

**MEMORANDUM FOR HEADS OF EXECUTIVE DEPARTMENTS AND
ESTABLISHMENTS**

SUBJECT: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs

Table of Contents

1. Purpose.....	3
2. Rescission.....	3
3. Authority.....	3
4. Scope.....	3
5. General Principles.....	4
a. Discounted Net Benefits and Related Outcome Measures.....	4
b. Cost-Effectiveness Analysis.....	5
c. Elements of Benefit-Cost or Cost-Effectiveness Analysis.....	5
6. Identifying and Measuring Benefits and Costs.....	6
a. Identifying Benefits and Costs.....	7
b. Measuring Benefits and Costs.....	8
7. Treatment of Inflation.....	9
8. Discount Rate Policy.....	10
a. Real versus Nominal Discount Rates.....	10
b. Public Investment Analyses.....	10
c. Cost-Effectiveness, Lease-Purchase, Internal Government Investment, and Asset Sales Analyses.....	11
9. Treatment of Uncertainty.....	13
a. Characterizing Uncertainty.....	13
b. Expected Values.....	13
c. Sensitivity Analysis.....	13
d. Adjustments for Uncertainty.....	14
10. Distributional Effects and Incidence.....	15

a. Identification of Groups.....	15
b. Weights.....	16
c. Economic Incidence.	17
11. Special Guidance for Public Investment.	17
a. Analysis of the Marginal Cost of Public Funds.....	17
b. Exceptions.	18
12. Special Guidance for Lease-Purchase Analysis.	18
a. Coverage.....	18
b. Required Justification for Leases.	18
c. Analytical Requirements and Definitions.....	19
13. Related Guidance.....	22
14. Implementation.....	22
15. Effective Date.....	22
16. Interpretation.	22
Appendix A: Definition of Terms.....	23
Appendix B: Additional Guidance for Discounting	26
Appendix C: Discount Rates for Cost-Effectiveness, Lease Purchase, and Related Analyses	29
Appendix D: Discount Rates for Benefit-Cost Analysis	30

1. Purpose.

The goal of this Circular is to promote social welfare through well-informed decision-making by the Federal Government. It provides general guidance for conducting benefit-cost and cost effectiveness analyses of certain Federal activities. It also provides specific guidance on the discount rates to be used in analyzing Federal programs whose benefits and costs are distributed over time. The general guidance can inform whether an agency has considered and properly dealt with all the elements for sound benefit-cost and cost effectiveness analyses.

2. Rescission.

This Circular replaces and rescinds Office of Management and Budget (OMB) Circular No. A-94, "Guidelines and Discount Rates for Benefit Cost Analysis of Federal Programs," dated October 29, 1992.

3. Authority.

This Circular is issued under the authority of 31 U.S.C. § 1111 and the Budget and Accounting Act of 1921, as amended.

4. Scope.

This Circular does not supersede agency practices that are prescribed by or pursuant to law, Executive Order, or other relevant circulars. The Circular's guidelines are suggested for use in the internal planning of Executive Branch agencies. The guidelines must be followed in all analyses submitted to OMB in support of legislative and budget programs in compliance with OMB Circular No. A-11, "Preparation and Submission of Annual Budget Estimates," and Circular No. A-19, "Legislative Coordination and Clearance." These guidelines must also be followed in providing estimates submitted to OMB in compliance with the Presidential Memorandum of April 29, 1992, "Benefits and Costs of Legislative Proposals."

- a. Aside from the exceptions listed below, the guidelines in this Circular apply to any analysis used to support Government decisions to initiate, renew, expand, contract, or stop programs or projects that would result in a series of identifiable benefits or costs. The Circular applies specifically to:
 - (1) Benefit-cost or cost-effectiveness analysis of Federal projects, programs, or policies (henceforth, "projects," where programs often consist of individual projects).
 - (2) Analysis of decisions whether to lease or purchase.
 - (3) Asset valuation and sale analysis.
- b. Specifically exempted from the scope of this Circular are decisions concerning:

- (1) Water resource projects (guidance for which is provided in the approved *Principles, Requirements and Guidelines for Water and Land Related Resources Implementation Studies*).
 - (2) Regulatory impact analysis (guidance for which is provided in OMB Circular No. A-4).
 - (3) The acquisition of commercial-type services by Government or contractor operation (guidance for which is provided in OMB Circular No. A-76).
 - (4) Federal energy management programs (guidance for which can be found in 10 CFR Part 436, as amended).
- c. This Circular applies to all agencies of the Executive Branch of the Federal Government, including independent agencies. (“Agency,” unless otherwise indicated, means any authority of the United States that is an “agency” under 44 U.S.C. § 3502(1).) It does not apply to the Government of the District of Columbia or to non-Federal recipients of loans, contracts, or grants. Recipients are encouraged, however, to follow the guidelines provided here when preparing analyses in support of Federal activities.
 - d. For small projects that share similar characteristics, agencies are encouraged to conduct generic studies and to avoid duplication of effort in carrying out economic analysis. See the section “Benefit Transfer Methods” in OMB Circular No. A-4 for more discussion of this topic.

5. General Principles.

Benefit-cost analysis is recommended as the technique to use in a formal economic analysis of government projects. *Cost-effectiveness analysis* is a less comprehensive technique, but it can be appropriate when the benefits from competing alternatives are the same or where a policy decision has been made that the benefits must be provided. (Appendix A provides a glossary of technical terms used in this Circular; technical terms are italicized when they first appear.)

a. Discounted Net Benefits and Related Outcome Measures.

The standard criterion for deciding whether a government project can be justified on economic principles is *discounted net benefits*—the discounted monetized value of expected net benefits (i.e., benefits minus costs). Discounted net benefits are computed by estimating the monetized benefits and costs associated with a specific decision, discounting future benefits and costs using an appropriate *discount rate*, and subtracting the sum total of discounted costs from the sum total of discounted benefits. Discounting benefits and costs transforms gains and losses occurring in different time periods to a common unit of measurement. Projects with the highest positive discounted net benefits generally increase social welfare the most and are generally preferred, while projects with negative discounted net benefits should generally be avoided.

When there are important costs or benefits that cannot be monetized, discounted net benefits are not fully computable. In these cases, discounted net benefits will not fully reflect the effect of a project on social welfare, and a comprehensive enumeration of the different types of benefits and costs, monetized or not, can be helpful in identifying the full range of project effects (for example, distributional effects, where relevant and appropriate). Quantifying costs and benefits to the extent possible is expected, even if assigning monetary values is not feasible. When analysts expect that the inclusion of non-monetized costs or benefits are large enough to change the conclusion of the analysis, a *threshold* or *break-even analysis* should be considered for inclusion in the benefit-cost analysis (to help assess, for example, whether unmonetized benefits could credibly justify a project). See Section 6.a.(5) for more discussion of this topic.

