College of Engineering

MAKING SENSE OF THE BENEFIT-COST PROVISIONS OF THE SAFE DRINKING WATER ACT

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ABSTRACT

Prior to 1996, drinking water standards were required to be as close to absolutely protective of human health as technically and economically feasible. The 1996 Amendments to the Safe Drinking Water Act gave EPA the option to set standards that are less protective than feasible, based on benefit-cost criteria. However, the 1996 Amendments do not simply instruct EPA to maximize net benefits, as is typical in an economic benefit-cost assessment. Instead EPA is instructed to "maximize health risk reduction benefits at a cost that is justified by the benefits". Exactly what this means is unclear. Many commentators on EPA rules base their evaluations on maximizing net benefits. In contrast, EPA has explicitly rejected simple maximization of net benefits by citing the priority given to health risk reduction in its legislative mandate. This study considers the impacts of different interpretations of the benefit-cost provisions of the 1996 Amendments. It concludes that the use of a higher monetary value for risk reduction than that currently used by EPA would more closely reflect the statutory preference for health benefits. However, the author does not advocate this as the preferred decision-making criterion. Instead an alternative procedure is described in which preference is given for outcomes likely to have positive net benefits over outcomes for which there is substantial uncertainty as to whether the net benefits will be positive. This approach will favor less dramatic regulatory actions in the short term, while allowing for more stringent regulations as uncertainties are reduced over time.

INTRODUCTION

The Safe Drinking Water Act Amendments of 1996 changed the basis for drinking water regulations. As a result of the 1996 Amendments, drinking water standards may now be less protective of human health than is feasible, based on benefit-cost considerations. However, performing a benefit-cost analysis on a health-based standard is problematic. The costs (typically of additional water treatment and monitoring) are monetary, while the benefits of prolonged human life, disease-free children, un-mutated genes, etc. are difficult to monetize. The 1996 Safe Drinking Water Amendments codified what some might call a dubious practice of placing a dollar value on human life and health and made it part of our societal decision-making process for drinking water standards. Benefit-cost analysis has already resulted in the establishment of standards for arsenic and uranium (EPA 2000a, EPA 2001) that are less protective of human health than is feasible.

This paper describes the benefit-cost provisions of the 1996 Amendments to the Safe Drinking Water Act. Alternative interpretations of these provisions are described, and the impact of these provisions on the regulatory process is illustrated using the recent revision to the arsenic drinking

water standard as a case study. Based on this case study and existing literature on regulatory decision making strategies, an alternative decision process for setting drinking water standards is proposed.

INTERPRETING THE SAFE DRINKING WATER ACT

The 1996 Amendments to the Safe Drinking Water Act did not establish benefit-cost analysis as the sole decision making criterion for drinking water standards. Instead a three-step process was established that allows for a number of different considerations to be taken into account. The first step in the process is the identification of the contaminant concentration that is believed to be absolutely protective of human health. This concentration is termed the Maximum Contaminant Level Goal (MCLG) and is not an enforceable standard. The second step is the identification of the concentration that is as close to the MCLG as it is technically and economically feasible to achieve. Before 1996, EPA was required to set the enforceable standard, termed the Maximum Contaminant Level (MCL), at this "feasible" level. Under the 1996 Amendments, an optional third step was added to this process. At EPA's discretion the MCL may be adjusted upwards from the "feasible" level based on benefit-cost considerations.

In practice, EPA has had to make a number of decisions as to how to interpret these instructions. One issue is how to set MCLGs for the many contaminants known or suspected to be carcinogenic. There is no level of exposure to carcinogens that is known to be absolutely safe. While some argue for the existence of thresholds, below which no carcinogenic effects exist, in practice it is difficult or impossible to verify the existence of such thresholds and even infinitesimal exposures are generally modeled as inducing correspondingly infinitesimal risks. Congress did not identify a "de minimus" level of risk appropriate for an MCLG, and EPA adopted a policy of setting the MCLG values for all carcinogens at zero. While zero may be a worthy goal, it is not much concrete help to a regulator trying to make a pragmatic decision. The technical and economic feasibility criterion used for determining the MCL does not provide much practical guidance either. Treatment capabilities have existed for decades that can remove almost any contaminant to below detectable concentrations. These technologies are not, as a rule, completely economically infeasible, though they usually come at a price substantially higher than conventional water treatment processes. In a few water systems with specialized needs many of them, such as activated carbon, reverse osmosis, and ion exchange, are already in use. While the use of these processes has been shown to be feasible, it is not necessarily pragmatic. A nationwide shift to such technologies would require a dramatic investment in drinking water infrastructure and in many locations (those with high quality source waters) would achieve only minimal risk reduction.

