Order Code RL31976

CRS Report for Congress
Received through the CRS Web

Benefit-Cost Analysis and the Discount Rate for the Corps of Engineers' Water Resource Projects: Theory and Practice

June 23, 2003

Kyna Powers
Analyst
Resources, Science, and Industry Division

Benefit-Cost Analysis and the Discount Rate for the Corps of Engineers' Water Resource Projects: Theory and Practice

Summary

Construction of large water resource projects, such as those of the Army Corps of Engineers (Corps), can be controversial because they involve trade-offs among various river uses, and between current and future generations. Pursuant to federal water project planning guidelines, the Corps weighs these trade-offs using benefit-cost analysis. If its analysis shows that a project's national economic development (NED) benefits exceed its NED costs, the Corps seeks project authorization from Congress. Congress authorizes the Corps to construct some of these large water projects through (usually) biennial Water Resource Development Acts. Since the Corps rarely recommends a project that does not have a benefit-cost ratio greater than 1.0, this report describes the decisions that influence this ratio, with a focus on the role of the discount rate.

One of the decisions that critically influence the outcome of a benefit-cost ratio is the choice of a discount rate to transform future benefits and costs into present values. The Corps uses a discount rate formula established in the Water Resources Development Act of 1974. This formula bases the discount rate on the average yield of long-term government securities. Some economists, however, argue that the rate should reflect the cost of displacing private investment, specifically the rate of return on capital in private markets, which is usually higher than long-term government securities.

Due to the temporal distribution of water projects' benefits and costs (*e.g.*, large near-term costs and with benefits typically distributed over very long time periods), projects evaluated with a lower discount rate are more likely to pass the benefit-cost ratio test than projects evaluated using a higher rate. Since the Treasury rate is generally lower than the rate of return on private investments, changing the water project rate (now 5.875%) to a rate of return closer to that on private investments, such as the OMB's base rate (now 7%), would likely decrease the number of projects that have a benefit-cost ratio of greater than 1.0.

Basing the water project rate on Treasury rather than private-sector rates is not the only controversial component of the discount rate formula. For example, the Corps calculates future benefits and costs using real dollars (*i.e.*, inflation is removed from these figures), but discounts using a nominal discount rate (*i.e.*, one that is not corrected for inflation to produce a "real" rate). This underestimates the present value of future benefits and costs and reduces the likelihood that long-term projects would pass the benefit-cost ratio test. Notwithstanding this technical inconsistency, there are other issues associated with the Corps discount rate formula: use of an average rather than a marginal rate of return, use of a rate based on long-term rather than shorter-term securities, and use of the yield rate rather than the coupon rate. Given the many factors that influence the discount rate, the net effect is unknown. In addition, many factors other than the discount rate affect the benefit-cost ratio and project recommendations, but are beyond the scope of this report. This is a background report and is unlikely to be updated.

Contents

List of Figures

List of Tables

Benefit-Cost Analysis and the Discount Rate for the Corps of Engineers' Water Resource Projects: Theory and Practice

Introduction

Construction of large water resource projects, such as those of the Army Corps of Engineers[1] (Corps) and the Bureau of Reclamation (Department of Interior), are often controversial because they involve trade-offs between various river and other water-related uses and between current and future generations. Therefore, each water resource management strategy results in winners and losers. For example, a free flowing river supports recreation, fisheries, and scenic beauty, while dams may support hydropower, flood control, navigation, water supply, and motorized or other recreation purposes. Managing rivers to achieve any individual or combination of benefits may diminish the benefits derived from other river uses. Because it is a choice among river or other water resource management objectives (*e.g.*, estuaries, ports, etc.), each large water project generates supporters and opponents.

During the course of controversy over these large water projects, there is inevitably debate over the project evaluation process. One of the more controversial aspects of this project evaluation process is benefit-cost analysis.[2] Benefit-cost analysis is a formalized procedure for estimating the benefits that a water resource development is expected to generate, the costs necessary to produce the project, and comparing them. Proponents of benefit-cost analysis contend that it is necessary to help quantify the differences among project alternatives. However, benefit-cost analysis is controversial because it is necessarily based on subjective decisions on what should (or should not) be included as benefits and costs, as well as how they ought to be evaluated. Critics of benefit-cost analysis often focus on the valuation

---

[1] The Corps is an executive branch agency within the Department of Defense that has both civil and military programs. Under its civil works mission, the Corps evaluates, plans, and implements water and related land projects in two major areas: water infrastructure (primarily flood control and navigation), and environmental management/ restoration. For more information on Corps programs see RS20866. "The Civil Works Program of the Army Corps of Engineers: A Primer."

[2] It should be noted that most other large federally sponsored infrastructure projects, such as airports and highways, are evaluated at the state level, where they may or may not be subject to benefit-cost analysis requirements. The federal role for these projects generally is to provide funding, not to physically construct the projects.

techniques used to calculate benefits and costs, and on the discount rate used to compare benefits and costs throughout time.[3]

Over the last few years, the Corps' project planning and evaluation process has stimulated significant controversy.[4] In 2000, allegations of improper manipulation of an economic study raised concerns about the integrity of the Corps' planning process.[5] Specifically, a Corps economist contended that officials manipulated a benefit-cost analysis to support a large and expensive project on the Upper Mississippi River-Illinois Waterway.[6] The Department of Defense responded to this allegation by conducting an internal investigation which suggested that the Corps may have an institutional bias toward large construction projects.[7] In 2001, at the request of the Department of Defense, the National Research Council, an arm of the National Academy of Sciences, examined the Upper Mississippi River-Illinois Waterway and criticized the assumptions and data used to conduct the Corps' feasibility study.[8] The Corps has been criticized for other projects as well. For example, a General Accounting Office (GAO) report released in June 2002 found that miscalculations, invalid assumptions, and inconsistent discount rates caused the Corps to overestimate the benefits of the Delaware River Deepening Project.[9]

Concerns regarding the Corps' project evaluation process have resulted in increased congressional scrutiny of the agency in recent years. Congress typically supports Corps projects through new and revised project authorizations in the (usually) biennial Water Resource Development Acts (WRDA), and through annual appropriations bills.[10] However, the 107th Congress did not pass legislation approving

---

[3] The Corps has also been criticized for undervaluing benefits and costs that cannot be easily measured monetarily (*e.g.*, benefits and costs associated with the destruction or production of fish and wildlife habitat or wetlands as system functions).

[4] For more information on proposed changes to the Army Corps of Engineers' planning process see: CRS Report RL30928, *Army Corps of Engineers: Civil Works Reform Issues for the 107th Congress.*

[5] These concerns were explored at length in a series of *Washington Post* articles dated February 24 and 25 and March 7, 2000 and several congressional hearings by the Senate Committee on Environment and Public Works, Subcommittee on Transportation and Infrastructure in 2000 and 2001.

[6] This economist served for 5 years as the technical manager of the economic study for the lock expansion project. For more information, see "Affidavit of Donald C. Sweeney" at: [http://www.qui-tam.com/CRaffidt.htm] on Nov. 13, 2002.

[7] Elaine Kaplan, U.S. Office of Special Counsel. Memo to the White House Re: OCS File No. DI-00-0792 (Dec. 6, 2000), p.7, point 2.

[8] National Academy of Sciences, *Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway* (Washington, DC: National Academy Press, 2001).

[9] U.S. General Accounting Office, *Report to Congressional Requesters: Delaware River Deepening Project; Comprehensive Re-analysis Needed*, GAO-02-604 (Washington, DC: June 2002) at [http://www.gao.gov].

[10] For more information on the project authorization and appropriation processes, see CRS Report RS20866 *The Civil Works Program of the Army Corps of Engineers: A Primer*

(continued...)

new Corps projects, in part due to disagreement over proposals to reform the Corps' project development process. Both Chambers of the 107th Congress held hearings examining the Corps' methodologies and several bills were introduced to change how the Corps plans for and evaluates its projects. One bill (S. 1987) called for independent peer review, for increasing the requisite benefit-cost ratio to 1.5, and for updating project planning guidelines.[11] Furthermore, House and Senate Appropriations Committees, which are responsible for Corps funding,[12] have expressed concerns about the Corps' project development process.[13]

Given recent congressional interest in how the Corps plans for and evaluates federal water projects, this report examines the federal planning guidelines for the Corps' water project evaluations. These planning guidelines establish the objectives of federal water projects, guide which benefits and costs contribute to the objectives, delineate methodologies for measuring benefits and costs, and set the discount rate formula. Each of these four components influences the benefit-cost ratio and each of these policy decisions is discussed below. Following a general history of federal water project planning guidelines, this report focuses on the discount rate. It describes the present discount rate, alternative methods for deriving a discount rate, and how the discount rate affects each project's benefit-cost ratio. Although this report focuses on the Corps, the project evaluation procedures and the discount rates that are described in this report also apply to the Bureau of Reclamation (Dept. of the Interior), the Tennessee Valley Authority (a government corporation),[14] and the Natural Resource Conservation Service (Dept. of Agriculture).[15]

The Corps Planning Guidelines: Federal Objectives

The Corps evaluates projects based on federal objectives as they are defined in federal water resource project planning guidelines. Specifically, the *Economic and*

---

[10](...continued)
(January 13, 2003).

