Assessing the Benefits of Drinking Water Regulations : A Primer for Stakeholders

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This document is intended to provide information on the process currently followed by EPA when assessing the benefits of drinking water regulations. It is not intended as guidance.

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OVERVIEW

The U.S. Environmental Protection Agency's (EPA's) Office of Ground Water and Drinking Water developed *Assessing the Benefits of Drinking Water Regulations: A Primer for Stakeholders* to provide information to stakeholders and other interested parties on analyzing the effects of regulations establishing Maximum Contaminant Levels (MCLs) for drinking water. This *Overview* summarizes the information contained in this document for those interested in a brief synopsis of key issues.

EPA created this document in response to new provisions contained in the 1996 Amendments to the Safe Drinking Water Act (SDWA), working closely with a group of stakeholders -- the Benefits Working Group of the National Drinking Water Advisory Council. The Amendments create specific requirements for assessing benefits and for using the resulting information in EPA decision-making. This document focuses on the benefits valuation issues commonly addressed by EPA's economists and policy analysts. We also briefly discuss the assessment of costs and risks, and provide references for more detailed information on these topics.

In addition to SDWA's statutory provisions, regulatory benefit-cost analyses conducted by the Federal government are subject to several other sets of requirements. Chief among these are guidelines developed by the U.S. Office of Management and Budget for all Federal agencies and guidance developed by EPA for its own programs. These documents require analysts to adhere to "best practices" as defined by the economics profession, and emphasize the need to clearly communicate (1) the rationale for decisions made in the course of the analysis; (2) the implications of the findings; and (3) the uncertainties in the resulting estimates. Regulatory analyses also comply with several statutory and administrative requirements for addressing impacts on selected groups, including small businesses and government units, low income and minority populations (i.e., environmental justice), and children. This document is based on, and consistent with, these sources of requirements for regulatory analyses.

The remainder of this *Overview* discusses five subjects: the SDWA requirements for benefits assessment; the general categories of benefits most often addressed; the measures of value preferred by economists; the general methods used to estimate these values; and the specific methods used to value benefits related to reducing the risks of mortality, morbidity and other effects. The following chapters provide more detailed information on these topics as well as references to the underlying literature.

SDWA Requirements For Benefits Analysis

EPA has used benefit-cost analysis for many years as one of several sources of information on the impacts of alternative policy choices. While there are many ways to categorize the positive and negative impacts of a regulation, traditionally EPA has

defined the "cost" side of the analysis as including estimates of the expenditures needed to comply with new regulations (e.g., of installing pollution control equipment) and of the market effects of these expenditures (e.g., on the prices charged for the products of affected industries). The "benefits" side of the analysis generally focuses on the effects of reducing contamination levels, including effects on human health, the natural environment, and man-made materials.

EPA's ability to use the results of these analyses in decision-making under SDWA was limited prior to the 1996 Amendments. The Agency's choice of regulatory levels was constrained by statutory language requiring EPA to set MCLs as close to the MCLG as is "feasible" [SDWA, Section 1412(b)(4)(B)], and defined feasible as the use of the best technology and treatment techniques examined for efficacy under field conditions, taking cost into consideration [SDWA, Section 1412(b)(4)(D)]. Under the amendments, EPA may, at its discretion, establish a less stringent MCL if the costs of achieving the lowest feasible level are not justified by its benefits.

The amendments list a number of issues that should be addressed in benefits analyses, including:

- the quantifiable and non-quantifiable health risk reduction benefits of control of the contaminant proposed for regulation at the specified MCL;
- the quantifiable and non-quantifiable health risk reduction benefits of any control of co-occurring contaminants that can be attributed solely to the proposed MCL, exclusive of compliance with other proposed or promulgated regulations;
- the quantifiable and non-quantifiable costs of compliance with the proposed MCL, including monitoring, treatment, and other costs, exclusive of costs of compliance with other proposed or promulgated regulations;
- the incremental costs and benefits associated with each alternative MCL under consideration;
- the effects of the contaminant on the general population, and on groups within the population that are likely to be at greater risk of adverse health effects from drinking water contaminants, such as infants, children, pregnant women, the elderly, and individuals with a history of serious illness;

- the increased health risks, if any, that may result from compliance with the proposed MCL, including risks associated with co-occurring contaminants; and,

- other relevant factors, including the quality of the available information supporting the analysis, the uncertainties in the analysis, and factors relating to the degree and nature of the identified risks.