Other summary effectiveness measures can provide useful supplementary information to discounted net benefits, and analysts are encouraged to report them also. One example is the number of injuries prevented per dollar of cost.

b. Cost-Effectiveness Analysis.

A project is cost-effective if, on the basis of *life cycle cost* analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits. Both monetized and unmonetized costs should be considered to the extent feasible. Cost-effectiveness analysis is appropriate whenever it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration. This is the case whenever (i) each alternative has the same annual benefits expressed in monetary terms; or (ii) each alternative has the same annual effects, but dollar values cannot be assigned to their benefits. Analysis of alternative defense systems often falls in this category.

Cost-effectiveness analysis can also be used to compare projects with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits, along with appropriate consideration of any unmonetized benefits. The alternative project with the largest benefits would normally be favored.

c. Elements of Benefit-Cost or Cost-Effectiveness Analysis.

(1) Policy Rationale. The rationale for the Government projects being examined should be clearly stated in the analysis. Subject to statutory constraints, projects may be justified on efficiency grounds where they address market failures, such as market power, public goods, externalities, and asymmetric information. Behavioral biases might also be considered to be a source of market failure. Projects may also be justified where they improve the efficiency of the Government's internal operations, such as cost-saving investments. More broadly, they may be justified where they have desirable distributional effects or promote important social values.

(2) Explicit Assumptions. Analyses should be explicit about the underlying assumptions used to arrive at estimates of future benefits and costs. In the case of

public health programs, for example, it may be necessary to make assumptions about the number of future beneficiaries, the services provided, and the rate of increase in medical prices. The analysis should include a statement of the assumptions, the rationale behind them, and a review of their strengths and weaknesses as appropriate. Key data and results, such as year-by-year estimates of benefits and costs, should be reported to promote independent analysis and review.

- (3) Analysis of Alternatives. Analyses should also consider alternative means of achieving project objectives to the extent feasible and appropriate. This can be done by examining different project scales, different methods of provision, and different degrees of government involvement. For example, in analyzing a decision to acquire a *capital asset*, the analysis should generally consider: (i) doing nothing; (ii) direct purchase; (iii) upgrading, renovating, sharing, or converting existing government property; or (iv) leasing or contracting for services. Analyses should include estimates of benefits and costs of each alternative considered.
- (4) Verification and Evaluation. Retrospective studies to determine whether anticipated benefits and costs have been realized are potentially valuable. Such studies can be used to determine necessary corrections in existing programs and to improve future estimates of benefits and costs in these programs or related ones.

Consistent with OMB guidance, agencies should plan to evaluate the effectiveness of their projects and should discuss the results of relevant evaluations and other evidence-building activities (if available) when proposing reauthorizations, increased program funding, or other programmatic or policy changes.

- (5) Transparency. As appropriate, to encourage transparency, agencies should seek to make available to the public their methods, data sources, and analytic choices on individual projects.

6. Identifying and Measuring Benefits and Costs

Analyses should include comprehensive estimates of the expected benefits and costs to society, to the extent feasible and appropriate, based on established definitions and practices. Analysis should seek to incorporate relevant strands of evidence including the best available science, historical data, and Indigenous and other local knowledge.

Social benefits and costs, and not only the benefits and costs to the Federal Government, should be the basis for assessing government programs or policies that have effects on private citizens or other levels of government. Social benefits and costs can differ from private benefits and costs as measured in the marketplace because of imperfections arising from, for example: (i) *external economies* or *diseconomies* where actions by one party impose benefits or costs on other groups that are not compensated in the marketplace; (ii) market power that distorts the relationship between marginal costs and market prices; (iii) regulations, subsidies, and taxes; or (iv) behavioral

biases. The time horizon and spatial scope for analyses should be selected to capture all the important benefits and costs to society expected to result from the project.

a. Identifying Benefits and Costs.

Both qualitative and quantitative benefits and costs should be recognized, as should both direct and indirect benefits and costs. Below are some guidelines to consider when identifying benefits and costs.

- (1) Incremental Benefits and Costs. Calculation of discounted net benefits should be based on a project's incremental benefits and costs, so that costs or benefits in the past should typically not count. Sometimes, though, analyses may count costs or benefits already incurred in a project (such as planning or design costs) to account for a project's overall net benefits. Analyses should take particular care to identify the extent to which a policy such as a subsidy program promotes substitutes for activities of a similar nature that would occur without the policy. Either displaced activities should be explicitly recorded as costs or only incremental gains should be recorded as benefits of the policy.
- (2) Intermediate Effects. Some benefits or costs are also embedded in other broader measures of benefits and costs. Analyses should be careful not to double-count in such situations.
- (3) International Effects. In many circumstances, analyses should focus on benefits and costs accruing to citizens and residents of the United States, including U.S. citizens residing abroad, in determining discounted net benefits. In other circumstances, analyses should also include effects experienced by noncitizens residing abroad. See the section "Scope of Analysis" in OMB Circular No. A-4 for more discussion of this topic.
- (4) Transfers. In many cases, there are no economic gains, beyond distributional effects, from a pure *transfer payment* because the benefits to those who receive such a transfer are matched by the costs borne by those who pay for it. Transfers that arise as a result of the project being analyzed should be accounted for separately, and a description of the transfer, such as the parties affected, the nature, the magnitude, and the distributional effects, should be included. It should also be recognized that a transfer resulting from a project may have benefits that are less than the project's real economic costs due to inefficiencies that can arise in the project's delivery of benefits and financing, or benefits that are greater than the project's real economic costs due to *multiplier* effects that may exist when resources are not fully employed.
- (5) Non-Monetized and Non-Quantified Benefits and Costs. Some important benefits and costs may be either difficult to monetize or difficult to quantify. When it is not feasible or appropriate to monetize or quantify certain effects, it is still important

that these be included in the analysis. A careful and rigorous identification and qualitative assessment of non-monetized and non-quantified benefits and costs, including information on their nature, timing, probability, scale, location, and distribution, should be included as part of the benefit-cost analysis. If the non-monetized benefits and costs are likely to be important, a threshold or break-even analysis may be considered for inclusion in the benefit-cost analysis. Threshold or break-even analysis asks what magnitude unmonetized benefits and costs would need to have for the project to yield positive discounted net benefits, or for one alternative to overtake another in terms of discounted net benefits. See the section “Methods for Treating Non-Monetized Benefits and Costs” in OMB Circular No. A-4 for more discussion of these types of analyses.