[11] Honorable Bob Smith Statements on Introduced Bills and Joint Resolutions, regarding S. 1987, *A bill to provide for the reform of the Corps of Engineers and other Purposes.* (*Congressional Record,* Daily Ed. (March 5, 2002) S1539. Hearing held on June 18, 2002.

[12] Corps funding is provided annually in title I of the Energy and Water Development Appropriations Acts. For more information on the Corps appropriations, see CRS Report RL31307, *Appropriations for FY 2002: Energy and Water Development*.

[13] For more information on congressional action, see CRS Report RL30928, *Army Corps of Engineers: Civil Works Reform Issues for the 107th Congress*. Appropriations Committee reports that include comments on this subject include: H.Rept. 106-693, S.Rept. 106-395, H.Rept. 107-112, S.Rept.107-39.

[14] The TVA is a wholly owned government corporation created by the Act of May 18, 1933 (16 U.S.C. 831). All functions of the Authority are vested in its three-member Board of Directors, the members of which are appointed by the President with advice and consent of the Senate. (See the *U.S. Government Manual* for 2001-02, p. 534.)

[15] The Corps is the focus of this report primarily because its project evaluation processes have been the subject of recent controversy and congressional hearings. The Corps is also the largest water resource agency in terms of funding and number of projects.

Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (Principles and Guidelines or *P&G),* guide water project evaluations.[16] Under the *P&G,* the objective of Corps projects is to increase National Economic Development (NED), thus the Corps is required to measure each project's contribution to this objective. Whenever feasible, these effects are to be measured in monetary terms, which are then used to calculate a benefit-cost ratio. These monetary measurements of NED are significant, because a project must generally have a benefit-cost ratio of at least 1.0 to be approved by the Corps.[17]

While the *P&G* emphasize the National Economic Development objective, previous planning guidelines had other, sometimes broader, planning objectives. Congress first established federal guidelines for evaluating the Corps' civil projects in the Flood Control Act of 1936.[18] This Act provides the basis for project evaluation by stating that a project should be undertaken "if the benefits to whomsoever they may accrue are in excess of the estimated costs" and if a project is needed to improve the lives and social security of the people.[19] Since then, planning guidelines have narrowed this objective to focus on specific types of benefits and costs. (See table 1, page 17, for the effective dates of federal planning guidelines.)

The first major implementation guidance for this statute was a 1950 report entitled *Proposed Practices for Economic Analysis of River Basin Projects*.[20] This document, which is known as the *Green Book*, states that the objective of benefit-cost analysis should be to maximize general economic welfare and economic efficiency from a comprehensive public viewpoint. Furthermore, the *Green Book* recommends that this broad objective include both market and non-market benefits and costs. For example, the benefits from a flood control project should include non-market benefits such as saving human lives, as well as market benefits, such as protecting physical property. Therefore the *Green Book* narrowed the objective of benefit-cost analysis to economic welfare and economic efficiency, but defined these objectives in broad terms (*i.e.* it included non-market effects).

While implementing the *Green Book* was voluntary, many of its procedures became mandatory in 1952, when they were incorporated into a document of the Bureau of the Budget (predecessor to the Office of Management and Budget) entitled

---

[16] U.S. Water Resources Council, *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*, approved by President Reagan on February 3, 1983 (pursuant to P.L. 89-80, as amended; 42 U.S.C. 1962). (Hereafter referred to as Principles and Guidelines or *P&G*) at: [http://www.iwr.usace.army.mil/iwr/pdf/p&g.pdf] on Nov. 11, 2002.

[17] To recommend a project with a benefit-cost ratio of less than one, the Corps must find that there is another, overwhelming, reason to pursue the project.

[18] Flood Control Act of June 22, 1936, ch. 688, 49 Stat. 1570 (33 U.S.C. 701). For a list of the documents governing the Corps' discount rate, see table 1 and table 2.

[19] *Ibid.*

[20] Federal Inter-Agency River Basin Committee, Subcommittee on Benefits and Costs. *Proposed Practices for Economic Analysis of River Basin Projects* (Washington, DC: May 1950).

"Budget Circular A-47."[21] Through Circular A-47, benefit-cost analysis became the dominant component of project evaluation. Circular A-47 states that, "except for unusual cases where adequate justification is presented," a project's estimated benefits must exceed its estimated costs. Throughout the 1950s, the Bureau of the Budget would not approve Corps projects that did not have a benefit-cost ratio, in terms of monetized benefits and costs, of at least 1.0. Although Circular A-47 states that benefits and costs should be estimated in monetary terms or in the most quantitative terms possible, a benefit-cost ratio only includes values measured in dollars. Non-market benefits and costs are included only when they are converted into dollars. Since monetization of non-market benefits and costs can be difficult and is often controversial, the Corps interpretation of Circular A-47 appeared to emphasize market over non-market benefits and costs.

The move toward a market benefit emphasis encountered resistance along the way. Throughout the 1950s, legislation was proposed to broaden evaluation procedures. In 1962, the Kennedy Administration, acting on a 1960 recommendation of the Senate Select Committee on Water Resources, further revised the guidance for water project planning and evaluation by preparing *Policies, Standards and Procedures in the Formulation, Evaluation, and Review of Plans for Use and Development of Water and Related Land Resources (P&S).*[22] These were printed as S.Doc. 97. This document replaced the strict benefit-cost ratio test with more general objectives. It stated that the basic purpose of project formulation is to provide the "best use, or combination of uses, of water and related land resources to meet all foreseeable short or long-term needs." In order to achieve this goal, S.Doc. 97 recommended that the Corps pursue multiple objectives, including economic development, preservation, and the well being of people.[23]

The Corps' evaluation process began changing again in 1968, when the then-active Water Resources Council[24] (WRC) began revising the mandatory guidelines printed in S.Doc. 97. In July 1970, a Special Task Force of the Water Resources Council (Special Task Force) proposed a new set of Principles and Standards (*P&S*) to supplant S.Doc. 97 for evaluating water resource projects. This proposal stated that the Corps should quantify a project's benefits and costs in terms of national economic development; quality of the environment; regional development; and social factors. Furthermore, it made clear that national economic efficiency should no longer be considered the

---

[21] Bureau of the Budget, Circular A-47 (Dec. 31, 1952).

[22] *Policies, Standards and Procedures in the Formulation, Evaluation and Review of Plans for Use and Development of Water and Related Land Resources,* S.Doc. 97 (87th Congress, Second Session), (Washington, DC: 1962) These were reissued in 1986; see 33 *Fed.Reg*. 19170 (Dec. 24, 1968) and 18 CFR §704.39. U.S.

[23] H.W. Shen, editor, "Chapter 20: Federal Guidelines for Water Resource Project Evaluation." *Environmental Impact on Rivers*. (Fort Collins, CO: Colorado State University, 1973), p. 20-6. (Hereafter referred to as Shen.)

[24] The Water Resources Planning Act of 1965 (P.L. 89-80, 78 Stat. 245; 42 U.S.C. 1952) created the Water Resources Council within the Executive Office of the President and gave it responsibility for establishing benefit-cost guidelines. The Reagan Administration abolished the active program of the Water Resource Council in the early 1980s; however, statutory authority for the agency remains.

primary objective. This proposal of the Special Task Force never went into effect. After review of the proposal and consultation with the Office of Management and Budget, the Water Resources Council published a revised version of the *P&S* for public comment.[25] In contrast to the proposal of the Special Task Force, the final version of the *P&S*,[26] which took effect in 1973, was much narrower in its approach to selecting feasible water projects. Specifically, it focused on a single national economic development objective.

The 1973 Principles and Standards remained in effect only a few months before being revised the direction of Congress. In 1974, the first in what has become a generally biennial series of Water Resource Development Acts (WRDA), was enacted.[27] Under § 80(c) of WRDA 1974, the President was authorized to study and revise the *P&S*, inclusive of interest rates, cost-sharing, and the multiple objectives suggested by the Special Task Force in 1970. One of the most significant features of the newly revised *P&S* under WRDA 1974 was that environmental matters were placed on a footing equal to economic development. As re-issued in 1980, the *P&S* relied on four co-equal accounts: national economic development, quality of the environment, regional development, and social factors. Although they were in effect, these accounts never gained political acceptance during an extended legislative and executive debate over water policy.

In September1982, the Water Resources Council repealed the Principles and Standards (*P&S*) and established the Principles and Guidelines (*P&G*)[28] which were approved by President Reagan in February 1983 and currently remain in effect.[29] The *P&G* establish four accounts, similar to the objectives under the *P&S*, including: National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Societal Effects (OSE).[30] Unlike the *P&S*, however, the *P&G* did not place equal weight on the four accounts. According to these *Principles and Guidelines*, "the federal objective of water and related land resources

---

[25] 36 *Fed.Reg*. 24144 **(**Dec. 21, 1971).

[26] The final version of the *P&S* which was approved by the President, was published in 38 *Fed.Reg*. 24778 (Sept. 10, 1973).