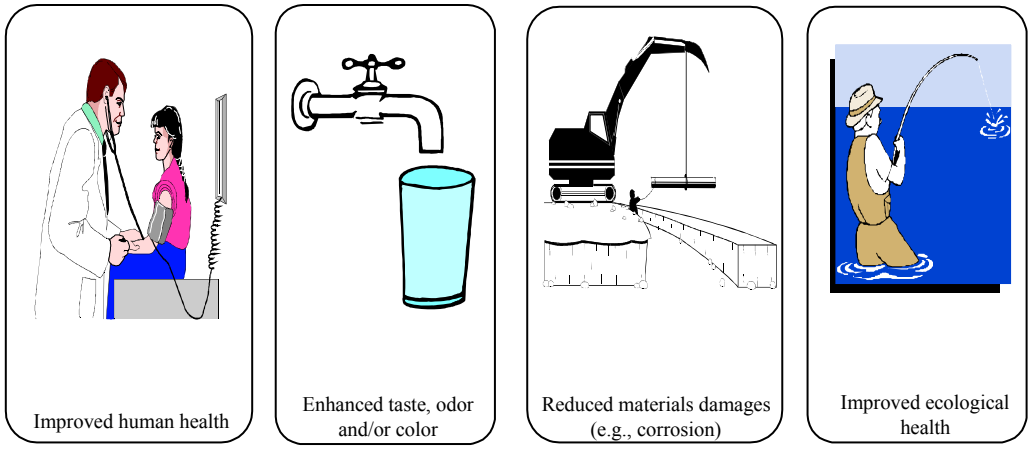
SDWA also requires that these analyses be based on the best available scientific research.

Types of Benefits

For regulations that establish MCLs, a variety of benefits may be associated with reducing the effects of contamination on users of public water supplies (including households, commercial establishments, and industry) as well as on the water system itself. Chief among these effects are reductions in human health risks. The regulations may decrease the risks of incurring particular illnesses or adverse health effects as well as the risks of dying from these illnesses.

Depending on the characteristics of the contaminants, drinking water regulations may have other types of benefits, including aesthetic effects (improved taste, odor, and/or color) and effects on man-made materials (e.g., reduced corrosion). In cases where significant increases in source water protection result from the regulation, ecological benefits may also accrue. Ecological benefits may include improved fishing and recreational opportunities, protection of biodiversity, or enhanced nonuse values (e.g., the pleasure of knowing that clean water exists). Examples of these benefits categories are illustrated in Exhibit 1.

Exhibit 1
Benefits of Drinking Water Regulations



To determine the types of benefits to be assessed for a specific regulation, analysts generally begin by developing an inclusive list of the possible effects of controlling the contaminants on all types of water users. Analysts then often conduct screening analysis of selected effects, focusing on those that are most likely to be significant. Next, analysts expand and/or refine the analysis as needed to address key sources of uncertainty. This type of sequencing is designed to focus Agency resources on addressing those issues most likely to affect the ultimate policy decision.

