

over the past 11 years, and this trend may continue (Ref 3).

Risk and Valuation of Risk. In September 1999, EPA updated a series of coefficients they developed to express the incremental lifetime risk of cancer morbidity or mortality per unit of intake. They then combined this per unit risk to the average and 90th percentile annual and lifetime intake of water from all sources (including bottled water, but they adjusted for bottled water that did not originate in the municipal water supplies they regulated) to calculate: (1) The total morbidity and mortality cancer risk due to drinking water containing uranium, and (2) the reduction in risk due to their proposed NPDWR for uranium. We adjust these values based on our calculation of the average annual intake of bottled water described previously in this document. The mortality risk coefficient per μg of uranium ingested is $3.97\text{E}-11$, and the morbidity coefficient is $6.13\text{E}-11$ (Ref. 4). In other words, for each μg of uranium ingested the lifetime risk of getting cancer increases by approximately 6 in 100 billion, while

the lifetime risk of dying from cancer increases by approximately 4 in 100 billion.

This risk estimate is applied to the decrease in Uranium ingested due to options 1 and 2. Between 0.9 percent and 1.4 percent of bottled water is expected to initially have uranium concentrations over $30 \mu\text{g}/\text{L}$. Based on 2001 total bottled water consumption, this translates into between 49 million and 76 million gallons of bottled water possibly above the standard. In the Radionuclides Rule, EPA expected that the reduction in uranium concentration in the out of compliance municipal water facilities would yield an annual decrease in the number of new fatal and nonfatal statistical³ cancer cases of 0.82 from an affected number of gallons of approximately 73 million.

For the calculations below, we assume that every bottled water consumer has an equal chance of drinking water from a facility that would be out of compliance with the standard. This makes the calculation much simpler, and since the mortality and morbidity risk coefficients are

linear and are not based on past exposure, the total reduction in risk is identical. If out-of-compliance bottled water facilities have uranium concentrations roughly equal to the EPA estimates, then applying this assumed reduction and the total annual per capita consumption attributable to the affected bottled water facilities yields a total number of fatal and nonfatal cancer cases avoided of between 0.55 and 0.85 per year for both options 1 and 2. We use a 6 percent growth rate to take into account an increase in exposure and population, in relation to the 7 percent discount rate used for the cost calculations. We also assume that the cancer mortality will occur 20 years in the future. The central estimate is somewhat sensitive to these assumptions, so we test different assumptions in the net benefits section below. Using standard valuation techniques for cancer morbidity and mortality yields an expected present value benefit of between \$8,700,000 and \$13,500,000. The calculations summary is in Table 4 of this document.

TABLE 4.—BENEFITS CALCULATIONS

Options	Cases of Cancer Avoided: EPA Method 1	Cases of Cancer Avoided: EPA Method 2	Present Value (\$) of Annual Cancer Cases (low-high)	Total Present Value (\$) (low-high)
1 and 2	.85	.55	629,000 (494,000–764,000)	11,112,000 (8,731,000–13,493,000)

A final source of uncertainty we need to account for is the upper and lower bound estimated by EPA for their cancer risk coefficients. In the 2000 analysis, EPA assumes an uncertainty cancer risk interval extending one order of magnitude above and below their risk coefficients. Applying this uncertainty interval to the benefits we have already calculated yields a final benefits interval of between \$870,000 and \$135,000,000. Although EPA does not include a probabilistic confidence interval associated with this additional source of uncertainty, they do state that the central tendency values they use for their main calculations are more likely (Ref. 2).

Sensitivity to Assumptions and Uncertainty: Benefits

These benefits calculations are subject to considerable uncertainty. The uncertainty interval used in the analysis is due to the uncertainty in the incidence and concentration of naturally occurring uranium and uncertainty in the uranium risk

coefficients. However, the main uncertain benefits that we do not quantify are: (1) The reduction in kidney disease due to reducing uranium concentration in bottled water, and (2) the reduction in cocontaminants due to the adoption of treatment technologies for uranium. Therefore, the quantified cancer benefits probably underestimate the true positive impact of the uranium standard.

4. Net benefits

Table 5 of this document presents the total costs and benefits for all three options.

TABLE 5.—COSTS AND BENEFITS

Options	Total Costs (\$) (low-high)	Total Benefits (\$) (low-high)
1 (EPA Monitoring Requirement)	2,930,000 (352,000–5,616,000)	11,112,000 (8,731,000–13,493,000)

person by 1 in a million, and the affected population consisted of 1 million people, it is expected that the number of eventual cancer cases

TABLE 5.—COSTS AND BENEFITS—Continued

Options	Total Costs (\$) (low-high)	Total Benefits (\$) (low-high)
2 (FDA Monitoring Requirement)	3,438,000 (477,000–6,889,000)	11,112,000 (8,731,000–13,493,000)
3 (No Action Taken)	0	0

In the most likely central values in the distribution of cost and benefits, EPA option 1 has positive net measured benefits and FDA option 2 has positive net measured benefits. The ranking of option 1 and 2 depends completely on the frequency of required testing: FDA would require an average of 1.19 tests per year per facility, while EPA, after a series of four tests, would only require an average of .61 test per year per facility. We tested the effects of 5 percent–7 percent discount rates and 15–30 year delays in cancer onset in our

observed would increase by 1. However, 1 is only the measure of central tendency in a distribution of effects.

³ A statistical cancer case refers to expectations. For example, if the risk of contracting cancer sometime during one's life increases for each