[27] Water Resources Development Act, March 3, 1974, P.L. 93-251, amended the *Federal Water Project Reclamation Act* (16 U.S.C. §460)

[28] The *P&G* were established pursuant to 42 U.S.C. §1962-a-2 and replaced the *P&S* (18 CFR, Parts 711, 713, 714, and 716).

[29] 38 *Fed.Reg*. 30993 (November 7, 1973).

[30] The NED "account displays changes in the economic value of the national output of goods and services." The EQ account "displays non-market effects on significant natural and cultural resources." The RED account "registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using national consistent projections of income, employment, output, and population." The OSE "account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts." *Economic and Environmental Principles for Water and Related Land Resources Implementation Studies.* 22 April 2000, established pursuant to the Water Resources Planning Act of 1965 (P.L. 89-80) as amended (42 U.S.C. §1962a-2 and d-1).

project planning is to contribute to the national economic development" consistent with national environmental law and other federal planning requirements. Therefore, the NED account is the most significant of the four accounts, and the only mandatory account used to evaluate federal water projects. Components of the other three accounts are often included in the NED account when they are monetized, but they are not considered as equivalent objectives.[31] The *P&G* further emphasizes the importance of the NED account by instructing the Corps to choose the NED-maximizing alternative unless "there are overriding reasons for recommending another plan, based on other Federal, State, local or international concerns."[32] Ultimately, therefore, the Corps' project recommendation largely rests on whether or not the project's NED benefits outweigh its NED costs.

Quantifying Benefits and Costs: National Economic Development

Given an objective, in this case national economic development, the second component of benefit-cost analysis is deciding which variables should be included. As with the selection of an appropriate discount rate, deciding which benefits and cost will be included and how they will be measured is a controversial and somewhat subjective process. For federal water projects, the *P&G* define which variables the NED account may include, notably increases and decreases in categories of goods and services expressed in monetary units; however, it does not include those benefits and costs that the Corps chooses not to value in monetary terms. The specific types of NED benefits and costs are described in the following paragraphs.

NED Benefits. The *P&G* establish procedures for identifying and measuring NED benefits. They define NED benefits as "increases in the national economic value of the national output of goods and services from a plan; the value of output resulting from external economies[33] caused by a plan; and the value associated with the use of otherwise unemployed or under-employed labor resources."[34] This definition means that NED benefits are the direct and indirect increases in production and employment attributable to a plan. Production benefits are measured "as the willingness of users to pay for each increment of output" a plan will create.[35] A project's output may include increases to the following categories of goods and services: municipal and industrial water supply; agricultural flood-water reduction; agricultural drainage; agricultural irrigation; erosion and sedimentation reduction; urban flood damage reduction; hydropower; transportation; recreation; and commercial or recreational fishing. (See

---

[31] If the RED and NED accounts were both considered equally, for example, the regional distribution of costs and benefits would be taken into consideration. Under the P*&G*, benefits to one region can offset the costs in another region. Likewise, economic benefits can offset any measurable environmental costs.

[32] *Principles and Guidelines*

[33] This term, "external economies," refers to the "cost-saving benefits of locating near factors (of production) which are external to the firm, such as locally available skilled labor, training, and resource and development facilities."

[34] *Principles and Guidelines*, 8.

[35] *Ibid.*, 9.

figure 1.) NED benefits can also include other direct benefits that "result from incidental increases in outputs of goods and services or incidental reductions in production costs."[36] For example, another direct benefit of a project designed to produce hydropower and to reduce flood damage might be to store water for summer irrigation releases.

As outlined below, the NED account may include a wide variety of direct benefits. However, it does not address the distribution of project benefits. For example, the NED benefit calculation does not distinguish between the benefits that are gained by a few people (*e.g.*, local barge owners) and those that are spread widely (*e.g.*, over all electricity consumers).

Figure 1. NED Benefits

Use of unemployed or under-employed labor*

Goods and services
a) Municipal and industrial water supply
b) Agricultural floodwater, erosion, and sediment reduction
c) Agricultural drainage
d) Agricultural irrigation
e) Urban flood damage reduction
f) Hydropower
g) Transportation
h) Recreation
i) Commercial Fishing

Other direct benefits*

* No sub-categories listed
Source: U.S. Water Resources Council, National Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. February 3, 1983

NED Costs. As described in the *P&G*, a project's NED account includes two categories of costs: implementation outlays and other direct costs. The first cost category, implementation outlays, are those costs that require the direct expenditure of money. It includes all the payments made to construct, operate, and maintain a project.[37] As shown in figure 2, the major sub-categories of implementation costs, as outlined by the *P&G*, are: post-authorization planning and design costs; construction costs; construction contingency costs; administrative services costs; fish and wildlife habitat

[36] *Ibid.*, 91. To the extent possible, the value of these goods and services is equal to their market price.

[37] U.S. Department of the Army, Corps of Engineers, Institute for Water Resources. *National Economic Development Procedures Manual-National Economic Development Costs*; Report 93-R-12 (Washington, DC: June 1993). (Hereafter referred to as NED Costs Report). Available at: [http://www.iwr.usace.army.mil/iwr/pdf/93r12.pdf] on Dec. 12, 2002

mitigation costs; relocation costs; historical and archaeological salvage operations costs; and land, water, and mineral rights costs.[38]

The second cost category, other direct costs, are "the costs of resources directly required for a project or plan," but for which no dollars are expended.[39] Basically, these non-market costs fall into three categories: implicit costs of displaced resources; uncompensated NED losses; and negative externalities[40] (figure 2). The implicit costs category includes the resources used for project completion for which no money is expended (*e.g.*, land or other resources donated for the project). Uncompensated NED losses result when the installation, operation, maintenance, or replacement of a project reduces the economic output (*e.g.*, loss of recreation user days from temporary decrease in water releases). These losses differ from implicit costs in that they are not necessarily associated with project construction. Negative externalities are the implicit or explicit costs for affected third parties (*e.g.*, loss of commercial or sport fishing).

Figure 2. Allowable NED Costs

Implementation Costs
- Post-authorization planning and design costs
- Construction costs, construction contingency costs
- Administrative services costs
- Fish and wildlife habitat mitigation costs
- Relocation costs
- Historical and archaeological salvage operations costs
- Land, water and mineral rights costs

Other Direct Costs
- Implicit costs of displaced resources
- Uncompensated NED losses
- Negative externalities

Source: U.S. Department of the Army, Corps of Engineers, Institute for Water Resources, *National Economic Development Procedures Manual- National Economic Development Costs;* Report 93-R-12.

As outlined above, the NED account may include a wide variety of direct costs; however, it does not address some qualitative equity concerns regarding the distribution of a project's costs. For example, the NED cost calculation does not distinguish between construction costs that are spread widely (*e.g.*, over many tax payers) and those that are borne by a few people (*e.g.*, commercial fishermen). Likewise, the NED account does not identify projects whose costs will be paid by people with specific age, income, or other demographic characteristics.

[38] *Ibid*.

[39] *Principles and Guidelines*, p. 99.

[40] NED Costs Report.

Evaluating NED Benefits and Costs

In addition to describing the types of benefits and costs that may be included in the NED account, the *P&G* outline the methods for evaluating the magnitude of these benefits and costs. Specifically, the *P&G* state that benefits and costs should be expressed in real, as opposed to nominal, prices.[41] This rule means that the Corps' estimates of future costs and benefits are based on today's price level (*i.e.* they are adjusted to remove the influence of expected inflation).[42] Calculating real (constant) dollar values attributable to some of the aforementioned benefits and costs, varies in difficulty. Whenever possible, the Corps values benefits and costs using market prices for the good or service. For example, the value of protecting structures from flood damage is based on the structures' market values. However, the valuation process becomes more challenging and controversial as the good in question becomes further removed from one that is traded in an actual market or will be traded in the more distant future. For example, it is more difficult to value a project's recreational benefits, or environmental costs, than to value its electricity benefits. For this reason, this approach has been criticized by economists, environmentalists and fiscal conservatives. However, the Corps is working to improve its non-market valuation methodologies. A discussion of these methods is beyond the scope of this report.[43]

The Discount Rate: Discounting Future Benefits and Costs

After quantifying all of the NED benefits and costs to whomever they may accrue, the next step in the analysis is to compare the benefits to the costs. This process is complicated by the fact that Corps projects take several years to construct and their projects and benefits continue for an indefinite number of years. In practice, the Corps evaluates benefits and costs over a period of up to 100 years.[44] Benefits and costs accrued at different points in this 100 year period are not directly comparable. Rather, a dollar earned today has more value than one earned tomorrow because people prefer to spend money today, and because a dollar could be invested today to yield more than a dollar tomorrow.[45] To compare benefits and costs accrued in different periods, the

---

[41] See *Principles and Guidelines* § 1.4.1(b) which reads: "The general level of prices for outputs and inputs prevailing during or immediately preceding the period of planning is to be used for the entire period of analysis."

[42] Specifically, all of the prices used to value benefits and costs are expressed in constant dollars.

[43] For more information on one common tool, contingent valuation, see CRS Report RL30242, *Assessing Nonmarket Values through Contingent Valuation*.