Definition of "Value"

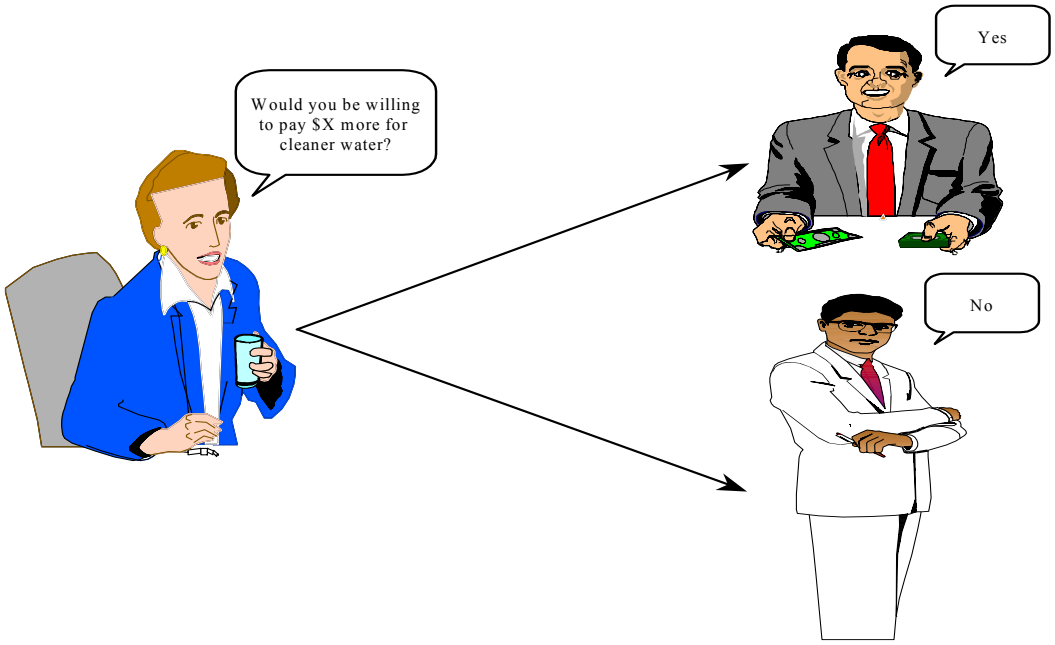
The practice of benefits assessment is based on the discipline of welfare economics. When determining the value of benefits such as those resulting from drinking water regulations, economists begin with the assumption that individuals derive utility (or a sense of satisfaction or well-being) from the goods and services they consume. Individuals can maintain the same level of utility while trading off different bundles of goods and services (e.g., one may be equally happy going to the movies or a baseball game), and their willingness to make these trade-offs can be measured in dollar terms.

In theory, the dollar value of a regulatory requirement is most appropriately measured by determining the change in income (or compensation) that has the same effect on utility (or the level of individual satisfaction) as the requirement. Because utility is difficult to measure directly, economists usually rely on estimates of *willingness to pay* to value the effects of these types of requirements. Willingness

to pay is the maximum amount of money an individual would voluntarily exchange to obtain an improvement; e.g., in drinking water quality.

Willingness to pay is a different concept than cost or price. Cost refers to the resources needed to produce a good or service; it does not measure the value of the good or service to members of society. Price is determined by the interactions of suppliers and consumers in the marketplace. Individual willingness to pay may exceed the current price, in which case the individual benefits from the fact that the market price is less than he or she is willing to pay. If price instead exceeds willingness to pay, then the individual would not purchase the good. An example of this concept is provided in Exhibit 2.

Exhibit 2
Individual's Willingness to Pay



The amount by which willingness to pay exceeds price is referred to as consumer surplus by economists, and aggregate changes in this difference (i.e., across all consumers) can be used to measure the dollar value of the social welfare effects of government policies. For example, consumers generally benefit from price decreases because willingness to pay will then exceed price by a larger amount.

