Estimating the Effect of Different Arsenic Maximum Contaminant Levels on the Affordability of Water Service

Scott J. Rubin
Attorney • Consultant
3 Lost Creek Drive
Selinsgrove, PA 17870
(570) 743-2233 • scott@publicutilityhome.com

Prepared under contract to the American Water Works Association
July 2000

Introduction

The Safe Drinking Water Act (SDWA) requires the Environmental Protection Agency (EPA) to consider the effect of new drinking water regulations on the affordability of water service in smaller communities.[1] In addition, Executive Order 12898 requires federal agencies to consider whether their actions will have a disproportionate effect on minority and low-income communities.[2]

EPA is considering a change in the maximum contaminant level (MCL) for arsenic from its current level of 50 micrograms per liter (µg/L)[3] to a more stringent level. EPA has proposed an MCL of 5 µg/L, with a request for comments on alternatives of 3, 10, and 20 µg/L.[4]

The purpose of this paper is to estimate the effect on the affordability of water service of a more stringent MCL for arsenic. Data will be analyzed from EPA's Arsenic Occurrence and Exposure Database, which contains the results of more than 100,000 arsenic samples from more than 1,100 counties in 25 states. EPA refers to this as the "25 States" database.[5] The affordability analysis will be conducted at the county level, after aggregating estimates of compliance costs for individual water systems within each county.

Background[6]

Examining the affordability of a new drinking water regulation is an important undertaking. It is not simply a legal or regulatory requirement. Rather, it is directly related to ensuring that the regulation will, in fact, achieve a public health benefit.

---

[1] SDWA § 1412(b)(4)(E), 42 USC § 300g-1(b)(4)(E)
[2] Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 59 *Fed. Reg.* 7629 (Feb. 16, 1994).
[3] 40 CFR § 141.11(b).
[4] U.S. EPA, Notice of Proposed Rulemaking, National Primary Drinking Water Regulations; Arsenic and Clarifications to Compliance and New Source Contaminants Monitoring, 65 *Fed. Reg.* 38,887 (June 22, 2000) (hereafter "NOPR").
[5] NOPR, p. 38,904.
[6] This section is taken, almost verbatim, from the author's paper evaluating the effect of the proposed radon regulation on the affordability of water service. Scott J. Rubin, "Assessing the Effect of the Proposed Radon Rule on the Affordability of Water Service" (AWWA Dec. 1999).

A potentially significant unintended consequence of a new regulation is that low-income households will make tradeoffs in order to pay their water bill. The literature is replete with studies that show that low-income households already are forced to make serious tradeoffs that affect the health and well-being of their members – including foregoing food and medical care.[7] [8] [9] [10] By diverting needed funds from these other necessities, a new drinking water regulation could adversely affect public health. Thus, the goal of an affordability analysis is not to compromise the safety of the water supply, but to ensure that any increased public health benefits from the water regulation are not negated by the tradeoffs that low-income households will make in order to pay for the regulation.[11]

In theory, any new regulatory requirement that increases the cost of water service might raise an issue about the affordability of water for some low-income households in certain communities. If the impact is limited to a few communities because of their unusual characteristics, then the provisions of the SDWA allowing for variances and grants based on affordability criteria can be expected to address the problem.[12]

In contrast, if the costs associated with complying with a new regulation will create affordability concerns for many low-income households in many communities, then the effects should be addressed through the process of establishing the regulation. To do otherwise would lead to a the requests for affordability-based variances negating the effect of the rule as a whole.

There are no hard and fast standards for determining whether the effects of a proposed rule would lead to affordability concerns. It does not appear necessary to have a "bright line" test for whether a proposed regulation raises affordability concerns, but there must be some sense for whether costs are relatively affordable. An additional cost in the range of $4 to $5 per month ($48 to $60 per household per year) would seem to be affordable for even the lowest-income households. One comprehensive study of low-income household expenditures and strategies found that even at the lowest income levels where serious tradeoffs were being made, households spend an average of $3 per month on lottery tickets.[13] While the authors of that study properly note that such expenditures might be necessary for the psychic well-being of the individual, it is

---

[7] Kurt Bauman, Direct Measures of Poverty as Indicators of Economic Need: Evidence from the Survey of Income and Program Participation, U.S. Census Bureau Population Division Technical Working Paper No. 30 (Nov. 1998), http://www.census.gov/population/www.documentation/twps0030/twps0030.html, as of Sept. 29, 1999 (showing that more than one-third of households with incomes under $10,000 were unable to meet at least one basic need).

[8] Kurt J. Bauman, Extended Measures of Well-Being: Meeting Basic Needs, U.S. Census Bureau Current Population Reports, P70-67 (June 1999) ("In 1995, … about 1 person in 5 lived in a household that had at least one difficulty meeting basic needs. These included households that didn't pay utility bills, didn't pay mortgage or rent, needed to see the doctor or dentist but didn't go, had telephone or utility service shut off, were evicted, didn't get enough to eat, or otherwise didn't meet essential expenses.")

[9] Kathryn Edin and Laura Lein, *Making Ends Meet: How Single Mothers Survive Welfare and Low-Wage Work* (Russell Sage Foundation 1997).

[10] U.S. Department of Agriculture, *Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project* (1997).

[11] See also Frederick W. Pontius, "Environmental Justice and Drinking Water Regulations," *Journal American Water Works Association* 92:3:14-20 (Mar. 2000).

[12] SDWA § 1412(b)(15), 42 USC § 300g-1(b)(15); SDWA § 1415(e), 42 USC § 300g-4(e); SDWA § 1452, 42 USC § 300j-12.

[13] Edin and Lein, *Making Ends Meet, supra.*

reasonable to conclude that expenditures of this magnitude could be diverted to paying the water bill without imposing serious public health consequences on the household.

On the other hand, expenditures that approached $8 to $10 per month or more ($96 to $120 per household per year) could raise serious affordability concerns for a low-income household. For example, Edin and Lein write that single mothers receiving welfare payments reported spending only $18 per month on medical care. So an increased expenditure for water of $8 to $10 per month would represent nearly half of the household's budget for medical care. Similarly, they reported that the average telephone bill was $31 per month, but "about one-third of the welfare-reliant mothers had their telephone disconnected or went without any phone service throughout the previous year." An $8 to $10 expenditure would represent one-quarter to one-third of the telephone bill which already is seriously at risk of going unpaid for many low-income households.