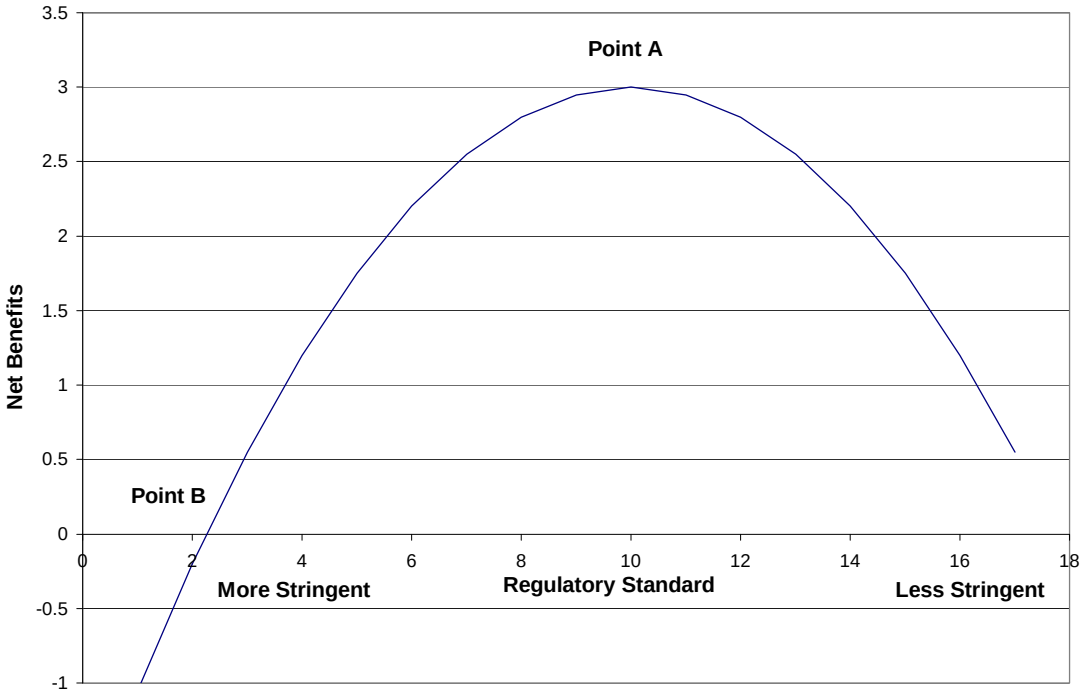
EPA attempted to define a "de minimus" level of risk by developing a policy of setting drinking water standards at levels that correspond to lifetime risks in the range of one in one million to one in ten thousand, with the exact level depending on pragmatic considerations. However, there was no legislative basis for this policy, nor was it ever implemented as a rule, making its use in standard setting problematic (AWWA 2000). Because of the lack of a clear basis for defining acceptable risk levels, EPA did not set explicitly risk-based standards prior to 1996 but instead found a means of setting non-zero standards based on the feasibility criterion. For an MCL to be enforceable, regulatory agencies must be able to reliably quantify when concentrations of the

contaminant exceed the MCL. To ensure that MCLs would be feasible to enforce, EPA developed the concept of the Practical Quantitation Limit (PQL). The PQL is "the minimum, reliable quantitation level that most laboratories can be expected to meet during day-to-day operations" (EPA 2000b). In the absence of any other means of justification for a non-zero standard, standards were typically set equal to the PQL, the lowest level that could practically be enforced.

The discretionary authority to use benefit-cost considerations in setting MCLs has also required interpretation. The statutory instructions are not simply to choose the MCL that maximizes net benefits, the standard benefit-cost analysis decision making criterion. Instead EPA is given discretionary authority to select the MCL that "maximizes the health risk reduction benefits at a cost that is justified by the benefits." Exactly what "justified" means in this context is not clear. If one believes that the monetized value of risk reduction reflects the rate at which resources not used in this rule would reduce other risks, then risk reduction would be maximized when net benefits are maximized. If one believes that the monetized value represents a societal trade-off between risk and a variety of other goods, then "justified" might be construed as a sort of budget constraint, indicating that the standard set should be as protective as possible, provided that net benefits are not negative.

