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When Arsenic is Safer in Your Cup of Tea Than in Your Local Water Treatment Plant

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Abstract

The arsenic drinking water standard has been an issue for over fifty years and a hot debate topic since 1977. The Safe Drinking Water Act Amendments of 1996 require the Environmental Protection Agency to promulgate a proposed regulation by January 1, 2000 and a final National Primary Drinking Water Regulation by January 2, 2001. This paper examines the health benefit and cost issues for various Maximum Contaminant Levels of arsenic exposure and examines some of the social and environmental consequences of setting the standard too low. The author proposes three alternatives for the proposed rule and concludes that the present standard of 50 ppb should not be lowered.

Contents

3. Form of Arsenic

4. Synergisms

5. Criticisms of Taiwan, Foreign, and U.S. Epidemiologic Studies

C. Treatment Technologies

III. Health and Safety Benefits v. Costs

A. Real health Risk Reduction?

B. Costs to Water Suppliers AKA Consumers

C. Consequences and Indirect Costs of a Lowered Arsenic MCL

1. Alteration of the Arsenic Cycle

2. RCRA: Hazardous Waste Generation, Storage, Treatment & Disposal

3. CWA: National Pollution Discharge Elimination System (NPDES) Permits

4. CERCLA: Impact on Superfund Cleanups

5. Western Water Law Impacts

6. Effects On Water Suppliers, Especially Small Rural Systems

a. Massive Permanent Federal/State Subsidies

b. Variances and Exemptions

c. Permanent Non-Compliance

d. Abandonment of Public Systems

e. Legislative Environmental Backlash

IV. Mythology of Call for Stronger Laws/Lower Standards to Protect Health

A. Zero Risk Goal (and MCLGS) Not Obtainable)

B. Risk Realities and Tradeoffs

C. Public Participation in Risk Assessment and Standard Setting

V. Alternatives to Meet the Goal of Safe Drinking Water Supplies

A. Leave the MCL at 50 ppb and Provide Free health Care for Any Individuals Who May Develop an Arsenic-Induced Skin Cancer

B. Leave the MCL at 50 ppb, complete the Long-Term Studies, and Review the Standard in the Year 2006

C. Set a Mandatory MCL at 50 or No Less Than 30 ppb and Let the Communities Choose if They Want Additional Protection

Conclusion

Introduction

Arsenic is defined as "a highly poisonous metallic element...."[1] History has shown this substance to be harmful to human health at high levels of exposure as it has been used as a poison for nearly 4000 years; but it is also useful to mankind in pesticides and weed-killers.[2] However, the effects of exposure at low concentrations is still a matter of strong debate in the scientific community with opinions ranging from arsenic being a nutritional requirement to a carcinogen. Arsenic regulation in public water supplies began in 1942 and remains in serious conflict between opposing views of environmental organizations and water suppliers with the courts tied to recognition of the Environmental Protection Agency's (EPA) discretion and final decision. Congress has attempted to set a deadline of January 1, 2001 to conclude the debate with

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[1] THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE 74 (1969).

[2] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 52 (Sept. 1994); THE AMERICAN HERITAGE DICTIONARY OF THE ENGLISH LANGUAGE 74 (1969). The Pueblo of Santa Ana is attempting to eradicate saltcedar, a non-native pest plant that has invaded the Rio Grande watershed, by "pressure feeding a 1% aqueous solution of Arsenal® herbicide," upstream of Albuquerque, New Mexico. Todd R. Caplan, Saltcedar Control and Riparian/Wetland Restoration on the Pueblo of Santa Ana 5 (1998), (unpublished manuscript on file with the Natural Resources Journal).

the Safe Drinking Water Act Amendments of 1996 (SDWAA).[3]

The SDWAA require the EPA to study the risk to human health of low-level exposure to arsenic, in cooperation with interested stakeholders and the scientific community.[4] Further, the amended act requires the agency to conduct and publish a cost-benefit analysis for a proposed National Primary Drinking Water Regulation (NPDWR) including a "Maximum Contaminant Level" (MCL) by January 1, 2000.[5] A final rule must be promulgated by January 1, 2001.[6] This is an ambitious schedule, especially if the EPA is to resolve the many technical and policy challenges complicating arsenic regulation in drinking water.

The MCL set by the EPA will be of critical importance to municipal and private water suppliers across the country. It will be particularly relevant to the future of many rural systems in the western part of the nation where naturally occurring arsenic is present in drinking water sources, particularly groundwater aquifers. The regulations will apply to any supplier of water with more than "15 service connections" or that provides "at least 25 persons" with drinking water regularly, including hotels, casinos and other establishments in addition to community facilities.[7] Regulated providers will have to install, maintain, and update treatment systems in many parts of the country to meet a MCL predicted to be below the current level of 50 μg/L or 50 parts per billion (ppb). In addition to capital investment and operational costs to treat incoming water, all waste products will have to be managed in accordance with federal and state pollution laws such as the Resource Conservation Recovery Act (RCRA). Large systems may be able to spread the cost over many users and reduce the negative impact to acceptable levels. But

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[3] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 109(a)(12)(A), 110 Stat. 1613, 1627-28 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998)).
[4] Id. at 1628.
[5] Id. § 104, 110 Stat. at 1623-24, 1628.
[6] See Id. § 109, 110 Stat. at 1628.
[7] See Id. § 101, 110 Stat. at 1616.

smaller systems will have to examine other alternatives to come into compliance since they lack the rate or tax base to minimize the cost distribution to individual households.

The costs may be justified to meet the goal of providing U.S. citizens with "safe" drinking water, but if the standard is lowered because of hypothetical benefits based on erroneous risk assessments and false assumptions versus real health improvements, the money will simply be wasted. Once the limited financial resources of the community are spent on unnecessary arsenic removal they will not be available for other more critical health and environment improvement projects such as hospitals, clinics, fire protection, pollution prevention, adequate waste management, crime prevention, road improvements, traffic safety, and schools.

There is strong scientific evidence that arsenic is not harmful at the low concentrations typically found in U.S. drinking water supplies. Hypothetical health threats justifying a lowered standard have been based upon EPA risk assessments using data from one epidemiologic report of arsenic-induced cancers in Taiwan, where concentrations in drinking water far exceeded any levels found in U.S. systems. Linear projections from that case study have resulted in the EPA's conclusion that drinking water at the current 50 ppb MCL for 70 years may result in development of arsenic skin cancers, but there has been no corroboration of their assumptions in the U.S.

There have been many substantive criticisms of the Taiwan study and the EPA methodology in using it to assess risks in exposed U.S. populations. One of the consistent observations is that long-term, chronic exposure to low-level doses of arsenic has not produced any measurable epidemiologic-evident diseases in U.S. populations who have been drinking the water for decades. This evidence points to a threshold level of arsenic, below which it does

produce any risk of adverse health effects, making reduction of the current standard unnecessary and not cost-effective. The SDWAA required the EPA to complete a study proposal to resolve the uncertainties in the present database by February 1997, however, the EPA only recently finalized the plan.[8] Thus, the critical long-term studies to resolve the debatable questions have only been funded in the last fiscal year and will not likely be completed before the initial deadline set by Congress to propose a new arsenic MCL.

If the new standard is set too low, the consequences to the environment and economies of the suppliers and their communities may create more serious problems and health risks than drinking the low levels of arsenic. The hypothetical and long-term risks of cancer may be shifted to an increased risk of exposure to hazardous waste, fatalities on the nation's highways from transportation of that waste to disposal units, and financial inability to confront more direct and actual health risks to citizens. Communities unable to meet the standard may seek relief in a variety of ways including: massive long-term federal subsidies, temporary variances and exemptions, permanent non-compliance, or abandonment of the public water system to avoid application of the rules. Potential public backlash against minimal environmental protection at the high cost in lieu of more immediately beneficial public services such as medical facilities may also occur. Unfortunately, the rural and largely poor communities, composed of concentrations of racial minorities, will face the largest costs, most significant lost opportunities for direct health benefits (such as medical facilities), and possibly be forced into perpetual lawbreaker roles or complete abandonment of systems. These disadvantaged populations will be forced to seek their own unreliable water supply, which will be the least "safe" in terms of the SDWAA requirements. The overall consequence of these potential negative ramifications of an excessively lowered standard is that the essential legislative goal to assure safe drinking water

[8] Id. § 109, 110 Stat. at 1627.

supplies will not be achieved and worse, in poorer communities, a regression to less healthy water sources may occur.

This paper proposes that the arsenic MCL should not be reduced below the current level until evidence exists that health benefits or reduced risk of chronic health damage justify the high costs of implementing a lower standard. Part I describes the history and current status of the arsenic drinking water standard. Information that affects MCL determination is examined in Part II, including the sources and concentrations of arsenic exposure, the debate concerning health and safety benefits for various levels of arsenic exposure, treatment technologies, and analytical detection levels. In Part III, the alleged benefits of a lowered MCL will be compared to projected costs to suppliers and consumers with examination of some potential consequences of setting a standard too low. Part IV analyzes the mythology of the value of setting "lower" standards without scientific proof of a health benefit. Finally, Part V proposes alternative mechanisms to meet the SDWAA goals.

Part I: History of the Arsenic MCL

It is important to note that the maximum contaminant level standard for a water supply constituent is not predicated upon added pollutants, but applies to any naturally occurring element in the water as well. The goal was and remains today to provide clean water at the tap of the consumer, no matter whether the source of the potential contaminant in the water is natural or the result of anthropogenic activities, although the principal emphasis of the SDWA has historically been aimed at introduced pollutants. However, regulation of a naturally occurring element may expand application of a drinking water regulation to many systems that may not have had to treat their source water due to the absence of external pollution impacts, forcing installation of previously unnecessary treatment systems.

A. Past Events

The U.S. Public Health Service (USPHS) set the first arsenic standard at 50 ppb in 1942 for interstate water carriers based on short-term, acute toxic exposure effects.[9] The impact of the regulation was only to bind water suppliers at the federal level who crossed state lines, but many states adopted the standard for intrastate suppliers as well.[10] The U.S.PHS reaffirmed the 50 ppb standard in 1946 and 1962 as grounds for rejecting a water supply.[11]

Using the 1962 U.S.PHS standard, the EPA set the National Interim Primary Drinking Water Regulation at 50 ppb on December 24, 1975.[12] Comments provided at that time recommended the MCL be set at 100 ppb because even the EPA noted that no illness had been observed for long-term chronic exposures as high as 120 ppb.[13] The agency did note long-term chronic effects at 300 to 2750 ppb.[14] However, the long-term chronic effects were based totally on studies reporting an association between arsenic exposure and skin cancer in Taiwan published in 1968.[15] In 1977, subsequent interpretations of that study's data and use of linear extrapolations of health effects from high to low doses, raised doubts about the validity and adequacy of the standard.[16] In contrast, animal studies had shown potential nutritional requirements for small doses of arsenic and human studies indicated arsenic could be metabolized at certain low-levels.[17] Thus, the EPA policy of adopting a goal of zero concentration for all known or suspected human carcinogens and then setting the MCL as close as technologically possible to the goal, was suspect in the arsenic scenario where low doses may

[9] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 6 (Sept. 1994).
[10] See Id.
[11] See Id. and Interstate Quarantine Drinking Water Standards, 27 Fed. Reg. 2152, 2154 (1962).
[12] See National Interim Primary Drinking Water Regulations, 40 Fed. Reg. 59,566, 59,570 (1975) (to be codified at 40 C.F.R. § 141.11 (b)).
[13] See Id. at 59,576.
[14] See Id.
[15] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 6 (Sept. 1994).
[16] See Id.

not only be not harmful, but essential nutrients.

To further complicate the issue of arsenic effects at low levels, the element exists in several valence states and chemical forms, so that one may be more toxic than another, or may be a carcinogen precursor, while other forms would not be. Thus, the early 1980's saw numerous studies being commissioned to answer many perplexing questions.[18] In its October 5, 1983 advance notice of proposed rulemaking, the EPA requested comments on whether the arsenic MCL should consider carcinogenicity, other health effects, nutritional requirements, and whether MCLs would be necessary for separate valence states.[19] A study commissioned by the EPA Office of Research and Development to review the available epidemiological studies in the U.S. resulted in a 1983 report which determined there was insufficient data to make the necessary statistical correlation between arsenic exposure and skin cancer.[20] The report further stated that the precursor effects of skin cancer were not present in U.S. populations and these effects would normally be evident in arsenic-induced skin cancer cases.[21]

In 1985 the EPA set the Recommended Maximum Contaminant Level (renamed Maximum Contaminant Level Goal (MCLG) in the 1986 Safe Drinking Water Act Amendments) to 50 ppb.[22] This level was based on the National Academy of Sciences' conclusion that 50 ppb balanced toxicity effects with possible nutrition essentiality and their Safe

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[17] See Id.
[18] See Id.
[19] Proposed Rules Environmental Protection Agency National Revised Primary Drinking Water Regulations, 48 Fed. Reg. 45,502, 45,512 (1983) (to be codified at 40 C.F.R. pt. 141).
[20] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 6 (Sept. 1994).
[21] See Id.
[22] See Proposed Rules Environmental Protection Agency National Primary Drinking Water Regulations; Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms, 50 Fed. Reg. 46,936, 46,957 (1985) (to be codified at 40 C.F.R. pt. 141).

Drinking Water Committee stated: "...that 0.05 mg/L provides a sufficient margin of safety."[23] Simultaneously, however, the EPA requested comments on alternate MCLGs of 100 ppb, based on noncarcinogenic effects, and 0 ppb, based on potential carcinogenic effects.[24]

The 1986 Amendments to the Safe Drinking Water Act interrupted the administrative process of setting the arsenic MCL. This Act converted the 1975 interim standard to an NPDWR, subject to revision by 1989, along with 82 other contaminants.[25] The amendment required that the MCLG, a non-enforceable standard, and the enforceable MCL be proposed together and that the MCL should be set as close to the "MCLG" as technologically feasible.[26] Thus, the nation had a MCLG of 50 ppb, but the scientific community was not certain it was necessary to protect human health, which made setting the final MCL a difficult task. The amendments required the EPA to promulgate national primary drinking water regulations (set MCL levels) for each contaminant that "has an adverse effect on human health and is known or expected to occur in public water systems" (emphasis added).[27] Additional language required EPA to set the MCLs at levels such that "no known or anticipated adverse health effects will be expected to occur" and such level should allow for an adequate margin of safety (emphasis added).[28] Thus, the EPA was justified, and the courts reasonably deferred to their choice of conservative assumptions and acceptance of hypothetical adverse health effects to provide "adequate safety margins."

The questions persisted about whether arsenic is an essential nutrient for human health, is

[23] Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6,6 (Sept. 1994); See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.
[24] See Proposed Rules Environmental Protection Agency National Primary Drinking Water Regulations; Synthetic Organic Chemicals, Inorganic Chemicals and Microorganisms, 50 Fed. Reg. 46,936, 46,960 (1985) (to be codified at 40 C.F.R. pt. 141).
[25] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›; Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 6 (Sept. 1994).
[26] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6,6 (Sept. 1994).

detoxified by humans at low levels, and whether the possible cancer risks calculated by the EPA were valid considering the inability of their linear models to account for safe threshold levels of a contaminant. The EPA's internal studies in 1988 were providing evidence that the dose/response curve may not be linear at exposure to arsenic below a threshold of 350 to 400 μg/day, but the true shape remained elusive.[29] However, the EPA's guidance documents and internal policies at that time did not allow variance from the conservative linear models.[30] The linear model projected skin cancer risks for arsenic ingestion (using standard 10^{-4} and 10^{-6} risk levels) at concentration ranges of .02 ppb to 2 ppb.[31]

Internal disagreement over the 1984 EPA health assessment led the EPA Risk Assessment Forum to convene a special technical panel to address arsenic-related concerns.[32] The panel's 1988 published report concluded that the risk of skin cancer was quantifiable from the Taiwan data, but the suspected risk of internal cancer effects was not determinable.[33] Further they found that definitive evidence was not available to conclude arsenic is an essential nutritional element or that a threshold effect exists.[34]

The EPA Science Advisory Board (SAB) reviewed the EPA studies and determined that the Taiwan data was adequate to conclude that high doses of ingested arsenic can cause skin cancer, but was inconclusive to determine cancer risk at the low levels of arsenic ingestion in the

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[27] Safe Drinking Water Act Amendments of 1986, Pub. L. No. 99-339, 100 Stat. 642 (codified as amended in scattered sections of 42 U.S.C. §§ 300 f to 300 j-11 (1982 & Supp. IV 1986)).
[28] 42 U.S.C. § 300 g-1(b)(3)(A) (Supp. IV 1986).
[29] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›; Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6,6 (Sept. 1994).
[30] See Draft Water Quality Criteria Methodology Revisions: Human Health, 63 Fed. Reg. 43,756, 43756 (1998).
[31] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.
[32] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6,6 (Sept. 1994).
[33] SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 4 (1988).
[34] See Id.

U.S.[35] Moreover, they found that arsenic levels below 200 to 250 μg/day may be detoxified in the human body.[36] They concluded the dose-response to ingested arsenic was nonlinear and criticized the 1988 forum report because it applied a linear risk assessment model, which probably resulted in unnecessarily high cancer risk estimates for low concentration values.[37]

This review and conclusion by the SAB caused the EPA to miss the 1989 deadline for proposing a revised NPDWR for arsenic and the Bull Run Coalition filed a citizen suit against them.[38] In 1990 a consent decree was entered by the court (and amended several times thereafter) that required the EPA to make a determination by June 1, 1991, as to whether to await the results of further research or to proceed with development of the revised rule.[39] A series of research studies were proposed by the SAB to resolve uncertainties in arsenic exposure levels and cancer risks.[40] However, in June 1991, the EPA rejected the proposals and concluded that additional research was not required to prepare a new regulation.[41] This activated the consent decree requirements that the agency propose a rule no later than November 1992, with a final rule promulgated by November 1994, rather than allowing up to seven more years to issue a proposed rule upon completion of the research projects.[42] The EPA decided that arsenic was a proven skin carcinogen in humans based upon the older Taiwan studies and a potential internal carcinogen from two new correlation studies published in 1992 that manipulated the same Taiwan data.[43]

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[35] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.
[36] See Id.
[37] See Id.
[38] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›; Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).
[39] See Id.
[40] See Id.
[41] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).
[42] See Id.
[43] The primary work was called the "Smith Study." See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998)

These conclusions triggered the automatic EPA policy to set the MCLG for arsenic to zero[44] and to proceed with a risk assessment calculation.[45] The implications of an internal cancer correlation to arsenic exposure caused the EPA to miss the 1992 deadline, which was pushed back to September 1994.[46] Again the SAB criticized the EPA rule-making methodology because the risk assessments still did not address the low-level exposure discrepancies in the Taiwan data and the available U.S. information from populations exposed to low levels where no cancers had been found.[47] In response to the SAB review, the EPA stuck to their linear dose-response models but did revise their draft criteria document causing the 1994 deadline to be missed and a revised rulemaking date of November 1995 to be set by the court.[48]

In May/June 1995, the American Water Works Association (AWWA) Research Foundation, AWWA Water Industry Technical Fund, and Association of California Water Agencies sponsored a workshop on arsenic research.[49] Their report prioritized necessary arsenic research discounted by the EPA in cancer mechanisms, epidemiology, toxicology, and treatment of water systems.[50] The EPA missed the November 1995 deadline. However, the SDWAA of 1996 were signed by the President on August 6, 1996, which established a mandate for additional cooperative research and set the new schedule to promulgate proposed and final

‹http://www.epa.gov/OGWDW/ars/ars1.html›; Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).

[44] See National Revised Primary Drinking Water Regulations, 48 Fed. Reg. 45,502, 45,502 (1983) (to be codified at 40 C.F.R. pt. 141).

[45] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.

[46] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).

[47] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994); SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 21 (1988).

[48] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).

[49] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.

[50] See Id.

arsenic rules.[51] With the new statutory deadlines, the arsenic regulation litigation was dismissed in November 1996.[52]

B. Summary and Current Status of the SDWAA of 1996

In its conference agreement, Congress describes the SDWAA as providing for:

> (1) revisions to the procedures, process, and criteria for regulating contaminants in drinking water to protect the public health; (2) special programs to help small public water systems meet the requirements of the Act; (3) provisions to promote cost-effectiveness in new drinking water regulations; (4) increased flexibility for water suppliers where consistent with public health; (5) new programs to promote the proper operation of public water system; (6) substantial new Federal financial and technical assistance to help water suppliers meet the requirements of the Act and to help States in carrying out programs under the Act; (7) refinements and new programs to improve protection of public health from drinking water contamination; and (8) consumers with information on the source of the water they are drinking and its quality and safety.[53]

The Conferees encouraged the EPA to work with the AWWA Research foundation to carry out the research projects mandated in its specific provisions applicable to the arsenic standard.[54]

The requirements of the SDWAA for the arsenic rulemaking are briefly: 1) develop a research plan to reduce the uncertainty in assessing health risks from low levels of arsenic by February 2, 1997 and use of best available, peer-reviewed science for decision-making; 2) conduct the research in consultation with the National Academy of Sciences, Federal agencies,

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[51] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›; Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 109(a)(12)(A), 110 Stat. 1613, 1627-28 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998).