- (6) Environmental Effects. Projects may directly affect or alter access to the natural environment and the benefits it provides. Analyses should account for relevant effects on ecosystem and environmental services, including effects on public health, when feasible. See forthcoming OMB guidance on ecosystem services for additional discussion on how to capture the welfare effects of ecosystem and environmental services.
- (7) Tailoring. Agencies should seek to balance performing the most comprehensive analysis possible with sensitivity to the resources required—by Federal agencies and especially by external applicants—to conduct the analysis. While accuracy is always important and agencies should conduct a rigorous and quantitative analysis whenever possible, the analytic methods used to measure benefits and costs can be tailored to the scope of the funding at issue or other contextual factors impacting the benefits or costs of additional analysis.

b. Measuring Benefits and Costs.

An estimate of *willingness-to-pay* is an aggregate measure of the maximum amount individuals are willing to spend to obtain a given benefit. Similarly, an estimate of *willingness-to-accept* is the minimum amount individuals are willing to accept to relinquish or forego a given benefit. Market prices provide a valuable starting point for measuring willingness-to-pay and willingness-to-accept, but sometimes prices do not adequately reflect the true value of a good to society. For example, externalities, market power, taxes or subsidies, behavioral biases, and incomplete information can distort market prices.

In other cases, market prices do not exist for a relevant benefit or cost. When market prices are distorted or unavailable, other methods of valuing benefits or costs may have to be employed. Measures derived from observed market behavior are generally preferred when they are available.

- (1) Measures of Consumer Surplus. Consumers would generally be willing to pay more than the market price rather than go entirely without a good they consume.

Consumer surplus measures the extra value consumers derive from their consumption, compared with the value measured at market prices. When it can be determined, consumer surplus provides a useful measure of the total benefit to society from a government project. Consumer surplus can sometimes be calculated by using econometric methods to estimate consumer demand.

- (2) Measures of Benefits and Costs. Willingness-to-pay or willingness-to-accept can be estimated through revealed preference, stated preference, or other methods. Revealed preference methods (based, for example, on changes in land values or variations in wage rates) have the benefit of being based on observable behavior, often involving market transactions. These methods can be particularly useful to establish values of certain benefits and costs that are reflected in observable tradeoffs that people actually make. Stated-preference methods can address a wide variety of goods and services that are not directly or indirectly traded in markets or do not cause observable behavioral changes and therefore are not easy to study through revealed-preference methods.
- (3) Multiplier Effects. Generally, analyses treat resources as if they were likely to be fully employed. Multipliers that estimate the secondary effects of government expenditures on employment and output may be included in limited situations, for example if a policy would have substantially different effects during a recession. Secondary effects should be presented in a separate analysis. Note that while measures such as changes in employment and output may be useful components in estimating benefits and costs, they are not themselves measures of social benefits or costs. Please consult with OMB before including multiplier effects in an analysis.

7. Treatment of Inflation.

Economic analyses should typically be accomplished using *real or constant-dollar* values, i.e., by measuring benefits and costs in units of stable purchasing power, to avoid the misleading effects of inflation. Such estimates may reflect expected future changes in *relative prices*, however, where there is a reasonable basis for estimating such changes. Where future benefits and costs are given in *nominal* terms, i.e., in terms of the future purchasing power of the dollar, the analysis can use these values rather than convert them to constant dollars, though this is discouraged. Nominal and real values must not be combined in the same analysis. Logical consistency requires that analysis be conducted either in constant dollars or in terms of nominal values. This may require converting some nominal values to real values or vice versa.

When an assumption is needed and not prescribed in law, the analyst should convert dollars expressed in different years using an appropriate and reliable general inflation index, such as the Gross Domestic Product price deflator, the Consumer Price Index, or the Personal Consumption Expenditure price index. The former two indices are projected in the Administration's economic assumptions in the President's Budget and Mid-Session Review. For projects that extend beyond the ten-year budget horizon, the inflation forecast can be extended by using the inflation rate for

the tenth year of the budget forecast. Alternative inflation estimates may be used for sensitivity analysis.

8. Discount Rate Policy.

In order to compute discounted net benefits, it is necessary to discount future benefits and costs. Benefits and costs are worth more if they are experienced sooner, all else equal, and discounting is the way to reflect this. All future benefits and costs should be discounted. Differences in timing for non-monetized benefits and costs should also be accounted for. The higher the discount rate, the lower is the present value of future benefits and costs. For typical investments, with costs concentrated in early periods and benefits following in later periods, raising the discount rate tends to reduce discounted net benefits. Technical guidance on discounting and a table of *discount factors* are provided in Appendix B.

a. Real versus Nominal Discount Rates.

The proper discount rate to use depends on whether the benefits and costs are measured in real or nominal terms.

- (1) A *real discount rate* that has been adjusted to eliminate the effect of expected inflation should be used to discount constant-dollar or real benefits and costs. A real discount rate can be approximated by subtracting expected inflation from a *nominal interest rate*.
- (2) A nominal discount rate that reflects expected inflation should be used to discount nominal benefits and costs. Most market interest rates are nominal interest rates in this sense.

b. Public Investment Analyses.

The guidance in this section applies to benefit-cost analyses of public investments that provide benefits and costs to the general public. Guidance related to cost-effectiveness analysis of internal planning decisions of the Federal Government is provided in Section 8.c.

To account for public investment impacts, the following guidance should be observed.

- (1) Base-Case Analysis. Constant-dollar benefit-cost analyses of proposed investments should report discounted net benefits and other outcomes determined using the real discount rate presented in Appendix D of this Circular. See Section 9.d. for more information about risk adjustments. Appendix D is updated every three years and is available on the OMB home page.
- (2) Other Discount Rates. Analyses can show the sensitivity of discounted net benefits and other outcomes to variations in the discount rate. The importance of these alternative calculations will depend on the specific economic characteristics of the project under analysis.