Another approach to evaluating affordability is to examine the effect on median household income in a community. Rather than focusing on the effect on the lowest-income households, this approach evaluates the impact on the community as a whole. Under this approach, if the total cost for water is on the order of 1.5 percent of median household income in the community, then water service should be affordable (Beecher and Shanaghan indicate that some states use other figures, ranging from 1.0 to 2.0 percent of median household income).[14] The U.S. Department of Agriculture (USDA) uses a similar criterion for determining the mix of grants and loans for water and wastewater projects. USDA assumes that a community's debt service obligation for a water or wastewater project should be no more than 1% of median household income.[15] Systems that would exceed this amount are eligible for grants for up to 75% of the project's cost. This 1% of median household income standard is consistent with total costs for water in the range of 1.5 to 2.0 percent of median household income.

For purposes of this study, it will be assumed that an impact of less than $50 per household per year is affordable for a low-income household, while an impact of $100 or more per year could raise serious affordability concerns which might require a low-income household to make a tradeoff that would be detrimental to its members' health or welfare. As noted, these are not hard and fast numbers, but they should provide an indication of the potential scope and magnitude of the effects of a proposed regulation on low-income households.

Alternatively, using the community-wide approach, it will be assumed that a regulation that increases the cost of water by 0.5 percent of median household income in a community might raise an affordability concern. This percentage is selected based on the author's previous work which showed that the typical water bill, for a household with median income, was 0.9 percent of income in 1989, with water rates increasing faster than the rate of growth in income.[16] Thus, an increased cost of 0.5 percent of median income would be more than a 50% increase in the water bill and would bring it close to 1.5 percent of median income overall.

---

[14] Janice A. Beecher and Peter E. Shanaghan, Water Affordability and the DWSRF, *Journal American Water Works Association*, Vol. 90, No. 5, 68-75 (1998).
[15] U.S. General Accounting Office, *USDA's Funding of Water and Sewer Projects*, GAO/RCED-95-258 (1995).
[16] Scott J. Rubin, A Nationwide Look at the Affordability of Water Service, *Proceedings 1998 Annual Conference of the American Water Works Association*, Water Research Vol. C, 113-129.

The selection of these ranges also is based on other considerations, including the fact that many low-income households do not pay directly for water. The author's previous study has shown that the percentage of low-income households that pay directly for water (rather than having it included in the rent) varies tremendously from one state to another. For example, nationwide about one-half of households with incomes less than $10,000 pay directly for water, but in some states the percentage exceeds 70%, while in others it is less than 15%.[17] Selecting target ranges for affordability on a per-household level recognizes that many of the lowest-income households will not be directly affected, though they do run the risk of paying these costs indirectly (through increases in rent or through landlords changing their policy and beginning to charge separately for water).[18]

Methodology

Data Selection

EPA's 25 States database provides a data set of more than 100,000 arsenic samples from more than 24,000 water systems. These systems are located in approximately 1,172 counties in 25 states.[19] A subset was created from the database containing only those samples from community water systems (CWS) that detected arsenic greater than or equal to 3 µg/L. This smaller data set (containing approximately 16,000 records) was then examined in detail and "cleaned" to ensure data consistency and completeness. This process included filling in missing entries for county and population served from EPA's Safe Drinking Water Information System (SDWIS) database, where possible. Entries where county and population data could not be obtained were deleted from the database. In addition, county names were edited to precisely match U.S. Census Bureau county names.[20]

This process was very successful, resulting in the loss of data for fewer than 4% of the water systems. The most significant loss was of systems in the state of Oklahoma which all were excluded because SDWIS does not contain county identifiers for that state.

Finally, the data set was further restricted to include data only from systems that use groundwater. The analysis is restricted to groundwater systems because of differences in the technologies (and costs) that would be used to remove arsenic from groundwater systems as opposed to surface water systems. In addition, it is very difficult to generically estimate the cost of arsenic removal in surface water systems because of different types of treatment that are already in place for those systems. Table 1 summarizes the effect of this data extraction and "cleaning" process.

---

[17] *Id.*

[18] There is a growing trend for owners of apartment buildings to begin metering and billing separately for water. Barbara Martinez, "Short Showers? More Tenants Lose Free Water," *Wall Street Journal*, Oct. 13, 1999, p. B1.

[19] This figure is approximate because several entries in the database do not have a county listed.

[20] All U.S. Census Bureau data on counties is from U.S. Bureau of the Census, *City and County Data Book 1994*, [http://fisher.lib.virginia.edu/ccdb/].

Table 1: Summary of Data Extraction and "Cleaning"

	Records	States	Counties	Systems	Population Served (x 1,000)
All observations	100,595	25	1,172*	24,599	103,856
CWS only	92,498	25	1,162*	19,527	102,464
Arsenic ≥ 3 µg/L	16,388	25	702*	5,305	50,057
County and population	15,826	24	1,022^	5,121	50,796^
Groundwater	12,639	24	856	4,491	21,143

* Includes blank counties
^ Population and number of counties are higher because missing data were filled in from SDWIS.

As shown in Table 1, the data set to be used for further analysis includes data for nearly 4,500 groundwater systems serving a population of more than 21 million people. These systems are located in 856 counties in 24 states.

Compliance Cost

The cost of complying with various possible arsenic MCLs was estimated based on the population served by each water system. The system-level compliance cost was derived in two parts: annual capital cost and annual operating & maintenance (O&M) cost. In order to develop the capital cost, it is necessary to estimate the capacity, in million gallons per day (MGD) of the treatment facility that the water system would construct to comply with the proposed regulation. In order to derive the O&M cost, it is necessary to estimate the average daily consumption of water within the water system, also in MGD.

Average daily consumption was estimated using actual per capita water consumption in each state during 1995, as reported by the U.S. Geological Survey (USGS).[21] Average consumption was calculated for each water system using Equation 1.