[52] See Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars1.html›.

[53] H.R. CONF. REP. NO. 104-741, at 85 (1996), reprinted in 1996 U.S.C.C.A.N. 1366, 1432.

interested public and private entities; and the Administrator may enter into cooperative agreements for the research; 3) issue a proposed regulation by January 1, 2000, which emphasizes risk communication, analysis of health benefits likely to occur, including considerations of sensitive populations, and costs of alternative options in preparation of the regulations; and 4) issue the final regulation by January 1, 2001 after appropriate public review and comment.[55] Congress authorized $2.5 million per year for 1997-2000 for the studies and in 1996 and 1997 appropriated $1 million each for arsenic research.[56] The new MCL will apply to non-transient, non-community water systems such as those servicing schools, office buildings, and casinos, in addition to community water systems supplying homes and other residences, a significant increase in the scope of the regulations.[57] The Act still does not apply to individual homeowners with private wells or to bottled water.[58]

Congress maintained its overall goal to provide safe drinking water but placed greater emphasis on using sound, objective scientific methods and benefit-cost analysis to improve the effectiveness of drinking water regulations.[59] Accompanying these new tools Congress mandated increased public education and participation in the process as well as increased cooperation with State and local governments to promote regulation of real health risk priorities. These revisions will be essential in resolving the debate concerning the final arsenic MCL.

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[54] See Id. at 1435.
[55] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 109(a)(12)(A), 110 Stat. 1613, 1627-28 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998)).
[56] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 109(a)(12)(A), 110 Stat. 1613, 1627-28 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998)); Office of Ground Water and Drinking Water, USEPA, Arsenic In Drinking Water – Regulatory History 2 (visited July 2, 1998) ‹http://www.epa.gov /OGWDW/ars/ars1.html›.
[57] See Office of Ground Water and Drinking Water, USEPA, Drinking Water Priority Rulemaking: Arsenic 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/arsenic.html›; Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 101, 110 Stat. 1613, 1616-17 (1996) (codified as amended at 42 U.S.C. § 300 f (West Supp. 1998)).
[58] See Id.
[59] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 3, 110 Stat. 1613, 1614-15 (1996) (codified as amended at 42 U.S.C. 300 f (West Supp. 1998)).

The amendments also clearly demonstrate that Congress wants to end the debate about arsenic. However, the timeline established may be too short and could thwart the objectives to use better science and benefit-cost analysis to set a necessary, but reasonable MCL. The EPA missed the February 1997 deadline to finalize a research plan, delaying funding and execution of the long-term studies necessary to answer the open questions concerning low-level arsenic exposures.[60] At the February, 1998 Stakeholder's meeting the EPA stated they would use current and future research to the extent available, but that they would meet the statutory deadline, reserving the use of long-term research effects for future reviews of the regulation.[61]

Thus, the results of the necessary research studies will not likely be available to the EPA at the year 2000 deadline to propose an NPDWR and the decision will be based upon current knowledge. This gives the EPA at least two options and this paper will propose others they may wish to consider in the proposed rulemaking. They can leave the MCL at 50 ppb and use the six-year review cycle[62] to lower the standard if more information becomes available on the true health risks associated with low-level exposures. Or they can lower the standard immediately, causing the potentially negative consequences this paper will discuss.

Choosing the first option subjects the EPA to the same criticisms from the environmental groups evident in the legislative history of the SDWAA of 1996 that the present standard is inadequate and should be lowered. However, the second option forces a lowering of the standard without performing the Congressional mandate to use the best, objective science, which is missing in the Taiwan study. It is conceivable they could raise the standard after selecting the

[60] The research plan was only finalized by the February 25, 1998 Stakeholder's Meeting. See Office of Ground Water and Drinking Water, USEPA, Executive Summary Stakeholder's Meeting: Arsenic in Drinking Water Wednesday, February 25, 1998, San Antonio, TX 2 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ndwac/sum_as2.html›.
[61] See Id.
[62] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104, § 3, 110 Stat. 1613, 16125 (1996) (codified as amended at 42 U.S.C. § 300 g-1 (b) (West Supp. 1998).

second option, upon completion of the long-term studies, but this is unlikely. It is very difficult to raise a standard without raising widespread opposition and public concern about "weakened" safety regulations for drinking water.[63] In addition, the capital investments required to meet the lower standard will be in place or ongoing and the harm of setting the standard too low will have already occurred in most communities, making retreat politically undesirable from the supplier's viewpoint. The first option provides the least long-term negative impacts and an opportunity to lower the standard if proven health risks are revealed in the long-term studies.

C. Current Status

Two arsenic stakeholders' meetings were conducted to discuss issues and concerns of interested parties on September 11-12, 1997 and February 25, 1998. The 1997 meeting consisted of presentation of information by the EPA, questions and answers, and open discussion.[64] In the 1998 meeting, the EPA stated it would use current and future arsenic research to the extent available to meet the statutory deadlines since the research plan and long-term studies had been delayed.[65] Further, the national occurrence database of arsenic related diseases would not be established until August 6, 1999 and the U.S. Geological Survey (U.S.G.S.) ambient ground water database was scheduled for release in the fall of 1998 to examine natural occurrence of arsenic in water supply sources.[66] Thus, the anticipated new information regarding arsenic will not be timely to set the proposed drinking water standard. The EPA stated it would propose the

[63] "Drafters of legislation should be particularly careful about introducing scientifically inappropriate standards...in light of the relative permanence of...standards. While there is nothing in theory which sets environmental...standards in stone, in practice they are rarely revised. The few cases where EPA has sought to relax existing standards were the source of intense controversy and litigation." Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals, 19 ECOLOGY L. Q. 269, 352 (1992).

[64] See Office of Ground Water and Drinking Water, USEPA, Executive Summary Stakeholder's Meeting Summary, Arsenic in Drinking Water September 11-12, 1997 (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ndwac/sum_as1.html›.

[65] See Office of Ground Water and Drinking Water, USEPA, Executive Summary Stakeholder's Meeting: Arsenic in Drinking Water Wednesday, February 25, 1998, San Antonio, TX 1 (visited July 2, 1998), ‹http://www.epa.gov/OGWDW/ndwac/sum_as2.html›.

new rule, setting the MCL as close as feasible to the MCLG of 0 ppb (based on the status of arsenic as a known carcinogen, ignoring mechanism and potential thresholds), considering analytical method capability, occurrence, treatment technologies, and regulatory costs and benefits, all of which are still in controversy.[67] Without the results of the research projects, the conclusion may already be pre-determined by EPA policy and the hard deadline established by Congress.

The SDWAA stipulated that the EPA prepare an arsenic research plan to study the low level health effects of arsenic and to consult with interested entities to resolve scientific uncertainties about health effects of arsenic that have spanned fifty years of regulatory effort. The plan was to have been finalized within six months of the Act's implementation, but the draft was only submitted for peer review and finalized in 1998.[68] This one-year delay beyond the mandated deadline has seriously impaired the congressional expectation to formulate an arsenic rule based upon the best scientific information. Congressional intentions were set out in the report for Senate Bill S.1316, which became the SDWAA of 1996 after amendment by the House during conference.[69] The following text describes those expectations:

> EPA has not completed this duty [establish standard] because of substantial scientific uncertainty about the cancer-causing effect of arsenic at very low doses. If the arsenic standard were revised based on current policy, the standard might be set as low as 5 parts per billion. A standard at this level may impose unnecessary compliance costs, if there is a threshold for the cancer-causing effect of arsenic that is substantially above this level. This bill allows additional time for research to resolve this scientific uncertainty...Prior

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[66] See Id.
[67] See Id.
[68] See Id.
[69] H.R. CONF. REP. NO. 104-741, at 85 (1996), reprinted in 1996 U.S.C.C.A.N. 1366, 1432.

to proposing a revised arsenic standard, the Administrator is to conduct a formal review of the research results and consult with the Science Advisory Board...These uncertainties are resolvable through additional research on the health effects of arsenic...It is unfortunate that EPA has not already conducted the research necessary to proceed with an arsenic standard.[70]

Language that was lost from the Senate bill in conference, but nevertheless expresses the findings of the Senate after the exhaustive hearings and discussions about the arsenic problem, is also relevant to illuminate the legislative goal for the new arsenic regulations:

> EPA is authorized to set the maximum contaminant level goal (MCLG) for a contaminant that is a known or probable human carcinogen at a level other than zero, if the Administrator determines that there is a threshold below which there is unlikely to be any increase in cancer risk and the MCLG is set at this threshold level with an adequate margin of safety.[71]

Congress wanted the EPA to determine if arsenic has a safe threshold and to quantify that level before rulemaking recommenced in the year 2000.

The final EPA plan includes studies of modes of action and levels of human exposure and metabolism (including sensitivity and susceptibility), methods to measure exposures to particular arsenic valences, and cancer and non-cancer health effects.[72] The research will be aimed at selecting proper health factors for more realistic risk assessment and identification of the shape of the dose-response curve at low doses.[73] The EPA awarded three research grants totaling $2 million and the AWWA Research Foundation and the Association of California Water Agencies

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[70] S. Rep. No. 104-169, at 39-40 (1995).
[71] Id. at 30.
[72] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Arsenic Research Plan (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/test/aars9.html›.

funded two independent research projects.[74] Unfortunately none of these studies will be completed in time for the year 2000 rulemaking proposal.[75]

The latest event affecting the arsenic standard is the revision of the EPA guidelines for preparation of health risk assessments in establishing water standard criteria under the Clean Water Act (CWA). The proposed revised guidelines establish generic methodologies for cancer risk assessments that could be used in setting NPDWRs under the Safe Drinking Water Act (SDWA).[76] The amendments are necessitated by many significant scientific advances in key areas of cancer risk assessment, exposure assessments, and bioaccumulation models, since the original guidance document was published in 1980.[77] With this document, the EPA is also attempting to establish more uniform risk assessment policies and procedures between its various programs offices, who all use different assumptions and models to determine health effects of various chemicals.[78]

The scientific advances recognized by the new draft guidelines are specifically for characterizations of risk at low, environmentally relevant exposure levels.[79] Of particular importance to the arsenic MCL proposal is the use of "mode of action information" versus previous assumptions that any level of a carcinogen causes cancer. The new methodologies allow more accurate quantification of cancer risks at low exposures using non-linear dose responses, supplementing or replacing the linearized multistage model so heavily criticized in the arsenic debate.[80]

This revised document meets the mandated requirements in the SDWAA to take a "state-

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[73] See Id.
[74] See Id.
[75] See Id.
[76] See Draft Water Quality Criteria Methodology Revisions: Human Health, 63 Fed. Reg. 43,756, 43,756 (1998).
[77] See Id.
[78] See Id. at 43,759.
[79] See Id. at 43,758.

of-the-science" approach in standard setting. There is no indication that the new guidelines will be used to set upcoming MCLs under the SDWA, but the EPA stated its intention to derive the CWA standards for several chemicals of high priority, including arsenic.[81] But one of the EPA's stated policy goals for the revision is to provide "greater clarity, transparency, reasonableness, and consistency in risk assessments across EPA programs."[82] Therefore, these revised guidelines should influence the determination of the proposed MCL for arsenic under the SDWAA.

Part II: Factors Affecting MCL Determinations

A. Sources of Arsenic in Water and the Environment

Arsenic is a nonmetal in the group of chemicals of the periodic chart containing nitrogen, phosphorous, antimony and bismuth, but its physical appearance resembles that of a metal so it is called a metalloid to distinguish it from a true nonmetal.[83] It commonly exists in several oxidation, or valence, states: +V (arsenate), +III (arsenite), 0 (arsenic) and –III (arsine).[84] Arsenic occurs naturally as the twentieth most abundant element in the earth's crust and is a component of more than 245 minerals.[85] Smelting of ores causes the production of arsenic trioxide as a by-product and can result in significant air pollution and contamination of surrounding land areas.[86] Arsenic is also added to the environment when fossil fuels are burned and through volcanic eruptions and other natural processes that cause its release.[87] Because of these characteristics arsenic is mobile in the environment as simple rock weathering converts arsenic sulfides to

[80] See Id.
[81] See Id. at 43,763.
[82] Id. at 43,769.
[83] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 52 (Sept. 1994).
[84] See Id.
[85] See Id. at 52-3.
[86] See Id. at 53.
[87] See Id.

arsenic trioxide, causing movement in dust, dissolution in rain, rivers, or groundwater.[88] Once the arsenic is liberated from the rocks and soils, it cycles through land, air and water masses, with water being the primary means of environmental transport generally as AsV with some AsIII present.[89] In aerated water, AsIII tends to be oxidized to the AsV form, especially at alkaline pHs, but at low pH values the AsV is reduced to AsIII.[90] Oxidized forms of arsenic are returned to sulfides by anaerobic processes in land and water sediments.[91]

Human exposure to arsenic is through air, food, and water uptake.[92] The air concentration is usually small (average U.S. exposure of .006 $\mu g/m^3$) although exposures can be higher in polluted areas around ore smelters or power plants (as high as 1 $\mu g/m^3$). Food is the most significant source but exposure depends on eating habits because of the varying concentrations of inorganic arsenic.[93] Some examples of this variance are marine crabs, lobster, shrimp and cod that contain 10 to 40 mg/kg compared to pickerel, catfish, coho salmon, other freshwater fish, pork and beef that typically have less than 1 mg/kg.[94] The U.S. Food and Drug Administration has estimated that U.S. adults ingest about 53 μg/day from food.[95] About half comes from fish and shellfish (27 μg), 4 μg from meat and poultry, 4 to 5 μg from grain and grain products, 3 to 4 μg from vegetables, and 13 to 17 μg per day with milk and milk products.[96] The amount of arsenic in the inorganic form is important because such intake is considered more toxic than ingesting organic arsenic compounds.[97] The amount of inorganic as a percent of total arsenic present in various food types is illustrated in Appendix A. Any proposed drinking water standard

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[88] See Id.
[89] See Id.
[90] See Id.
[91] See Id.
[92] See Id.
[93] See Id.
[94] See Id.
[95] See Id.
[96] See Id.

is based on a total estimated exposure minus the amounts predicted to occur in food or inhalation. The EPA uses a conservative allowance of 20% of the exposure from the drinking water pathway.

Arsenic content in water depends on the amount of mineralization of local soils and local conditions.[98] Groundwater is an especially important source of naturally occurring arsenic, particularly in areas where geochemical conditions favor dissolution into the water and locations with geothermal activity or previous volcanic deposition mechanisms.[99] Thus, ground and surface waters in the western states have higher concentrations of arsenic from their associated soils, with surface water generally having lower concentrations.[100] The wells in the Taiwan study had arsenic concentrations of 1820 ppb., while U.S. well levels have been rarely reported exceeding 100 ppb.[101] Generally, water supplies for U.S. systems are well below the current arsenic MCL of 50 ppb.[102]

Historical data on the occurrence of arsenic in surface and ground water systems was limited to collection of violations of the 50 ppb standard and samples with an analytical detection limit of about 5 ppb.[103] Most samples were not collected or analyzed for lower levels, making arsenic distribution below the current MCL highly speculative. However, projections of the number of systems and populations affected by proposed NPDWRs are essential to conduct the cost-benefit analyses of MCL options as well as assess technological capability of treatment

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[97] See Id. at 54.
[98] See Id. at 54.
[99] See Janet G. Hering et al., Arsenic Removal by Ferric Chloride, 88 No. 4 J. AM. WATER WORKS ASS'N 155, 155 (Apr. 1996).
[100] See Id.
[101] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 54 (Sept. 1994).
[102] See Id.
[103] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Occurrence of Arsenic, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars5.html›.

systems.[104] More information is also required on the occurrence and distribution of AsIII and AsV in the water sources. New surveys are being conducted to fill in these gaps and the U.S.G.S. is preparing an arsenic ambient ground water occurrence database.[105] To date, no single existing survey is sufficiently comprehensive to serve as a basis for regulation.

The AWWA synthesized results of three newer surveys of arsenic occurrence in U.S. drinking water supplies to estimate how possible MCL levels would affect compliance of water systems.[106] Detectable levels of arsenic, above 0.5 ppb, were found in 73% of the respondent surface water sources and 58% of the ground water sources.[107] Delivered water levels dropped to 45% for surface systems (already have treatment systems), but was largely unchanged at 53% for groundwater systems (few treatment plants).[108] The authors' compliance projections for MCLs ranging from 2 to 20 ppb agreed fairly well with the EPA estimates: 25% of community water systems (11,550-11,890) in violation of a 2 ppb level; 6 to 17% (2775-7870) would violate 5 ppb; and 1 to 3% of systems (510 to 1360) were projected to violate an MCL of 20 ppb.[109]

The AWWA survey used U.S.G.S. information to make consistent and quality controlled estimates of ambient water arsenic levels.[110] Confirming prior results, concentrations were higher in ground water systems and in states west of the Mississippi.[111] States predicted to have the highest ground water concentrations are Nevada, California, Arizona, Washington, Idaho, Montana, Utah, New Mexico, North Dakota, Nebraska, Oklahoma, Arkansas, Missouri,

[104] See Id.
[105] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Occurrence of Arsenic in Ground Water – USGS Activities (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars6.html›.
[106] See Michelle M. Frey & Marc A. Edwards, Surveying Arsenic Occurrence, 89 No. 3 J. AM. WATER WORKS ASS'N 105, 105 (Mar. 1997).
[107] See Id.
[108] See Id.
[109] See Id.
[110] See Id. at 107.
[111] See Id.

Minnesota, Michigan, New York and Florida.[112] Significantly, many of those systems serve small, poor, rural, minority populations who will be disproportionately affected by the cost of implementing a very low arsenic MCL. Simultaneously, these communities provide epidemiologic evidence that lower concentrations do not cause long-term disease, since there is no widespread occurrence of arsenic related cancer. Further, no cases of arsenic-related cancer has ever been reported in the U.S.[113] In fact, some residents have been drinking these naturally arsenic laden waters for hundreds of years, such as occupants of the Isleta Pueblo in New Mexico since 1200 A.D.[114]

B. Arsenic Health Effects and the U.S. Debate

Arsenic is clearly toxic at high levels of acute exposure. Short-term exposure to doses of more than 500 μg/Kg/day can cause serious blood, nervous system, gastrointestinal disorders and may lead to death from cardiovascular collapse.[115] A 70 kilogram adult consuming 2 liters of water per day at the current MCL of 50 μg/L would only receive 100 μg/day in addition to the 53 μg/day from food. The lethal dose for about half of these adults would be 70,000 to 280,000 μg/day.[116]

Arsenic is classified as a human carcinogen by the International Agency for Research on Cancer and by the EPA based on occupational health studies that have firmly established a relationship between inhaled arsenic and lung cancer.[117] Unlike most carcinogens, classification

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[112] See Id.
[113] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 21 (1988).
[114] See Denise D. Fort, State and Tribal Water Quality Standards Under the Clean Water Act: A Case Study, 35 NAT. RESOURCES J. 771, 772 (1995).
[115] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 56 (Sept. 1994).
[116] An acute exposure event occurred in Perham, Minnisota in 1972 when 13 employees were exposed to arsenic concentrations of 2100 to 11,800 μg/L from their employer's water well over a 10-week period. Three of the employees experience signs of subacute and chronic poisoning, but did not suffer irreversible effects. See Id. at 57.
[117] See Id. at 56.

of arsenic is based solely on human data since it has not been found to cause cancer in animal experiments, the usual comparable model system for studying carcinogenic compounds; rather studies with typical research animals have indicated that arsenic is an essential nutrient.[118] This means the mechanism of action by arsenic in the development of cancer is unknown, although some evidence indicates it acts as a promoter, rather than an initiator.[119] The association between skin and possible internal cancers based on ingestion is based strictly on epidemiologic investigations reporting cancer effects in populations in Taiwan exposed to high concentrations in their drinking water and food.[120] In that population common signs of long-term, ingestion exposures were dermal changes such as variations in skin pigments, hyperkeratoses and ulcerations.[121] In its worst expression, the affected skin thickens and cracks while turning from white to black, especially at the extremities such as the feet, and is called blackfoot disease.[122] The exact etiologic mechanism of this disease is unknown, but diet and life-style factors are suspected to contribute to its development.[123]

Chronic exposure to low concentrations is the primary interest in setting an arsenic MCL, since water below the current U.S. arsenic standard of 50 ppb never results in acute exposure levels.[124] The controversy centers on the dependence of the EPA on the Taiwan study (where these effects were endemic) when none of these health effect precursors have been seen in U.S. populations nor have any arsenic-induced skin cancers been reported in the U.S.[125] The disease is

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[118] See Id. at 55-6.
[119] See Id. at 56.
[120] See Id. at 56; SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 (1988).
[121] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 56 (Sept. 1994).
[122] See Id.
[123] See Id.
[124] See Id.
[125] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 21 (1988).

fully treatable with the only fatalities occurring in Taiwan due to lack of medical care.[126]

Unlike most environmental contaminants, there is a large human database (millions of people living in the western U.S.) available to study exposure to low doses of inorganic arsenic. Specific U.S. studies have found no association between exposure in drinking water and cancer but have been criticized for involving populations too small for statistical analysis.[127] The debate in the scientific community is over the interpretation of the Taiwan data and its application to the risk assessment process used to develop the U.S. MCL (see supra Part I). All of the epidemiologic studies that have reported an association between arsenic in drinking water and skin cancer and increased mortality from internal cancers of liver, bladder, kidney, and lung in exposed populations have been conducted in other countries such as Taiwan, Hungary, Mexico, Chile, and Argentina.[128] The Taiwan study used as the basis of EPA's risk assessment was comprised of only 40,000 individuals, by Tseng et al. in 1968.[129] The EPA used a linear extrapolation model from the cancers associated with high concentration exposures to recommend a drinking water MCL of 2 ppb.[130]

The controversy centers on why there is an absence of reported cancer incidences in the U.S. if arsenic has been determined a "known carcinogen" in the worldwide studies. To solve the discrepancies we must ask whether there is:

1. a threshold dose below which arsenic does not trigger disease?