Measuring the value of benefits in dollar terms has two key advantages. First, expressing both costs and benefits in monetary terms allows policymakers to more easily compare these measures of a regulation's impact. Second, valuation provides

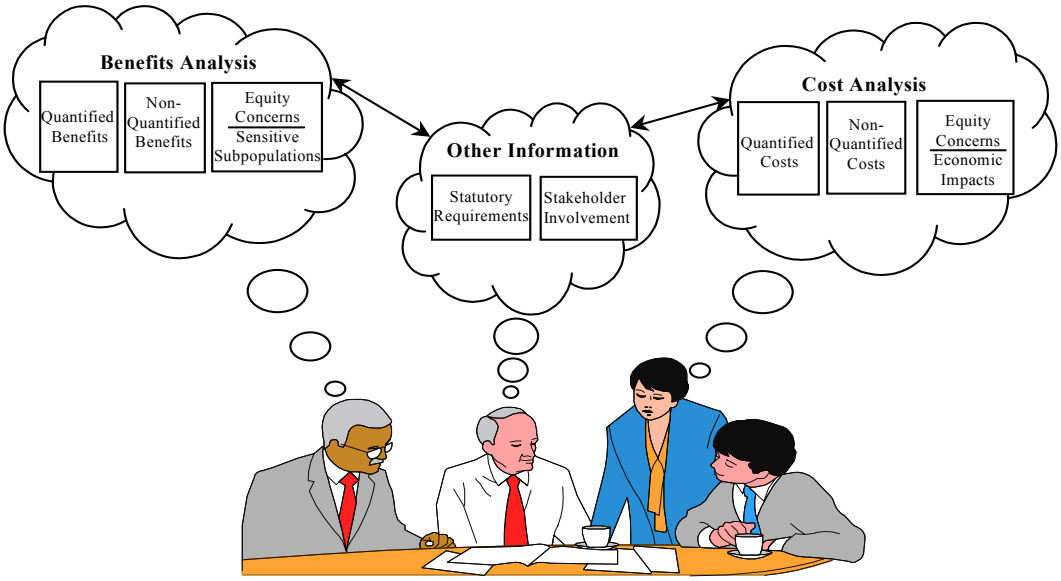
explicit information on the values held by individual members of society for the benefits of alternative policy choices.

However, critics of benefit-cost analysis are concerned that this approach does not take into account the distributional effects of a policy. For example, they argue that lower income individuals may not be treated equitably if decisions are based solely on willingness to pay (which is constrained by income). Economists traditionally focus on how individuals value changes in their own well-being -- aggregating the individual values to determine total benefits, and argue that ethical judgements about distributional effects should be addressed separately.

Because of these concerns, economic benefit-cost analyses of EPA regulations are supplemented by analyses of effects on equity. For example, analysis of environmental justice (effects on low income and minority groups) and risks to children are required for all major EPA regulations. In addition, SDWA requires that EPA consider effects on sensitive subpopulations *"such as infants, children, pregnant women, the elderly, and individuals with a history of serious illness, or other subpopulations likely to be at greater risk..."*

Also, many benefits can be difficult to quantify or may be quantifiable but difficult to value in monetary terms. EPA explicitly considers these non-quantified or non-monetized benefits in setting regulatory standards. The many factors EPA considers are illustrated in Exhibit 3 below.

Exhibit 3
Information for Decision-Making



Valuation Methods

The preferred approach for valuing the benefits of environmental regulations is generally to determine individuals' willingness to pay (WTP) by observing the market demand for related improvements. However, there is often no marketplace for directly buying and selling reductions in environmental contamination. When market data are lacking, economists may use a variety of methods to estimate WTP, which are often divided into two categories: *stated preference methods* and *revealed preference methods*.

Stated preference methods typically employ survey techniques and ask respondents to "state" what they would pay for a good or service. These methods can be used to directly value the program of concern (e.g., "how much would you be willing to pay for a program that would reduce the concentrations of arsenic in drinking water from 10 µg/L to 5 µg/L?") or to assess specific effects of the program (e.g., "how much would you be willing to pay for a program that would reduce the risks of incurring kidney disease from 10/100,000 to 5/100,000?").