[44] According to the *P&G* (p.5), the period of analysis is to be the time required for implementation plus the lesser of (1) the period of time over which any alternative plan would have significant beneficial or adverse effects; or (2) a period not to exceed 100 years.

[45] Inflation also decreases the value of future benefits and costs when they are measured in *nominal* dollars, but not when they are measured in *real* dollars. Again, *real* dollars have already been adjusted for inflation, but *nominal* dollars are not.

Corps must convert future benefits and costs to present values.[46] This conversion process, known as discounting, requires the use of an interest rate, also known as the discount rate.

The discount rate is important because it has a major impact on the outcome of benefit-cost analyses. "A high discount rate places a low value on future benefits and as such will justify only projects with very high [future] rates of return, whereas a low discount rate is more lenient."[47] In this manner, the level of the discount rate has a significant effect on projects that provide benefits over a long time horizon, but have large initial construction costs. Conversely, projects with high maintenance costs and large near-term benefits are the least affected by a high discount rate.

How the Calculation Works. The overall effect of the discount rate on a project's benefit-cost analysis depends on the distribution of each project's benefits and costs. Figure 3 provides an example of how the discount rate affects two projects with different distributions of benefits and costs over time. For simplicity, benefits and costs are assumed to occur in only two time periods: year one (the short-run) and year 50 (the long-run). In this example, the benefits and costs are stated in real dollars, thus the discount rates shown in examples (A) and (B) are real rates of return.[48]

In example (A), the discount rate has very little effect on the project's benefit-cost ratio because there are large short-run benefits. Specifically, the short-run (SR) benefits equal $100 and the short-run costs equal $90 while the long-run (LR) benefits and costs are both $100. When the discount rate is zero, the benefit-cost ratio is ($100+$100)/($90+$100) or 1.05. When the real discount rate is 6%, the long-run benefits and costs are discounted.[49] Specifically, the present value of $100 is equal to $100/ $[(1+0.06)^{50}]$ or $5.42. In this manner, the benefit-cost ratio with a discount rate of 6% is (100+5.42)/(90+ 5.42) or 105.42/95.42 or 1.10. Therefore, this project would pass the benefit-cost ratio test regardless of the discount rate.

The discount rate has more impact on projects that generate few near-term benefits, but for which benefits accrue over a long time horizon as is the case for many Corps projects. In figure 3, example (B), the project has few short-run benefits ($60) but large long-run benefits ($400). Furthermore, the project's short-run costs ($100) are larger than the short-run benefits, while the long-run costs ($50) are much lower than the long-run benefits ($400). With a zero discount rate, the benefit-cost ratio would be 3.07.

---

[46] Rather than convert future benefits and costs into a single present value, they could also convert those values into average annual benefits and costs.
U.S. Department of the Army, Corps of Engineers, *National Economic Development Procedures Manual- National Economic Development Cost,*. IWR Report 93-R-12 (Washington, DC; June 1993).

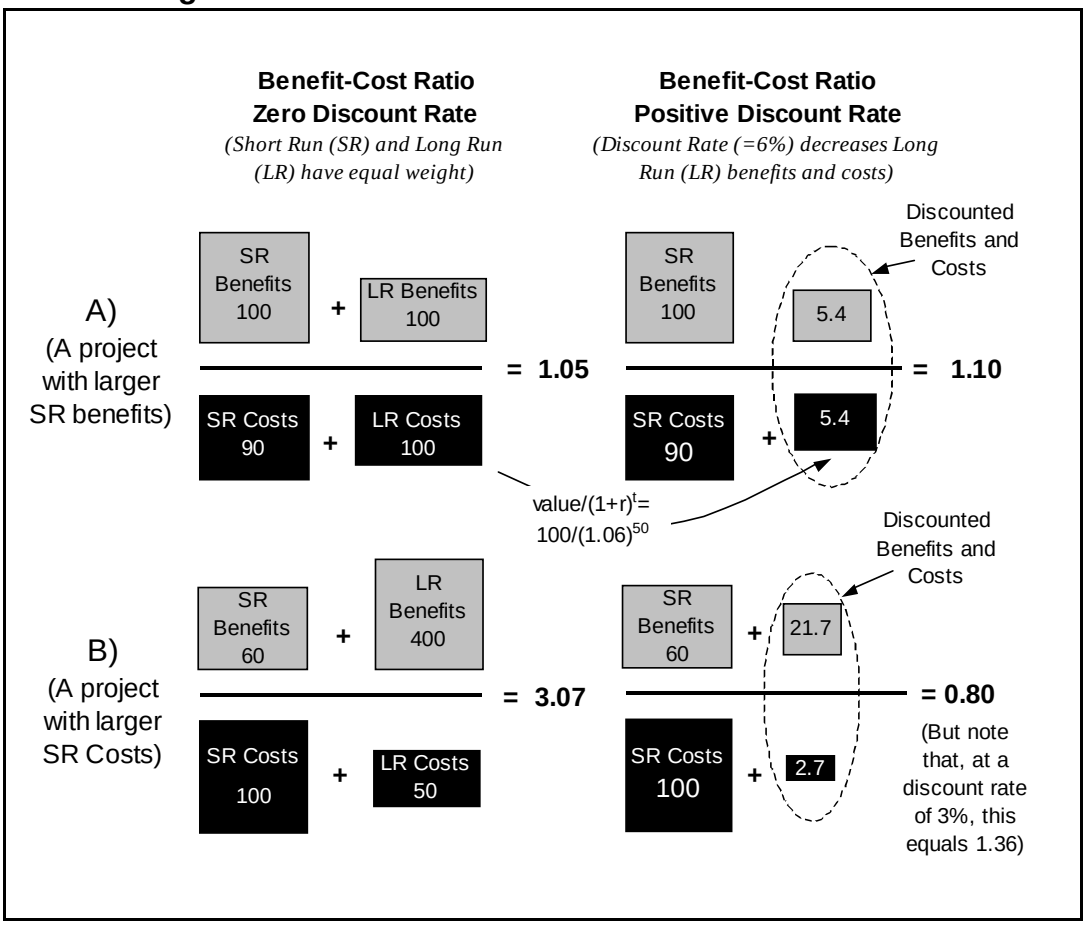
[47] CRS Report 76-150. *Benefit-Cost Analysis of Water Resource Projects.*

[48] Benefits and costs measured in real dollars should be discounted using a real discount rate. Nominal dollars should be discounted using a nominal discount rate.

[49] To discount future benefits or costs, the following formula is used: Future benefit or cost divided by $(1+ \text{discount rate})^{t}$, where t equals the number of years. In this case, (t) is 50 because that is the average length of analysis for water projects. In reality, benefits and costs for each year (1 through 50) would be discounted.

However, a 6% discount rate would cause the benefit-cost ratio to decrease to 0.80. At this rate, the project would not pass the benefit-cost ratio test. If the discount rate was lowered to 3%, however, the project in example (B) would pass the test with a benefit-cost ratio of 1.36. As shown in example (B), the discount rate could dictate whether or not a project passes the benefit-cost ratio test.

Figure 3. Benefit-Cost Ratios and the Discount Rate



Choosing an "Appropriate" Discount Rate

The discount rate is an important variable in benefit-cost analysis because it determines the relative weight of current *vis-a-vis* future benefits and costs. Unfortunately for policymakers, however, academic experts disagree on the appropriate discount rate for evaluating whether a public investment is good for the nation.[50] The debate has economic, political, and ethical components. On one level, scholars debate whether or not agencies should discount a project's future benefits or costs, especially when they are difficult to monetize and will be realized by future generations.[51]

---

[50] This report describes the discount rate used for evaluating public investment decisions, that is the rate that is used when deciding whether or not a public investment is good for society. However, this rate may be different than the rate used to show budgetary impact. A project that results in net social benefits may not be good for the budget.

[51] Although most experts agree that it is appropriate to discount monetary sums payable to

(continued...)

However, most economists support discounting because constructing and maintaining a federal project diverts resources from other investments or from consumption.[52] Therefore, each investment has a cost. This cost is either associated with the return that could be earned on the next best use of capital (known as the opportunity cost of capital or OCC) or the rate of return that must be paid to induce people to defer an additional unit of current consumption (this is equivalent to their marginal social rate of time preference (SRTP)).[53] Discounting is the method for incorporating these costs into benefit-cost analysis.

In a perfectly functioning market, a discount rate calculated to reflect the SRTP or the OCC would be identical. However, capital market imperfections, such as taxes,[54] risk aversion, and uncertainty cause these discount rates to differ and cause disagreement regarding the discount rate calculation. Economists have generally proposed four major formulations for calculating the social discount rate: the pre-tax return on investment method, the after-tax savings method, the shadow price of capital method, and weighted-average method.[55] (See figure 4.) These formulas are described below and are followed by a more specific description of the Corp's discount rate.

---

[51](...continued)
future generations, some philosophers, legal scholars and economists have argued that the non-market benefits and costs passed to future generations are just as valuable as those accrued today, and thus should not be discounted. Edward R. Morrison, "Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis." *The University of Chicago Law Review*, V. 65 (1998): 1333-1369. (Hereafter referred to as Morrison.)