2. a minimum amount of arsenic required for basic nutrition and overall nutritional variances contributing to cancer incidence in the study populations?

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[126] See Id.

[127] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 57 (Sept. 1994).

[128] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Health Effects Research, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars10.html›.

[129] See Id.

[130] See Id.

3. a difference in form of arsenic between organic/inorganic compounds and AsIII versus AsV valence states?
4. and a synergistic relationship between arsenic and other chemicals not assessed in the foreign studies but absent in U.S. water supplies?

1. Threshold Dose

Many scientists believe that there is a threshold dose below which arsenic does not trigger any adverse health effects. Arsenic levels in U.S. public water supplies are generally well below 50 ppb because of the 1942 health standard, with few reported violations. In contrast the levels in the water supplies of the exposed populations for the other countries reporting arsenic-related cancer incidences are all much higher: Taiwan up to 1820 ppb, Hungary exceeding 100 ppb, Mexico 400 ppb, Chile up to 800 ppb, and Argentina exceeding 250 ppb.[131]

Arsenic can be detoxified in the body and through metabolic processes suggesting a threshold level of arsenic exposure below which adverse health effects would not occur.[132] Exposure above this unquantified level would result in only partial detoxification and adverse effects commensurate with exposure may be expected to occur.[133] Some studies have suggested that doses of inorganic arsenic up to 200 to 250 ppb are detoxified and excreted rapidly from the body.[134] More detailed understanding of the biochemical processes and related disease mechanisms are critical in assessing effects of low-dose exposures and interpretations of the epidemiologic studies.

The general outlines of the process are known, although the point at which adverse health effects occur is not. Arsenic is a normal component of the human body and once ingested, can be

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[131] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 54 (Sept. 1994).
[132] See Id. at 55.
[133] See Id.

excreted directly or soluble forms can be absorbed from the gastrointestinal tract at rates of 40 to 100% with the less toxic AsV form absorbed better than AsIII.[135] Once absorbed, arsenic is transformed to an organic acid and transported by the blood to different organs.[136] Retained arsenic migrates to the soft tissues with the highest levels accumulating in the nails and hair.[137]

Arsenic metabolism involves two processes that could be the agents of harmful effects.[138] After entering a cell, AsV is reduced to AsIII, which is then methylated to the organic acids in the liver.[139] AsV can substitute for phosphate and interfere with normal cell functions, while AsIII has a high affinity for thiol groups in proteins, causing inactivation of a variety of enzymes.[140] The most significant impacts are interference with necessary enzyme reactions in the body, which is possibly the linkage to cancer development at exposure above the levels the body can metabolize and excrete.[141] The organic arsenic acids do not bind strongly to biological molecules in humans and so their relative toxicity is assumed to be less than the untransformed inorganic AsIII and AsV.[142] It has been reported that inorganic AsV is one-tenth as toxic as AsIII and organic acids are thought to be less toxic than AsV, although chronic effects of these organic forms is not known.[143] Thus, the body is constantly detoxifying the arsenic that is not immediately excreted or absorbed by the tissues through this methylation process.[144]

The form of arsenic affects the rate at which it is excreted from the body.[145] Some of the inorganic arsenic is excreted via urine immediately in the same form in which it was ingested (III

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134 See Id.
135 See Id. at 54.
136 See Id.
137 See Id.
138 See Id.
139 See Id.
140 See Id. at 55.
141 See Id.
142 See Id.
143 See Id.
144 See Id.

or V).[146] After methylation it is also excreted as an organic acid.[147] Most blood arsenic is excreted rapidly with 50 to 90% cleared in two to four days.[148] However, the specific pharmacokinetics of arsenic in the human body are not well understood.[149]

This metabolic and elimination process may detoxify exposure to low-level concentrations such as are found predominantly in the U.S. It may also explain why even with the Taiwan study, cancer rates dropped significantly for low-level exposures. Further research is essential to elucidate whether a threshold exists and if so, at what level it might occur and if it depends on the form of arsenic interacting with the human body.

2. Essential Nutrient

Related to the threshold dose issue is whether or not arsenic is an essential nutrient at low levels, but becomes toxic above some specified exposure level, such as occurs in other human-required vitamins. Studies with minipigs, goats, chicks, hamsters, and rats have indicated that arsenic is required for adequate nutrition, but there is insufficient data for the assessment of it being a required human nutrient.[150] The Food and Nutrition Board of the National Research Council and the EPA do not consider arsenic to be an essential element for human health, but the question persists.[151] Extrapolation from the animal studies suggests a safe and adequate dietary intake for humans to about 12 to 40 μg/day.[152] Although no human pathological condition has been attributed to arsenic deprivation, that may be a result of the high levels of arsenic available in the typical daily diet that supplies more than 40 μg regularly.[153] A 1994 study by Mayer et al.

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145 See Id.
146 See Id.
147 See Id.
148 See Id.
149 See Id.
150 See Id.
151 See Id.
152 See Id.
153 See Id.

reported a positive correlation between lowered arsenic serum levels in hemodialysis patients and central nervous system injury, cancer and vascular diseases and concluded that "arsenic should be considered or may be defined to be essential for human life processes."[154] More work is needed, but these studies point to a "safe" or even "necessary" low level of arsenic ingestion.

3. Form Of Arsenic

There are questions concerning the ingestion toxicity of the various chemical formulations and valence states of arsenic, organic v. inorganic, AsIII v. AsV. As described above the metabolism of arsenic and its affinity/effect on human cellular activity varies with valence state and chemical composition as an organic acid. Organic arsenic forms have been thought to be less toxic because of the steady excretion of these compounds.[155] However, experimental data on effects of organic forms of arsenic are not as well characterized and limited studies in animals suggest that organic arsenic may also produce cancer health effects.[156] Food sources thus become important in determining exposure to the variant forms of arsenic, such as reliance on fish, which is a source of high levels of organic forms or milk and dairy products, which have higher percentages of inorganic arsenic (see Appendix A).

Additionally, the inorganic AsIII form of elemental arsenic may be more carcinogenic than the AsV form in the human body. Without specific studies to isolate the valence forms and no corroborating animal studies, little is known about potential variances in health affects between these two types. AsIII is believed to be more adverse in its effects, while AsV is more universally present in food and water and may be more benign. Unfortunately, chemical conversion between these two species occurs rather quickly at various pH levels and thus

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[154] See Id.
[155] See Id.
[156] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Health Effects Research 1, (visited July 2, 1998) <http://www.epa.gov/OGWDW/ars/ars10.html>.

tracking any particular form within the body's biochemistry presents some unique challenges.

If the arsenic is attached to particles in the water and not dissolved, it may not be available for assimilation in the metabolic process, called "low bioavailability," and is quickly excreted. Further, the colloidal species are incorrectly identified as AsIII in many analytical procedures because the acid added to the sample reduces any AsV to AsIII, causing potential over-estimates of the presence of the more toxic form.[157] None of the studies have differentiated between dissolved arsenic or particulate attachment in water supplies. This may also be a critical difference in population exposures and cancer development.

Neither the domestic nor foreign studies have collected data on the form of arsenic in the exposed populations. Therefore, the exposures in the various populations may not only be a function of high and low concentrations, but the particular organic or inorganic composition of the arsenic and/or its valence state in the food and water supplies of the area.

4. Synergisms

Other chemicals or conditions may be present with the arsenic that act in concert or initiate the disease mechanism to be triggered. Examples of potential contributors are zinc and selenium and their biochemical reactions in conjunction with genetic factors, dietary, other lifestyle factors that inhibit the methylation process and thereby diminish the detoxification process.[158] Even if the Taiwan population suffered from poor nutrition, had genetic predisposition to the diseases, and lived a lifestyle encouraging consumption of larger volumes of water and/or concentration in food preparation, thereby increasing their exposure, valid arguments can be made that someone in the U.S. would be in a similar circumstance, especially

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[157] See Marc Edwards et al., Considerations in As Analysis and Speciation, 90 No. 3 J. AM. WATER WORKS ASS'N 103, 112 (Mar. 1998).
[158] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 55 (Sept. 1994).

poorer, rural populations.[159] However, the presence of other chemicals or compounds that may affect biochemical processes may be significant and explain the distinctive differences between foreign and U.S. populations if concentration level alone does not account for the observed variances.

5. Criticisms of Taiwan, Foreign and U.S. Epidemiologic Studies

The 1968 Tseng et al. report was an epidemiologic study of 40,000 Taiwanese persons where drinking water from deep wells contained arsenic from 0 to 600 ppb (up to 1820 from other sources).[160] The major uncertainty and criticisms of the results of the study are (1) undocumented actual dose exposures of the individuals with pre-cancer lesions and actual development of disease; (2) unassessed contribution and form of exposure to arsenic in their food supply; (3) unassessed co-exposures to other contaminants known to be or potentially carcinogenic contaminants in drinking water; (4) effects of diet and nutritional status in arsenic induced toxicity and carcinogenicity; (5) and whether some individuals were more sensitive to the effects of arsenic than others.[161] None of these questions were addressed in the reported data and subsequent studies have not been undertaken to resolve the significant issues raised.

If the basic study was flawed, then projections to any other population would be inadvisable; yet the EPA has based its entire assessment of the carcinogenicity of arsenic on this single study. The subsequent Smith report by which the EPA inferred possible linkages to internal organ cancers is just a manipulation of the same Taiwan database and thus does not

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[159] See Priorities for the Reauthorization of the Safe Drinking Water Act: Hearing Before the Subcommittee on Health and Environment of the House of Representatives Committee on Commerce, 104th Cong. No. 104-57, 148-152 (1996) (Report by Paul Mushak & Annemarie F. Crocetti entitled Risk and Revisionism in Arsenic Cancer Risk Assessment).

[160] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Health Effects Research 1, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars10.html›; Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 54 (Sept. 1994).

[161] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Health Effects Research 1-2, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars10.html›.

resolve the inherent uncertainty and potential flaws of the study.[162] The overall conclusions and projections of cancer risk based on this isolated study may be so tainted that the research envisioned by Congress in the SDWAA would be the only objective source of confirmation to support its usage in MCL rule-making.

One of the most significant criticisms of the Taiwan study is that the data from the research itself can be used to show that a low-dose threshold response is present. In 1993, other researchers have reexamined the data and found non-linear dose-response relationships even though Tseng, Smith, and the EPA used linear models in their risk assessment processes to determine cancer relationships and allowable exposure levels.[163] Below the 50 ppb level of exposure, the relationship to the number of cancers was erratic and analysis of the data at the village level found wide variations in arsenic concentrations in artesian and shallow wells.[164] These variations indicate that combining the low-level concentrations into the database may have created an impression of cancer rates that do not even exist in Taiwan when exposures are below a critical threshold.[165] Similarly other studies looked at different chemicals that occurred in the Taiwan water analyzes such as zinc and selenium and applied a multiple linear regression model to analyze potential multiple exposure variables.[166] The results indicate a non-linear dose-response relationship between arsenic and skin cancer in the Taiwan population beginning at a threshold concentration below 320 ppb, with other chemicals having significant correlation to disease development.[167] The new analyses support the criticism that performing accurate low-level extrapolations is not possible from the Taiwan data since two distinctive relationship

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162 See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 59 (Sept. 1994).
163 See Id. at 60.
164 See Id.
165 See Id.
166 See Id.
167 See Id.

patterns emerge. Credence from the EPA's primary study of a safe threshold further weakens the position that the MCLG should be zero and the MCL should be as close to that level as possible.

In contrast, epidemiologic studies of several U.S. communities served by supplies or private wells with elevated arsenic concentrations (Lane County, Oregon; Millard County, Utah; Lassen County, California; Fairbanks, Alaska; and Fallon, Nevada) have failed to show any arsenic related cancers.[168] This difference may result from variances in socio-demographic characteristics, overall dietary intake, limitations of study design, and the relatively small exposed populations studied in the U.S. restricting the statistical power to detect effects.[169] However, these are the same criticisms directed at the use of the single Taiwan study, which used a rather small statistical database of 40,000 persons. Therefore, the U.S. studies may be more comparable and valid than the EPA has been willing to admit.[170] Furthermore, the actual number of U.S. citizens drinking water at levels above the implicated health risk MCL of 2 ppb, is in the millions and some indication of this signature cancer should have shown up. However, no cases, or even precursor skin alterations, have been reported.

Two other foreign studies are instructive. A recent study in Hungary found no significant differences in cancer frequency in adults consuming drinking water contaminated with arsenic compared to an unexposed control population.[171] Two small towns in Mexico, 37 kilometers apart, share very similar economic and atmospheric conditions, dietary and lifestyles, genetic backgrounds, and have similar age and sex distributions.[172] The only apparent difference between the two communities is that one has a single well drinking water supply with arsenic at

[168] See Id. at 57.
[169] See Id.
[170] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Health Effects Research 1-2, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars10.html›.
[171] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 57 (Sept. 1994).

about 411 ppb and the other a well measuring at 5 ppb (each about 70% AsV and 30% AsIII and about the same depth).[173] Four cases of arsenic-induced cancers were observed in the first village and none were seen in the second village.[174] The population size was small (less than 400 in each village) but the comparative value of the study is enormous because the variability in arsenic exposure was so well controlled.[175] These studies provide strong support for the threshold dose theory as opposed to an assumption that any arsenic ingestion is harmful.

Arsenic seems to be acting as inconsistently in causing cancer as it suffers from the schizophrenia altering between its metallic and nonmetallic elemental states. The pressure from the environmental groups and the health organizations for setting a low standard simply ignores these apparent differences between the possible cancer action of high and low dose levels. They rest their demand for a zero MCLG and lowest MCL possible on the singular identification of arsenic as a known human carcinogen or by incorrectly linking arsenic to other cancer-causing agents found in drinking water supplies. The following quotes from their testimony during the SDWAA hearings illustrates their scientifically unsupported or erroneous position:

> ...but problems like arsenic in drinking water, where we are still operating under a standard set in 1942 that...was inadequate because it didn't recognize that arsenic causes cancer. And we are still operating under that standard and still pretending that arsenic does not cause cancer.[176]
>
> ...over 10,000 Americans contract cancer every year from tap water contaminants such as disinfection-byproducts, known human carcinogens like arsenic...in our public water

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[172] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 13-14 (1988).
[173] See Id.
[174] See Id. at 14.
[175] See Id.

supplies.[177]

...The House bill delays the deadline for regulation of the known carcinogen arsenic...and would result in millions of Americans continuing to consume unhealthful levels of this widespread toxin.[178]

Unfortunately, the fear of cancer in the U.S. population is reflected in Congressional reaction to these statements. During the hearing, Representative Bilirakis stated, "...there is too much cancer is this country and we've...[got] to do everything possible...to make sure that water is safe."[179] This then becomes the pressure on the EPA to act conservatively once a chemical is identified as a human carcinogen regardless of evidence that the exposure pathway and concentration are critical elements in the safety assessment. In the arsenic case, Congressional and EPA assumptions about how cancer-causing agents work and the existing models are inadequate to predict a likely nonlinear dose response. The long-term studies needed to resolve the unanswered questions are years away but the EPA has been ordered to act by January 2000.

C. Treatment Technologies

Availability and efficiency of treatment technologies is another factor used by the EPA in their technology assessment to set the new arsenic MCL. Some of the limitations and issues associated with the primary technologies are presented in Appendix B. There are several significant constraints on public water systems in their selection of a treatment system.

Most of the systems are only effective when treating arsenic in the form of AsV.[180] When the AsIII form occurs it will have to be converted to the AsV through pre-oxidation processes

[176] Priorities for the Reauthorization of the Safe Drinking Water Act: Hearing Before the Subcommittee on Health and Environment of the House of Representatives Committee on Commerce, 104th Cong. No. 104-57, 93 (1996) (statement of Gregory Wetstone, Legislative Director, Natural Resources Defense Council).
[177] Id. at 95.
[178] Id. at 101.
[179] Id. at 131.

such as chlorination, mixing with ferric chloride or potassium permanganate, or use of ozone and hydrogen peroxide as possible chemical reagents.[181] For a community system, the treatment process must include the cost of installation and maintenance of these required "pre-treatment" processes, even though such costs are often overlooked in the initial system designs.

Treatment of arsenic is difficult because it requires removal of a dissolved substance and common gross filtration techniques will not work. Chemical removal is required and these are technically complex systems requiring utilization and storage of hazardous chemicals and extensive monitoring and maintenance protocols. Most systems also waste a significant amount of influent, requiring that supply volumes be increased to allow the "wastage" of up to 40% of incoming water, a difficult problem in the arid west.

All of the processes will generate a variety of wastes, which must be properly managed, treated, and discarded. After the arsenic has been removed from the water, it will be concentrated into either brine or a sludge of some type. Both of these waste forms will very likely be classified as hazardous wastes requiring handling, storage, treatment and disposal pursuant to the rigorous requirements of RCRA. Such wastes must be removed within 90 days or at maximum 12 months with an approved storage permit (issued after a lengthy process of several years, if at all). These wastes will be accumulating in or near residential areas and will be adjacent to all critical water supply reservoirs. The removal schedule will require significant increases in truck traffic to effect timely removal to treatment and storage facilities, of which there are few and most are largely out of state for the majority of water systems; certainly not the local sanitary landfill (see infra Part III.C.2).

This all translates into high cost, need for well-trained operators, and management of

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[180] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Treatment Technologies: Removal 1, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars4.html›.

hazardous chemicals and wastes that make the processes inappropriate for most small, poor, rural systems. This has led to research into the Point of Use/Point of Entry systems described in Appendix B. However, these units still must be maintained, replaced, and monitored, and the EPA has not waived monthly reporting requirements, thereby sharply increasing the cost of these units to a small community. Waste management will be done by the homeowner and will likely create future problems with improperly disposed of brine concentrates.

No single treatment process is ideal to meet the proposed low MCLs and it is likely that a series of several treatment units will be required. All of the processes have advantages and disadvantages, but share the characteristics of complex and expensive operation. For large systems, complete redesign of existing treatment units may be required. For those systems with minimal or no existing treatment facilities any of these units will create significant capital and long-term maintenance and operation expenses.

D. Analytical Detection Level

One critical factor in the EPA technology assessment is the analytical detection level of a chemical. Any MCL established must also provide a means to sample and evaluate compliance on a routine basis. Standards set below the detection level cannot be adequately enforced because there is no reliable measure of what the actual concentrations are in the water system. Historically, the EPA has equated the affordable technology requirement of the SDWA to be the feasible detection level of a carcinogen in order to set the MCL as close to the zero MCLG as possible, rather than a full assessment of the treatment technologies costs and practical limitations.[182] Thus, the practical analytical capability of existing laboratory equipment and

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[181] See Id.