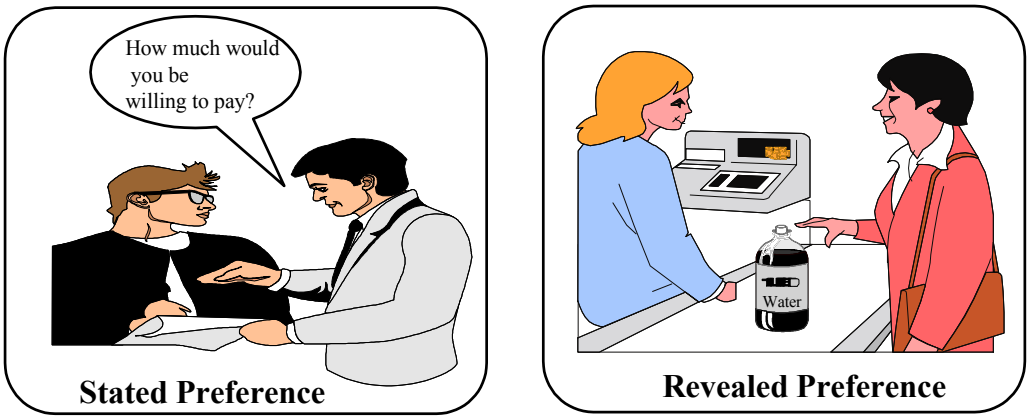
Revealed preference methods are based on observed behaviors that can "reveal" values based on prices and preferences for related market goods or services. For example, if an individual chooses to pay $50 a month to drink bottled water rather than $30 a month to drink tap water because he or she believes that the bottled water

is cleaner and safer, presumably this individual values the additional cleanliness and safety of the bottled drinking water at no less than $20 per month ($50 - $30 = $20).

Examples of revealed preference methods may include studies of wage-risk trade-offs, costs of illness, and averted costs. These methods use actual market data for related goods instead of relying on individual's predictions of their own behavior. However, there is often an imperfect match between the commodities valued in these studies and individual's' willingness to pay for the effects associated with a rulemaking. For example, bottled water purchases may not be affected by establishment of an MCL for an individual contaminant or group of contaminants, if such purchases reflect concern about a range of contaminants or about convenience, taste, odor, or color. The medical expenditures included in a cost of illness study may reflect the availability of insurance, rather than individual's true willingness to pay, and exclude the value of avoiding pain and suffering.

The types of studies often used to value the benefits of environmental regulations are illustrated in Exhibit 4 below.

Exhibit 4
Stated and Revealed Preferences



When assessing EPA regulations, analysts often transfer benefits estimates from existing studies rather than conduct new primary research. Benefit transfer involves reviewing the relevant valuation literature, selecting studies that address effects similar to those addressed by the regulations, and applying the estimates from the studies to the regulatory analysis. Key issues in conducting these transfers include ensuring that the studies used are of reasonable quality (e.g., adhere to best practices

for the particular type of research) and are applicable to the policy of concern (e.g., consider similar effects and similar populations). In some cases, it may be possible to adjust the primary research results to address differences between the study scenario and the regulatory scenario.

Valuation of Health Risks and Other Effects

Regulation of contaminants in drinking water may reduce the risks of incurring a variety of health effects, including acute or chronic illnesses that may sometimes result in death. Below, we summarize current practices for valuing mortality and morbidity risks, as well as other effects.

Mortality Risks

Mortality risk reductions are generally valued using estimates of the "value of statistical life" (VSL). VSL does not refer to the value of an identifiable life, but instead to the value of small reductions in mortality risks throughout a population. A "statistical" life can be thought of as the sum of small individual risk reductions across an entire exposed population. For example, if 100,000 people would each experience a reduction of 1/100,000 in their risk of premature death as the result of a regulation, the regulation can be said to "save" one statistical life (i.e., 100,000 * 1/100,000). If each member of the population of 100,000 were willing to pay $50 for this risk reduction, the corresponding value of a statistical life would be $5 million (i.e., $50 * 100,000). VSL estimates are appropriate only for valuing small changes in risk; they are not values for saving an individual's life.