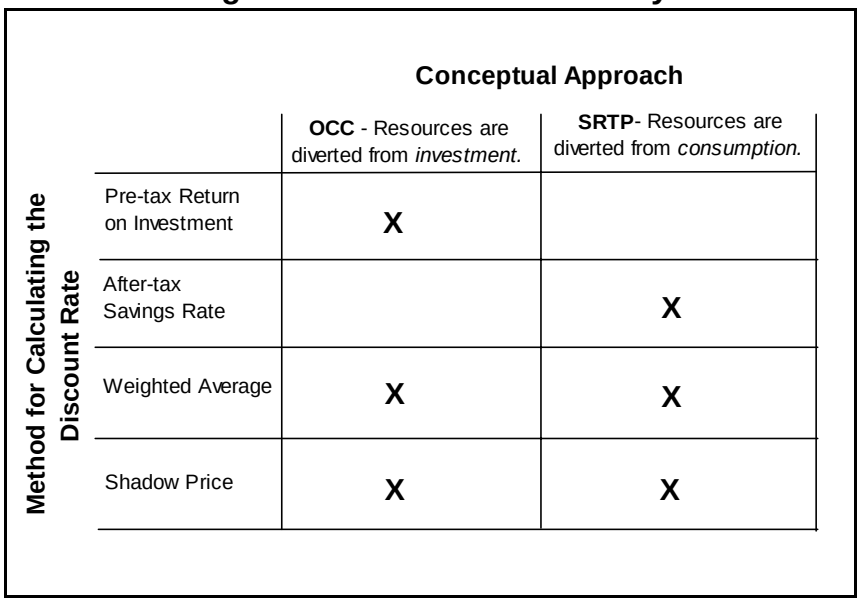
[52] Federal Aviation Administration, Department of Transportation. "Chapter 5: Multi-period Economic Decision Criteria" at: [http://www.api.faa.gov/apo3/tofc.htm] on Dec. 2, 2002. (Hereafter referred to as FAA.) See also: Marco Boscolo, Jeffrey Vincent, and Theodore Panayotou, *Discounting Costs and Benefits in Carbon Sequestration Projects*, Harvard Environment Discussion Paper No. 41 (Feb. 1998). (Hereafter referred to as Boscolo *et al.*)

[53] The SRTP is composed of two factors: 1) a pure rate of time preference based on people's desire to gain short-term gratification, and 2) an assumption that per capita consumption will grow over time, diminishing marginal returns to future consumption. (FAA, page 5-2)

[54] According to Robert Anderson, Office of Management and Budget, Feb. 11, 2003, the corporate income tax is one of the main reasons for differences between the numbers that come out of different discounting approaches.

[55] Boscolo *et al.*

Figure 4: Discount Rate Theory



Pre-Tax Return on Investment. One method for calculating a discount rate that approximates the next best use of capital, known as the opportunity cost of capital (OCC), is the pre-tax return on investment. The pre-tax return on investment is the rate of return on private-sector investments, adjusted for inflation.[56] Most federal benefit-cost analyses use a discount rate based on this approach as established by the OMB.[57] Specifically, the Office of Management and Budget (OMB), in Circular A-94,[58] sets a base discount rate that is the average rate of return to private capital consistent with national income and product accounts.[59] The OMB believes that this rate is appropriate for evaluating public investments because it accounts for the displacement of private investment.[60] The rate is currently set at 7%.[61]

---

[56] See FAA, and Boscolo *et al.* This method is based on the idea that investing in private markets is the best alternative use of capital to using the capital to fund federal projects. Using this rate of return allows policymakers to compare the project's rate of return to what return might have come from investing the same capital in private markets.

[57] However, it should be noted that very few agencies actually conduct benefit-cost analyses and those that do have some leeway to use other rates in addition to the OMB's base rate. Water projects are exempt from Circular A-94, so they do not use the OMB's base discount rate.

[58] Office of Management and Budget, *Circular A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Program*, Transmittal Memo No. 64, at: [http://www.whitehouse.gov/omb/circulars/a094/a094.pdf] on 1/31/03.

[59] Discussion with Norm Starler, the Office of Management and Budget, Washington, DC, on February 11, 2003.

[60] Circular A-94

[61] In 1992, the OMB lowered this discount rate from 10% to 7%. One reason the rate was changed is that tax rates on capital were lowered between the 1960s and 1990s.

Although this formula is widely used, calculating a discount rate using the pre-tax rate of return on private investments is still contentious. In part, the difficulty is based on the vast array of possible private sector interest rates. Additionally, there are a number of theoretical bases for arguing that the pre-tax rate of return on private sector investment does not accurately measure the opportunity cost of capital. For example, some argue that this formula generates an average rather than a marginal rate of return.[62] Furthermore, the private sector rate of return may reflect individual rather than societal premium for risk.[63] This argument is based on the perspective that people may be more willing to accept risks as a group than as individuals. Therefore, a rate based purely on the pre-tax return on investment may overestimate the discount rate thereby making it more difficult to obtain a benefit-cost ratio of greater than one, particularly for long-lived projects.

After-Tax Savings. The resources used to construct federal water projects may also be diverted from consumption through taxes. Therefore, some economists believe that the discount rate should reflect the compensation required by society to substitute future consumption for current consumption (i.e., the SRTP).[64] This is sometimes measured as the rate of return on U.S. Treasury debt adjusted for inflation and taxes.[65] The discount rate used by the Corps and other water resource agencies generally follows this method, but the water project rate is not adjusted for taxes.[66] Today, this rate is 5.875%.

Using the after-tax savings rate as the discount rate faces a number of critiques. As with the pre-tax rate of return on private investments, the this formula may generate an individual rather than a social rate of time preference even if it is equal to the individual rate of time preference. According to economists at the Federal Aviation Administration, "observed interest rates reflect the preferences of individual members of society who have finite lives and are currently living."[67] Because society exists for an indefinite time period, it may place more value on future consumption than would an individual. Therefore, observed rates may overestimate the discount rate for actions

---

[62] A.E. Bordman, D.H. Greenberg, A.R. Vining, and D.L. Weimer. *Cost-Benefit Analysis: Concepts and Practice, (*Upper Saddle River, NJ: Prentice Hall, 1996). A marginal rate of return is more appropriate for evaluating proposed projects because it is the rate of return that could be earned if the capital were invested rather than an average of what has been earned on past investments. From a numerical standpoint, this is important because marginal rates of return are usually lower than average rates of return.

[63] Boscolo *et al.*, p. 5.

[64] FAA., p. 5-4.

[65] Boscolo *et al.*, 5-4. Specifically, the After-Tax Savings rate equals the (pre-tax real discount rate) * (1-tax rate) or around 2.5 to 5 percent. See Richard O. Zerbe, Jr. and Dwight D. Dively. *Benefit-Cost Analysis: In Theory and Practice*, (New York, NY: HarperCollins College, 1994), 287.

[66] The OMB also recommends a discount rates based on the Treasury's borrowing rates in certain circumstances. Specifically, the OMB suggests the Treasury's rates for: 1) cost-effectiveness analysis, 2) lease-purchase analysis, 3) internal government investments, and 4) asset sales analysis. (Circular A-94)

[67] FAA, p. 5-5.

that will affect the distant future, but it may be less relevant for projects with short and medium-term effects. Conversely, some economists argue that a riskless rate of interest, such as the Treasury rate, should not be used for evaluating long-term projects. There is also an argument that tax finance should take into account the welfare loss from taxes, called the excess burden of taxation. The excess burden of taxation is the difference between welfare gains from trade with and without taxes.[68] Such a welfare loss could be reflected in a higher discount rate.

The Weighted-Average Method. The weighted average method recognizes that a project may divert resources from consumption and from alternative investments. If the resources were not used for a federal project, for example, the public could spend the money, or the money could be invested in the private sector. Since the social rate of time preference and the opportunity cost of capital may yield different discount rates, the weighted average method uses a discount rate that combines the pre-tax return on investment and the after-tax savings techniques. Specifically, this method defines the social discount rate as the weighted[69] average of the SRTP (which is often computed as the post-tax savings rate of return) and the OCC (typically computed as the pre-tax return on private investment),[70] so it faces the same critiques as both methods.

The Shadow Price of Capital. In addition to the other three methods, the OMB and some economists prefer a third approach to discounting known as the shadow price. However, the shadow price of capital approach is rarely used to examine federal projects because it has stringent information requirements. It also generates different discount rates for each project depending on how the project affects future consumption and investment. For more information on how to compute the shadow price of capital see FAA or Boscolo *et al.*[71]

History of The Discount Rate Used by the Corps

Unlike most federal agencies,[72] the Corps and three other water resource agencies conduct water project evaluations using a discount rate dictated by specific planning guidelines rather than the base rate set by the Office of Management and Budget.[73] (See table 1.) The first discount rate formula for federal water projects was established in the *Green Book* (1950). These voluntary guidelines stated that the "interest rate for Federal, non-Federal public, and private investment should in general use the long-term

---

[68] Richard Zerbe *et al.*, p. 128.

[69] The weights reflect assumptions about the percentage of resources that are diverted from consumption and from alternative investments. The weights are not project-specific.

[70] Boscolo *et al.*, p. 7. The weights represent the percentage of resources diverted from consumption versus the percentage diverted from savings.