[182] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals, 19 ECOLOGY L. Q. 269, 310-11 (1992).

sampling methods becomes the key constraint on the regulatory stringency in setting the MCL.[183]

Another practical problem associated with this detection level is determining which systems in the U.S. actually have arsenic above the standard. Thus, the ability to assess the impact of the regulation is limited to those systems that can report concentrations low enough to be counted in the cost-benefit analysis. If arsenic cannot be reliably be detected below 4 ppb, it will be difficult to determine how many systems will be affected by an MCL below that level—maybe most of the systems in the U.S.

A final issue with regard to detection levels is the form of arsenic as either dissolved or colloidal and AsIII or AsV. The MCL will undoubtedly be as total arsenic, but colloidal arsenic that is converted to the dissolved phase or AsIII in the sampling process will give inaccurately high total concentrations.[184] Further, the particulate-bound arsenic can interfere with treatment systems, increasing costs and may also not be available to biological assimilation, passing through the body harmlessly.[185] The problem is how to separate all of these different arsenic forms when samples are tested for concentration, i.e. is the sample result based on laboratory alterations or do they represent the real arsenic presence in its many forms in a water system? To date, none of these variations have been thoroughly assessed and thus the EPA research plan includes obtaining more information on sampling and occurrence of arsenic forms.

Current standard analytical methods for arsenic are not reliable below 4 ppb.[186] Some methods can achieve levels as low as 0.5 ppb, but require extremely careful sampling procedures and the most expensive analytical costs, creating two difficult problems for systems required to

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[183] See Id.

[184] See Janet G. Hering et al., Arsenic Removal by Ferric Chloride, 8 No. 4 J. AM. WATER WORKS ASS'N 155, 166 (Apr. 1996); Marc Edwards et al., Considerations in As Analysis and Speciation, 90 No. 3 J. AM. WATER WORKS ASS'N 103, 112 (Mar. 1998).

[185] See Id.

[186] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 10 (Sept. 1994).

take frequent samples.[187] A March 1998 AWWA study conducted laboratory tests and collected samples from various water suppliers to compare the methods available for arsenic analysis (see Appendix C).[188] At present, any MCL set below 4 ppb could not be reliably enforced because arsenic concentrations cannot be consistently measured at those levels. Practical determinations of compliant versus non-compliant systems would not be feasible.

Part III: Health and Safety Benefits v. Costs

A. Real Health Risk Reduction?

The hypothesized health hazard of drinking water containing dissolved arsenic below 50 ppb is only the increased chance or risk of developing an induced cancer over a 70 year lifetime. In other words, a person must drink 2 liters per day of the water at a specified concentration level every day for 70 years, to increase the chance of developing a non-fatal arsenic-induced cancer. There is no immediate health threat at all nor is there any increased cancer risk from drinking such water occasionally. The linear extrapolation from the Taiwan study resulted in a maximum likelihood of 5×10^{-5} (.00005) of developing cancer by drinking water with 1 ppb arsenic for 70 years.[189] Therefore, the chances of never developing an arsenic induced-cancer at this concentration level is .99995 or greater than 99%.

Risk estimates for ingested arsenic have been driven by policy, default, and conservative EPA assumptions considering such variables as chemical essentiality, threshold, dose-response functions, cancer potency factors, and other relevant disease causation factors.[190] Historically, the agency followed Congress' lead in supporting a zero tolerance for carcinogens in food and

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[187] See Marc Edwards et al., Considerations in As Analysis and Speciation, 90 No. 3 J. AM. WATER WORKS ASS'N 103, 103 (Mar. 1998).

[188] See Id.

[189] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 2 (1988).

[190] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 61 (Sept. 1994).

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[188] See Id.
[189] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 2 (1988).
[190] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 61 (Sept. 1994).

water as incorporated into the SDWA of 1974, thus the policy decision to set MCLGs to zero for any known or suspected carcinogen regardless of evidence it had no adverse effect at low concentrations.[191] Further, the EPA used a default assumption of linearity to extrapolate the cancer risk range assuming no thresholds and that carcinogens pose risks to humans at any concentration.[192] This methodology totally ignores any threshold effects or the potential arsenic detoxification in standard metabolism. The added necessity to meet statutory deadlines has driven a very conservative risk estimation process that does not reflect the actual health risks of arsenic in U.S. drinking water supplies.[193]

The long-term problem created by this compound conservatism is that the MCL becomes THE "safe level" even though it may be much lower than the "actual" disease action level. The standard argument to maintain a system that dramatically over-estimates cancer risk is to protect sensitive or vulnerable subgroups of the population and account for exposures to variable chemical valences or reactions with other potentially carcinogenic materials.[194] The EPA employs additional safety reduction factors if data is scarce or when projecting human risks from animal studies.[195] A 10-fold safety factor is typical for extrapolation from studies of long-term human exposures, such as arsenic in the Taiwan study, while a 100-fold factor is used when extrapolating from animal experiments to average humans, which could not be used in this case since no animals have shown cancer upon arsenic ingestion.[196] This is a simplistic way to address very complex chemical-specific issues and may provide extra protection or on the other hand, it

[191] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Drinking Water Standards Development 2, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars2.html›.
[192] See Id.
[193] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 61 (Sept. 1994).
[194] See Robert Harris et al., Risk Assessment in the Remedy Selection Process at Hazardous Waste Sites, SC27 A.L.I.-A.B.A. 249, 259 (1997).
[195] See Id.
[196] See Id.

may simply be a waste of resources to reach unnecessarily low concentration levels.[197] Fundamentally there are many uncertainties inherent in the development of MCL standards and strict demarcations between "safe" and "unsafe" exposure levels are not expressed in their numeric value, but rather in the process and the utilization of the available data.[198] Thus, in the view of the public, environmental groups, the media, and particularly in the law, the standard erroneously drives the determination of safety, rather than the reality that conservative margins of safety are employed to establish a standard well below the "true" safe level. A measure above the MCL is considered "unsafe," when in truth, the methods employed by the EPA allow a certain amount of exceedance to be in a zone of "no adverse effects."[199]

Moreover, the current view of science and the EPA (by congressional mandate), is that not all carcinogens cause cancer in the same way and a particular contaminant may have a non-linear dose-response relationship, negating the assumption that all doses, no matter how low, can cause adverse effects.[200] Further, in the arsenic example, the low levels may in fact be essential nutrients and removal may result in adverse consequences from setting the standard so low that arsenic deprivation becomes a new disease threat. It is now being recognized that simultaneous use of many "worst-case" assumptions to derive estimates of harmful doses result in values so extreme that in all probability the adverse outcome would never occur.[201] Thus, the "safety" of exposure would be better presented in ranges of values linked to type of exposure, rather than a single concrete number that takes on a mystical quality evincing a characterization it never had--that drinking water with concentrations below the MCL, or worse the MCLG, is healthy and at

[197] See Id.
[198] See Id.
[199] See Id.
[200] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Drinking Proposed Carcinogen Risk Assessment Guidelines and MCLG Determinations 1, (visited July 2, 1998) ‹http://www.epa.gov /OGWDW/ars/ars8.html›.

higher levels is dangerous.

Cancer is too complicated of a disease to hinge decisions on single standards for any water constituent. It is a disease with a long latency period, arising from many causes, only some of which have been identified, and human exposures to potential carcinogens are complex, uncertain and poorly documented.[202] Furthermore, the lifetime risk of developing cancer for any U.S. citizen is 25%, or 1 in 4 Americans will develop some form of cancer over a 70-year life span.[203] But cancers attributable to exposure to toxic substances, especially through ingestion, account for only 2% of the overall number of cancers in the country.[204] So 98% of the "cancer" problem is caused by something else—genetics, viruses, diet, lifestyle (smoking) or some complex combination of all the above, which are all being studied relentlessly.[205] Drinking water exposure results in a very small number of cancers and reducing potential cancers from such exposures is working at the narrow margin of overall cancer risk.

Furthermore, it is known that certain harmful exposures are concentration-based. For example, exposure to the sun in small doses is not considered harmful, while suntans and burns are precursor events for development of lethal skin cancers. Most people would not advocate reducing solar exposure to zero or as close to that level as possible. Likewise, chemicals may combine and act together in a carcinogenic manner, when alone they are not harmful. A case in point is addressed by the SDWA itself, which requires disinfection processes to be employed against bacteria, that create immediate health risks to exposed humans. The residuals of some of

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[201] See Robert Harris et al., Risk Assessment in the Remedy Selection Process at Hazardous Waste Sites, SC27 A.L.I.-A.B.A. 249, 262 (1997).
[202] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 ECOLOGY L. Q. 269, 279 (1992).
[203] See Id.
[204] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 306 (1994) and John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 50 (Nov. 1995), quoting Richard Doll & Richard Peto, The Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today, 66 J. NAT'L CANCER INST. 1191 (1981).

these processes, specifically chlorination, became suspects of carcinogenic substance generation when combined with other benign organic materials, particularly in surface waters.[206] This was a major issue in the 1986 amendments to the act and Congress directed the EPA to identify and regulate any harmful disinfection residuals and by-products as contaminants.[207] These materials were only in the water because of the tremendously beneficial activity of killing harmful bacteria, a much more serious and immediate threat to human health. Thus, the EPA confronted the task of developing a rule that ensured safe levels of disinfectants and their by-products while continuing to require disinfection to ensure microbiological safety.[208]

Such synergistic relationships and threshold dose responses are probably the norm and not the exception in a complex water environment. Arsenic confronts scientists and regulators as a material that may act with other unidentified agents, acts harmfully only in particular valence states, or only causes adverse actions at high concentrations. But none of the harmful modes of operation are known or will be known by the deadline to set the national water standard. The only sure fact is vast epidemiologic data from currently exposed U.S. populations, indicating that low-levels of arsenic ingestion is not a significant health threat and has not led to widespread cancer development. Until more is known, the issue becomes whether the U.S. wants to incur large costs to its citizens and possibly generate other unforeseen problems, such as the chlorination disinfection debacle, by unnecessary removal of a natural element from drinking water.

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[205] See John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 50 (Nov. 1995).

[206] "As a class of chemicals these compounds are referred to as trihalomethanes or disinfection byproducts. One recently published summary of peer-reviewed health studies estimated that approximately 15 percent of the bladder and rectal cancers (10,000 cases per year) in the US are caused by these compounds in drinking water supplies." S. Rep. No. 104-169, at 6 (1995). See supra Text II.B.5, this cancer risk is the source of the NRDC concerns expressed in their testimony before Congress, to which they erroneously added the hypothetical, but undemonstrated arsenic cancer risk.

[207] See William E. Cox, Evolution of the Safe Drinking Water Act: A Search for Effective Quality Assurance Strategies and Workable Concepts of Federalism, 21 Wm. & Mary Envtl. L. & Pol'y Rev. 69, 85 (1997).

Reaching for a goal of providing clean water to our populace and its most vulnerable members is desirable, but an overly conservative approach that results in unnecessary costs with no additional health protection is not. Scarce financial and personnel resources are better applied to solving environmental and social problems that create much more immediate risks to health. Excessive emphasis on reducing insignificant risks necessarily diverts valuable resources from addressing more significant cancer risks, such as tobacco exposure, or more pressing environmental problems such as air pollution, external contamination of water supplies and protection of ecological systems.[209] Rather than using the traditional federal approach of legal coercion, Congressional purpose to involve the local populations and governments in the decision making process will be better served through education about potential risks, uncertainties of the assessment process, and the possible adverse consequences of an arsenic-removal program.[210]

Before the 1996 amendment, which mandates benefit versus cost analysis in standard setting, the EPA was projecting the effects of reducing the arsenic MCL standard to various proposed concentration levels.[211] The 1994 estimates of the number of skin cancers averted for these long-term arsenic exposure levels were as follows:[212]

Alternative Arsenic MCL

20 μg/L	5 μg/L	2 μg/L
15	63	108

Even though it is difficult to express good health value completely in terms of dollars, an

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[208] See Id.
[209] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 348 (1992).
[210] See William E. Cox, Evolution of the Safe Drinking Water Act: A Search for Effective Quality Assurance Strategies and Workable Concepts of Federalism, 21 Wm. & Mary Envtl. L. & Pol'y Rev. 69, 96 (1997).
[211] See Frederick W. Pontius, Crafting a New Arsenic Rule, 86 No. 9 J. AM. WATER WORKS ASS'N 6, 8 (Sept. 1994).

"avoided" cancer can be assigned a financial worth. The value of the estimated reduction in carcinogenic risks can be expressed by a concept called "value per statistical life saved." [213] Federal regulatory agencies use this method to evaluate the amount of money people are willing to pay to accept higher levels or demand lower levels of risk.[214] Using literature reviews, the EPA has established a value range of $2-10 million per "statistical fatality avoided," while the Congressional Budget Office reports this value to be between $.6 and 10.9 million in 1992 dollars.[215] This is a total figure and also requires a death. The arsenic skin cancer by contrast is fully treatable and considered non-fatal, thus making a per cancer avoidance value somewhat lower than these fatality estimates, but in no event more than $11M per avoided cancer.

Since the number of cancers averted are at most 108 over a 70 year period, but more likely zero based upon existing data for these low-levels of exposures it appears the arsenic risk in drinking water is not a real one. The numbers of cancers projected are based on the EPA's compound conservative approach with built in safety factors and dismissal of apparent safe and/or necessary threshold levels. It appears that none of the alternative lower MCLs will reduce any health risks and U.S. citizens will simply be wasting billions of dollars to install treatment systems. Until the actual mode of carcinogenic action of arsenic is known, lowering the current standard is just taking a conservative guess based on a linear model from one study in Taiwan where the only fatality from this disease has occurred.[216] Contrary evidence is strong that there is a difference for low-level exposures and thus reliance on a study of only 40,000 people in Taiwan, exposed to very high levels of arsenic, as the sole basis to judge harmful effects in the

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[212] See Id.
[213] See Robert S. Raucher et al., Cost-Effectiveness of SDWA Regulations, 86 No. 8 J. AM. WATER WORKS ASS'N 28, 30 (Aug. 1994).
[214] See Id.
[215] See Id. and TERRY DINAN, THE SAFE DRINKING WATER ACT: A CASE STUDY OF AN UNFUNDED FEDERAL MANDATE, A CBO Study 28 (1995).

U.S. is a surreal play on the general cancer fear.

B. Costs to Water Suppliers AKA Consumers

The SDWA has always required that the enforceable MCL must consider analytical methods, treatment technology, economic impacts (costs), and regulatory impacts, even though the nonenforceable MCLG may be set at zero for a carcinogen.[217] Thus, the EPA has long been in the business of projecting costs. However, the EPA does not include all of the costs that a water system might incur in complying with MCL requirements. Excluded costs include material handling,[218] residual disposal, administrative expenses, and additional financial burdens to install multiple treatment units because of a disbursed network of groundwater wells.[219]

In 1998, the AWWA reported the results of recent surveys attempting to estimate the cost of implementing a lowered arsenic MCL.[220] The authors used a methodology that projected feasible treatment technologies (Appendix B) that may be selected by water suppliers of various sizes and concentrations of influent arsenic.[221] They found the effect on small systems would be substantial, but the cost burden would be shared equally between small systems, less than 10,000 people, and larger systems.[222] However, because the small systems cannot achieve economies of

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[216] See SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 21 (1988).
[217] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Drinking Water Standards Development at 1, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars2.html›.
[218] For example, if the City of Albuquerque uses the ion exchange treatment method, they may require about 1 ton of input salt per Million gallons treated. In a peak summer day, the City may be required to treat 190 Million gallons, thus requiring purchase, shipment, and storage of 190 tons of salt PER DAY. In addition to the railroad cars of salt required, there will be ancillary costs to store, manage, and distribute that much salt to each groundwater well system on a daily basis, such as trucks, drivers, storage buildings, etc. The waste generated will probably be a higher volume of brines and/or sludges requiring the reverse handling expenses and resources. Interview with John M. Stomp, P.E., Manager Water Resources, Public Works Department, City of Albuquerque, in Albuquerque, N.M. (October 8, 1998).
[219] See Robert S. Raucher et al., Cost-Effectiveness of SDWA Regulations, 86 No. 8 J. AM. WATER WORKS ASS'N 28, 31 (Aug. 1994).
[220] See Michelle M. Frey et al., Cost to Utilities of A Lower MCL for Arsenic, 90 No. 3 J. AM. WATER WORKS ASS'N 89, 89 (Mar. 1998).
[221] See Id.
[222] See Id.

scale there will be higher per customer cost for small systems because the expenses must be distributed over fewer customers or taxpayers. Groundwater systems will bear 62 to 82% of the total costs as compared to surface water systems because of the higher occurrence of elevated arsenic concentrations and the historic lack of required treatment systems.[223] Most surface water systems already have treatment units that may have to be expanded or improved, but the basic capital investment costs may be lower.

The study predicted treatment facility capital and operating costs for various treatment processes for 12 different system sizes identified by the EPA in its cost estimation procedures.[224] Costs for handling wastes were also estimated.[225] However, even this study declined to predict the cost of handling residuals that must then be handled as RCRA hazardous wastes rather than routine disposal at local landfills.[226] Such expenses are complex and vary by location and proximity to permitted treatment and disposal facilities, so even the costs presented by AWWA may underestimate the true expenses a water utility will face after a treatment unit is installed.[227] Actual costs will be also be higher if a series of treatment units must be installed to comply with the new standard.[228] Unfortunately, the most expensive and/or complex systems effect the best removal, while the conventional, less difficult operational units are the least expensive and effective at removal.[229] Thus, a water supplier may have to choose the more expensive option to achieve compliance, but will then face higher material/waste handling costs, and will have to replace lost influent water. States in the west will have to confront state water law policies and procedures to appropriate new supplies.

[223] See Id. at 89, 94.
[224] See Id at 91.
[225] See Id.
[226] See Id. at 91, 97,
[227] See Id. at 91.
[228] See Id. at 92-3.
[229] See Id. at 94.

Summation of the results of the AWWA survey are:[230]

Arsenic MCL µg/L	Estimated # facilities To exceed MCL				Average Compliance Cost $ Millions/year
	Groundwater		Surface Water		
	Small	Large	Small	Large	
0.5	20,469-24,749	633-816	0-2011	433-360	19,280
1.0	14,787-17,803	349-610	0- 712	105-258	8,975
2.0	10,341-11,166	230-409	0- 277	57- 95	4,178
5.0	4,088- 4,480	128-218	0- 79	17- 22	1,521
10.0	1583- 2224	35- 95	0- 0	0- 8	708

In addition to annual compliance cost, the large initial capital costs ranged from nearly $6 Billion for a 10 ppb MCL to more than $120 Billion for an MCL of 0.5 ppb. Amortizing these costs over an expected life of facilities, the total annual cost for an MCL of 2 ppb was estimated at nearly $5.4 Billion, $2.4 Billion for a 5 ppb standard, and $0.8 Billion for 10 ppb.[231]

Using EPA estimates of the number of non-fatal cancers prevented by the 2 ppb MCL of 108 over a 70 year lifetime, the cost per arsenic-related cancer averted would be a total of $3.5 Billion as compared to the maximum acceptable social benefit cost of $11 Million for an actual death. The figure would be $2.67 Billion per averted cancer at 5 ppb and about $2.24 Billion at 10 ppb.[232] Furthermore, the total 1994 national costs to meet ALL other drinking water standards was estimated to be $4.2 Billion. If the arsenic standard is set at 2 ppb the estimated national costs for this single element would more than double the entire investment made thus far to

[230] See Id. at 96.
[231] See Id. at 97.
[232] Since 15 averted cancers is the estimate for 20 ppb, I used an estimate of 25 treatable cancers avoided for 10 ppb multiplied by 70 years and by the total annual cost of $0.8 Billion.

implement all previous drinking water standards.[233] That is a tremendous cost to ONLY possibly prevent a maximum of 108 projected, non-fatal cancers, especially when none have been reported in any of the communities where water influent currently exceeds those arsenic levels.