- (3) Shadow Price of Capital. Using the shadow price of capital to value benefits and costs is the analytically preferred means of capturing the effects of government projects on capital investment. To use this method accurately, the analyst must be able to estimate what proportion of the benefits and costs of a project fall on capital (as opposed to consumption) and convert the estimated amounts of displaced (or induced) capital into consumption-equivalent values before discounting. However, this often may not be feasible: a shadow price specific to a particular context may not be well established, or the distribution of impacts from the project on capital and consumption may not be readily quantifiable. In such cases, the analyst may wish to consider a sensitivity analysis using an appropriate range of shadow prices and assumption about the proportion of effects falling on capital. As a default, OMB recommends bounding estimates of the shadow price of capital. See the section “Accounting for Effects on Capital” in OMB Circular No. A-4 for additional detail.
- (4) Long-Term Discounting. Special ethical and economic considerations, including issues about impacting future generations, can suggest the use of lower discount rates over the long term. See the section “Discount Rates” in OMB Circular No. A-4 for additional detail. If benefits or costs that occur several decades or more in the future are important to a project, such as enhancing climate mitigation and adaptation or promoting other environmental benefits, agencies can consider using declining discount rates. Agencies should consult with OMB before using such rates.

c. Cost-Effectiveness, Lease-Purchase, Internal Government Investment, and Asset Sales Analyses.

The Treasury’s borrowing rates should be used as discount rates in the following cases:

- (1) Cost-Effectiveness Analysis. Analyses that involve constant-dollar costs should use the real Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. This rate is computed using the Administration’s economic assumptions for the Budget, which are published in January of each year. A table of discount rates based on the expected interest rates for the first year of the budget forecast is presented in Appendix C of this Circular. Appendix C is updated annually and is available on the OMB home page. Real *Treasury rates* are obtained by removing expected inflation over the period of analysis from nominal Treasury interest rates. Analyses that involve nominal costs should use nominal Treasury rates for discounting, as described in the following paragraph.
- (2) Lease-Purchase Analysis. Analyses of nominal lease payments should use the nominal Treasury borrowing rate on marketable securities of comparable maturity to the period of analysis. Nominal Treasury borrowing rates should be taken from the economic assumptions for the Budget. A table of discount rates based on these assumptions is presented in Appendix C of this Circular. Constant dollar lease-

purchase analyses should use the real Treasury borrowing rate, described in the preceding paragraph.

- (3) Internal Government Investments. Some Federal investments provide internal benefits that take the form of increased Federal revenues or decreased Federal costs. Unlike the case of a federally funded highway, which provides external benefits to society as a whole, it is appropriate to calculate such a project's discounted net benefits using a comparable-maturity Treasury rate as a discount rate. The rate used may be either nominal or real, depending on how benefits and costs are measured.

Some Federal activities provide both Federal cost savings and external social benefits. For example, Federal investments in information technology can produce Federal savings in the form of lower administrative costs and external social benefits in the form of faster claims processing. The discounted net benefits of such investments should be analyzed with the real discount rate discussed in Appendix D of this Circular unless the analysis is able to allocate the investment's costs between provision of Federal cost savings and external social benefits. Where such an allocation is possible, Federal cost savings and their associated investment costs may be discounted at the Treasury rate, while the external social benefits and their associated investment costs should be discounted at the base-case real rate.

- (4) Asset Sale Analysis. Analysis of possible asset sales should reflect the following:
- (a) The discounted net benefits to the Federal Government of holding an asset is best measured by discounting its future value using a Treasury rate. The rate used may be either nominal or real, depending on how earnings are measured.
 - (b) Analyses of government asset values should explicitly deduct the cost of expected defaults or delays in payment from projected cash flows along with government administrative costs. Such analyses should also consider explicitly the probabilities of events that would cause the asset to become nonfunctional, impaired, or obsolete, as well as probabilities of events that would increase asset value.
 - (c) Analyses of possible asset sales should assess the gain in social efficiency that can result when a government asset is subject to market discipline and private incentives. Even though a government asset may be used more efficiently in the private sector, potential private-sector purchasers will generally discount such an asset's value at a rate in excess of the Treasury rate, in part, due to the cost of bearing risk. When there is evidence that government assets can be used more efficiently in the private sector, valuation analyses for these assets should include sensitivity comparisons

that discount the value of such assets with the rate of interest earned by assets of similar riskiness in the private sector.

9. Treatment of Uncertainty.

Estimates of benefits and costs are often uncertain because of imprecision in both underlying data and modeling assumptions. Because such uncertainty is intrinsic to many analyses, its effects should be analyzed and reported. Useful information in such a report would include the key sources of uncertainty; expected value estimates of outcomes; the sensitivity of results to important sources of uncertainty; and where possible, the probability distributions of benefits, costs, and net benefits.

a. Characterizing Uncertainty.

Analyses should attempt to characterize the sources and nature of uncertainty. Ideally, probability distributions of potential benefits, costs, and net benefits should be presented. It should be recognized that many phenomena that are treated as deterministic or certain are, in fact, uncertain. Examples of such uncertainty include the size of future populations benefiting from investments and the frequency and severity with which investments may face or mitigate certain hazards. In analyzing uncertain data, objective estimates of probabilities should be used whenever possible. Stochastic simulation methods can be useful for analyzing uncertain phenomena and developing insights into the relevant probability distributions. In any case, the basis for the probability distribution assumptions should be reported. Any limitations of the analysis because of uncertainty or biases surrounding data or assumptions should be discussed.

b. Expected Values.

The expected values of the distributions of benefits, costs and net benefits can be obtained by weighting each outcome by its probability of occurrence and then summing across all potential outcomes. If estimated benefits, costs, and net benefits are characterized by point estimates rather than as probability distributions, the expected value can be used to generate a central tendency.

Estimates that differ from the central tendency (such as worst-case estimates) may be provided in addition to such values, but the rationale for such estimates must be clearly presented. For any such estimate, the analysis should identify the nature and magnitude of any bias. For example, costs can grow faster or slower than initial expectations; analyses should consider whether past experience suggests that initial estimates of benefits or costs are optimistic or pessimistic.

c. Sensitivity Analysis.

Discounted net benefits and other outcomes should be recomputed to determine how sensitive outcomes are to changes in major assumptions. The assumptions that deserve the most attention will depend on the dominant benefit and cost elements and the areas of greatest uncertainty of the project being analyzed. For example, in analyzing a retirement program, one could consider analyzing alternative assumptions about the number of

beneficiaries, future wage growth, inflation, and the discount rate. In general, it is worthwhile to consider sensitivity analyses for estimates of: (i) important inputs to benefits and costs; (ii) the discount rate; (iii) the general inflation rate; and (iv) the distribution of key variables. Models used in the analysis should be well documented and, where possible, available to facilitate independent review.

d. Adjustments for Uncertainty.

In addition to calculating expected values across possible outcomes, the analysis should account for risk. Projects with net benefits that increase with other determinants of social welfare, such as aggregate consumption, generally increase the riskiness of the project over long horizons. For example, if a hazard mitigation project has benefits linked to property values, there is risk that the property could be more valuable—and thus the hazard mitigation more valuable—in cases where aggregate consumption and economic growth are higher. Because of risk aversion, a project with higher net benefits when aggregate consumption is higher (that is, with *systematic risk*) should have lower discounted net benefits relative to a project that has the same expected net benefits regardless of aggregate consumption. In other words, relative to when net benefits are certain, welfare is lower when people tend to get low net benefits when they already have low consumption and high net benefits when they already have high consumption.