The implications of these two decision making approaches are shown for a hypothetical MCL in Figure 1. As an increasingly stringent standard is set (as one moves left, towards lower MCL values on the x-axis), both the costs and benefits of the standard increase. However, the costs increase more rapidly than the benefits as increasingly stringent standards affect larger numbers of water systems, and the benefits of regulating these additional water supplies are smaller than the benefits of regulating systems with greater health risks. Thus one typically has a peak in net benefits (benefits minus costs) at a moderate value of the MCL. Less stringent standards produce fewer benefits by failing to reduce health risks sufficiently. More stringent standard produce fewer benefits because of their higher costs which outweigh the additional health benefits of a stricter standard. The first interpretation (maximizing net benefits) would require setting the standard at the peak of the net benefits curve (Point A). The second interpretation (as protective as possible provided that net benefits are not negative) would set the standard at the point where the net benefits curve intersects the x-axis (Point B).

Figure 1



The rule making process for the revision to the arsenic MCL provides an example of how the benefit-cost provisions of the 1996 Amendments have been implemented in practice. In 2000 EPA proposed that the MCL for arsenic be reduced from 50µg/l to 5µg/l (EPA 2000b). EPA set the MCLG at zero, following the standard practice for carcinogenic contaminants. EPA determined the "feasible" level for the MCL to be 3µg/l, based on the PQL. The decision to propose an MCL of 5µg/l rather than 3µg/l was based on benefit-cost considerations. EPA's analysis indicated that the benefits roughly equaled the costs for an MCL of 5µg/l. EPA justified the selection of this standard by noting that it was the most stringent that would not result in negative net benefits. Thus EPA appeared to be using the second interpretation (as protective as possible provided that net benefits are not negative) when it proposed an arsenic standard of 5µg/l. However, this interpretation was criticized by commentators who preferred the first interpretation of the benefit cost provisions of the 1996 Amendments, that of simply maximizing net benefits (AWWA 2000). According to this viewpoint, it makes no sense to establish a rule with zero net benefits, as it does not improve overall societal welfare. Worse still, it represents a loss of potential benefits that could be obtained by a moderately less stringent standard. (In Figure 1, the move from Point A to Point B clearly produces a decline in net benefits.) However, there are concerns with setting the standard at Point A as well. While this level may maximize societal benefits, it does not necessarily maximize health benefits as required by the 1996 Amendments. This is because the monetary value of risk reduction used by EPA for the arsenic revision, $6.1 million/life, is based on labor market studies of how much additional compensation is required for workers to perform marginally more dangerous jobs. One conceivable justification for accepting a higher-paying but more dangerous job is that one could use the additional money to reduce other risks (e.g., buy a safer car, obtain better or more regular

health care, etc.). However, individuals value things besides risk reduction and are likely to devote some of their savings towards things that do not reduce risk (travel, education, etc). Thus health risk benefits would actually be maximized somewhere to the left of Point A in Figure 1. In order to determine the point at which health benefits are maximized, one would need to use a different monetary value for risk reduction. This would value risk reduction not on willingness to trade of risk for monetary compensation but instead look at how much risk decreases as households have additional income (or how much risk increases as income declines). This is a more difficult value to estimate but available studies put this figure considerably higher than the labor market estimates of the value of risk, at around $15 million/life.

EPA appears to have abandoned its initial interpretation of the benefit-cost provisions of the 1996 Amendments. In the final arsenic rule (EPA 2001), EPA set the standard at 10µg/l rather than 5µg/l. As with the proposed rule, the adjustment from the feasible level of 3µg/l was based on benefit-cost considerations. However, EPA no longer justified the chosen standard as merely avoiding negative net benefits. Instead EPA moved towards the more conventional benefit-cost criterion of maximizing net benefits but still showed some preference for health benefits. EPA found that the estimates of the net benefits of 10µg/l and 20µg/l were similar. A set of assumptions was identified under which 10µg/l would maximize net benefits. In addition, the fact that the upper bound of the estimated benefits was higher for 10µg/l than for 20µg/l was cited to further support the selection of 10µg/l as the new standard. This appears to be a third interpretation of the benefit-cost provisions of the 1996 Amendments, that under conditions of uncertainty one should chose the more stringent standard as this level will produce a higher upper bound for the health benefits.

CRITIQUING THE INTERPRETATIONS

All three of these interpretations have short comings. The first (maximizing net benefits) does not appear to respect the statutory instructions giving preference to health benefits. The second (achieving zero net benefits) is not in accordance with standard principles of benefit-cost analysis and appears to have been abandoned by EPA. The third (selecting the more stringent of two standards with roughly equal net benefits) is also problematic since uncertainty in regulatory impacts typically increases as standards become more stringent. Thus the preference for a stricter standard in the face of uncertainty, will typically result in the selecting of an MCL with higher uncertainty in its impacts over an MCL with similar estimated benefits, but less uncertainty in its impacts. The increasing uncertainty of more stringent standards can be seen by noting that the magnitude of the costs and benefits increases as standards become more stringent and thus the uncertainty in the difference of the two quantities will also increase (unless they are very tightly correlated).