Equation 1: $$\text{Average use } (\text{MGD}_{\text{avg}}) = \frac{\text{Population served x per capita use}}{1{,}000{,}000}$$

Plant capacity was estimated using the relationship between capacity and average flow. Equation 2 was developed in the author's previous work dealing with the proposed radon regulation.[22]

Equation 2: $$\text{Plant capacity } (\text{MGD}_{\text{cap}}) = \text{MGD}_{\text{avg}} \text{ x } 6.3302 \text{ x Population}^{-0.1025}$$

Both capital and O&M costs were calculated using equations developed by Frey, *et al.*, that provide cost estimates in 1999 dollars.[23] Systems with design flows of less than 1.0 MGD are assumed to use activated alumina with throw-away media at a level of 7,000 bed volumes, as well as pre-oxidation. Systems with a design flow of 1.0 MGD or larger are assumed to use

21 U.S. Geological Survey, National Water Use Data (by state) for 1995, [http://water.usgs.gov/watuse/spread95]
22 Scott J. Rubin, "Assessing the Effect of the Proposed Radon Rule on the Affordability of Water Service" (AWWA Dec. 1999).
23 M.M. Frey, J. Chwirka, R. Narasimhan, S. Kommineni, and Z. Chowdhury, *Cost Impacts of a Lower Arsenic MCL* (AWWA and AWWARF 2000).

coagulation-assisted microfiltration with solids separation and recycled waste flow.[24] The O&M and capital cost equations are shown as Equations 3-6. These equations assume that arsenic compliance costs for a system do not vary if the MCL changes unless, of course, the system falls below the MCL before treating the water. That is, a system with an untreated arsenic level of 15 µg/L would face approximately the same compliance costs if the MCL is set at 3, 5, or 10 µg/L. This is consistent with EPA's finding that the MCL level does not significantly affect a system's treatment cost.[25]

Design flow < 1.0 MGD – Capital Cost

Equation 3: $1{,}744{,}515(MGD_{cap}) + 11{,}862 + 7{,}277\ [7{,}277 \text{ is pre-oxidation cost}]$

Design flow < 1.0 MGD – O&M Cost

Equation 4A: $14{,}136(MGD_{avg}) + 1{,}162\ [\text{pre-oxidation cost}]$

Equation 4B: $-22{,}529(MGD_{avg})^2 + 542{,}552(MGD_{avg}) + 1{,}961\ [\text{activated alumina}]$

Design flow ≥ 1.0 MGD – Capital Cost

Equation 5: $1{,}021{,}846(MGD_{cap}) + 1{,}923{,}097$

Design flow ≥ 1.0 MGD – O&M Cost

Equation 6: $74{,}928(MGD_{avg}) + 113{,}121$

The resulting capital cost, which is a total construction cost, was then annualized using OMB's standard discount rate of 7% and assuming a repayment period of 20 years, which is equivalent to a capital cost recovery factor of 9.33% per year.[26] This 7% rate also appears to be a reasonable estimate of the cost of money to water systems, recognizing the mix of public and private financing that would be used.

The sum of annual capital costs and O&M costs provides an estimate of the annual, system-level arsenic compliance cost for each water system in 1999$.

Aggregation by County

The compliance cost and population data for each water system were then aggregated by county. This provides an estimated compliance cost for each county, as well as the population served by the water systems in the data set in each county. In order to conduct an affordability analysis, it is necessary to have some level of confidence that the demographic data are applicable to the population that will pay the cost of compliance. In order to provide this confidence, further analysis was restricted to counties where the population served by the water systems in the data set was equal to at least 50% of the population of the county according to the 1990 census. Table 2 shows the number of counties, and other information, remaining for analysis after this population screen was applied.

---

[24] These assumptions were provided by M.M. Frey of McGuire Environmental Consultants, Inc., through personal communication.

[25] NOPR, p. 38,939.

[26] NOPR, p. 38,959.

Table 2: Counties After Application of Population Screen

	States	Counties	Systems	Population Served (x 1,000)
Data set before screen	24	856	4,491	21,143
Data set after population screen	18	199	1,437	11,679

It should be emphasized that water systems in counties that failed to meet the population screen will face compliance costs, and potential affordability concerns, that may be comparable to those in counties where the screen was met. The screen is being used only as a method to ensure that readily available demographic data relate to the population served by community water systems.

Finally, an average per-household compliance cost was developed for each county by dividing the total compliance cost by the population served divided by the average number of people per household in the county, as shown in Equation 7.

Equation 7: $$\text{Cost per household} = \frac{\text{Total Cost}}{\text{Population Served } / (\text{Population}/\text{Household})}$$

Validation of Cost Estimates

The cost estimates for the water systems in these 199 counties were compared to the national cost estimates developed by Frey, *et al.* to determine the reasonableness of the cost-estimating procedures.

In the 199 county database, 1,060 water systems had an arsenic detect of 5 µg/L or higher. The estimated annual compliance cost for these systems, based on the procedures discussed above, is $467.2 million.

EPA's 25 State database contains 3,223 groundwater systems with an arsenic detect of 5 µg/L or higher. Thus, the 199 county database contains approximately 33% of the groundwater systems with an arsenic detect of at least 5 µg/L.

Consequently, to determine the reasonableness of the cost-estimating procedure used in this analysis, the estimated compliance cost should equal approximately 33% of the total national compliance cost developed by Frey, *et al.*