[71] FAA, p. 5-1. Boscolo *et al.*, p. 6.

[72] Other agencies with oversight over large construction projects, such as the FAA or DOT, generally do not conduct benefit-cost analysis. Any such analysis likely occurs at the state level, and the federal agency provides partial project funding.

[73] Agencies, such as the EPA, which do conduct benefit-cost analyses of proposed regulations, are required to use the base rate set by OMB Circular A-94.

borrowing rate applicable." In this manner, the *Green Book*, and all subsequent planning guidelines have used a discount rate formula based on the average interest rate on long-term U.S. Treasury bonds.[74]

Table 1. Discount Rate Guidelines for Federal Water Projects

Document	Effective Dates
Bureau of the Budget Circular, A-47	12/31/1952- 05/15/1962
Senate Document 97	05/15/1962- 12/24/1968
Water Resources Council	12/24/1968- 10/25/1973
Principles and Standards	10/25/1973- 03/07/1974
WRDA 1974 § 80	03/07/1974- present

Over time, the discount rate formula changed in subtle ways. The first mandatory guidelines were established in 1952 by the Bureau of the Budget, in Circular A-47. In this document, the Bureau of the Budget stated that the discount rate should be "the average rate of interest payable by the Treasury on interest-bearing marketable securities of the United States outstanding at the end of the fiscal year preceding such computation." Furthermore, the choice of which market securities rate to use was based on the economically useful life of the project being evaluated. If the economically useful life of the project was longer than 15 years, then the marketable securities in question were to be those that had original terms to maturity of 15 years or more. When the economically useful life of the project was less than 15 years, the marketable securities in question were to be those that, at the time of original issue, had "terms to maturity not more than 12 months longer or shorter than the economically useful life of the project." Under this formula, as shown in table 2, the discount rate varied from 2.5% in 1957 to 2.625% in 1961.

In 1962, S.Doc. 97 replaced Circular A-47 as the document governing discount rates for federal water projects. This document simplified Circular A-47 by establishing a uniform discount rate. Specifically, S.Doc. 97 dropped the differentiation among projects with different useful lives. Instead, all projects were to use a discount rate calculated as "the average rate of interest payable by the Treasury on interest-bearing marketable securities of the United States outstanding at the end of the fiscal year preceding such computation, which, upon original issue, had terms to maturity of 15 years or more." Under this formula, the discount rate ranged from 2.625% in 1962 to 3.25% in 1968.

---

[74] It should be noted that Circular A-94, which replaced Circular A-47, still recommends Treasury rates for some purposes, but not for discounting the benefits and costs of government capital projects. While some economists have criticized the Corps and the Bureau of Reclamation's use of a long-term interest rate instead of a current yield, the agencies do not have discretion in this area. Rather, the formula is spelled out in the Water Resources Development Act of 1974 (P.L. 93-251).

In 1968, the Water Resources Council (WRC) revised the guidelines as printed in S.Doc. 97 to cap annual changes in the discount rate. The WRC also changed the discount rate formula from the coupon rate (the interest rate stated on a bond) to the yield rate on long-term Treasury bonds (the face value divided by the market price).[75] Furthermore, the 1968 criteria stipulated that the rate could not change by more than 0.25% per year. Under these changes, the discount rate increased at its maximum annual rate from 4.625% in 1969 to 5.625% in 1974.

In October 1973, the WRC issued new regulations, known as *Principles and Standards* that altered the discount-rate formula to be used for evaluating federal water resource projects (*P&S*).[76] Specifically, it differed from the then-existing criteria (the 1968 alteration of S.Doc. 97) by basing the rate on securities with an average of 50 years remaining to maturity, rather than 15 years or more as stipulated by the 1968 revision. The *P&S* also increased the allowable change in the discount rate to 0.5% per year. However, the *P&S* only guided the formulation of the discount rate for a matter of months. During this period the discount rate was 6.875%.

Six months later, the Water Resource Development Act of 1974 (WRDA 1974) reinstated the discount rate formula formerly established in S.Doc. 97, as amended by the Water Resources Council in 1968. By reverting to the discount formula under S.Doc. 97, the 1974 discount rate decreased from 6.875% to 5.625%. Furthermore, the maximum yearly rate change again became 0.25%. Since 1974, the formulation of the discount rate has remained unchanged.[77] In practice, the rate is the average year yield on government securities with 15 years or more to maturity. This rate is computed annually by the Treasury Department and published by the Bureau of Reclamation.[78] As shown in table 2, the discount rate increased steadily from 1975 (5.625%) to 1987 (8.875%), then decreased steadily after 1990. Today the rate is 5.875%.

Table 2. The Federal Discount Rate for Water Project Evaluation, 1957-2002

Year(s)	A-47	S.Doc. 97	WRC 1968	*P&S*	WRDA 1974
1957-1960	2.500				
1961	2.625				
1962		2.625			
1963		2.875			
1964		3.000			

[75] Depending on whether the bond is selling at a premium or a discount, the Coupon Rate will be higher/lower than the Yield Rate.

[76] In 1970, the WRC task force suggested an interest rate based on the social rate of time preference (SRTP) rather than on SRI. The proposed initial rate was 5.5%. In 1971, the WRC, not the task force, proposed a discount rate of 7%.

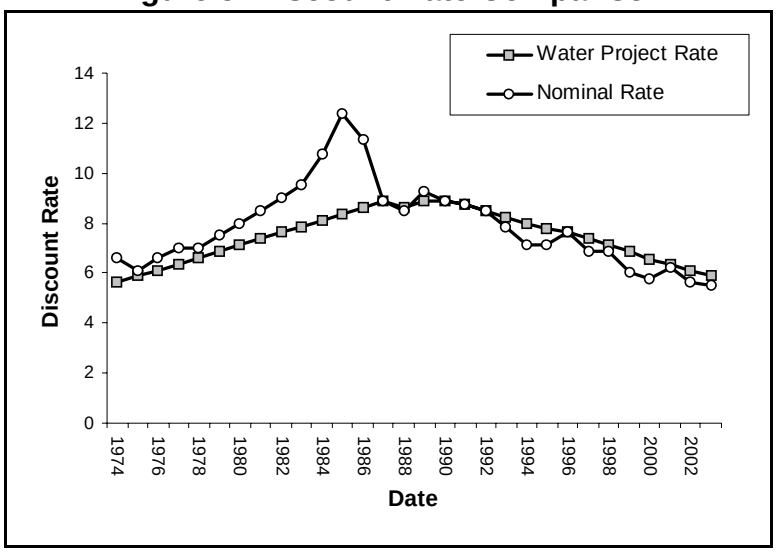
[77] The discount rate formula is established by Section 80 of WRDA 1974 (Pub. L. 93-251).

[78] Bureau of Reclamation. "Change in Discount Rate for Water Resources Planning," 67 *Fed.Reg.* 76756 (Dec. 13, 2002)

1965-1967		3.125			
1968		3.250			
1969		3.250	4.625		
1970			4.875		
1971			5.125		
1972			5.375		
1973			5.500		
1974			5.625	6.875	5.625
1975					5.875
1976					6.125
1977					6.375
1978					6.625
1979					6.875
1980					7.125
1981					7.375
1982					7.625
1983					7.875
1984					8.125
1985					8.375
1986					8.625
1987					8.875
1988					8.625
1989-1990					8.875
1991					8.750
1992					8.500
1993					8.250
1994					8.000
1995					7.750
1996					7.625
1997					7.375
1998					7.125
1999					6.875
2000					6.625
2001					6.375
2002					6.125
2003					5.875

Source: U.S. Dept. of Agriculture, Natural Resource Conservation Service, *Plan Formulation Rate for Federal Water Projects,* at: [http://www.nrcs.usda.gov/technical/RESS/issues/rates.html] on Dec. 17, 2002.

Figure 5. Discount Rate Comparison



Analysis of the Water Project Discount Rate

The Army Corps of Engineers, Bureau of Reclamation, the Tennessee Valley Authority, and the Natural Resources Conservation Service use a nominal discount rate (*i.e.*, one that is not corrected for inflation) based on the average rate of return on Treasury bonds, as directed by WRDA 1974 (Pub. L. 93-251). Specifically, the rate is the average yield on Treasury securities with 15 or more years remaining to maturity rounded to the nearest one eighth of one percent, and capped at an annual change of .25 percentage points (water project rate in figure 5).

The Cap. As is shown in figure 5, the water project rate generally changes by the maximum percentage points allowable (.25 percentage points).[79] Without the cap, the discount rate (the nominal rate in figure 5) would have changed by at least .25 percentage points per year.[80] Due to the cap, the water project rate remained lower than the nominal rate throughout the 1980s, and has generally been higher through the 1990s. Although there may be benefits to maintaining a relatively constant discount rate, the lag means that the discount rate does not reflect current borrowing costs, a main rationale for tying the rate to long-term treasury bonds in the first place.

Rate Maturity. The size of the discount rate is also affected by the decision to use yield rates on bonds with relatively long maturities (*i.e.*, 15 or more years). According to an OMB official, a more appropriate concept would be to use the market yield on currently outstanding debt, rather than on long-term debt, because it rises and

---

[79] There were only three years — 1989, 1990, and 1996 — when the water project rate did not change by the maximum of .25 percentage points.