To value mortality risks, EPA analysts often use VSL estimates applied in the recent report to Congress, *The Benefits and Costs of the Clean Air Act, 1990 to 2010,* since these estimates have been subject to substantial peer review. They are derived from 26 studies, 21 of which consider the increase in wages that workers demand for riskier jobs and five of which are based on contingent valuation surveys. The resulting values (in 2000 dollars) range from $0.8 million to $17.8 million per statistical life saved, with a mean of $6.3 million. Given the uncertainty in these estimates, a range of values are generally presented in the benefits analysis, including upper and lower bound estimates as well as the central estimate. EPA is now researching a number of topics related to improving the use of these types of estimates.

When applying this range of estimates to the effects of a particular rule, benefit analysts consider differences between the scenarios addressed in the original studies and the risk reductions addressed by the regulations. For example, the types of fatal risks assessed in the 26 studies (primarily work place accidents) differ from the types of fatal risks affected by environmental regulations (which are often cancer-related).

The subjects of the studies may differ in age, income, or baseline health status from the populations most likely to be affected by the regulations. The studies also do not address factors such as altruism; i.e., individual's willingness to pay for improvements in the health of others. The empirical literature does not provide adjustment factors for many of these (potentially counter-balancing) sources of bias, hence many of these concerns are often discussed qualitatively.

Morbidity Risks

Regulations establishing MCLs also often reduce the risks of incurring nonfatal cancers or other nonfatal health effects. Studies of total willingness to pay (WTP) to avoid an illness, which generally use contingent valuation or other stated preference methods, are available for only a limited number of health effects. Benefit transfer techniques are often used to apply these estimates of WTP to other types of effects. In some cases, analysts may instead rely on estimates using the cost of illness (COI) method. COI studies often include medical expenses (e.g., doctor visits, prescription medicine, hospital stays) and may include lost work time (e.g., foregone earnings), but generally do not address lost leisure time or pain and suffering. They focus on expenditures (which may be influenced by the availability of insurance), rather than on willingness to pay to reduce future risks. Economists believe that COI studies generally understate willingness to pay for morbidity risk reductions.

Analyses of the morbidity risk reductions attributable to drinking water regulations may include estimates of COI and/or total WTP, along with a discussion of the advantages and drawbacks of the valuation methods and an evaluation of the quality and relevance of the individual studies from which the estimates were obtained. The COI studies will provide reasonably certain estimates of averted costs that generally can be interpreted as a lower bound on WTP; the WTP estimates may be less certain (due to the methods used or specific effects studied) but more consistent with the theoretically correct definition of value.

Other Effects

In addition to effects on morbidity or mortality, some drinking water regulations may affect the aesthetic qualities of public water supplies (taste, odor, color) or the damages they cause to man-made materials (corrosion, build-up, impurities). The approach to assessing these types of effects often relies on avoided cost methods. These methods generally involve comparing the costs (e.g., for replacing corroded pipes) that are likely to be incurred in the absence of the rule to the costs likely if alternative MCLs are established. In some cases, studies of willingness to pay (e.g., using contingent valuation) may also be available. For regulations that lead to increases in source water protection, ecological benefits may also accrue -- such as improved recreational opportunities, protection of biodiversity, or nonuse values such as the pleasure of knowing clean resources exist. The methods appropriate for

valuation of these effects will depend on the types of effects considered, but may include analyses of avoided costs or use of contingent valuation surveys.

In applying these valuation methods, analysts often apply informed judgement to determine the appropriate approach for a particular rulemaking. As noted in OMB guidance on conducting economic analysis: *"You will find that you cannot write a good regulatory analysis according to a formula. The preparation of high-quality analysis requires competent professional judgement. Different regulations may call for very different emphasis in the analyses, depending on the importance and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to key assumptions."* The rationale for these judgements, the limitations and uncertainties in the analysis, and the implications for decision-making are communicated in the materials presenting the results of the analysis.