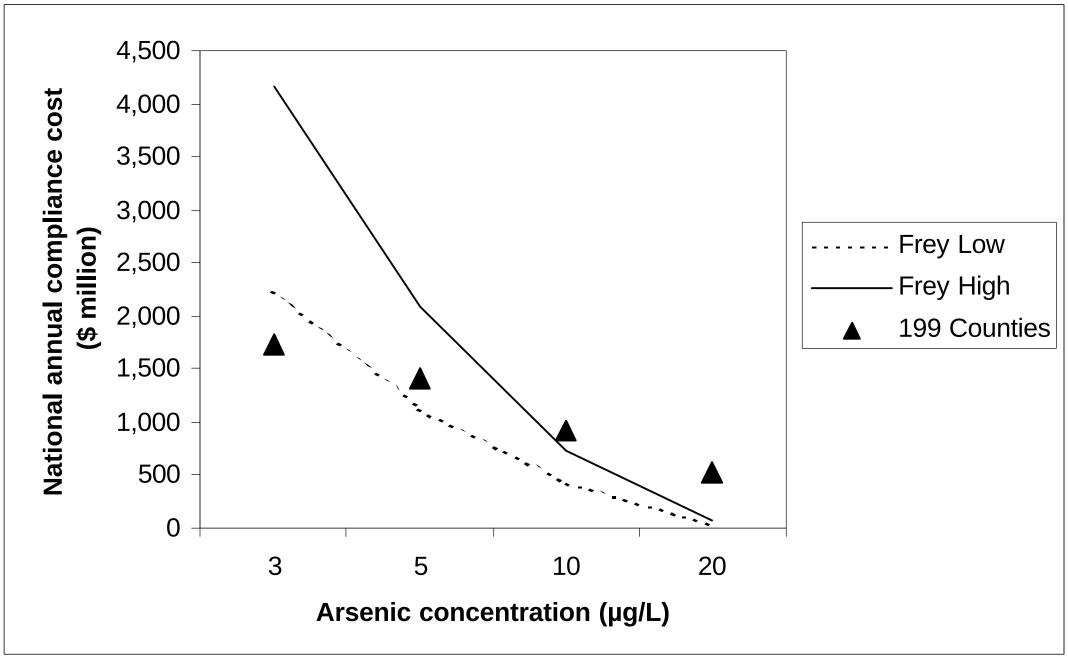
Frey, *et al.* determined that the national annual compliance cost for 5 µg/L would lie in the range of $1,135 million to $2,090 million, with a baseline estimate of $1,535 million.[27] Thus, a cost estimate for 33% of the affected systems would be expected to lie in the range of $375 million to $690 million, with a baseline estimate of $507 million.

The estimate developed in this analysis of $467.2 million fits this range extremely well and falls within 10% of the baseline value from the national cost estimate.

[27] Frey, *et al.*, Table ES.7.

A similar comparison of the cost estimates resulting from this analysis with those developed by Frey, *et al.* at 3, 10, and 20 µg/L shows that the cost estimating procedure understates the likely compliance cost at 3 µg/L and overstates the likely compliance cost at 10 and 20 µg/L. Figure 1 shows a graphical comparison of the cost estimates developed for the water systems in the 199 county database (divided by the percentage of systems represented in the 199 county database) with those developed by Frey, *et al.*, for the United States as a whole.

Figure 1: Comparison of Cost Estimates for 199 Counties with National Cost Estimates



It is reasonable to conclude, therefore, that the affordability estimates developed in this analysis for an MCL of 5 µg/L are representative of the impact of the proposed MCL nationwide. The affordability estimates developed for the alternative of 3 µg/L understate the likely impact nationwide, while the estimates for the alternatives of 10 and 20 µg/L overstate the likely affordability impact.

Income and Demographic Data

The relevant census data – including population, number of households, household income distribution, median household income, and number of people in poverty, among others – were taken from the U.S. Census Bureau's *City and County Data Book.*[28] Income and poverty data are for calendar year 1989. Population and household data are as of March 1990.

All income amounts were then inflated using the change in the Consumer Price Index from the annual level for 1989 to the annual level for 1999 (an increase of 34.35%).[29] This placed all income amounts in 1999$, the same units used for the compliance cost estimates. For example, assume that the 1990 census reports that 100 people in County X had an income in the range of $15,000 to $24,999, which has a midpoint of $20,000. For purposes of this analysis, the

---

[28] U.S. Bureau of the Census, *City and County Data Book 1994*, [http://fisher.lib.virginia.edu/ccdb/].
[29] U.S. Bureau of Labor Statistics, Consumer Price Index-All Urban Consumers, Base Period 1982-1984=100, as of May 2000 [http://stats.bls.gov/cpihome.htm].

midpoint was inflated by 34.35% to $26,870 and it was assumed that all 100 people had that level of income in 1999. Similarly, the median household income that is reported by the Census Bureau was inflated by the same 34.35%.[30]

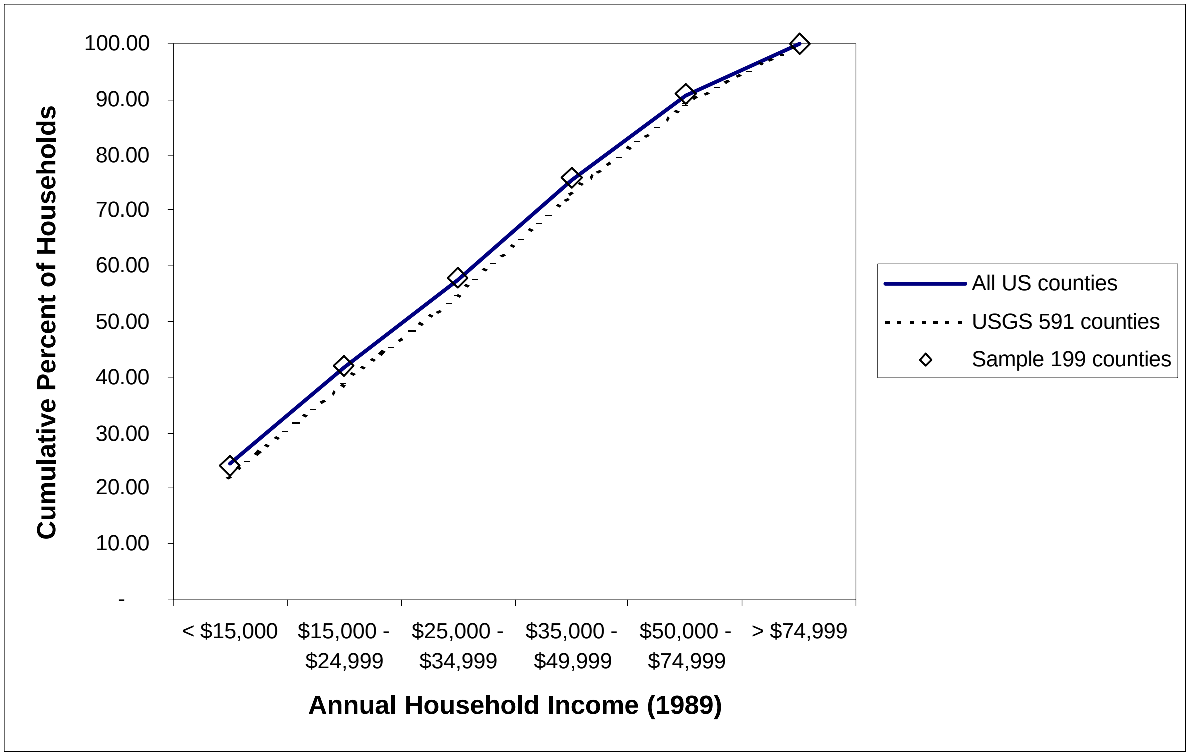
Finally, before conducting any further analysis, the characteristics of the counties that met the population screen were compared to all counties in the United States[31] and to the approximately 595 counties in the USGS arsenic database.[32] Table 3 shows that the group of 199 counties is reasonably representative of the United States as a whole and the USGS database, in terms of income, incidence of poverty, and household size. Figure 2 plots the income distribution curves for the data set, the counties in the USGS database, and all U.S. counties. While it cannot be concluded that the characteristics of the data set's 199 counties precisely mirror those of the entire country or the counties in the USGS database for all possible demographic characteristics, it appears reasonable to use these data to provide additional information that will be used to establish national drinking water policy.