A decision rule that gives preference to outcomes with higher uncertainty is exactly the opposite of typical decision making preferences. Uncertainty in impacts is generally viewed as undesirable and options with less uncertainty are preferred over those with higher uncertainty. Given two standards with equal expected benefits, one would expect that EPA, and society at large, would prefer a standard that is highly likely to have a net positive impact over one that may or may not have a net positive impact (even if the more uncertain standard has a higher upper bound on estimated net benefits).

Since there are concerns with all three interpretations currently in use, what is the appropriate interpretation? Perhaps the most rigorous interpretation of the 1996 Amendments would be to use the standard benefit-cost criterion of maximizing net benefits and to address the statutory requirement to maximize health benefits but using the roughly 15 million/life figure based on risk-risk tradeoffs, rather than the 6.1 million/life figure that is based on inferred employee preferences (i.e., that may value things besides health risk reduction). The effect of such an interpretation would be to justify more stringent standards. Of course this approach can be criticized on the grounds that it does not maximize overall benefits (the public may have valid preferences for things other than risk reduction). The claim here is not that this is the preferred decision rule, but only that this is the most accurate interpretation of the existing benefit-cost provisions of the 1996 Amendments.

ALTERNATIVE DECISION-MAKING CRITERIA

Now that a variety of interpretations of the existing benefit-cost provisions have been explored, it is worth considering whether there are better strategies for incorporating benefit-cost considerations into the drinking water regulatory process. A major shortcoming of the existing standard setting procedure is that it introduces benefit-cost analysis into the decision-making process without accounting for the uncertainties likely to exist in the pre-regulatory estimates of the benefits and costs of proposed drinking water standards. Past experience has shown that pre-regulatory benefit-cost analyses frequently conflict in their assumptions and predictions (Gurian et al. 2001). However, the existing statutory guidelines do not contain specific guidance for regulatory decision making under uncertainty. Such guidelines should give preference to outcomes with less uncertainty in their impacts. The effect of such a strategy would be to favor less stringent regulations over more stringent regulations, since more stringent regulations will typically have more uncertain outcomes. If fact, the net benefits of more stringent regulations are likely to be highly uncertain, if incremental, or marginal, values are considered (that is, they will not offer a clear improvement over slightly less stringent regulations). These considerations suggest two more or less equivalent guidelines for decision making under uncertainty. The first is that if two standards have similar expected net benefits, then the standard with the lower uncertainty in net benefits should be preferred over the standard with the higher uncertainty in net benefits. A second formulation would state that in cases when uncertainty is such that it is unclear if the net benefits of a standard are positive, then a less stringent standard, that is highly likely to have positive net benefits, may be established on an interim basis. This second formulation has been developed in an earlier work (Gurian 2004) and is proposed here as the preferred formulation. It is believed that the emphasis on actions with positive net benefits would make the justification for this approach easier to explain to the public, without the need to refer to abstract principles of decision theory involving tradeoffs between expected value and variance. The reference to an interim standard would take into account the asymmetry of many regulatory decision issues. An overly stringent standard generally produces an irreversible investment that can not be recovered if the standard proves not to be as beneficial as was hoped. In contrast, a standard that proves to be too lax may, if designed appropriately, be able to be made more stringent without inducing undue inefficiencies in the process. The appropriate design of the interim standard is critical, as it should avoid multiple compliance actions at the same site if further changes are made to the standard. It should also help provide information to

reduce uncertainty for further regulatory actions. These factors suggest that interim standards may most appropriately be targeted at a smaller number of water systems with the highest contaminant levels. If such systems are required to meet a target value for the final standard, then this will eliminate the need for them to take subsequent compliance actions and will provide the most information about the cost and feasibility of compliance with the target standard.

It may be necessary to acknowledge that some inefficiencies are inevitable in such an inexact science as that of regulatory design. Compensatory funding might be offered to water utilities required to take multiple compliance actions as a result of revisions to an interim standard. Such compensation would reflect the benefits accruing to society at large by the actions of these utilities in the form of reducing uncertainty and allowing for more informed subsequent regulatory actions.

It is hoped that the approach proposed here will provide a means of addressing difficult and controversial regulatory issues by focusing on less dramatic regulatory actions that are more likely to have positive net benefits. Acknowledging uncertainty and giving it a formal place in the decision making process offers an opportunity to take incremental actions for which uncertainty is lower. The knowledge gained from such actions will provide a means to reduce uncertainty for future regulatory actions.

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