The preferred way to address such risk is to calculate *certainty-equivalents*, which involve adjusting uncertain expected values to account for risk. For an uncertain benefit, the certainty-equivalent is the number of certain dollars that the uncertain benefit is worth to its recipient. A certainty-equivalent valuation can be thought of as the expected value of a benefit or cost less a premium (positive or negative) that reflects risk aversion. One way to incorporate risk aversion into the analysis is to directly determine individuals' certainty-equivalent valuations for relevant benefits or costs through their willingness-to-pay for (or willingness-to-accept) specific outcomes related to a project. Another approach is to translate the valuation of uncertain outcomes into certainty-equivalent valuations by modeling individual preferences, for example, using an assumed utility function. Under this approach, the analysis would first estimate the distribution of possible outcomes, and then convert these estimates of outcomes into ex-ante certainty-equivalent values using a concave utility function. One simple approach uses a constant elasticity utility function. OMB urges agencies to invest in the analytical capabilities to calculate such measures. See the section “Economic Values of Uncertain Outcomes” in OMB Circular No. A-4 for more on certainty equivalents.

In the absence of calculating certainty equivalents, systematic risk should be captured through the discount rate for a project by applying a risk premium, which reflects the extent to which a project is less (or more) valuable on net by virtue of the positive (or negative) correlation of its benefits with times when aggregate consumption is high.¹ An estimate of

¹ The approach outlined in this Circular regarding a risk adjustment for use when certainty-equivalents are not

an appropriate risk premium for analysis of such projects is presented in Appendix D of this Circular.

Agencies may be able to calculate investment-specific risk premia. Some projects may have net benefits that are more or less correlated with aggregate consumption. For example, spending to prepare for a pandemic could actually have higher net benefits when social welfare is lower—and thus justify a negative risk premium. Other spending may be particularly positively correlated with future consumption, justifying the use of a higher risk premium. In these cases, agencies should consult with OMB for approval in using a different discount rate for a particular project.

Agencies should be careful in a project analysis to apply consistent principles on discounting and risk, which may require using different discount rates for different costs and benefits, even within a project. For example, for a project that includes benefits of avoided greenhouse gas emissions, an agency would discount these benefits at the risk-free rate if the social cost of greenhouse gases is calculated through simulations that measure damages using certainty-equivalent valuations. For other costs or benefits in the same analysis for which certainty-equivalent valuations are not calculated, agencies would use a risk premium.

10. Distributional Effects and Incidence.

The benefits and costs of a project can affect different groups differently. When a project is expected to have differential effects on subgroups of the population, agencies should consider analyzing and discussing these effects, to the extent feasible and appropriate, along with the analysis of discounted net benefits. The availability of data and methodologies will influence the type of analysis (e.g., qualitative or quantitative).

a. Identification of Groups.

Distributional effects may be analyzed by grouping individuals or households according to income class (e.g., income quintiles), geographical region, or demographic group (e.g., age, race or ethnicity, sex, or gender). Other classifications, such as by industry or occupation, may be appropriate in some circumstances.

calculated is specific to the context of analyses subject to this Circular. As noted previously, this Circular does not apply to regulatory impact analyses. For many regulations the appropriate risk premium adjustment would be negligible, as they provide their largest value to society when mitigating the harms of a number of risks or market inefficiencies in bad states of the world. By contrast, the benefits of many Federal investments are positively correlated with future economic conditions. In addition, while the benefits of regulations are often heavily concentrated on mortality risk reductions—the value of which is not highly correlated with good or bad states of the world—that is not the case for Federal investments. Including the risk premium in the discount rate in the context of Federal investments and other analyses subject to this Circular captures the impact of systematic risk when conducting a finer-grained certainty-equivalents analysis for specific projects is not feasible. For discussion of risk adjustment in the context of analysis of regulations, see OMB Circular No. A-4.

Analysis should aim at identifying the relevant groups of people who gain and lose from policy decisions. Effects on the preexisting assignment of property rights by the project under analysis should be reported if appropriate. Where a policy is intended to benefit a specified subgroup of the population, such as low-income households, the analysis should consider how effective the policy is in reaching its targeted group.

b. Weights.

Benefit-cost analysis often assumes that everyone values a marginal dollar of costs or benefits equally. When a project is expected to have differential effects on subgroups of the population, an agency may choose to use different weights in benefit-cost analysis. For example, weights may be based on the diminishing marginal utility of income to acknowledge that the marginal dollar is more valuable (in terms of social welfare) to a person with lower income than a person with higher income. Weights can also be based on the tendency of market-based methods to value things that low-income people use at low amounts. The income-weighted estimate of net benefits can be used as the primary estimate of the net benefits or as a supplemental estimate.

One practical approach to implementing weights that account for diminishing marginal utility uses a constant-elasticity specification to determine the weights for subgroups defined by annual income.² To follow this approach, first compute the traditional net benefits for each subgroup. Then, compute a weighted sum of the subgroup-specific net benefits: the weight for each subgroup is the median income for that subgroup divided by the U.S. median income, raised to the power of the absolute value of the income elasticity of marginal utility times negative one.³ A default estimate of 1.4 can be used for the absolute value of the income elasticity of marginal utility. See the section “Weights and Benefit-Cost Analysis” in OMB Circular No. A-4 for further explanation.

Agencies may also wish to “income-average,” or use an average value for a given benefit or cost across the whole population, when individuals across the population would have a different willingness-to-pay or willingness-to-accept for spending. For example, agencies may use a value of statistical life that does not depend on sub-population income or a population-average home value. Agencies should be cautious in applying income weights

² Income—as used here—is net of government taxes and transfer programs.

³ In other words, the analyst can compute a weighted sum of the subgroup-specific net benefits where the weight for subgroup i , denoted w_i , is

$$w_i = \left(\frac{\bar{y}_i}{y_{\text{med}}} \right)^{-\varepsilon}$$

In this formula, \bar{y}_i is the median income for subgroup i , y_{med} is U.S. median income, and ε is the elasticity of marginal utility. As noted previously, the analyst will need to consider how to account for differences in household or family size when measuring income by group. There may be circumstances in which it may be more acceptable to provide weights as a function of mean income for each subgroup rather than median, such as when doing so improves consistency between the calculated weight and the incidence of benefits and costs within the subgroup.

to such values since distributional considerations about income may have already been partly or fully addressed through the use of such values.

c. Economic Incidence.