Table 3: Comparison of Data Set to United States and USGS Database

	All Counties	**USGS Database (591 counties)***	**199 Counties**
Number of households (1990)	91,697,776	37,288,257	5,269,066
Population (1990)	248,102,973	101,717,473	14,949,814
Avg. people per household (1990)	2.7	2.4	2.8
Median household income (1989)	$30,725	$32,381	$30,418
Percent of people in poverty (1989)	13.1%	12.4%	14.6%
Percent of households with income less than $15,000 (1989)	24.3%	22.1%	24.0%
Percent of people age 65 and over (1990)	11.9%	11.2%	10.7%
* The USGS database contains five or more arsenic samples for 595 counties; however, a match of the county code to the *City and County Data Book* was obtained for only 591 of the counties.			

[30] Neither income distributions nor poverty distributions changed significantly between 1989 and 1997, the most recent year for which a complete analysis is available, as discussed in the author's radon paper. It is not known whether significant changes occurred between 1997 and 1999, but in the absence of information indicating a change in the trend from 1989 to 1997, it appears reasonable to assume that income distributions have remained fairly constant. As a result, it appears reasonable to increase 1989 income data by the Consumer Price Index to estimate income levels and income distributions in 1999. Similarly, it appears reasonable to use 1989 data for the percentage of people in poverty to estimate the percentage of people in poverty in 1999.
[31] Data for all counties are slightly different from data for the entire United States because of the exclusion of the District of Columbia and territories. Data for all counties are from the *City and County Data Book 1994*.
[32] M.J. Frazio, A.H. Welch, S.A. Watkins, D.R. Helsel, and M.A. Horn, *A Retrospective Analysis of the Occurrence of Arsenic in Groundwater Resources of the United States and Limitations in Drinking-Water Supply Characterizations*, USGS Water Resources Investigations Report 99-4279 (1999); the database supporting this study was publicly released in May 2000 at [http://co.water.usgs.gov/trace/data/arsenic_may2000.txt].

Figure 2: Comparison of Income Distribution for Data Set, USGS Database, and all U.S. Counties



Results

The potential impact of changing the arsenic MCL on the affordability of water service can be evaluated in terms of the effect on counties, households, and people who are living in poverty. While each of these points of view relies on the same underlying data – the estimated cost of compliance – each presents a slightly different picture of any potential affordability concern.

County Impacts

Table 4 and Figure 3 show the county-wide impacts of the various potential arsenic MCL levels. These results show that at an arsenic level of 5 µg/L, only 17% of the counties have an average compliance cost below $50 per household per year, which is the level that we assume is affordable. In fact, nearly 75% of the counties will have a compliance cost that is more than $100 per household per year, which is the level at which serious affordability problems could arise. Moreover, approximately 55% of the counties will face an average compliance cost that is more than 0.5% of median household income. As discussed previously, this equates to a likely increase in water rates of more than 50% and is likely to bring the total cost of water above the threshold affordability level of 1.5% of median household income.

Table 4: County Impacts

	3 µg/L	5 µg/L	10 µg/L	20 µg/L
Counties with compliance cost < $50 per household per year	0 (0%)	33 (27%)	102 (51%)	151 (76%)
Counties with compliance cost $50 to $100 per household per year	13 (7%)	18 (9%)	23 (12%)	15 (8%)
Counties with compliance cost $100 to $200 per household per year	54 (27%)	70 (35%)	43 (22%)	18 (9%)
Counties with compliance cost >$200 per household per year	132 (66%)	78 (39%)	31 (16%)	15 (8%)
Counties with compliance cost < 0.5% of median household income	35 (18%)	89 (45%)	147 (74%)	177 (89%)
Counties with compliance cost 0.5% to 1.0% of median household income	106 (53%)	78 (39%)	36 (18%)	17 (9%)
Counties with compliance cost > 1.0% of median household income	58 (29%)	32 (16%)	16 (8%)	5 (3%)

Figure 3: County-Level Compliance Cost as a Percentage of Median Household Income