[80] The water project discount rate without the cap (the nominal rate) is equal to the "Hydropower Interest Rates" from "Economics Guidance Memorandum Number 01-02: Fiscal Year 2001 Interest Rates" by James F. Johnson (Dec. 14, 2000) updated for 2002, at: [http://www.usace.army.mil/inet/functions/cw/cecwp/General_guidance/egm02-02.pdf]

falls with current changes in capital market conditions.[81] Long-term yield rates, such as the rate presently used for federal water projects, are generally smaller than the current yield, thus they could result in more projects passing the benefit-cost ratio test. As shown in the Mid-State Project example, from *Benefit Cost Analysis: In Theory and Practice*, the 1967 water project rate of 3.125% resulted in a benefit-cost ratio of 1.24, while the 1967 current yield of 4.85% would have resulted in a benefit-cost ratio of 0.89.[82] Just as moving to a current yield would increase the discount rate and decrease the benefit-cost ratio, adopting a longer-term rate would decrease the rate and increase the benefit-cost ratio.

Real Dollars and a Nominal Discount Rate. The current discount rate policy for federal water projects contains a significant inconsistency. The Corps' governing documents guide it to calculate benefits and costs in real dollars,[83] but to use a nominal discount rate.[84] Generally, a real discount rate is used to discount real dollars, or a nominal discount rate is used to discount nominal dollars. Either combination will result in the same present value and benefit cost ratio. On the other hand, mixing real and nominal figures, as the Corps does, will alter present value calculations and the benefit-cost ratio.

To illustrate the problem with mixing real values and nominal rates, consider the previous example (B) illustrated in figure 3. In this example, long run benefits were shown in real dollars (Benefits = $400) and were discounted using a real discount rate of 6%. At a real discount rate of 6%, discounted long-run benefits equaled ($400/$(1.06)^{50}$) or $21.72. When a nominal discount rate is used to discount nominal dollars, the result is similar. Using the same figures from figure 3 and an expected inflation rate of 2%, the nominal discount rate would be 8% (*i.e.*, real discount rate + expected rate of inflation). The nominal value of $400 in 50 years would be ($400*$(1+.02)^{50}$) or $1,076.64. As shown in figure 5, discounting the nominal value of $1,076.64 with a nominal discount rate (8%) results in a value similar to the result found when discounting real dollars with a real discount rate.

However, mixing real and nominal figures overstates or understates the discounted present value. When the Corps discounts 400 real dollars using a nominal discount rate of 8%, it understates the project's discounted present value ($9 instead of $23) by removing inflation from the dollar value and not from the discount rate. Given the temporal distribution of benefits and costs for many Corps projects (*i.e.*, near-term costs and long-term benefits), this practice reduces the number of long-term projects that pass the benefit-cost ratio test.

---

[81] Discussion with Robert Anderson, Office of Management and Budget, Washington, DC, on Feb. 11, 2003.

[82] Richard O. Zerbe, Jr. and Dwight D. Dively, *Benefit-Cost Analysis: In Theory and Practice*, (New York, NY: Harper Collins College Publishers, 1994) on p 5.

[83] The *Principles and Guidelines* stipulates that the Corps use "real" dollars.

[84] The WRDA 1974 sets the discount rate formula.

Figure 6: Discounted Present Value of Long-Term Benefits

	Nominal Dollars ($1,076.64)	Real Dollars ($400)
Nominal Rate (8%)	$\frac{400*(1.02)^{50}}{(1+.08)^{50}} = \frac{1076.64}{46.90} = 22.96$	$\frac{400}{(1+.08)^{50}} = \frac{400}{46.90} = 8.53$
Real Rate (6%)	$\frac{400*(1.02)^{50}}{(1+.06)^{50}} = \frac{1076.64}{18.42} = 58.44$	$\frac{400}{(1+.06)^{50}} = \frac{400}{18.42} = 21.72$

Formula

Discounted Present Value of X $= \frac{X}{(1+r)^t}$

where t = # of years, 50
r = real or nominal discount rate
X = real or nominal value

Comparison of Alternative Discount Rate Approaches

As described above, federal water projects are evaluated using a discount rate that most closely follows the social rate of time preference (SRTP) approach to discounting.[85] However, many economists view the SRTP as only a second-best approach because it assumes that resources are diverted from consumption and does not acknowledge that some resources may be diverted from investment.[86] Furthermore, the water project rate lags behind the long-term Treasury rate, may not reflect current borrowing rates, and is used to discount real dollars, an arguably inappropriate method. Given these issues, it may be useful to compare the rate used for federal water projects with a few of the many possible alternative rates.

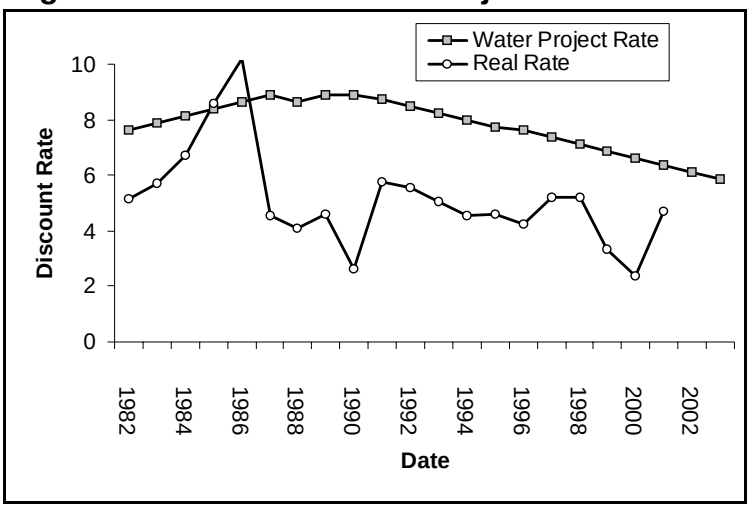
The "Real" Discount Rate. As described above, the Corps currently discounts real dollars using a nominal discount rate. Specifically, the *P&G* stipulates that benefits and costs be measured in real dollars, but the discount rate formula, established in the Water Resources Development Act of 1974, results in a nominal rate. One way to remedy this problem would be to transform the nominal water project rate into a real

[85] The rate used for federal water projects does not follow the SRTP approach in that it is not adjusted for taxes.

[86] The shadow price method, on the other hand, accounts for resources that are diverted from both sources.

discount rate.[87] This could be accomplished by adjusting the water project rate for inflation. In figure 7, the real water project discount rate is approximated[88] by subtracting the inflation rate from the water project rate.[89] The resulting "real rate" approximates what the water project rate would be if it was adjusted for inflation and was not constrained to an annual change of .25 percentage points. After comparing the nominal water project rate and the real rate, depicted in figure 7, one can see that the real water project rate is generally lower than the Corps' discount rate. If the Corps' rate had not been capped, the "real" water project rate would also have been lower than the Corps' rate in 1986.[90] However, changing the discount rate formula to a real rate would not address other formulaic choices including the use of: an average rather than a marginal rate of return, a yield rate rather than a coupon rate, Treasury securities with 15 or more years remaining to maturity rather than a different group of Treasury securities. Furthermore, the Corps valuation and discounting practices do not incorporate the uncertainty associated with future benefits and costs.[91] Incorporating uncertainty and other formulaic choices could support the use of a higher discount rate.

Figure 7: The "Real" Water Project Interest Rate



---

[87] Alternatively, a change to the *P&G* could allow a project's benefits and costs to be measured in nominal dollars to go with the nominal discount rate stipulated by WRDA '74.

[88] This rate is an approximation because an accurate "real discount rate" would use expected inflation rate for the time period in question rather than actual inflation rates.

[89] The "real rate" is the water project rate (without the .25 percentage point cap) minus inflation, measured by the Consumer Price Index. The water project rate (without the .25 percentage point cap) is equal to the "Hydropower Interest Rates" from the "Economics Guidance Memorandum Number 01-02: Fiscal Year 2001 Interest Rates" by James F. Johnson (Dec. 14, 2000) updated for 2002 at: [http://www.usace.army.mil/inet/functions/cw/cecwp/General_guidance/egm02-02.pdf]. Annual inflation rates were calculated as changes in the Consumer Price Index (CPI-U) from the Federal Reserve Bank of St. Louis, at: [http://www.economagic.com/em-cgi/data.exe/var/inflation-cpiu-dec2dec].