Individuals or households are the ultimate recipients of income or other benefits; business enterprises, nongovernmental organizations, or other entities are merely intermediaries. Analyses of distribution should identify economic *incidence*, or how costs and benefits are ultimately borne by households or individuals. When estimating the effects of a project on different groups, it is appropriate to take into account how it will affect government tax collection. For example, if a project increases wages of a given income group by \$100, but that group's wage tax rate is 20%, only \$80 of income should be attributed to the group, and the other \$20 should be counted as increasing government revenues (and therefore reducing the cost of the project). In such cases, it may be useful to calculate the *marginal value of public funds*, calculated as beneficiaries' net willingness to pay for a project divided by the government cost net of resulting tax revenue.⁴

Determining economic incidence can be difficult because benefits and costs are often redistributed in unintended and unexpected ways. For example, a subsidy to produce a commodity will usually raise the incomes of the commodity's suppliers, but it can also benefit consumers of the commodity through lower prices and reduce the incomes for suppliers of competing products. A subsidy also raises the value of specialized resources used in the production of the subsidized commodity. As the subsidy is incorporated in asset values, its distributional effects can change.

11. Special Guidance for Public Investment.

This section's guidance applies only to public investments and not to cost-effectiveness or lease-purchase analyses. Because taxes generally distort relative prices, they have a marginal cost that can be expressed as a percentage of the revenue that they raise. Studies of the U.S. tax system suggest a range of values for the *marginal cost of public funds*, of which a reasonable estimate is 25 cents per dollar of revenue. Such studies typically reflect assumptions that may not apply in many cases, as discussed in the section "The Marginal Cost of Public Funds" in OMB Circular No. A-4.

a. Analysis of the Marginal Cost of Public Funds.

The presentation of results for public investments may include a supplementary analysis with a 25 percent marginal cost of public funds. Thus, in such analyses, costs in the form of public expenditures should be multiplied by a factor of 1.25 and discounted net benefits recomputed.

⁴ See Nathaniel Hendren & Ben Sprung-Keyser, *A Unified Welfare Analysis of Government Policies*, 135 Q. J. ECON. 1209–1318 (2020).

b. Exceptions.

Where specific information suggests that the marginal cost of public funds is lower (or higher) than 25 percent, supplementary analyses may use a different figure. When a different figure is used, an explanation should be provided for it. An example of such an exception is an investment funded by user charges that function like market prices. In this case, the marginal cost of public funds would be zero. A similar analysis can be done for a marginal value of public funds calculation.

12. Special Guidance for Lease-Purchase Analysis.

The special guidance in this section does not apply to the decision to acquire the use of an asset. In deciding that, the agency should conduct a benefit-cost analysis, if possible. Only after the decision to acquire the services of an asset has been made is there a need to analyze the decision whether to lease or purchase.

a. Coverage.

The Circular applies only when both of the following tests of applicability are satisfied:

(1) The lease-purchase analysis concerns a capital asset, including property of durable nature such as equipment, machinery, tools and instruments, contracts for information technology and telecommunications equipment, ships, buildings, facilities, installations, or land, that:

- (a) Is leased to the Federal Government for a term of three or more years;
- (b) Is new, with an economic life of less than three years and leased to the Federal Government for a term of 75 percent or more of the economic life of the asset;
- (c) Is built for the express purpose of being leased to the Federal Government; or,
- (d) Is leased to the Federal Government and clearly has no alternative commercial use (e.g., a special-purpose government installation).

(2) The lease-purchase analysis concerns a capital asset or a group of related assets whose total fair market value exceeds \$1 million.

b. Required Justification for Leases.

All leases of capital assets must be justified as preferable to direct government purchase and ownership. This can be done in one of three ways:

(1) By conducting a separate lease-purchase analysis. This is the only acceptable method for major acquisitions. A lease represents a major acquisition if:

- (a) The acquisition represents a separate line-item in the agency's budget; or,
 - (b) The agency or OMB determines the acquisition is a major one; or,
 - (c) The total purchase price of the asset or group of assets to be leased would exceed \$500 million.
- (2) By conducting periodic lease-purchase analyses of recurrent decisions to lease similar assets used for the same general purpose. Such analyses would apply to the entire class of assets. OMB approval should be sought in determining the scope of any such generic analysis.
- (3) By adopting a formal policy for smaller leases and submitting that policy to OMB for approval. Following such a policy should generally result in the same lease-purchase decisions as would conducting separate lease-purchase analyses. Before adopting the policy, it should be demonstrated that:
- (a) The leases in question would generally result in substantial savings to the Government that could not be realized on a purchase;
 - (b) The leases are so small or so short-term as to make separate lease-purchase analysis impractical; and
 - (c) Leases of different types are scored consistently with the instructions in Appendices B and C of OMB Circular No. A-11.
- c. Analytical Requirements and Definitions.
- Whenever a Federal agency needs to acquire the use of a capital asset, it should do so in the way that is least expensive for the Government as a whole.
- (1) Life Cycle Cost. Lease-purchase analyses should compare the net discounted present value of the life cycle cost of leasing with the full costs of buying or constructing an identical asset. The full costs of buying include the asset's purchase price plus the net discounted present value of any relevant ancillary services connected with the purchase. Guidance on the discount rate to use for lease-purchase analysis is in Section 8.c.
- (2) Economic Life. For purposes of lease-purchase analysis, the economic life of an asset is its remaining or productive lifetime. It begins when the asset is acquired and ends when the asset is retired from service. The economic life is frequently not the same as the useful life for tax purposes.

- (3) Purchase Price. The purchase price of the asset for purposes of lease-purchase analysis is its fair market value, defined as the price a willing buyer could reasonably expect to pay a willing seller in a competitive market to acquire the asset.
- (a) In the case of property that is already owned by the Federal Government or that has been donated or acquired by condemnation, an imputed purchase price should be estimated. Guidance on making imputations is provided in Section 12.c.(6).
 - (b) If public land is used for the site of the asset, the imputed market value of the land should be added to the purchase price.
 - (c) The asset's estimated residual value, as of the end of the period of analysis, should be subtracted from its purchase price. Guidance on estimating residual value is provided in Section 12.c.(7).
- (4) Taxes. In analyzing the cost of a lease, the normal payment of taxes on the lessor's income from the lease should not be subtracted from the lease costs since the normal payment of taxes will also be reflected in the purchase cost. The cost to the Treasury of special tax benefits, if any, associated with the lease should be added to the cost of the lease. Examples of such tax benefits might include highly accelerated depreciation allowances or tax-free financing.
- (5) Ancillary Services. If the terms of the lease include ancillary services provided by the lessor, the present value of the cost of obtaining these services separately should be added to the purchase price. Such costs may be excluded if they are estimated to be the same for both lease and purchase alternatives or too small to affect the comparison. Examples of ancillary services include:
- (a) All costs associated with acquiring the property and preparing it for use, including construction, installation, site, design, and management costs.
 - (b) Repair and improvement costs if included in lease payments.
 - (c) Operation and maintenance costs if included in lease payments.
 - (d) Imputed property taxes excluding foreign property taxes on overseas acquisitions except where actually paid. The imputed taxes approximate the costs of providing municipal services such as water, sewage, and police and fire protection. See Section (6) below.
 - (e) Imputed insurance premiums. See Section (6) below.