Congress requires an assessment of the cost-effectiveness in setting drinking water standards, including the new arsenic rules in the SDWAA.[234] The arsenic rule could potentially double the entire cost of the SDWA program and strap the financial capabilities of the many water supply utilities forced to remove this naturally occurring chemical. The cost could exceed $50 million dollars per year per treatable cancer avoided at the lower standards. Following the SDWAA mandate that EPA consider cost-effectiveness of MCLs leads one to the conclusion that a lowered arsenic standard would be far outside the reach of the benefit value range, even adjusted to 1998 dollars. Small systems will bear a disproportionate share of the costs but will realize few benefits if no cancers are averted in their towns. Even in 1994, with the regulations in place at time, systems serving fewer than 100 people bore 14% of the national costs of MCLs for carcinogens but realized only about 2.5 % of the carcinogenic risk reduction.[235] A lowered arsenic MCL could double or triple the water bills for systems serving fewer than 500 people.[236] However, the cancer risk will likely remain unchanged (remain at zero incidents for arsenic-related disease) since all of the upcoming regulations combined only achieve 1% of the risk reduction accomplished by the entire program and the arsenic is a minute fraction of that 1%.[237] At some point the regulations are not cost-effective and fail the Congressional requirement that new MCLs will not create expenses in excess of expected health benefits. The lowest arsenic

[233] See Michelle M. Frey et al., Cost to Utilities of A Lower MCL for Arsenic, 90 No. 3 J. AM. WATER WORKS ASS'N 89, 100 (Mar. 1998).
[234] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 104, 110 Stat. 1613, 1623-4 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998)).
[235] See Robert S. Raucher et al., Cost-Effectiveness of SDWA Regulations, 86 No. 8 J. AM. WATER WORKS ASS'N 28, 33 (Aug. 1994).
[236] See Id. at 34.

MCLs seems to be falling into that category, especially for small groundwater supply systems in the west.

Finally, the costs to water suppliers, especially in rural areas, are not just quantified in dollars. These small communities have a very difficult time attracting and keeping the type of educated personnel required to maintain these systems, even if they obtain the financial aid to install the treatment unit. The treatment systems for a centralized unit will be complex and will require the use of certified operators.[238] This cost to a small community will be high because of the competition with larger water systems for these same personnel. Larger systems are better able to compete for trained operators and to adjust to turnover. Such turnover in a small system could be devastating. In New Mexico, many small communities are too far apart to form regional systems and thus consolidate financial and personnel resources to meet these challenges. The administrative burdens will also be too immense to meet the monitoring and reporting requirements, even with approved variances. These expenses are difficult for small towns to adsorb. Even the SDWAA authorized point-of-use systems, require regularly monitoring and compliance reports by the utility to assure compliance. This could make such decentralized systems a more expensive drain on local personnel resources than many can withstand.

C. Consequences and Indirect Costs of a Lowered Arsenic MCL

1. Alteration of the Arsenic Cycle

Whenever there is an attack on an alleged environmental problem, usually other unforeseen problems are spawned because of the complex interaction of ecological systems. The water cycle of the planet is one of those complex systems, where changes in one part may have serious and unexpected consequences in other areas. In the case of arsenic, the regulation will

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[237] See Id. at 32.

not protect against added pollutants, but rather is removal of a natural dissolved constituent that is constantly cycling with water by complex geochemical reactions. Those interactions are currently in a state of equilibrium in the U.S. ecosystems.

A revised MCL for arsenic will introduce a dramatic change in the balance by removing naturally occurring arsenic on a vast scale. That arsenic will be completely removed from the system, because the waste brines and sludges must be diluted in large bodies of water or encapsulated for burial as concentrated hazardous waste at a few isolated permitted disposal facilities. RCRA requires that all hazardous wastes be treated to "immobilize" the arsenic so that it cannot migrate from the hazardous waste facility to "contaminate" water, air, or soil. The proposed regulations will be an attempt to permanently remove water-borne arsenic from its natural cycle in contrast to its present movement in the system.

Several studies have indicated that arsenic is an essential nutrient, at least for small rodents at low levels. If that is the case, permanent removal of arsenic on a grand scale from water systems may interrupt the food chain and create arsenic deficiencies for all life forms. This result may not happen immediately, but after years of removal, in thousands of communities, a significant imbalance may be created in the arsenic cycle affecting ecosystems in adverse ways that cannot presently be imagined.

Problems may also be generated by upsetting current natural balances with other chemicals in water causing them to become "more" toxic without the arsenic influence. That certainly has already occurred with the disinfection residuals that are created by chlorination of the water supplies and now requires a separate regulation just to correct the "new" problem

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[238] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 123, 110 Stat. 1613, 1652-3 (1996) (codified as amended at 42 U.S.C. § 300 g (West Supp. 1998)).

created by trying to fix the old problem of microbial contamination in water supplies.[239] There is no reason to assume that such future unknown problems will not be created by changing the basic elemental chemical balances naturally found in ground and surface waters.

The lack of understanding of how these complex systems work leads well-meaning regulators to postulate benefits that are later offset by a new set of severe environmental problems. Examples abound in environmental legislation and policies such as: protection of introduced wild horses and their displacement of natural species, fire suppression in national forests creating greater fire damage because of excessive fuel build-up, oil spill clean-ups in Alaska killing natural cleansing bacteria, introduction of mongoose into Hawaii to remove the introduced rats and now both very neatly destroy endemic birds, and a host of other single issue management schemes that fail to recognize ecosystem principles. Removal of low levels of arsenic from drinking water may not only fail to produce the touted health benefit, but may also create serious problems that will only be recognized after adverse consequences have manifested themselves. Massive removals of arsenic from water will begin a grand experiment in ecological modification, in which humans and the entire biota will be guinea pigs. The results will come in at a future date and only time will determine if the final outcome is positive or negative.

2. Resource Conservation Recovery Act (RCRA): Hazardous Waste Generation, Storage, Treatment & Disposal

Removal of the arsenic from drinking water will create hazardous wastes in concentrated sludges and brines, which must be handled, stored, treated and disposed per RCRA requirements.[240] Not only are these expensive requirements, they are aimed at removal and

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[239] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 104, 110 Stat. 1613, 1625 (1996) (codified as amended at 42 U.S.C. § 300 g-1(b) (West Supp. 1998)).

[240] See Resource Conservation Recovery Act, § 42 U.S.C. §§ 6901 et seq. (1994).

entombment of the material for all of time to avoid any future human exposure to toxic substances. The wastes must be isolated and treated with great care and then shipped to permitted treatment, storage, and disposal sites, of which there are a limited number nationwide.[241]

For cities with multiple well sites and no central water plant (a common occurrence in the west) multiple hazardous waste generating, and possibly storage, units will be necessitated. These facilities will be located in or near residential areas, parks, schools, and other sensitive living areas of the community. Removal will also require the transportation of the wastes regularly through those residential areas. Finally, the trucks required to ship the waste to permitted facilities will increase the hazardous load traffic on many country roads, which have never had to deal with such vehicles, and increase the overall volume of hazardous waste transported on highways throughout the country.

These activities, therefore, shift the risk from low probabilities of cancer over a 70-year lifetime to much higher risks at being exposed to concentrated, now acutely toxic levels of arsenic, in citizen's backyards. Furthermore, the increased truck traffic greatly enhances that known probable hazard of a car accident because of the greater number of trucks and opportunities for fatal car accidents. The risk of driving will be increased for all persons using those roads, and thus the risk of harm or death from a well documented and known threat has significantly risen while attempting to reduce a long-term hypothetical risk from an unproven and highly improbable threat in the water supply.

And finally, the land disposal restrictions in RCRA set required treatment levels for hazardous waste before burial based on SDWA MCLs.[242] This action is taken to immobilize the waste and prevent contamination of actual or potential drinking water supplies, one of the

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[241] For example, there are no permitted disposal facilities in the state of New Mexico, so all hazardous wastes must be shipped out every 90 days or annually if the generation facility has a storage permit.

ancillary goals of RCRA. This means that a lowered arsenic MCL will also lower the threshold levels to classify any arsenic containing material as hazardous and dictate treatment requirements of all such waste packages. This process makes it extremely likely that all treatment residuals from water supplies plants will be hazardous waste because of the altered definition. The cost to the nation will be felt through consumer price increases in every manufacturing or other process that generates RCRA arsenic bearing wastes, which will have to meet the new lower standards for waste characterization and treatment before disposal.

The economic impacts and increased risks resulting from a lowered arsenic MCL in the RCRA regulatory universe will be widespread over the country and will increase generation and transportation of hazardous waste. The presently dilute arsenic will not be welcomed in the air, soil or subsequent receiving waters after it has been concentrated to more toxic levels.

3. Clean Water Act (CWA): National Pollution Discharge Elimination System (NPDES) Permits

The SDWA MCLGs and MCLs are used by states, Indian tribes and Pueblos,[243] and local agencies to determine water quality standards for surface waters in their jurisdictions, which then drive NPDES permit requirements for point and non-point source discharges into those water systems. Even though the SDWA standards are not "safe" levels per se, they become the guidance to governmental entities as the "safe" level of constituents in their surface waters. Worse, these organizations often use the MCLG, which for all "known" carcinogens is an arbitrary zero, making compliance impossible in areas of naturally occurring higher levels of arsenic.

This was certainly the case when the Pueblo of Isleta established a water quality standard

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[242] See Resource Conservation Recovery Act, § 42 U.S.C. § 6924 (d)-(g) (1994).
[243] Indians are treated as states under the SDWA. Safe Drinking Water Act, § 42 U.S.C. §§ 300 g- 300 J-26 (1994).

for arsenic of .0175 ppb or 17 parts per trillion for the Rio Grande running through their lands.[244] The standard is especially problematic since the water in the Rio Grande naturally exceeds 4.1 to 5.3 ppb dissolved arsenic in the flowing water and ranges from 1500 to 3800 ppb in the bottom sediments.[245] The arsenic in the river system originates in waters draining from the volcanic deposits in the nearby Jemez Mountains where geothermal springs have arsenic concentrations between 700 and 1500 ppb and only the sediment sorption action keeps the flowing water at lower concentrations.[246] Ironically, the Pueblo depends on groundwater supply wells in the area with similar arsenic levels to those of the City of Albuquerque, which average about 17 ppb and other Pueblos upstream are using arsenic herbicides in wetland restoration projects.[247] Because of the potential impact on their NPDES permit, the city challenged the standard in City of Albuquerque v. Browner, but the Court upheld the minute level despite evidence that it was unreasonable, unscientific, and non attainable.[248] The Court determined that the Pueblo had the power to establish such a standard in order to protect its citizens, even if such a standard becomes meaningless.[249] Arsenic at such levels cannot be detected with current analytical methods (see supra Part II.D) and thus the Pueblo cannot establish an enforcement mechanism that will measure compliance.[250] Furthermore, the water in the river will always exceed this level because of the natural occurrence of arsenic in soils over which the river flows.[251] Despite these

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244 See Denise D. Fort, State and Tribal Water Quality Standards Under the Clean Water Act: A Case Study, 35 NAT. RESOURCES J. 771, 774 (1995).
245 See Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997, 1013 (1995).
246 See Id. at 1013-4.
247 See Denise D. Fort, State and Tribal Water Quality Standards Under the Clean Water Act: A Case Study, 35 NAT. RESOURCES J. 771, 774 (1995); CAPLAN, supra note 2.
248 See Mark A. Bilut, Albuquerque v. Browner, Native American Tribal Authority Under the Clean Water Act: Raging Like a River Out of Control, 45 SYRACUSE L. REV. 887, 896 (1994).
249 See Id.
250 See Id. at 900.
251 See Denise D. Fort, State and Tribal Water Quality Standards Under the Clean Water Act: A Case Study, 35 NAT. RESOURCES J. 771, 774 (1995); Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved

technical limitations, the CWA requires that the Pueblo standard be used by the EPA in formulating NPDES permits for all discharges upstream.[252]

The CWA provides ample examples where the MCLG and MCL drive safety determinations that were never meant to be implied causing tremendous ripples throughout the economic interests of municipalities and businesses it regulates. Since all states and tribes have independent authority to establish water quality standards and will inevitably use the SDWA standards as guidance or authority to establish "safe" levels of materials, the result could be more regulations and permit requirements that cannot be technically met. These standards will be based upon conservative and potentially incorrect assessments of the danger of low-levels of ingested arsenic to which humans are exposed. Therefore, NPDES permit issuance, enforcement, and effectiveness is likely to become more complex if the arsenic MCL is lowered.

There will be no avoidance of mandatory lowering levels of arsenic in waste waters, even when the discharger did not add it in the water. Cindi Mojtabai examined how such a requirements goes beyond the scope of the CWA, which requires restoration of effluent to influent levels, not removal of incoming pollutants.[253] However, the courts are upholding the standards on the grounds that states and tribes can set such strict levels to protect their people.[254] But when these strict standards require removal of naturally occurring constituents to impossible

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a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997, 1014 (1995).

[252] See Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997, 998 (1995). For a complete discussion of this interaction see: Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997(1995); Mark A. Bilut, Albuquerque v. Browner, Native American Tribal Authority Under the Clean Water Act: Raging Like a River Out of Control, 45 SYRACUSE L. REV. 887, 896 (1994); and Denise D. Fort, State and Tribal Water Quality Standards Under the Clean Water Act: A Case Study, 35 NAT. RESOURCES J. 771, 774 (1995).

[253] See Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997 (1995).

[254] See Id.

levels that cannot be measured, the "safety" they are attempting to ensure can never be achieved or justified. This is an abuse of any MCLG, but the situation is made worse when the MCL is as unjustified to protect human health as the forthcoming standard for arsenic appears to be.[255]

Therefore, any MCL for arsenic set under the CWA will have far reaching impacts beyond community water suppliers and may adversely impact businesses and other concerns required to obtain NPDES permits. Loss of jobs, or simply the increased costs of many goods and services will be potential outcomes of this extension of an inappropriately lowered MCLG and MCL, reducing further the overall benefit of the proposed lower arsenic standards.

4. COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA): Impact on Superfund Cleanups

CERCLA requires the use of "applicable or relevant and appropriate" (ARAR) environmental standards as furthered defined in 40 C.F.R. § 300.5, in developing cleanup levels for contaminants at superfund sites throughout the country.[256] Billions of dollars are being spent at these sites to remove introduced contaminants to some acceptable level based on risks and other health-based standards. A key ARAR that is used in this process is the MCLG and MCL set under the SDWA. Thus, a low arsenic MCL may increase cleanup costs at such sites throughout the nation, and worse, may require the removal of naturally occurring minerals in the soil that were not added pollutants. Furthermore, many states have implemented their own analogous cleanup programs and use the SDWA MCLs in a similar manner for state regulated sites. If these standards are lowered below naturally occurring levels of arsenic in the soils, many

[255] One unfortunate benefit of a lowered MCL for arsenic on influent water will be an enhance capability of the City to meet its NPDES requirements driven by the Pueblo of Isleta Water Quality Standard of 17 parts per trillion since the influent water is easier to clean of dissolved arsenic than complex sewage waters. Interview with Greg P. Smith, Attorney, City of Albuquerque, in Albuquerque, N.M. (September 10, 1998). However, the City would be better off if the Pueblo standard and the NPDES permit requirements were based on a rational assessment of safe levels of arsenic and not hypothetical projections from a single questionable study.

operations will be required to remove arsenic that they did not deposit at the sites. This in turn will generate more hazardous waste requiring treatment, storage and disposal that will further affect the natural arsenic cycle.

The EPA's use of enforceable MCLs for ARARs rather than the MCLG was challenged by several states in 1993 in State of Ohio v. United States Environmental Protection Agency.[257] The Court found that the EPA gave a permissible construction to an undefined term in the statute under the Chevron doctrine.[258] The state wanted the EPA to require cleanups to the MCLG for all constituents where that level was set to zero under the SDWA since the MCLG is health based and the MCL is adjusted upward taking into account available technology and implementation costs.[259] They argued that section 121 of CERCLA converted the MCLG into enforceable standards.[260] However, the court accepted the EPA's determination that zero MCLGs are not attainable and thus should not be an ARAR at cleanup sites; in such cases only the MCL would be used in establishing cleanup criteria.[261] This case illustrates how states and the EPA will use MCL and MCLGs to make health and safety determinations in order to drive other regulatory requirements, especially hazardous materials clean ups. If the chemical is a natural constituent such as arsenic and not an introduced contaminant at the site, agencies could force cleanup levels to MCLs (and states could use MCLGs) that require soil remediation to conditions beyond previous uncontaminated conditions. It appears that this was the goal of the

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[256] 42 U.S.C. § 9621(d)(2)(A) (1994).
[257] State of Ohio v. United States Environmental Protection Agency, 997 F.2d 1520 (D.C. Cir. 1993).
[258] "Where congressional intent on the precise question at issue is unclear, it is enough that the Agency's construction is reasonable." Chevron v. Natural Resource Defense Council, 467 US 837 (1984) cited at Ohio, 997 F.2d at 1527.
[259] See Ohio, 997 F.2d at 1529.
[260] "Such remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act...where such goals or criteria are relevant and appropriate under the circumstances of the release or threatened release." 42 U.S.C. § 9621 (d)(2)(A), cited in Ohio, 997 F.2d at 1529.
[261] See Ohio, 997 F.2d at 1530.

states in Ohio.

It may not be congressional intent to remove all arsenic from western soils (a vastly overwhelming enterprise considering its widespread occurrence) but by forcing the EPA to set a standard by 2000, using current questionable data and compounded conservative assumptions and risk models, that may indeed be the outcome of a new MCL in the 1 to 30 ppb range. This is another argument for EPA to leave the standard at 50 ppb until the long-term studies are completed to form a better understanding of the arsenic mode of action and true relationship to cancers resulting from ingestion of low levels.

5. Western Water Law Impacts

In water-short areas, such as the arid West, the Appropriation Doctrine developed as the law of water use and distribution.[262] Water must be applied to beneficial use and a specific quantity is granted by administrative permit or establishment of priority right before the state programs began.[263] An essential feature of water law is the goal to implement wise policies of resource allocation that will ensure use of the resource to produce maximum benefits for man and for society as a whole.[264] Courts have consistently determined that no appropriation of water was valid where water was simply going to be wasted because its use must be viewed in terms of present and future demands on the source of supply.[265] Another element of western water law is the concept of public trust or protecting the public welfare in transfers from one use to another.[266] Evaluating public welfare is difficult, but does invoke concepts of conservation and reductions of wasteful practices in the planning and administrative process of managing water

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[262] See GEORGE A. GOULD AND DOUGLAS L. GRANT, CASES AND MATERIALS ON WATER LAW 6 (5th ed. 1995).
[263] See Id.
[264] See Id. at 10.
[265] See State of Washington Department of Ecology v. Grimes, 852 P.2d 1044. (Wash. 1993)
[266] See Charles T. DuMars & A. Dan Tarlock, Symposium Introduction: New Challenges to State Water Allocation Sovereignty, 29 NAT. RESOURCES J. 331, 341-2 (1989).

resources for the states and their citizens.[267]

The difficulty of the arsenic problem in this setting is that the treatment processes will require wastage of large amounts of water, as high as 40% for some options. That will require western communities to transfer or acquire additional water rights to cover the losses, forcing the closure of farming and other activities that currently hold those rights. In the transfer process, public welfare and waste issues will have to be considered. If the arsenic MCL will produce few measurable health benefits, but create large losses of a precious commodity—water—then the transfer process will be difficult to accomplish. The displacement of the water will not be used to sustain vital agricultural interests or municipal water supplies, but will instead be removed from the states as hazardous waste to remote permitted facilities or evaporated in waste treatment processes. The resultant loss of water could easily be termed as "waste" and thus create a substantial barrier to transfer water rights to communities systems in need of large additional quantities of water to make up for treatment losses.

Furthermore, water rights are becoming ever more valuable and expensive in water-short states. Thus, a community supplier trying to meet a lowered arsenic standard will be required to resolve these legal and community value issues and pay for increasingly costly influent water. These costs have not been added to the analysis and are difficult to predict precisely, but the general contours of the problem are clear in western communities who have existing water rights, but will be faced with the difficult prospect of obtaining more to meet new requirements.

6. Effects on Water Suppliers, Especially Small Rural Systems

For many small communities, the high costs of the treatment units in capital investment and annual operation and maintenance will quickly strip their resources. Large municipal or

[267] See Charles T. DuMars & Michelle Minnis, New Mexico Water Law: Determining Public Welfare Values in Water Rights Allocation, 31 ARIZ. L. REV. 817, 834-9 (1989).

private systems will simply pass the cost on to their rate-base. But small rural systems do not have this ready avenue to financial resources. Some possible solutions are Massive Permanent Federal/State Subsidies, Variances and Exemptions, Permanent Non-Compliance, Abandonment of Public Systems, and Legislative Backlash. Unfortunately, the last three options thwart the intent of the SDWA to provide all Americans with clean drinking water, with the most negative impacts being visited on the communities with the least amount of money and political influence to voice their concerns and provide input into the regulation promulgation process. The basic principle of the SDWA is thus completely destroyed by the mechanisms that will be used to avoid strict, expensive requirements and possibly unnecessary concentration standards. Larger communities may be able to afford the cost, but will share the frustration of spending money on an unnecessary program for which they derive no benefits. All of society could benefit from utilization of the billions of dollars a lowered arsenic standard will cost in more immediate environmental or health protection programs.

a. Massive Permanent Federal/State Subsidies

The SDWAA provide a new grant/loan program whereby federal dollars will be used to supply money to needy communities (private suppliers and transient non-community entities such as casinos are now allowed access to these grants and loan guarantees).[268] Congress has provided a complex formulation to keep control of the money so it is applied only to SDWA compliance and requires states to contribute 20% matching funds.[269] A prioritization scheme has been established and "set-asides" established for specific programs such as health effects studies,

[268] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 130, 110 Stat. 1613, 1664-5 (1996) (codified as amended at 42 U.S.C. § 300j et.seq. (West Supp. 1998)).
[269] See Id. at 1666.

technical assistance and operator certification programs.[270] Presupposing that a community has the ability and resources to get into this program it does place burdens on the federal taxpayer.

