered. These groups will possibly want to add to the material presented there. Other groups, with either broader or more limited interests, can assemble those impacts important to them for each of the alternatives. Groups, large and small, could meet to assemble their own tabular display of impacts, many of which will have been documented elsewhere in the environmental review study. The Corps of Engineers, an environmentally active group, or a newspaper may then take the initiative in assembling all sets of impacts and distributing them in their totality. Were this done, each group would be made aware of how and why all other groups developed their perception, and support or lack thereof, of various project alternatives.