- (6) Estimating Imputed Costs. Certain costs associated with the Federal purchase of an asset may not involve a direct monetary payment. Some of these imputed costs may be estimated as follows:
- (a) Purchase Price. An imputed purchase price for an asset that is already owned by the Federal Government or which has been acquired by donation or condemnation should be based on the fair market value of similar properties that have been traded on commercial markets in the same or similar localities. The same method should be followed in estimating the imputed value of any Federal land used as a site for the asset.
 - (b) Property Taxes. Imputed property taxes may be estimated in two ways.
 - (i) Determine the property tax rate and assessed (taxable) value for comparable property in the intended locality. If there is no basis on which to estimate future changes in tax rates or assessed values, the first-year tax rate and assessed value (inflation adjusted for each subsequent year) can be applied to all years. Multiply the assessed value by the tax rate to determine the annual imputation for property taxes.
 - (ii) As an alternative to step (i) above, obtain an estimate of the current local effective property tax rate from the Building Owners and Managers Association's Regional Exchange Reports. Multiply the fair market value of the government-owned property (inflation adjusted for each year) by the effective tax rate.
 - (c) Insurance Premiums. For real property, determine local estimates of standard commercial coverage for similar property from the Building Owners and Managers Association's Regional Exchange Reports. For all other asset categories, identify a widely accepted source for standardized insurance premiums for the asset under consideration. Premiums may need to account for regional differences.
- (7) Residual Value. A property's residual value is an estimate of the price that the property could be sold for at the end of the period of the lease-purchase analysis, measured in discounted present value terms.
- (a) The recommended way to estimate residual value is to determine what similar, comparably aged property is currently selling for in commercial markets.

(b) Alternatively, book estimates of the resale value of used property may be available from industry or government sources.

(c) Assessed values of similar, comparably aged properties determined for property tax purposes may also be used.

(8) Renewal Options. In determining the term of a lease, all renewal options shall be added to the initial lease period.

13. Related Guidance.

- a. OMB Circular No. A-4, “Regulatory Analysis.”
- b. OMB Circular No. A-11, “Preparation and Submission of Annual Budget Estimates,” Appendix B, “Budgetary Treatment of Lease-Purchases and Leases of Capital Assets.”
- c. OMB Circular No. A-19, “Legislative Coordination and Clearance.”
- d. OMB Circular No. A-70, “Federal Credit Policy.”
- e. OMB Circular No. A-76, “Performance of Commercial Activities.”
- f. OMB Circular No. A-109, “Policies to Be Followed in the Acquisition of Major Systems.”
- g. OMB Circular No. A-129, “Policies for Federal Credit Programs and Non-Tax Receivables.”
- h. OMB Circular No. A-130, “Management of Federal Information Resources.”
- i. “Joint OMB and Treasury Guidelines to the Department of Defense Covering Lease or Charter Arrangements for Aircraft and Naval Vessels.”
- j. Executive Order 12866, “Regulatory Planning and Review.”
- k. Presidential Memorandum of April 29, 1992, “Benefits and Costs of Legislative Proposals.”
- l. Office of Science and Technology Policy and Council on Environmental Quality, “Guidance for Federal Departments and Agencies on Indigenous Knowledge,” Nov. 2022.
- m. “Guidance for Assessing Changes in Environmental and Ecosystem Services in Benefit-Cost Analysis,” forthcoming.

14. Implementation.

Economic analyses submitted to OMB will be reviewed for conformity with Items 5 to 12 in this Circular, through the Circular No. A-11 budget justification and submission process, and Circular No. A-19, legislative review process.

15. Effective Date.

The effective date of this Circular is November 9, 2023.

16. Interpretation.

Questions concerning interpretation of this Circular should be addressed to the Office of Economic Policy, Office of Management and Budget (a94@omb.eop.gov).

Appendix A: Definition of Terms

Benefit-Cost Analysis – A systematic method of assessing the impacts of government projects, in which benefits and costs are reported using a common measure (usually dollars) to the extent feasible, and are compared.

Benefit-Cost Ratio – The ratio between the discounted present value of benefits and the discounted present value of costs.

Capital Asset – Tangible property, including durable goods, equipment, buildings, installations, and land.

Certainty-Equivalent – A certain (i.e., nonrandom) outcome that an individual values equally to an uncertain outcome. For a risk-averse individual, the certainty-equivalent for an uncertain set of benefits may be less than the mathematical expectation of the outcome. For example, an individual may value a 50-50 chance of winning \$100 or \$0 as only \$45. Analogously, a risk-averse individual may have a certainty-equivalent value for an uncertain set of costs that is larger in magnitude than the mathematical expectation of costs.

Consumer Surplus – The maximum sum of money a consumer would be willing to pay to consume a given amount of a good, less the amount actually paid. It can be represented graphically by the area between the demand curve and the price line in a diagram representing the consumer's demand for the good as a function of its price.

Cost-Effectiveness Analysis – A systematic quantitative method for comparing the costs of alternative means of achieving the same stream of benefits or a given objective.

Discount Factor – The factor that translates expected benefits or costs in any given future year into present value terms. The discount factor is equal to $1/(1 + \text{the discount rate})^t$ where t is the number of years from the date of initiation for the project until the given future year.

Discount Rate – The rate used in calculating the present value of expected yearly benefits and costs.

Discounted Net Benefits – The difference between the discounted present value of benefits and the discounted present value of costs.

External Economy or Diseconomy – A direct effect, either positive or negative, on someone's profit or welfare arising as a byproduct of some other person's or firm's activity. Also referred to as neighborhood or spillover effects, or externalities for short.

Incidence – The ultimate distributional effect of a tax, expenditure, or regulatory program.