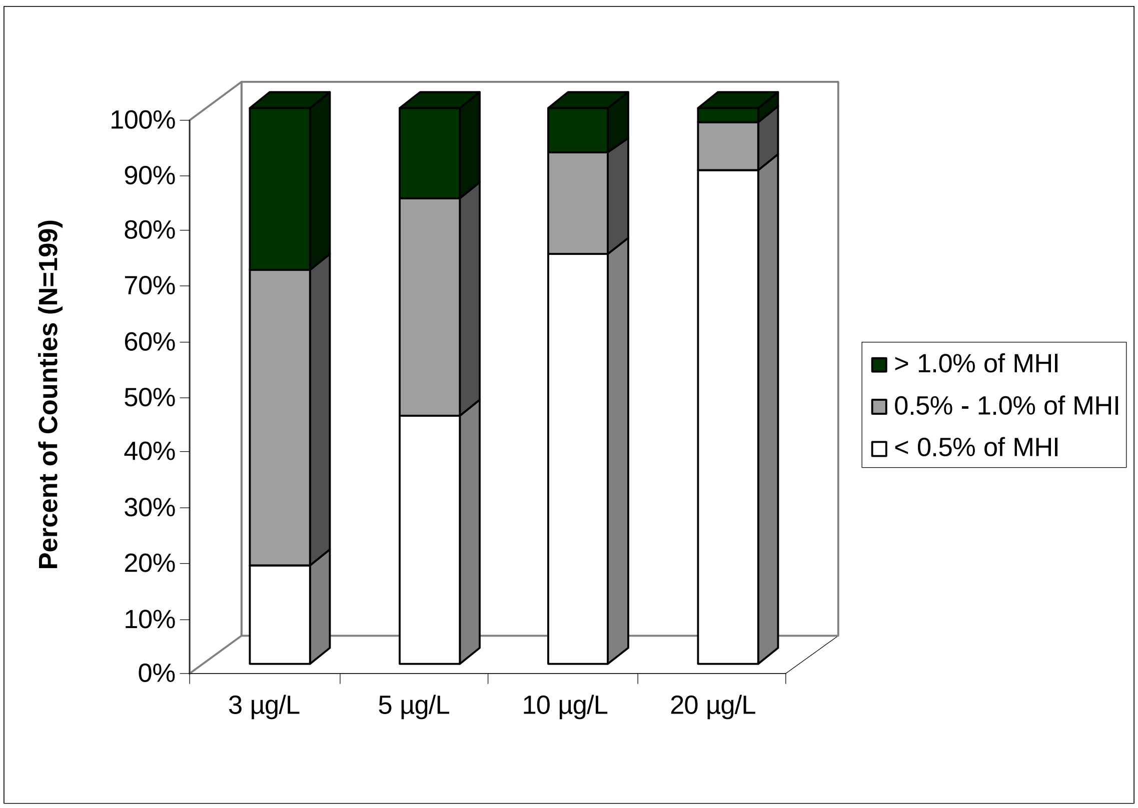


Table 4 also presents results at even higher cost levels – more than $200 per household per year and more than 1.0% of median household income. These figures represent cost levels that are at least *twice as high* as the level that is expected to raise affordability concerns for the county as a whole. These results show that if the MCL is set at 5 µg/L, almost 40% of these counties would face average household compliance costs of more than $200 per year, while 16% of the counties would see water rates increase by more than 1% of median household income. This represents an approximate doubling of water rates to a level that is likely to be more than 2.0% of median household income. Water rates at this level are very likely to raise serious affordability concerns.

Table 4 and Figure 3 also show that most of these potentially serious affordability concerns can be alleviated if the MCL is set at a higher level, while lowering it to 3 µg/L would greatly exacerbate these concerns. Establishing the MCL at a higher level mitigates these impacts, potentially to the point where any remaining affordability concerns can be alleviated through existing grant programs or the establishment of variance technology.[33] For example, at an MCL of 20 µg/L, approximately 17% of the counties would see household compliance costs exceed $100 per year. Further, as explained previously, this analysis overstates the costs at 10 and 20 µg/L, so the actual affordability impact at 20 µg/L is expected to be less severe than is shown here.

Household Impacts

The household impacts are summarized in Table 5 and Figure 4. That table and figure show that at an MCL of 5 µg/L, 94% of households are estimated to spend more than $50 per year. Further, 20% of the households are in counties where the estimated compliance cost will exceed 0.5% of median household income.

Table 5: Household Impacts

	3 µg/L	5 µg/L	10 µg/L	20 µg/L
Households with compliance cost < $50 per year	0 (0%)	326,160 (6%)	1,689,329 (32%)	3,069,823 (58%)
Households with compliance cost $50 to $100 per year	1,890,017 (36%)	2,130,554 (40%)	2,481,288 (47%)	1,772,582 (34%)
Households with compliance cost $100 to $200 per year	2,659,627 (51%)	2,359,378 (45%)	976,174 (19%)	373,443 (7%)
Households with compliance cost >$200 per year	719,422 (14%)	452,974 (9%)	122,275 (2%)	53,218 (1%)
Households in counties with compliance cost < 0.5% of median household income	3,697,433 (70%)	4,223,795 (80%)	4,845,201 (92%)	5,095,084 (97%)
Households in counties with compliance cost 0.5% to 1.0% of median household income	1,398,597 (27%)	948,181 (18%)	375,398 (7%)	158,339 (3%)
Households in counties with compliance cost > 1.0% of median household income	173,036 (3%)	97,090 (2%)	48,467 (1%)	15,643 (0%)

Once again, it can be seen that establishing the MCL at a higher level would alleviate most of these potential affordability concerns, while lowering the MCL to 3 µg/L would significantly worsen these concerns. For example, at an MCL of 3 µg/L, 65% of the households would face compliance costs of more than $100 per year (compared to 54% at 5 µg/L), but this figure declines to just 8% of households if the MCL were to be established at 20 µg/L.

[33] EPA has not proposed a variance technology because it mistakenly believes that an MCL of 5 µg/L will not raise any affordability concerns for any system size category. NOPR, p. 38,926.