Federal taxpayer commitment: The statute authorized a total of $9.6 billion for the program to be set aside annually from 1994 through 2003 so that state revolving loan funds (SRLFs) could be established.[271] Congress appropriated $725 million for FY 1998 and the president's FY 1999 budget requests an additional $775 million for the program.[272] The law mandates allotment to states according to a needs survey conducted by the EPA, however, one was not yet completed for the FY 1997 distribution of $1.275 Billion, which was done proportionally.[273] By March 1998, EPA had dispersed about $529 million of the FY 1997 funds.[274]

State/Community burden: Water systems must comply with all the requirements of the SDWAA including expanded monitoring and reporting requirements. Further, the EPA will be establishing minimum standards for certification required for plant operators. States can lose up to 20% of their funding if they fail to comply with such requirements.[275] Thus, a state can community burden to continue receiving funds will be strict scrutiny for compliance with the entire web of the federal SDWA program elements. Further restrictions allocate specific amounts of the funds to particular problem areas such as, 15% of the loan fund must be provided to systems serving less than 10,000 persons.[276] However, the money cannot be used for monitoring,

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[270] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 122-3, 110 Stat. 1613, 1651-3 (1996) (codified as amended at 42 U.S.C. § 300j-1(3) and § 300g et.seq. (West Supp. 1998)).
[271] See James Bourne & Veronica Blette, Greater Funding Opportunities for Drinking Water Systems, 90 No. 5 J. AM. WATER WORKS ASS'N 34, 35 (May 1998).
[272] See Id.
[273] See Id. at 35-6.
[274] See Id. at 37.
[275] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 123, 110 Stat. 1613, 1652 (1996) (codified as amended at 42 U.S.C. § 300g et.seq. (West Supp. 1998)).
[276] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 130, 110 Stat. 1613, 1665 (1996) (codified as amended at 42 U.S.C. § 300j et.seq. (West Supp. 1998)).

operation, maintenance, or purchasing land for treatment facilities.[277]

States must develop their programs to meet minimum federal requirements, but are allowed some flexibility.[278] Public review and comment must be completed when the state applies for their specific grants and before funds are disbursed.[279] Local plans can only be funded after following the state prioritization requirements aimed at identifying projects accomplishing the largest net health benefits.[280] Systems with an approved variance will not be eligible for loans while systems seeking exemptions are required to be eligible for and secure such financial assistance before it will be approved.[281]

This program will provide more resources to smaller systems who need assistance, but will the small communities ever be able to fly on their own? The arsenic treatment technologies at present are complex, expensive and will require costly, regular maintenance and replacement. For many rural communities, there may never be an end to their need for technical assistance and financial support. Infusion of federal and state tax monies may not only be perpetual, it may have to increase steadily over time, thus the federal taxpayer will have to maintain a long-term commitment to supply such grants and loan guarantees. If the economy does not support continuance of the programs and funds are cut off, the treatment facilities may also not be maintained or replaced resulting in failure to comply with the arsenic NPDWR.

b. Variances and Exemptions

The SDWAA establishes variances and exemptions options for small systems to ease the transition into full compliance but these are not permanent immunities from meeting all

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[277] See Id. at 1664-5.
[278] See James Bourne & Veronica Blette, Greater Funding Opportunities for Drinking Water Systems, 90 No. 5 J. AM. WATER WORKS ASS'N 34, 36 (May 1998).
[279] See Id.
[280] See Id. at 38.
[281] See Id.

regulatory requirements. Before a variance can be granted, the system must:

1. install the best technology or other means for complying with an MCL;

2. not have an alternative source of water available that does not require treatment;

3. and the variance must not create unreasonable risk to public health.[282]

Upon issuance, a compliance schedule must be established to attain full conformance to the SDWAA requirements.[283]

Thus, for a small community having difficulty finding and applying financial and personnel resources to the arsenic problem, a variance is of little use. They will probably be unable to install the best technology and most will not have alternative sources of water supply with lower arsenic levels since it is naturally occurring regionally. The compliance schedule requirements attempts to assure eventual conformance and eliminate any discrimination against poorer communities and their respective health needs by allowing the system to meet higher MCLs, solely on a financial justification. However, the variance may be difficult to obtain for many small systems in terms of technical, personnel, and financial capabilities, even with the SRLF program. Further, it will not provide relief from the extensive and tough SDWA requirements for monitoring, reporting, and operator certification, for which fewer funds are available in the grants/loan guarantees.

In addition to specific requirement, the SDWAA requires that systems requesting monetary assistance must complete a financial restructuring analysis.[284] The restructuring options suggested by the Congressional Budget Office and previewed by Congress include: 1) purchasing cooperatives among systems, 2) mutual aid networks, 3) contract operation and

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[282] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 116, 110 Stat. 1613, 1641-4 (1996) (codified as amended at 42 U.S.C. § 300jg-4 (West Supp. 1998)).
[283] See Id.

maintenance, (4) wholesale purchase of water; and 5) consolidation of ownership into regional systems.[285] However, these options are not available in areas of the west where communities are widely disbursed, have significant cost barriers and few assets, and could potentially lose their established water rights under state law. Improving financial responsiveness will be difficult and costs will continue to increase, especially for the rural poor communities.[286]

Exemptions are available for small systems that are unable to comply because of compelling factors, which can include economic ones.[287] However, they must also be unable to comply with the MCLs by management or restructuring changes as discussed above and not be able to develop alternative sources of water.[288] Few rural water suppliers will be able to restructure their sole responsible employee, who handles the water well, sewage treatment system, the fire department, and the local newspaper, for example. The communities may simply not have the personnel resources, in spite of the infusion of cash, nor be able to overcome the legal difficulties of losing or combining water rights.

Again, an exemption grant cannot create unreasonable risk to health and cannot even be requested if a variance has been obtained. If financial assistance is needed the supplier must enter into agreements to obtain assistance or become part of a regional water system.[289] Finally, the exemption is not a permanent excuse for noncompliance and so a compliance schedule must be established that cannot involve a time period greater than 3 years beyond the regulation of the effective date of the MCL, with extensions up to 6 years possible for facilities serving less than

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[284] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 116, 110 Stat. 1613, 1641-2 (1996) (codified as amended at 42 U.S.C. § 300 g-4 (West Supp. 1998)).
[285] See TERRY DINAN, THE SAFE DRINKING WATER ACT: A CASE STUDY OF AN UNFUNDED FEDERAL MANDATE, A CBO Study 38 (1995).
[286] See Robert S. Raucher et al., Cost-Effectiveness of SDWA Regulations, 86 No. 8 J. AM. WATER WORKS ASS'N 28, 35 (Aug. 1994).
[287] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 117, 110 Stat. 1613, 1644-5 (1996) (codified as amended at 42 U.S.C. § 300g-5 (West Supp. 1998)).
[288] See Id.

3000 persons.[290]

Thus, exemptions and variances will not be permanent solutions for small strapped facilities. This means that federal and state financial and technical assistance programs will have to become part of the landscape for SDWAA compliance in perpetuity or the community will be forced to seek other means to avoid compliance with its mandates.

c. Permanent Non-Compliance

One option will be for systems to stay in a permanent state of non-compliance. If they cannot afford to build the systems, fines and coercion will not work in forcing compliance because they will not have the money for those either. These types of police-actions against small communities have negative political undertones because they are not viewed as favorably as enforcing environmental restrictions on private companies and businesses which have been targeted as "bad" guys in environmental issues by Congress and many environmental groups.[291] Furthermore, the penalties are assessed against the very persons the law was designed to protect.

The difficulties of forcing municipal suppliers to comply with SDWA provisions was illustrated in United States v. City of North Adams.[292] The Court imposed a civil penalty of $67,200.00 for exceeding SDWA MCLs of turbidity, coliform bacteria, as well as failing to meet monitoring requirements. A permanent injunction was granted to force construction of an adequate treatment plant and take interim measures needed to protect the health of the water consumers.[293] The SDWA allows a civil penalty up to $25,000 per day per violation and the EPA requested a penalty of $250,000.00 as warranted in the retribution goal for continuing violation

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[289] See Id.
[290] See Id.
[291] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 335 (1994).
[292] United States v. City of North Adams, Civ. A. No. 89-30048-F, 1992 WL 391318, (D. Mass. May 18, 1992).
[293] See Id. at 5.

and to deter future violation.[294] In order to pay such a fine the city of 16,000 persons would have had to impose a one-time $37.73 charge per household or finance the penalty over twenty years.[295] The Court balanced the ability of the city to pay with other fiscal impacts on the residents and reduced the penalty.[296] Persuasive to the Court was the factual evidence that the residents would also have to bear the cost of design, construction, manning, maintenance, and operation of the treatment facility estimated to be $11 million and creating an annual debt service of $1,043,322 at 7.12% interest over twenty years for the small town.[297] This court recognized that penalizing the community only added to the financial burden to come into compliance and thus punished the very persons the water system was compelled to protect. Clean water should be the objective, not stringent enforcement with large retributive penalties.

The communities may simply continue existing operations and not attempt to comply with a new arsenic standard. An example of this type of dilemma was presented to Congress during the amendment process. The following is the dialogue between Congressman Mike Synar and Wendell Ellis, owner and part-time operator (he had other duties to the subdivision) of a water system in Spicewood, Texas serving 61 people:

> Mr. Synar. Mr. Ellis, you told us...that you are having a hard time affording the salt [for a pilot ion exchange treatment unit]; is that correct?
>
> Mr. Ellis. That is correct...I can't afford it...I have an invoice in my briefcase of the last purchase...one palette of salt—and it was $265 and some few cents, and that will last 25 days.
>
> Mr. Synar. What are you going to do after that?

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[294] Id. at 1,3.
[295] Id. at 3.
[296] Id. at 4.
[297] Id.

Mr. Ellis. I may go in violation.[298]

This situation will repeat itself in many small communities if a reduced arsenic MCL is implemented. Non-compliance will simply be ignored or at many facilities and may not even be detected if base monitoring is not conducted to ascertain if the system has an "arsenic" problem. It will be suspected that in most communities with groundwater supplies that arsenic levels will be more than an MCL of 1, 2, 5, 10, or 20 ppb, but many of these communities have heretofore not been regulated by the SWDA. Unless the state or EPA has gathered independent baseline information, the actual levels in many systems will remain unmeasured. This will result in quiet, non-compliance based on ignorance of actual arsenic levels in the systems or deliberate avoidance of a costly treatment program.

d. Abandonment of Public Systems

A viable option for many small communities will be to abandon their supply systems. They can simply stop the utility service and force residents to use bottled water or to obtain their own supply in what ever manner is possible (drill their own well or procure water elsewhere). Statistics for the 1990 U.S. census show that approximately 16 million households are not served by community water systems.[299] Nearly fifteen million of these are served by private wells and more than one million households take their water from cisterns, springs, rivers, lakes, or other untreated surface water sources.[300] An arsenic standard that is too low may add more persons to this number as systems disconnect to come below the 15 service connection or 25 persons requirement for SDWA to apply.

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[298] Impact of Safe Drinking Water Act Regulations on Small Drinking Water Systems Hearing Before the Environment, Energy, and Natural Resources Subcommittee of the Committee on Government Operations House of Representatives, 103rd Cong. 81-82 (1994) (statement of Wendell Ellis, Owner and Operator, Quail Creek Water System, Spicewood, TX).

[299] See Clive Davies et al., USEPA's Infrastructure Needs Survey, 89 No. 12 J. AM. WATER WORKS ASS'N 30, 37 (Dec. 1997).

[300] See Id.

Public health risks are significant for this group of people and arsenic will be a minor worry compared to potential biological and other contaminants that can cause direct and immediate illness. Hauled water is often stored in barrels, which can be carriers of pathogens and other contaminants depending on the origin of the drum, such as containing pesticides in agriculture areas.[301] Many of these households lack basic sanitation for washing and food preparation.[302] A 1995 Centers for Disease Control and Prevention study of more than 5500 private wells in nine mid-western states estimated that approximately 41% of them were contaminated with coliform bacteria and more significantly, 27% of them produced samples contaminated with E. coli, which indicates sewage pollution.[303]

The SDWAA set up special provisions to deal with some of these problems, especially for native Americans and colonias along the U.S.-Mexico border.[304] However, even this aid will be unavailable if there are insufficient appropriations to adequately fund the SRLFs.[305] There are no provisions to provide additional funds to community water suppliers that must abandon their systems to avoid the strict regimen of SWDA requirements.

If the SDWA regulates arsenic at levels so low that community systems cannot reasonably comply with its requirements, the broader goals of the SDWAA with its other more important health protection measures, such as disinfection, will have been lost. The higher health risk will be imposed for failure to achieve a minor and possibly nonexistent reduction in risk of developing a non-fatal, treatable, arsenic-induced skin cancer. Many persons may then be subjected to increased enteric disease and exposure to deadly microorganisms in contaminated

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301 See Id.
302 See Id.
303 See Id.
304 Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 135, 307, 110 Stat. 1613, 1679-80, 88-9 (1996) (codified as amended at 42 U.S.C. § 300j et. seq. (West Supp. 1998)).
305 See Id. at § 304, 110 Stat. at 1684.

and unregulated water they are forced to procure on their own. The following statements of Representative Tom A. Coburn speaking to the disinfection by-product rule of the SDWAA, but equally applicable to the proposed arsenic rule, illustrate how opposed this result will be to congressional purpose to protect Americans from known risks:

> But we require a great deal more scientific research that moves beyond the hypothetical health risks identified...to clearly establish human health risks...Nevertheless, we already known that the public health risks from the various pathogens—bacteria, viruses, and protozoa—in drinking water far outweigh the hypothetical cancer risks associated with DBPs.[306]

This option is a backward step away from Congress' desire to assure all Americans have safe drinking water, particularly for the poor facing definite higher health risks in their immediate search for non-regulated water to avoid an unlikely long-term arsenic cancer threat.

e. Legislative Environmental Backlash

When compliance with environmental regulations becomes expensive and yields little benefit to the actual discernible health and safety, as in the case of requiring clean-up of naturally occurring water constituents, people very easily become disenchanted with environmental protection laws and regulations.[307] Residents will notice if their community water supply is cutt off or their water bills quadruple. They will notice hazardous waste production facilities in their neighborhoods and waste trucks on public roads. If just one person is killed per year as a result of the truck traffic, 70 annual deaths will occur to avert a maximum of 108 possible non-fatal cancers, a high price for long-term health risk reduction due to arsenic exposure in water.

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306 H.R. CONF. REP. NO. 104-741, at 131 (1996), reprinted in 1996 U.S.C.C.A.N. 1366, 1428.

307 See Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997, 1015 (1995).

It is certain that when limited financial resources must be diverted to an arsenic removal effort, less will be available to the affected communities for fire protection, police protection, education, and many other community services.[308] Even if the community can procure loans or increase fees/taxes, the money is taken from families making choices on educational expenses, medical costs, insurance coverage and a host of other risk reduction decisions families continuous make. Economists have noted that some environmental rules are far more expensive per life saved than many chronically underfunded public health programs of vital importance to communities to meet immediate health needs.[309] These lost opportunities could save more lives.

The public's view of such choices was beautifully illustrated by a letter presented to the Senate during debate of Senate Bill S. 1316, subsequently passed as the SDWAA. The letter is from Ms. Audrey Stone of Bucksport, Maine and she wrote:

> As I rely totally on my Social Security check...as are many other residents of this community, you can readily see that the impact of water increase in excess of $200 per year poses grave threats to my ability to maintain my residence. Additionally, those residents who have another source of water supply may choose to shut off the water company at the street, returning to their own source of water and defeating the purpose of this...act. Further, this leaves less ratepayers to absorb the cost of the mandated improvements...I strongly believe we have to preserve public confidence in the safety of our drinking water, but current Federal laws seek to achieve the goal of clean drinking water in a very expensive and sometimes very wasteful manner...there was a former city official from Lewiston, ME, who said, as a result of the costs of water regulations...'We

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[308] See Id.
[309] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 336 (1992).

will have the cleanest water in the State and the dumbest kids.'[310]

Backlash against a wasteful effort will be against the entire program, no matter what level of good it accomplishes in other areas. A current example is the difficulty with the Endangered Species Act and the steady decline in support of that law as private property interests were affected and community projects were stopped to come into compliance with its mandates, resulting in increased calls for amendment or cancellation.[311] Any lack of support for the SDWA could cause much more harm to U.S. communities overall than simply leaving low levels of natural substances out of the regulatory scheme until they are really proven to be dangerous.[312]

Part IV: Mythology of Call for Stronger Laws/Lower Standards to Protect Health

There are many reasons for setting drinking water standards as low as possible, beginning with the basic desire to have a healthy life and provide a safe environment for Americans. Water is a basic need and having a safe supply is a significant health issue. There is also the fear of the unknown and the sources of frightening diseases like cancer are not easy to identify. A long-term goal of the U.S. has been to try to eliminate the "causes" of disease. In water systems numeric criteria are set, often arbitrarily or as best guesses, in a complex, poorly understood system. These MCLs can be used to fool the public into a belief that simply meeting the standards creates total safety. But regulation of single elements has only been partially successful.[313] The SDWAA has adopted a more scientific approach, but has provided the EPA with tools to err on the side of safety. Congress has directed that standards be set low enough to provide an "ample margin of

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310 141 CONG. REC. S1316 (daily ed. November 19, 1995) (statement of Senator Cohen, cosponsor of the bill).
311 See Cyndi Mojtabai, Arsenic and Old Lace: The EPA Should Not Have Approved a Water Quality Standard for Arsenic that is Below Natural Background Levels in City of Albuquerque v. Browner, 35 NAT. RESOURCES J. 997, 1015 (1995).
312 See Id. at 1016.
313 See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 306-7 (1994).

safety" for potential dangers against the most sensitive persons in the population.[314]

Congress began its attempts to regulate safety in the area of cancer risk in the 1950s because of widespread public concern about this scary disease, accounting for roughly one in four deaths in the U.S. each year.[315] The first regulation of the cancer threat was the 1958 Delaney Amendment to the Federal Food, Drug and Cosmetic Act , 21 U.S.C. §§ 301-394, (FFDCA) which compelled zero risk by prohibiting addition of ANY known chemical carcinogen to food.[316] The statute still reads, "...provided, that no additives shall be deemed to be safe if it is found, after tests...to induce cancer when ingested by man or animal...."[317]

This amendment reflected the fears of the people and set the stage for future conservative policies of setting SDWA MCLGs for any known carcinogen to zero.[318] The statute only applied to processed food additives and assumed that natural carcinogens did not exist, i.e. only man-made chemicals were the culprits.[319] Further, Congress assumed that only a few chemicals would be regulated by its terms.[320] However, thousands of naturally occurring chemicals have failed the Ames carcinogen screening test, thus should be listed as "known" carcinogens per the Delaney amendment and the SDWA.[321] They are not regulated under the FFDCA because they are not "additives", but their cancer potency may be higher than the man-produced chemicals, or non-

[314] See Robert Harris et al., Risk Assessment in the Remedy Selection Process at Hazardous Waste Sites, SC27 A.L.I.-A.B.A. 249, 252 (1997).
[315] See Alon Rosenthal, et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 271 (1992).
[316] See Id. at 296-7.
[317] Federal Food, Drug and Cosmetic Act, § 21 U.S.C. § 348(c)(3)(A) (1994).
[318] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 286 (1992).
[319] See Id. at 298.
[320] "Today, two-thirds of the more than 800 chemicals tested so far have been found to cause or promote tumors in rodents. Yet more than 50,000 synthetic chemicals remain untested." John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 46 (Nov. 1995).
[321] See James Trefil, How the Body Defends Itself From the Risky Business of Living, 26 No. 9 SMITHSONIAN 43, 48 (Dec. 1995).

existent at low concentrations as it appears for ingested arsenic.[322]

The drafters and promoters of legislation seeking zero risk or zero concentration levels of suspect chemicals are either naively or dishonestly identifying environmental risks as unacceptable and promoting public fears with an implication that complete elimination of risk is an attainable and preeminent public goal.[323] Such misrepresentation ultimately undermines civic education and perpetuates antiquated societal attitudes and expectations about how environmental risks are computed and managed.[324] It also prevents the necessary debate about risk tradeoffs and costs so as to place resources for maximum risk reduction in areas that society deems appropriately beneficially.[325] Legislatures will not ignore the political fallout from environmental and health organizations making accusations of impermissibly high standards even without evidence of a need for lowering them.[326] The ignorance of Congress, judges, journalists, and the general public works to favor unreasonable MCLs when the specter of the "Angel of Death" rises over the television when the news-caster spits out the word "carcinogen."