Inflation – The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. Inflation is usually measured by a broad-based price index, such as the implicit deflator for Gross Domestic Product or the Consumer Price Index.

Life Cycle Cost – The overall estimated cost for a particular project alternative over the time period corresponding to the life of the project, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance.

Marginal Cost of Public Funds – A measure of the cost to society resulting from the distorting effect of taxes. This concept is also sometimes referred to as the deadweight loss of taxation.

Marginal Value of Public Funds – A measure of the benefits of a project relative to the size of the associated net government expenditure. It is calculated as beneficiaries' net willingness to pay for a project divided by the government cost net of resulting tax revenue.

Multiplier – The ratio between the direct effect on output or employment and the full effect, including the effects of second-order rounds or spending.

Nominal Interest Rate – An interest rate that is not adjusted to remove the effects of actual or expected inflation. Market interest rates are generally nominal interest rates.

Nominal Values – Economic units measured in terms of purchasing power of the date in question. A nominal value reflects the effects of general price inflation.

Real or Constant Dollar Values – Economic units measured in terms of constant purchasing power. A real value is not affected by general price inflation. Real values can be estimated by deflating nominal values with a general price index, such as the implicit deflator for Gross Domestic Product or the Consumer Price Index.

Real Discount Rate – An interest rate that has been adjusted to remove the effect of expected or actual inflation. Real interest rates can be approximated by subtracting the expected or actual inflation rate from a nominal interest rate. A precise estimate can be obtained by dividing one plus the nominal interest rate by one plus the expected or actual inflation rate and subtracting one from the resulting quotient.

Relative Price – A price ratio between two goods as, for example, the ratio of the price of energy to the price of equipment.

Shadow Price – An estimate of the marginal value of a good or input, reflecting the effects of market distortions such as externalities or taxes. For example, the shadow price of capital is marginal societal willingness to pay for capital relative to consumption.

Threshold or Break-Even Analysis – An analysis that asks what magnitude unmonetized benefits and costs would need to have for the project to yield positive discounted net benefits, or for one alternative to overtake another in terms of discounted net benefits.

Transfer Payment – A shift in money or goods from one party to another. More generally, when a project generates a gain for one group and an equal-dollar-value loss for another group, the project is said to cause a transfer from the latter group to the former.

Treasury Rates – Rates of interest on marketable Treasury debt. Such debt is issued in maturities ranging from 28 days to 30 years.

Willingness-to-Accept – The minimum amount an individual would be willing to take in order to relinquish a good or service.

Willingness-to-Pay – The maximum amount an individual would be willing to give up in order to acquire a good or service.

Appendix B: Additional Guidance for Discounting

1. Sample Format for Discounting Deferred Costs and Benefits

Assume a 10-year project that will commit the Government to the stream of real (or constant-dollar) expenditures appearing in column (2) of the table below and which will result in a series of real benefits appearing in column (3). The discount factor for a 3.1 percent discount rate is shown in column (4). The present value cost for each of the 10 years is calculated by multiplying column (2) by column (4); the present value benefit for each of the 10 years is calculated by multiplying column (3) by column (4). The present values of costs and benefits are presented in columns (5) and (6) respectively.

Year since initiation, renewal or expansion (1)	Expected yearly cost (2)	Expected yearly benefit (3)	Discount factors for 3.1% (4)	Present value of costs Col. 2 x Col. 4 (5)	Present value of benefits Col. 3 x Col. 4 (6)
1	\$10.00	\$0.00	0.9699	\$9.70	\$0.00
2	20.00	0.00	0.9408	18.82	0.00
3	30.00	5.00	0.9125	27.37	4.56
4	30.00	10.00	0.8850	26.55	8.85
5	20.00	30.00	0.8584	17.17	25.75
6	10.00	40.00	0.8326	8.33	33.30
7	5.00	40.00	0.8076	4.04	32.30
8	5.00	40.00	0.7833	3.92	31.33
9	5.00	40.00	0.7598	3.80	30.39
10	5.00	25.00	0.7369	3.68	18.42
Total				\$123.37	\$184.92

NOTE: The discount factor is calculated as $1/(1 + \text{discount rate})^t$ where t is the year.

The sum of column (5) is the total present value of costs and the sum of column (6) is the total present value of benefits. Discounted net benefits are \$61.55, the difference between the sum of discounted benefits and the sum of discounted costs.

2. End-of-Year and Mid-Year Discount Factors

The discount factors presented in the table above are calculated on the implicit assumption that costs and benefits occur as lump sums at year-end. When costs and benefits occur in a steady stream, applying mid-year discount factors is more appropriate. For instance, the first cost in the table may be estimated to occur after six months, rather than at the end of one year to approximate better a steady stream of costs and benefits occurring over the first year. Similarly, it may be assumed that all other costs and benefits are advanced six months to approximate better a continuing steady flow.

The present values of costs and benefits computed from the table above can be converted to a mid-year discounting basis by multiplying them by 1.0154 (the square root of 1.031). Thus, if the above example were converted to a mid-year basis, the present value of costs would be \$125.27, the present value of benefits would be \$187.76, and the discounted net benefits would be \$62.49.

3. Illustrative Discount Factors for Discount Rate of 3.1 percent

<u>Year since initiation, renewal or expansion</u>	<u>Year-end discount factors</u>	<u>Mid-year discount factors</u>	<u>Beginning-of- year discount factors</u>
1	0.9699	0.9849	1.000
2	0.9408	0.9552	0.9699
3	0.9125	0.9265	0.9408
4	0.8850	0.8987	0.9125
5	0.8584	0.8716	0.8850
6	0.8326	0.8454	0.8584
7	0.8076	0.8200	0.8326
8	0.7833	0.7954	0.8076
9	0.7598	0.7714	0.7833
10	0.7369	0.7482	0.7598
11	0.7148	0.7257	0.7369
12	0.6933	0.7039	0.7148
13	0.6724	0.6828	0.6933
14	0.6522	0.6622	0.6724
15	0.6326	0.6423	0.6522
16	0.6136	0.6230	0.6326
17	0.5951	0.6043	0.6136
18	0.5772	0.5861	0.5951
19	0.5599	0.5685	0.5772
20	0.5430	0.5514	0.5599
21	0.5267	0.5348	0.5430
22	0.5109	0.5187	0.5267
23	0.4955	0.5031	0.5109
24	0.4806	0.4880	0.4955
25	0.4662	0.4733	0.4806
26	0.4521	0.4591	0.4662
27	0.4385	0.4453	0.4521
28	0.4254	0.4319	0.4385
29	0.4126	0.4189	0.4254
30	0.4002	0.4063	0.4126