Figure 4: Range of Household-Level Compliance Costs

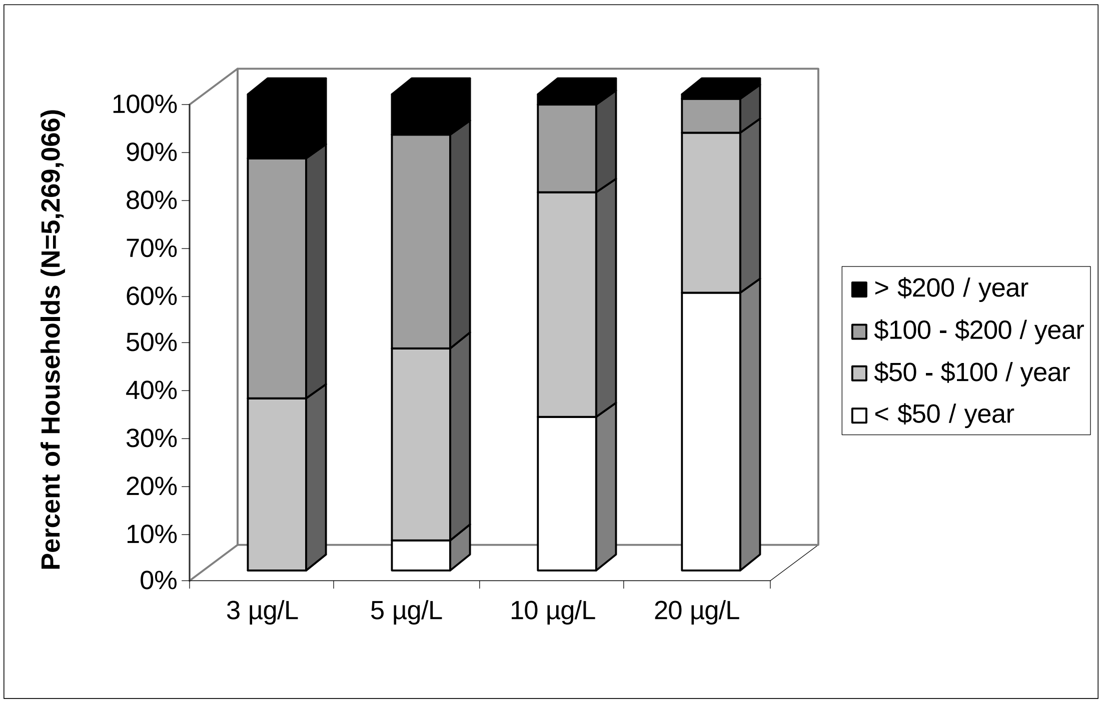


Table 6 and Figure 5 provide another measure of the impact of different arsenic MCL levels on households. This table and figure compare the compliance cost to the actual distribution of household incomes in each county. Rather than examining a percentage of median household income, this table and figure are based on an analysis that applies the estimated compliance cost to the actual income distribution in each county (using the midpoint of income ranges, escalated to 1999$, as described above). This analysis provides another perspective on the affordability question. Rather than just examining the magnitude of cost increases, it evaluates those cost increases as a percentage of household income across the range of incomes.[34]

Table 6: Impacts on Households by Percentage of Income

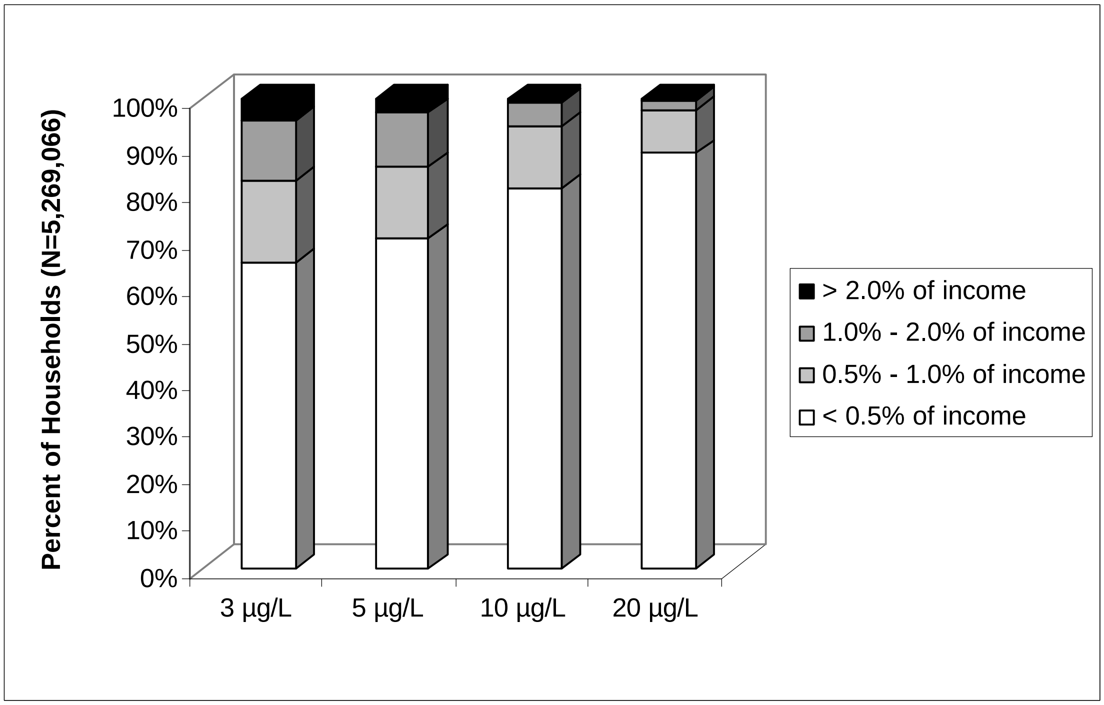
	3 µg/L	5 µg/L	10 µg/L	20 µg/L
Household cost < 0.5% of income	3,425,134 (65%)	3,698,635 (70%)	4,266,744 (81%)	4,657,874 (88%)
Household cost 0.5% - 1.0% of income	921,301 (18%)	812,456 (15%)	701,074 (13%)	482,021 (9%)
Household cost 1.0% - 2.0% of income	691,791 (13%)	618,592 (12%)	263,742 (5%)	111,932 (2%)
Household cost > 2.0% of income	230,840 (4%)	139,383 (3%)	37,506 (1%)	17,239 (0%)

The results shown in Table 6 and Figure 5 are consistent with the tables discussed above. They show that the lower MCL levels are likely to cause serious concerns about the affordability of water service. For example, setting the MCL at 5 µg/L would result in 30% of the households in this data set having their water bill increase by more than 0.5% of their household's income. In

[34] The income ranges used in this analysis, which are taken directly from the *City and County Data Book*, are $0 to $14,999, $15,000 to $24,999, $25,000 to $34,999, $35,000 to $49,999, $50,000 to $74,999, and over $75,000 in 1989 dollars.

fact, more than one in every eight households would see their water bills increase by 1.0% of household income or more. As has been discussed above, higher MCLs would mitigate this impact, such that setting the MCL at 20 µg/L would see only 12% of households have their water bills increase by more than 0.5% of their income, with less than 3% of households seeing increases equivalent to 1% of household income. Similarly, setting the MCL at 3 µg/L would exacerbate these concerns, such that 35% of households would see an increase of more than 0.5% of household income, with one in six households seeing increases of more than 1.0% of household income.