The substantial risks created by the treatment process are often ignored in setting the standard and only become problematic for a community when the NPDWR is implemented. The increased production and transportation of hazardous waste, removal of a potential essential nutrient, and upsetting the natural arsenic cycle can become significant and more harmful than the original concentrations of dissolved arsenic in water. Thus, the health risk will not be zeroed or necessarily reduced, only shifted into some other form of threat.

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[322] See Id.
[323] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 354 (1992).
[324] See Id.
[325] See Id. at 355.
[326] See Id. at 356.

A. Zero Risk Goal (and MCLGs) Not Obtainable

Zero levels of risk or chemical concentrations cannot be achieved by any means, including setting rigid standards. Every chemical element on earth moves in cycles and it is a basic law of science that matter can neither be created nor destroyed. The materials can be moved around, combined in new forms, or displaced from natural processes, but everything has to go somewhere and on an ecological level are critical to keep important cycles balanced and functioning properly. Risks shift with changes from one place to another but are not eliminated. Additionally, zero levels cannot be detected by current equipment because of the limitations of the measuring instruments and techniques. Congress is beginning to recognize that the limits of science and uncertainty in measuring dangers, requires restriction of impossible social policies.[327]

The courts have assisted in entrenching notions of zero levels of risks and associated MCLGs by deferring to EPA's judgments and assessments, which may be politically motivated or just "convenient." They have recognized that the adverse economic impacts of a zero standard could be severe and may jeopardize plants or whole industries and the jobs depending on them, but upheld zero discharge standards for polychlorinated biphenyls (PCBs) even in the absence of test data in Environmental Defense Fund v. EPA.[328] The Court found that since the evidence in the case was "at least suggestive of carcinogenicity," it was sufficient to justify the standards.[329] Unfortunately, cancer risk assessment calculations are highly uncertain and depend on choice of biological assumptions, statistical models, sources of data, and conservative policies.[330] Although

[327] "...there should be some acknowledgement that zero risk is seldom necessary or achievable." Safe Drinking Water Act Amendments of 1995 Hearing Before the Committee on Environment and Public Works United States Senate, 104th Cong. 6 (1995) (opening statement of Hon. Craig Thomas, US Senator form the State of Wyoming).
[328] Environmental Defense Fund, Inc. v. EPA, 548 F.2d 62, 88 (D.C. Cir. 1978).
[329] Id. at 89.
[330] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L Q. 269, 276, 282 (1992).

the procedures seem quite rigorous and the results very precise, they are not.[331] Risk assessments never reveal who will be stricken with the disease—just a probability that a particular number of cancers may arise somewhere in the population over the 70 years of exposure by drinking water with constituents at certain levels.[332]

The regulators and the courts have rejected similar risk assessments arguments presented by opponents to the regulations. In Illinois Pure Water Committee v. Director of Public Health, the Court held that such opponents, who produced evidence that there was some risk of a higher incidence of cancer associated with fluoridated water, did not sustain their burden of showing the mandatory fluoridation statute was an unreasonable exercise of police power.[333] However, when the EPA chooses to reject evidence of no cancer effects, the court upholds their discretionary decision and such evidence cannot be used to negate a highly uncertain and unjustified standard.

The EPA has difficulty rejecting data that suggests a substance is a carcinogen in humans because of the congressional and public fear of the disease.[334] This is exacerbated by calls from environmental groups who still insist on a command and control approach to solve environmental problems and demand the lowest standard possible—including zero for carcinogens.[335] In the arsenic debate, the Natural Resources Defense Council (NRDC) and the United States Public Interest Research Group issued a 1995 report stating that arsenic was a "deadly carcinogen" and millions of people were being needlessly exposed.[336] They disingenuously referred to the Wisconsin study that found 10,000 cancer deaths each year traced

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[331] See Id. at 277.
[332] See Id. at 294.
[333] Illinois Pure Water Committee, Inc. v. Director of Public Health, 470 N.E. 2d, 988 (Ill. 1984).
[334] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 276, 284 (1992).
[335] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 325 (1994).

to trihalomethane (disinfection by-product) and conveniently included arsenic as an accompanying "deadly carcinogen" without referencing the documented reports that no arsenic-induced cancers have been reported in the U.S.[337] Ignoring the legitimate scientific debate about the effects of ingesting low levels of arsenic, the NRDC spokesperson insisted that the MCL for this "known carcinogen" was set before its dangers were known and called for revised standards to be set as low as possible to protect the public from the cancer threat.[338] They also criticized any attempts to do cost-benefit analysis as a mechanism to produce "unsafe" higher standards that benefits the water industry and creates unnecessary risk for people.[339] The pressure on the EPA from these groups is intense and unrelenting with the mantra of "deadly carcinogen," even for a chemical whose worst skin cancer effects are fully treatable when detected.

The EPA has acknowledged in court that zero is an unachievable and unmeasurable goal. In the Ohio case, the agency used the impossibility of zero to defend using the MCLs and not the MCLGs to set ARARs in the CERCLA program.[340] The EPA's rationale was "that it is impossible to detect whether 'true' zero has actually been attained."[341] During the rule making the EPA had "emphasized that…zero is not a measurable level in scientific terms."[342] The EPA further stated that "Due to limitations in analytical techniques, it will always be impossible to say with certainty that the substance is not present. In theory, RMCLs [MCLG] at zero will always

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336 See Trouble on Tap: Arsenic, Radioactive Radon and Trihalomethanes in our Drinking Water, cited by Deborah Wenger, How Safe is Drinking Water? It Depends on Whom You Ask, 11 No. 6 ENVTL. COMPLIANCE & LITIG. STRATEGY 9, 9 (1995).
337 See Id. and SPECIAL REPORT ON INGESTED INORGANIC ARSENIC SKIN CANCER; NUTRITIONAL ESSENTIALITY, U.S. Environmental Protection Agency, EPA/625/3-87/013 21 (1988).
338 See Trouble on Tap: Arsenic, Radioactive Radon and Trihalomethanes in our Drinking Water, cited by Deborah Wenger, How Safe is Drinking Water? It Depends on Whom You Ask, 11 No. 6 ENVTL. COMPLIANCE & LITIG. STRATEGY 9, 9 (1995).
339 See Id.
340 State of Ohio v. United States Environmental Protection Agency, 997 F.2d 1520 (D.C. Cir. 1993)
341 Id. at 1530 citing 55 Fed. Reg. 8,752, 8,752 (1990).
342 Id. citing 50 Fed. Reg. 46,884, 46,897 (1985).

be unachievable…"[343] The Court accepted the EPA's explanation that one can never prove a true zero level and acknowledged that such measurements on any device only shows that it is not sufficiently sensitive to detect the presence of the chemical, demonstrating the detectable level of the measuring instrument, but never true zero.[344]

In contrast, the Court in International Fabricare Institute v. United States Environmental Protection Agency, affirmed the EPA decision to set a MCLG of zero for dibromochloropropane and ethylene dibromide, as an expert, reasoned determination that met the congressional mandate of the SDWA to set the standard at a level at which no known or anticipated adverse effects on health of person occur and which allows an adequate margin of safety.[345] The Court found that the agency's assessment that any exposure to these chemicals could be harmful was adequate even in light of scientific criticisms of the underlying studies in terms of limited statistical power and indefinite exposure data.[346] Similar to the arsenic debate, objections to the studies consisted of very high exposures to the chemicals extrapolated with linear models to low environmental levels and disregarded evidence of reduced toxicity over time due to chemical degradation.[347] Since the EPA considered and then rejected the contrary information, the Court upheld their decision on setting the zero MCLG.[348] The Court "happily" found that the judiciary does not have to undertake comparative evaluations of conflicting scientific evidence; their only role is to discern whether the agency's evaluation was rational.[349] In its conclusion the Court stated,

> …our responsibility is limited to determining whether the EPA's interpretations of the SDWA are permissible and whether in applying the Act, the Agency has abided by the

[343] Id. citing 49 Fed. Reg. 24,330, 24,347 (1984).
[344] See Id.
[345] International Fabricare Institute v. United States Environmental Protection Agency, 972 F.2d 384, 390, 391 (D.C. Cir. 1992).
[346] See Id. at 391-3.
[347] See Id. at 393.
[348] See Id. at 391-2.

> requirements of the APA. As we are not scientists and must defer to the Agency's judgments on matters within its technical competence, our task is to assure that they be reasoned, not that they be right.[350]

This result indicates that the power is in EPA's hands and the courts will defer to their selection and rejection of studies, data, assumptions, and models, in making the health risk determination and setting the MCL level for arsenic.

The inconsistency in the EPA's use of data is highlighted by the 1987 case, Natural Resources Defense Counsel v. Environmental Protection Agency, where the Court upheld their decision to not set a standard to zero for a possible carcinogen, vinyl chloride.[351] The NRDC wanted the "possible" carcinogen MCLG to be set at zero, but the Court found that they had overlooked the possibility that even with a non-zero level, contaminants have a tolerably safe threshold within the meaning of the SDWA.[352] As for the non-zero vinyl chloride standard, EPA chose not to categorize the compound as a possible carcinogen based entirely on long-term animal studies that had not produced a carcinogenic effect, ignoring two studies with potential human cancer results.[353] In the same case, industry groups challenged the TCE standard that was set to zero by presenting conflicting animal studies about the carcinogenicity of the compound in humans.[354] Again the Court would not weigh the competing scientific evidence but affirmed that EPA has the discretion to accept or reject whatever studies it desires as long as it addresses the comments in the rulemaking process in a rational manner.[355] The fact that EPA choose to embrace two very negative studies and ignore all contrary studies was of no import to the court

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[349] See Id. at 398.
[350] Id. at 399.
[351] Natural Resources Defense Council, Inc. v. Environmental Protection Agency, 824 F.2d 1211 (D.C. Cir. 1987).
[352] See Id. at 1215.
[353] See Id. at 1217.
[354] See Id. at 1216.
[355] See Id.

as long as the agency defended the choice, zero or non-zero standards were within the contours of the SDWA requirements.[356] Thus, EPA acceptance of a single study showing arsenic is a carcinogen while rejecting studies demonstrating that it is not harmful at low levels will be accepted by the courts as long as the rule making process is followed.

Finally in another 1987 NRDC case the EPA demonstrated the arbitrary nature of accepting or rejecting contrary scientific studies and the inability of opponents to thwart the agency's will in court.[357] In this case the NRDC wanted the standard for fluoride to be lowered from the EPA level of 4 ppm, claiming that the RMCL would not adequately protect particularly susceptible individuals who drink large quantities of water from developing crippling skeletal fluorosis.[358] In the record, EPA defended the higher level by stating that "although a significant number of people in the United States have long been exposed to levels above 4 mg/L, only 2 cases of crippling fluorosis related to drinking water have ever been documented in this country."[359] The Court decided that EPA had reasonably concluded that the SDWA does not require protection of those who may put themselves at higher risk by unusual dietary practices with national regulations.[360] Further, the EPA had ignored NRDC produced foreign studies documenting health effects in other countries, because such reports were not predictive of adverse results at the levels found in U.S. waters and that there were other sources of the disease than fluoride in water.[361] The Court found that the SWDA requires the MCLG to be set with reference to known or anticipated adverse health effects, not merely possible effects and since the EPA action was

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[356] See Id. at 1217-9.
[357] See Natural Resources Defense Council, Inc. v. Environmental Protection Agency, 812 F.2[nd] 721 (D.C. Cir. 1987).
[358] See Id. at 724.
[359] Id. citing 50 Fed. Reg. 47,142, 47,144, 47,147, 47,151-52 (1985).
[360] See Id at 724.
[361] See Id. at 725.

rational and promoted the legislative design, it affirmed the standard.[362] For the arsenic standard it seems EPA is working in reverse of its defense in this case by only accepting one foreign study with low predictive value in the U.S. and no known or anticipated adverse health effects, only a remote possibility of treatable cancers. Yet the courts will uphold the EPA decision regardless of which study, with its particular flaws, they use or ignore for their final determination.

Environmentalists will continue to adhere to the rhetoric that zero should be the appropriate policy goal.[363] It is also apparent that risks for causing cancer from environmental doses are very small and will be difficult to control and monitor.[364] Regulation of minor issues like ingested arsenic will not likely pass benefit/cost tests because the expense will be so high and the return on investment so much lower than those experienced for the bigger problems of the past and there is no "bad" actor to blame for a naturally occurring substance.[365] Furthermore, politicians avoid placing blame for environmental problems on consumers and are reluctant to ask voters directly to shoulder the burden of cleaning up the environment because they garner more votes if a clean environment can be provided without direct citizen incurred costs.[366] Thus, special, one-sided interests will continue to drive legislation and rulemaking without any regard to who pays or what benefits being gained with the big bills. Zero risk can never be attained, but lots of money can be wasted trying to reach such an impossible goal.

B. Risk Realities and Tradeoffs

All human activities carry some degree of risk, probability of injury, disease, or death, and many informal risk assessments are made each day.[367] To allocate scarce personal or societal

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[362] See Id.
[363] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 326 (1994).
[364] See Id. at 327.
[365] See Id. at 307, 335.
[366] See Id. at 330, 335.
[367] See John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 43 (Nov. 1995).

resources, risks are evaluated and tradeoffs are made.[368] The risk of driving can be determined by accumulating historical occurrence of the accidents but for chemicals not enough is known about how they act, alone or synergistically, to identify the conditions under which a given exposure is likely to create a measurable harm.[369] It is now known that harm is not just a matter of exposure, but also of how much exposure.[370] Human bodies can handle a lot from nature, even toxic chemicals, as each cell takes a damaging "hit" about every ten seconds and is constantly repairing itself.[371] But the aging process is one which might be attributed to accumulation of damage to the DNA over trillions of such exposures (hits) from all sources including metabolizing foods.[372] Cancer rates increase with age and this may be more because of the aging of the cells and their ability to respond to damage than to any particular isolated exposure.[373] Thus, regulation of a chemical may create certain tradeoffs, causing other harmful risks such as removal of wastes on highways, while not reducing the ingestion risk because removing one constituent alone may be insufficient to produce the desired health benefit.

Risk has always been part of life and humans are hard-wired to respond, so whether the risk is voluntary (skydiving from a plane) or involuntary (being pushed out of a plane), the body will react in the same way.[374] Drinking water with possible natural carcinogens poses no more risk than eating foods, which naturally contain dozens of potential and known carcinogens.[375] But the public and environmental groups perpetuate the myth that voluntary risk is tolerable, while involuntary risk is not. Studies have found that Americans are unwilling to tolerate even

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[368] See Id. at 43, 45.
[369] See Id.
[370] See Id. at 46.
[371] See James Trefil, How the Body Defends Itself From the Risky Business of Living, 26 No. 9 SMITHSONIAN 43, 43, 47 (Dec. 1995).
[372] See Id. at 47.
[373] See Id.
[374] See John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 44 (Nov. 1995).
[375] See Id.

minimal risk if they perceive it is involuntary.[376] Is exposure to naturally occurring arsenic in water supplies a voluntary or involuntary situation?

Americans tend to accept natural dangers such as sunburns because the sun is natural and doesn't carry the specter of death associated with asbestos exposure.[377] Unfortunately, sun damaged skin poses a serious cancer threat risk that results in fatal cancers, while most citizens will never be exposed to harmful levels of asbestos.[378] Thus, naturally occurring arsenic seems less fearful to citizens, so environmental groups like NRDC must refer to it as a "deadly carcinogen" and imply that it has been added to the water, with a sinister water supplier refusing to clean up. Bruce Ames, molecular biologist at UC Berkeley, who invented the Ames test used to screen chemicals for carcinogencity, criticizes its use and overreaction to the results because so many synthetic and natural chemicals fail, but are not serious threats to human health.[379] For example, coffee contains 1000 natural chemicals of which 26 have been tested and 19 produced cancer in laboratory animals.[380] Under the Delaney amendments, if coffee was synthetic the Food and Drug Administration would have to ban it for sale in the U.S.[381] As in the arsenic scenario, the threshold harmful dose may be the more critical element to determine in making the risk assessment and resource tradeoffs.

Driving is one of the most hazardous American activities with more than 100 persons dying every day in an accident.[382] Larger cars are safer than small ones and wearing seat belts reduces the risk of death by 42%.[383] However, the Center for Disease Control estimates that there

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376 See Id. at 47.
377 See Id.
378 See Id.
379 See Id. at 48.
380 See Id.
381 See Id.
382 See Id. at 45.
383 See Id. at 45-6.

is a one in a million risk of dying for every 40 miles driven in the U.S.[384] Since most people in the U.S. drive 40 miles many times during a single day, week or year, the amount of risk is enormous and is much higher than the possibility of developing cancer by drinking water at the MCL for ANY carcinogenic chemical for 70 years. But this comparison is even worse if the chemical, such as arsenic, does not cause cancer at low doses, wherein a person may never suffer any health risk in relation to other higher risks of disease or accident. The best possible reduction in non-fatal arsenic-induced cancer would be 108 cases over 70 years at the 2 ppb level. That number is trivial compared to the 110 American deaths PER DAY in car accidents.[385] If the money spent on arsenic removal from water supplies could be applied to improving the safety of U.S. roadways, significant numbers of American lives could be saved. Providing basic medical services to small rural communities would be a significant improvement in their health and risk reduction of early deaths to more immediate accident and disease threats.

Smoking is a significant risk, with one cigarette cutting five minutes off a life span and cumulative impacts result in years removed from a life.[386] However, the riskiest activity in the U.S. is unemployment and poverty because of the associated problems in unhealthy eating, lack of medical care, and affect on mental health.[387] Living in poverty reduces life expectancy by about nine years.[388] A 1994 Congressional Budget Office research study examined whether regulations that decreased the level of contaminants in drinking water can cause an offsetting

[384] Dr. Vernon Houk, Centers for Disease Control, Address at the New Mexico Hazardous Waste Society Annual Meeting (March 1989). The one in a million risk level is the lowest level chosen by EPA to select an MCL for drinking water contaminants. See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Drinking Water Standards Development at 2, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars2.html›.
[385] See John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 45 (Nov. 1995).
[386] See Id. at 46.
[387] See Id.
[388] See Id.

increase in risk by lowering the income that individuals have to spend on health.[389] These researchers found that regulations costing more than $50 million per life saved can have an adverse effect on mortality because of the offsetting negative impact of reducing money the ratepayers would use to correct more immediate health threats.[390] Drinking water with arsenic at 2 μg/L for 70 years only creates a .00005 or .005% chance of developing a related cancer and its removal will require billions of dollars. The cost will far exceed this $50 million limit and to prevent, not a death, but a hypothetical, treatable skin cancer. Paying for the arsenic removal could result in an increase in the poverty levels, especially in areas already populated with poor minority groups, which is more risky for many citizens and more likely to reduce expected life spans. Risk management comes down to cost and choices in how to make reductions, not whether it is a voluntary or involuntary action, or the exposure is natural or unnatural.

Cancer is the risk that people worry about most.[391] A 1981 study indicated that roughly 1/3 of cancers were caused by smoking and smoking-related behavior, another 1/3 by diet and the remainder by life style choices such as occupation or recreational activities. Environmental carcinogens accounted for only 2% of all cancers.[392] In 1987 an EPA study concluded that it was spending vast sums of taxpayer money on certain activities that were inconsequential to number of lives saved and overall environmental impact.[393] But the political reality is that Americans demand cancer risk reduction regardless of the minimal risk level because environmental exposure is involuntary.

Since the decision is a risk tradeoff and not elimination, Americans need to consider how

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389 See TERRY DINAN, THE SAFE DRINKING WATER ACT: A CASE STUDY OF AN UNFUNDED FEDERAL MANDATE, A CBO Study, Footnote 4, 28 (1995).
390 See Id.
391 See John F. Ross, Risk: Where Do Real Dangers Lie?, 26 No. 8 SMITHSONIAN 42, 47 (Nov. 1995).
392 See Id. at 50.
393 See Id.

much and what risk reduction to fund. Money can be well-spent to improve health and reducing threats by improving transportation systems (making cars and roads safer), reducing air pollution, reducing smoking and occupational exposures to chemicals, and funding those health care systems that protect people from immediate dangers. How the money is spent should be a community decision, not a mandate driven by special interests groups that need a toxic substance to get attention and raise funds.[394] This would be the beginning to recognize the risks of living and adopt a rational approach to controlling and reducing the really significant ones.[395] Arsenic removal doesn't appear to be a substance for which society will get much bang for the bucks.