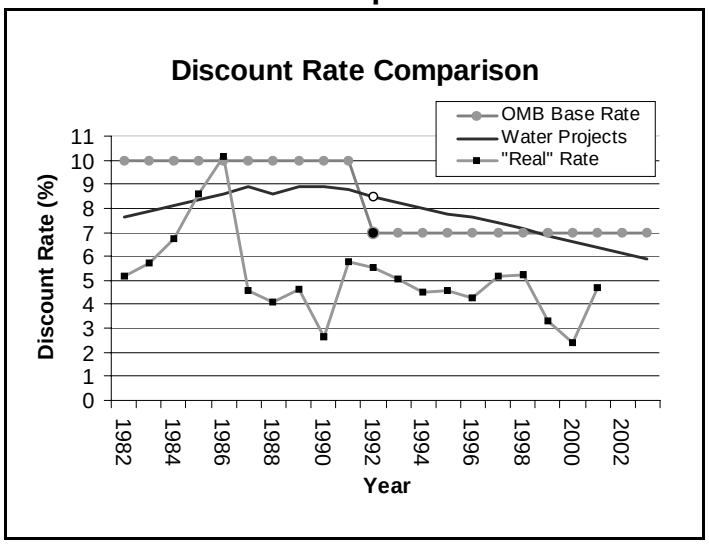
[90] The "real rate" is also lower than the OMB's rate because the latter is based only on government securities.

[91] For more information on discounting and uncertainty, see: Coleman Bazelon and Kent Smetters, "Discounting Inside the Washington D.C. Beltway," *Journal of Economic Perspectives*, v. 13, no.4 (1999): 213-228.

The OMB's Base Rate. Another concern regarding the water project rate has nothing to do with the mechanics of the formula. Rather, many economists do not agree that it is appropriate to base discount rate for federal projects on the government's borrowing rate. Instead, some economists, including officials at the Office of Management and Budget (OMB), recommend that projects' benefits and costs be discounted using the shadow price method.[92] Given the difficulty of implementing the shadow price method, however, the OMB recommends a base rate that is based on the opportunity cost of capital approach. Specifically, the OMB's base rate approximates the average rate of return to private capital in the United States. The OMB recommends this real discount rate, established through Budget Circular A-94, to most federal agencies for assessing their projects.[93] Although this base-rate is based on what is generally viewed as a second-best approach to discounting, it is preferred by economists who believe that government projects shift resources from the private sector. Furthermore, it is a real discount rate, thus the Corps recommends that it be used to discount real dollars.

As shown in figure 8, the OMB's recommended discount rate has been higher and lower than the Corps' rate over time. Until 1992, when the OMB lowered its base discount rate from 10% to 7%, the OMB rate was higher than the rate used for federal water projects. From 1992 through 1998 the water project rate declined toward the OMB rate and in 1999, the OMB rate of 7% exceeded the water project rate of 6.875%. (See figure 8.) The OMB rate also exceeds the current water project rate of 6.125%.[94]

Figure 8. The OMB v. Water Project Discount Rate Comparison



[92] Circular A-94 states that the shadow price method is the preferred method for calculating the discount rate. Due to the method's stringent information requirements, however, the OMB approves the shadow price method on a case by case basis.

[93] It should be noted that very few agencies actually conduct benefit-cost analyses and those that do have some leeway to use other rates in addition to the OMB's base rate. Water projects are exempt from Circular A-94, so they do not use the OMB's base discount rate.

[94] Note that real water project rates would have been lower than the Corps base rate over the last 20 years.

Conclusion

In a Nation with limited resources, the Flood Control Act of 1936 promoted the construction of federal water projects for which the benefits are expected to exceed the costs. While this general concept is straightforward, applying benefit-cost analysis faces both conceptual and practical challenges. These challenges stem from the fact that benefit-cost analysis is neither a fully comprehensive nor an exact method for evaluating the welfare trade-offs a project could generate, particularly environmental and social trade-offs. For example, the process is limited by the choice of which benefits and costs to include in the analysis. For federal water projects, the *P&G* stipulate that the Corps' analysis include all increases and decreases to national economic development (NED). The analysis is also limited by measurement techniques, because the benefit-cost ratio only includes benefits and costs that are measured in dollars. A continuing challenge for benefit-cost analysis is accurately monetizing non-market values, such as a project's environmental and social effects. Therefore, project assessments are often based on a limited set of factors that are clearly measurable in dollar terms while ignoring factors that cannot be readily quantified in dollars.

Another controversial component of benefit-cost analysis for federal water projects, and the focus of this report, is the discount rate. This rate is used to place a present value on the monetized economic, environmental, and social benefits or costs that will accrue to future generations. It can be contentious because different rates lead to different conclusions about project desirability, and because there is no indisputably correct discount rate. Regardless of debates on the discount rate's theoretical and formulaic foundation, it is the size of the discount rate that affects the Corps benefit-cost analyses. Since most water projects have large up-front construction costs and more distant benefits, a lower discount rate will lead to more projects passing the benefit-cost hurdle. However, the Corps does not choose its discount rate. Rather the Corps discount rate is based on a statutory formula established by the Water Resource Development Act of 1974 (Pub.L. 93-251). Therefore, supporters and opponents of federal water projects look to changing the discount rate formula as a way to affect the number and type of proposed projects.

There are many theoretical approaches to discounting. The discount rate currently used to evaluate federal water projects is based on a formula for measuring the return on savings. However, there are many theoretical alternatives to using the return on savings. For example, some economists suggest that the discount rate be derived from rates of return in the private sector. The OMB recommends such a rate for evaluating most federal projects. In general, the government borrowing rate tends to be lower than the rate of return in the private sector. Therefore, changing the water project discount rate to a rate of return in the private sector would likely decrease the number of projects that currently pass the benefit-cost ratio test.

Even if the theoretical approach to discounting were not contentious, formulaic decisions still lead to disputes. The water project discount rate is a nominal interest rate estimated from average rates of return on long-term Treasury bonds. One of the main differences between this and other rates used to discount "real" future costs and benefits is that it has not been adjusted for inflation (*i.e.,* it is a nominal rather than a real rate). According to economists, the use of a nominal rate to discount real dollars is conceptually incorrect. Rather, economists argue for using a real rate to discount real

dollars. An inflation-adjusted discount rate calculated using similar long-term Treasury bonds would generally be lower than the rate currently used by the Corps, and thus would likely increase the number of projects that would pass the benefit-cost ratio test.[95] However, changing the formula to create a real water project rate would not end the debate. Rather, the Corps' discount rate is based on a number of formulaic choices. For example, the formula directs the Corps to use: a Treasury rate rather than a market rate, a pre-tax rate rather than a post-tax rate, an average rather than a marginal rate of return, a yield rate rather than a coupon rate, and a rate based on securities with 15 or more years remaining to maturity. Changing any of these elements would also affect the size of the discount rate. Consequently, among both supporters and opponents of Corps' water projects, any proposed change in the discount rate is likely to generate considerable debate.

[95] Real discount rates are lower than nominal rates so long as there is inflation.

Projects: Theory and Practice Summary Construction of large water resource projects, such as those of the Army Corps of Engineers (Corps), can be controversial because they involve trade-offs among various river uses, and between current and future generations. Pursuant to federal water project planning guidelines, the Corps weighs these trade-offs using benefitcost analysis. If its analysis shows that a projectâ€™s national economic development (NED) benefits exceed its NED costs, the Corps seeks project authorization from Congress.Â Critics of benefit-cost analysis often focus on the valuation 1 The Corps is an executive branch agency within the Department of Defense that has both civil and military programs. Benefit-cost evaluations have been part of Corps of Engineers planning studies since the early twentieth century. As discussed in Chapter 2, the Corps began standardizing its more routine economic procedures in the 1920s, providing estimates of project benefits and costs.Â The following section reviews the use of benefit-cost analysis in Corps water resources project planning studies.Â For example, the Corps often uses unit day values, estimated through benefits transfer, to represent the economic value of environment or natural resources, and the Corps publishes unit day values for use in valuing recreational impacts of its projects.5 These approaches estimate WTP for project or resource use outcomes using goods or services other than the ones for which the values are. Cost-Benefit Analysis and the Environment. Further developments and policy use 2018. Highlights.Â While the theory of social discounting shows clearly how the social discount rate should be dened, in practice numerous questions arise, especially when considering actions with implications for generations in the far distant future: intergenerational projects and policies. In such contexts, there is strengthening theoretical and empirical support for the use of discount rates that decline with time.Â Cost-Benefit Analysis and the Environment: Further Developments and Policy Use explores the latest theoretical developments, as well as the political economy surrounding the practical applications of such analyses. Theory. Costâ€“benefit analysis is often used by organizations to appraise the desirability of a given policy. It is an analysis of the expected balance of benefits and costs, including an account of any alternatives and the status quo.Â Ford's costâ€“benefit analysis had estimated that based on the number of cars in use and the probable accident rate, deaths due to the design flaw would cost it about $49.5 million in wrongful death lawsuits; a recall would cost $137.5 million. The company failed to consider the costs of negative publicity, which forced a recall and reduced Ford sales.[34].Â The selection of a discount rate for this calculation is subjective. A smaller rate values the current generation and future generations equally. Prepared for the State Water Resources Control Board. By the Economic Analysis Task Force for Water Recycling in California. Technical Authors: Sachi De Souza.Â Projects with projected negative financial benefits for one or more years of operation can be regarded as financially unfeasible and may require leverage from additional funding sources or changes in the financial plan. ES-5. Conclusions Economic and financial analyses are useful to identify benefits and costs of a project alternative.Â Cost-effectiveness was kept as the preferred criteria to select a project alternative. Most recently, the bond law of 2002 provided grants without specific funding criteria requirements.