Figure 5: Distribution of Household-Level Compliance Cost as a Percentage of Household Income



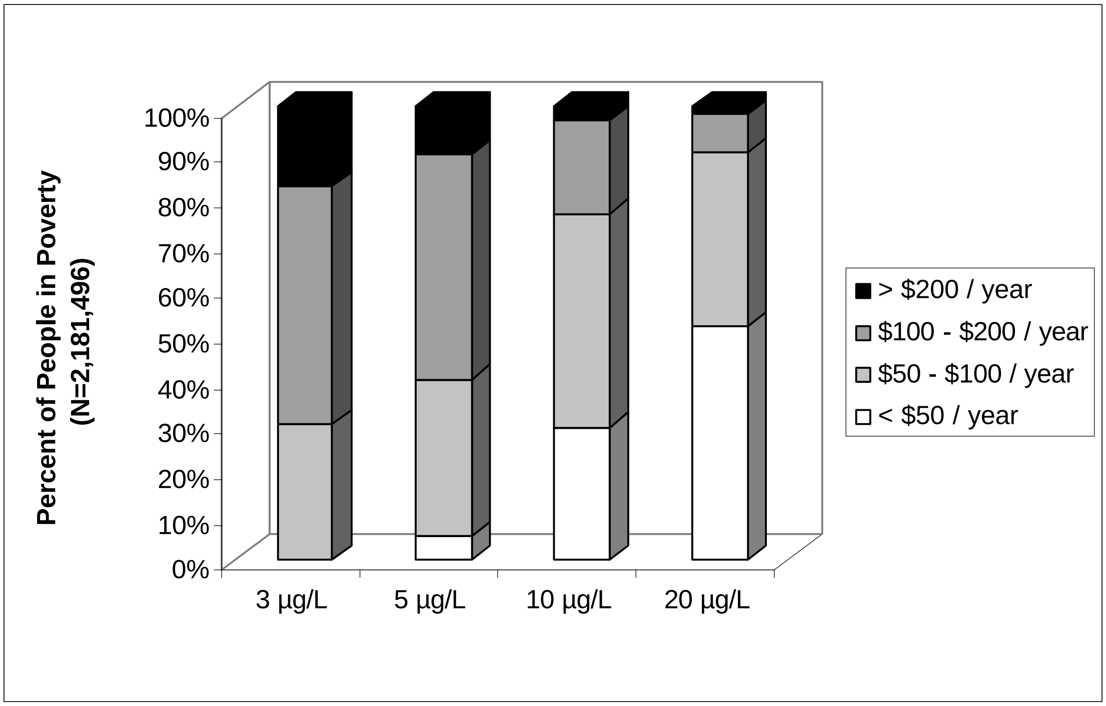
Poverty Impacts

Finally, Table 7 and Figure 6 summarize the estimated impacts of different MCL levels on people who live in households that have incomes below the poverty threshold. Here again, setting the MCL at 5 µg/L would raise serious affordability concerns for people whose incomes are below the poverty level. More than 60% of these impoverished people would face increases in their water bills of more than $100 per year, with one in ten facing an increase of more than $200 per year. Increases of this magnitude for people that already are living in poverty could result in serious tradeoffs that could affect the health of those individuals, as discussed above.

Table 7: Impacts on People in Poverty

	3 µg/L	5 µg/L	10 µg/L	20 µg/L
People in poverty with compliance cost < $50 per household per year	0 (0%)	109,840 (5%)	639,012 (29%)	1,121,376 (51%)
People in poverty with compliance cost $50 to $100 per household per year	656,209 (30%)	759,594 (35%)	1,029,611 (47%)	841,039 (39%)
People in poverty with compliance cost $100 to $200 per household per year	1,141,885 (52%)	1,078,957 (50%)	447,697 (21%)	185,386 (9%)
People in poverty with compliance cost > $200 per household per year	383,402 (18%)	233,105 (11%)	65,176 (3%)	33,695 (2%)

Figure 6: Distribution of Compliance Costs for People with Incomes Below Poverty Level



As has been seen from other measures of affordability, setting the MCL at a level of 10 or 20 µg/L greatly reduces (but does not completely eliminate) these effects. It should be noted that setting the MCL at 3 µg/L results in 70% of the people with incomes below the poverty level facing increased water costs of more than $100 per year, with one in five impoverished households facing an increase of more than $200 per year.

Conclusion

From the available data, it is reasonable to conclude that establishing a new arsenic MCL at a level of 5 µg/L (or lower) will raise serious concerns about the affordability of water service for a majority of affected groundwater systems. This conclusion is supported by an examination of:

- county-level impacts, based on the percentage increase in water costs for households with median income in each county;
- household-level impacts, based on the percentage of households that would see water costs increase by more than 0.5% of their income; and
- impacts on people with incomes below the poverty level, based on the percentage of people who would face increased expenditures for water of more than $100 per year.

These impacts are a function of the cost of treating groundwater for arsenic, the size of the affected water systems (the smaller the system, the higher the cost per household to treat the water for arsenic), and the demographics of the affected population. Due to the sheer number of systems that would face affordability concerns, it is believed that existing variance and grant programs would not be adequate to alleviate the affordability concerns raised by establishing the MCL at 5 µg/L.

Establishing the MCL at a higher level, particularly at 20 µg/L, alleviates most, but not all, of this adverse effect. The remaining impact, at the 20 µg/L level, however, should be sufficiently small to be mitigated through existing variance and grant programs. This assumes, of course, that EPA designates variance technologies and permits primacy agencies to grant variances. Unfortunately, the NOPR assumes that establishing an MCL of 5 µg/L would not raise any affordability concerns and, therefore, EPA has not proposed a variance technology.[35] This could leave many systems exposed to water rates reaching unaffordable levels without providing either the systems or their residents with a reasonable alternative.

These conclusions appear to be robust, in that they are based on a data set encompassing more than 1,400 water systems of various sizes in 199 counties in 18 states. The data from these counties appear to be reasonably representative of the United States as a whole. It is reasonable to conclude, therefore, that the types of affordability impacts that have been determined for the counties in the data set would be replicated throughout the United States where a groundwater system would be required to install treatment to meet a new arsenic MCL.

[35] NOPR, p. 38,926.