C. Public Participation in Risk Assessment and Standard Setting

There is some need for national uniform standards to assure "relative safe" drinking water for all citizens and travelers in the U.S. However, decentralization of authority is a valuable trend to recognize the managerial potential of the state and local governments and their ability to respond to the diversity of local conditions.[396] It is also important to educate local communities about the uncertainties in risk assessment, standard setting, and that there are real costs as well as benefits to environmental policy; the community should make the final decision about how much they want to pay for an associated reduction in health risk.[397] Further, the public will be able to evaluate the increase in other risks, such as transporting hazardous wastes, in exchange for the exposure risk being reduced, thus, making the marginal cost decision

[394] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 325 (1994).
[395] See James Trefil, How the Body Defends Itself From the Risky Business of Living, 26 No. 9 SMITHSONIAN 43, 48 (Dec. 1995).
[396] See William E. Cox, Evolution of the Safe Drinking Water Act: A Search for Effective Quality Assurance Strategies and Workable Concepts of Federalism, 21 Wm. & Mary Envtl. L. & Pol'y Rev. 69, 163 (1997).
[397] See Robert W. Hahn, United States Environmental Policy: Past, Present and Future, 34 NAT. RESOURCES J. 305, 347 (1994).

themselves.[398] Overall, involvement by the local community, whether a small rural town or large municipality, should increase confidence in the regulation, garner public support to make financial and talent contributions needed for project success, and accept the lost opportunities for developing other beneficial programs.[399] Finally, the process would be more democratic and allow risk management decisions to be made by the people and not unelected, unaccountable administrative officials or a Congress which lacks the attention span, expertise, and appreciation of the costs of the purported benefits to the local communities.[400]

Congress has expressed its intent for the SDWA standard-setting to be more of a pubic choice. In the SDWAA a primary findings was, "procedures for assessing the health effects of contaminants establishing drinking water standards should be revised to provide greater opportunity for public education and participation..."[401] And in findings 8 and 10:

> (8)...more effective protection of public health requires—(A) a Federal commitment to set priorities that will allow scarce Federal, State, and local resources to be targeted toward the drinking water problems of greatest public health concern; (B) maximizing the value of the different and complementary strengths and responsibilities of the Federal and State governments...
>
> (10) consumers served by public water systems should be provided with information on the source of the water they are drinking and its quality and safety...[402]

Further, Congress has mandated that the EPA will involve the public in the decision-making in section 103, "...the Administrator shall ensure that the presentation of information on public

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[398] See Alon Rosenthal et al., Legislating Acceptable Cancer Risk from Exposure to Toxic Chemicals 19 Ecology L. Q. 269, 353 (1992).
[399] See Id. at 355.
[400] See Id. at 339, 341, 343.
[401] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 3, 110 Stat. 1613, 1615 (1996) (codified as amended at 42 U.S.C. § 300f (West Supp. 1998)).
[402] Id.

health effects is comprehensive, informative, and understandable."[403] In that section Congress requires the EPA to discuss the population or subgroup addressed by the health effects, the expected risk, the upper-bound or lower-bound estimate of risk, and each significant uncertainty identified in the process of the assessment with studies identified that could reconcile inconsistencies in the scientific data. These requirements illustrate Congressional desire for the public to be more informed and active in deciding what the standards should be and not to allow the EPA or NRDC decide that the U.S. should pay over $10 billion in the first year to remove low levels of naturally occurring arsenic.

There is some congressional concern that the public will overreact and/or not understand the reports required by the SDWAA, particularly the annual consumer confidence report. This fear was expressed by Representative Greg Ganske in the conference report. He wrote:

> ...I remain concerned that the report required under Sec. 131(4)(B) if not carefully and thoughtfully developed and written could be misconstrued by the public at large. It is crucial that the report accurately convey the differences between the MCL and MCLG [especially where the MCLG is zero] and reflect the real risks faced by system consumers ...It is vital that we do not repeat the same mistakes the Congress made in communicating the risks of Alar.[404]

In the Joint Explanatory Statement of the Committee on Conference, they provided additional guidance to the EPA:

> EPA regulations should include a clear statement that all drinking water, including bottled water, contains contaminants, usually at levels below the threshold that would present a health risk to humans. The presence of contaminants in drinking water does not

[403] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 103, 110 Stat. 1613, 1621 (1996) (codified as amended at 42 U.S.C. § 300g-1(b) (West Supp. 1998)).

necessarily indicate that the drinking water is unsafe for human consumption.[405]

Many of these fears can be averted if the public education process and participation begins at a much earlier stage. The arsenic standard seems like a natural beginning because of the high costs, uncertain benefits, and the real impacts a lowered MCL will have on local communities.

Part V: Alternatives to Meet the GOAL of Safe Drinking Water Supplies

The principle goal of the SDWA is to provide safe drinking water.[406] Meeting this goal does not mean setting a standard so low that local resources are wasted on removing a chemical that may not be harmful, such as arsenic. Three alternatives are presented to meet the statutory requirement to propose a draft arsenic rule by January 1, 2000.

A. Leave the MCL at 50 ppb and Provide Free Health Care for Any Individuals Who May Develop an Arsenic-Induced Skin Cancer

Instead of viewing the 50 ppb as old and defunct because it did not consider potential carcinogenic effects, the view should be that is working very well to protect American's health since no arsenic related cancers have been reported in the U.S. since it was set in 1942. If the studies are proven correct that the threshold dose below which harmful effects will not occur is 250 ppb, using the 20% maximum allowance for water ingestion, one calculates that 50 ppb is a correct standard for drinking water. The large body of evidence, millions of Americans drinking water above the proposed lowered limits but well below the 50 ppb MCL, provides corroboration that the current standard is working and protecting health on a nationwide basis.

If in the unlikely event someone does develop the characteristic arsenic-induced skin

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[404] H.R. CONF. REP. NO. 104-741, at 129 (1996), reprinted in 1996 U.S.C.C.A.N. 1366, 1426.
[405] Id. at 88, 1435.
[406] See Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 3, 110 Stat. 1613, 1615 (1996) (codified as amended at 42 U.S.C. § 300f (West Supp. 1998)).

cancer, they should be provided with free treatment and all associated medical, wage, and other losses could be paid directly to them. Even if this required $10 million per person, the total bill for the maximum 108 cancers the EPA projects would be less than the billions of dollars it will cost to meet any of the proposed lower standards, nationwide. Since this cancer is fully treatable, this option is not condemning anyone to die in order to save the expenses to the country.

Likewise, if such a cancer arose, it would provide an excellent opportunity to more fully study the particular circumstances of that individual's lifestyle and exposure to better understand the action mode of arsenic. Such valuable information could be used to more rationally analyze the arsenic standard as the SDWAA requires in section 103, "...the Administrator shall use...the best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective scientific practices and data collected by best available methods..."[407] This would eliminate the need to project hypothetical cancer occurrence on the basis of a single, questionable foreign study where conditions may be totally incomparable to U.S. situations. The EPA's arguments in the fluoride case and the vinyl chloride cases above can be used to show why caution should be used to base such an expensive MCL on so few studies and such questionable data. Further, the inability to raise a standard that has been lowered too much should preclude taking drastic action without results of the long-term studies now underway.

B. Leave the MCL at 50 ppb, Complete the Long-term Studies, and Review the Standard in the Year 2006

This option is similar to number 1, but would actually schedule a formal review and reconsideration of the standard at the first reevaluation point established in the SDWAA,

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[407] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 103, 110 Stat. 1613, 1621 (1996) (codified as amended at 42 U.S.C. § 300g-1(b) (West Supp. 1998)).

regardless of the presence or absence of an arsenic-induced skin cancer being reported in the U.S. It would defer the investment of billions of dollars if a lower standard is not justified to actually reduce health risks upon the results of the long-term studies being conducted during this time interval. If arsenic has a safe threshold, at which water systems are currently below, that should be known before system modifications are mandated and the new risks of a removal system discussed earlier are imposed upon a community. This option would avoid all of the potential negative consequences to a removal program, allow more time for public education and participation processes, and perhaps determine ways to improve the treatment processes to reduce those potential problems.

Exercising this alternative is also consistent with congressional mandates to involve local and state governments in the process, make use of the best science available (which will not likely be available by the year 2000), and the direction to the EPA not set standards where costs exceed any commiserate benefits to be gained by the burden of the regulation.

C. Set a Mandatory MCL at 50 or no less than 30 ppb and Let the Communities Choose if They Want Additional Protection

The EPA could set a single mandatory standard, to address national concerns of uniform minimum safety levels, such as 50 ppb or no less than 30 ppb, below which the AWWA has determined the incremental costs do not justify further expenditure for benefits gained.[408] The second step would be to provide full public education about the debate on the health effects of low-levels of arsenic, the uncertainties, and the current evidence that no cancers are developing at the 50 ppb standard. Then provide the communities with the mandatory national standard and a range of optional lower standards with their associated costs and hypothetical benefits. Let the

communities choose the amount of risk they are willing to take and/or their chosen level of commitment of financial and personnel resources to meet lower standards. This process will allow each community to evaluate the "potential" adverse health effects and determine how much insurance they want to purchase at a local level.

Such a proposal is consistent with the increased public participation that Congress is trying to achieve in the SDWAA. It further would provide maximum support to the water system as it reaches out to procure water rights; to finance the treatment system; to design, construct, and operate the plant; and to remove waste residuals. With community support these tasks will be easier with creative, local solutions more likely to manifest themselves. Such decentralized decisions will assure that the public welfare for each region can be evaluated for its particular values and culture, while providing the nationwide standard to protect the federal interstate concerns and interest. This option would also attempt to prevent the disastrous investment and consequences cycle to community suppliers required by a national order to unnecessarily treat their supply water below a level the community believes is necessary to protect its health. It should also prevent enforcement actions against towns that penalize the persons the regulation is intended to protect simply because they cannot reach the lowest MCL levels, but can reach the 30 or 50 ppb standard. The key to this option is to provide the public with the information needed to allow a rational choice to achieve the lower standards if they desire to obtain the technical and financial resources required.

Again, upon completion of the long-term studies the mandatory standard could be revisited and more information provided to communities to revise their decisions if necessary. This provides increased flexibility for the EPA, State, and local governments and lets the people

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[408] The AWWA "knee of the curve" analysis determined that the point at which costs are optimized is an arsenic standard of 20 or 30 ppb. See Michelle M. Frey et al., Cost to Utilities of A Lower MCL for Arsenic, 90 No. 3 J.

decide how and when they want to reduce their risk.

None of these alternatives foreclose the EPA from lowering the standard, if required, upon completion of further studies, manifestation of disease outbreaks, or upon their review every six years. They are also within the authority granted by Congress, which would be recognized in the courts under the Chevron doctrine, under section 104 which states:

> ...if the Administrator determines...that the benefits of a maximum contaminant level...would not justify the costs of complying with the level, the Administrator may, after notice and opportunity for public comment, promulgate a maximum contaminant level, that maximizes health risk reduction benefits at a cost that is justified by the benefits.[409]

Each of these options provide greater flexibility and a better assessment of the actual health risks of arsenic before establishing a standard which could waste money and potentially create more health dangers, whether or not that is the expected or desired outcome.

Conclusion

The new arsenic MCL should not be reduced below the present standard of 50 ppb. The uncertainties of agency risk assessments and substantial costs to implement a lowered MCL are too great to justify the marginal and hypothetical projected benefits. The potential adverse consequences of implementing a reduced standard shift a long-term hypothetical risk to present day high risks to public health and safety, especially for the rural poor. The federal funding loan guarantee and grant programs are insufficient to meet the needs of most small communities to implement arsenic removal from their water supplies, but worse the marginal benefits obtained do not justify the expenditures of those funds at all. The money would be better spent on real

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AM. WATER WORKS ASS'N 100, 100 (Marc. 1998).

health risks in drinking water such as bacterial contamination and providing water supplies to currently at-risk populations with no water supply at all. This does not foreclose the possibility to reduce the MCL at a future date if the long-term studies reveal that there is a significant danger in exposure to low levels of arsenic. The converse will not work, i.e. set the standard low and then try to raise it in six years if the studies show no risk. The damage will have been done, investments made, opportunities lost for more beneficial community projects, and the unnecessary cancer scare secure in the minds of the public.

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[409] Safe Drinking Water Act Amendments of 1996, Pub. L. No. 104-182, § 104, 110 Stat. 1613, 1624 (1996) (codified as amended at 42 U.S.C. § 300g-1(b) (West Supp. 1998)).

Appendix A

PERCENTAGE OF INORGANIC ARSENIC TO TOTAL ARSENIC PRESENT[410]

Food	Inorganic Arsenic %
Milk and dairy products	75
Meat (beef and pork)	75
Poultry	65
Fish	
Saltwater	0
Freshwater	10
Cereals	65
Rice	35
Vegetables	5
Potatoes	10
Fruits	10

[410] See Frederick W. Pontius et al., Health Implications of Arsenic in Drinking Water, 86 No. 9 J. AM. WATER WORKS ASS'N 52, 56 (Sept. 1994).

Appendix B

TREATMENT TECHNOLOGIES

Coagulation/Filtration effectively removes AsV in laboratory and pilot-plant tests.[411] The type and amount of coagulant affects the efficiency of the process, which is also reduced by either high or low pH ranges. The coagulant is significant in that the resultant waste sludge may be classified as a hazardous waste requiring management pursuant to the rigorous RCRA requirements. The high cost, need for well-trained operators, and variability in process performance makes these processes inappropriate for most small systems.[412] Moreover, even for large systems, the treatment system may have difficulty consistently meeting a low-level MCL.[413]

Lime Softening is likely to provide a high percentage of arsenic removal for influent concentration of 50 ppb, however it may be difficult to reduce the final concentrations consistently to 1 ppb.[414] Further the system is best operated in a pH range of greater than 10.5.[415] Systems using this methodology would probably require an additional treatment step to meet lower MCLs.[416] This system also requires well trained operators, is high in cost, and the resultant waste sludges will likely be hazardous waste under RCRA.[417]

Activated Alumina is effective in treating water with high total dissolved solids, but selenium, fluoride, chloride and sulfate compete for adsorption sites.[418] This method is highly

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[411] See Office of Ground Water and Drinking Water, USEPA, Arsenic in Drinking Water Treatment Technologies: Removal 1, (visited July 2, 1998) ‹http://www.epa.gov/OGWDW/ars/ars4.html›.
[412] See Id. at 3.
[413] See Id.at 1
[414] See Id.
[415] See Id.
[416] See Id.
[417] See Id. at 3.
[418] See Id. at 1.

selective for AsV and creates regeneration problems with the treatment bed with possibly 5 to 10% loss of adsorptive capacity for each run.[419] That means the beds would have to be replaced often driving up the operating costs. Compounded with that problem is a lack of availability of F-1 alumina, the preferred coagulant media, and testing of substitutes has not yielded sufficiently high removals.[420] Because of the chemical handling requirements and complexity of this process it would be a dangerous system for small operations.[421] The highly concentrated waste stream is a brine whose disposal will be problematic both as a liquid and a potential hazardous waste.[422]

Ion Exchange can effectively remove arsenic, however sulfate, TDS, selenium, fluoride and nitrate compete for sites affecting the treatment run length.[423] Passage through a series of additional ion exchange columns could improve removal and decrease regeneration frequency, but this increases complexity and cost of the system.[424] Suspended solids and precipitated iron can clog the treatment bed and high levels of these constituents may require additional pretreatment.[425] Again the waste by-product of this process is a highly concentrated brine and disposal will be problematic for small systems.[426] The brine will have to be treated to remove the arsenic before the liquid waste could be disposed into a sanitary sewer or a receiving body of water and the resultant sludge would very likely be a hazardous waste under RCRA.[427] This process could be recommended as the Best Available Treatment for small, ground water systems with low sulfate and TDS or as a polishing process after filtration systems for large operations.[428]

Reverse Osmosis provided efficiencies of removal greater than 95% when operated at the

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[419] See Id. at 1.
[420] See Id. at 3.
[421] See Id. at 3.
[422] See Id. at 3.
[423] See Id. at 2.
[424] See Id. at 2.
[425] See Id. at 2.
[426] See Id. at 3.
[427] See Id.

ideal psi in pilot studies.[429] In the western U.S., this system is problematic because it results in only 60% recovery of finished water (i.e. for every 100 gallons put into the treatment plant, only 60 gallons will come out).[430] This requires a significant increase in input water and a huge volume of wasted water (40% of the input stream) which can be reduced somewhat by recycling.[431] The resultant waste brine will have the same waste disposal problems as discussed above. Further the treatment unit is subject to extensive corrosion, which will require additional control and/or frequent replacement to meet low-level MCLs.[432]

Electrodialysis Reversal is expected to achieve removal efficiencies of 80%.[433] For input arsenic concentrations of 21 ppb the resultant treated stream would have a levels of 3 ppb and thus would not meet an MCL of 1 or 2 ppb.[434] This method again results in water rejection of about 20-25% of influent, which is very problematic in water-scarce regions of the west.[435] This process is easier to operate than reverse osmosis or nanofiltration, but is more expensive and has higher process inefficiency.[436] It also has significant energy input costs.

Nanofiltration was capable of arsenic removal of over 90% in laboratory tests, however removal efficiency dropped significantly during pilot-scale tests where the process was operated at more realistic recoveries. It also produces significant loss of input water, making its use in the west more expensive to assure adequate flows of influent.

Point of Use/Point of Entry (POU/POE). These devices can be effective and affordable

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[428] See Id.
[429] See Id. at 2.
[430] See Id.
[431] See Id. at 3.
[432] See Id.
[433] See Id. at 2.
[434] See Id.
[435] See Id. at 3.
[436] See Id.

compliance options for small systems in meeting a new arsenic MCL.[437] The EPA performed one case study in conjunction with the Village of San Ysidro, NM with approximately 200 people, where a re-verse osmosis unit was installed in the village homes and resulted in removal of 86% of the total arsenic.[438] Adopting a POU/POE treatment system in this community required more record-keeping to monitor individual devices than a central treatment unit.[439] Furthermore, special regulations would be required regarding customer responsibilities, water utility responsibilities and required installation of a device in each home.[440] The bottom line is that these units require maintenance and replacement and the reporting requirements of the SDWA cannot be waived, so there are still significant costs for the small water supplier to incur, which may not offset the cost of a centralized treatment unit. However, these devices would relieve the disposal costs of hazardous sludges and brines because household hazardous waste is exempted from RCRA regulation. Unfortunately, the waste products will probably go into septic tanks, which are not capable of handling concentrated toxic wastes, creating a different kind of vexing disposal problem.

New Technologies:

Some prospective technologies being investigated include Ion Exchange with Brine Recycling, Iron Coagulation with Direct Filtration, and Conventional Iron/Manganese Removal Processes.[441] Pilot tests of these treatment options have been conducted but all of these systems have high operating costs, still produce problematic wastes, and have critical operating parameters that can effect removal such as: complex mixing energy, variable detention times, pH requirements, negative effects of competing chemicals like TDS, sulfates, etc., and variable

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[437] See Id. at 2.
[438] See Id.
[439] See Id. at 3.
[440] See Id.

concentrations of reagents required in the process.[442]

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[441] See Id. at 2-3.
[442] See Id.

Appendix C

DIFFICULITIES IN ANALYTICAL DETECTION OF ARSENIC IN WATER

The March 1998 AWWA study found that analytical techniques can accurately detect less than .5ppb total arsenic if certain conditions are met: iron, nitrate, chloride and other interferences must be eliminated and the expensive graphite furnace atomic adsorption techniques are used to overcome poor recoveries.[443] They found no techniques adequately preserved arsenic species during transport to accurately assess partition between the particulate form, AsIII, and AsV, thus, the method must be applied in the field to reduce time lag between collection and analysis.[444] Significantly, they found that particulate arsenic represented a significant fraction of the total arsenic in the U.S. water supplies they sampled, which is critical for selection/maintenance of a treatment process and could indicate low bioavailability of this fraction for adsorption into the human body.[445]

[443] See Marc Edwards et al., Considerations in As Analysis and Speciation, 90 No. 3 J. AM. WATER WORKS ASS'N 103, 103 (Mar. 1998).
[444] See Id.
[445] See Id. at 112.