Enforcing Regulation:
The Impact of Violating Drinking Water Standards on Infant Health at Birth in the US

Matthew Harding, Stanford University

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Matthew Harding†

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Abstract

This paper documents the impact of different drinking water violations on infant health outcomes at a national level *net* of the impact of existing regulations. It shows that while avoidance behavior such as buying drinking water is significant, it cannot fully offset the health impact of water contaminants. Moreover, consumers only respond to the most salient contaminants and fail to appreciate the risks associated with water contamination. Once exposure has occurred medica, medical treatment is not sufficient to compensate for the damage to fetal health. This paper also shows that enforcement activities can be very effective at minimizing exposure even when enforcement is informal and does not make use of the full extent of the law.

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†Department of Economics, Stanford University, 579 Serra Mall, Stanford, CA 94305; Phone: (650) 723-4116; Fax: (650) 725-5702; Email: mch@stanford.edu. Department of Economics, Georgetown University, ICC 554, 37th and O Sts., NW, Washington, DC 20057.

1 Introduction

Unconstrained economic activity can lead to socially suboptimal outcomes such as pollution or insider trading and it has long been recognized that regulation plays an important role in shaping the conduct of market participants. As a result regulations were developed to influence and guide the behavior of economic agents. For example, the Clean Air Act of 1970 aims at protecting the public from hazardous air contaminants, while US statutory law includes a number of provisions against insider trading punishable by incarceration.

Since the enforcement of regulations is costly and the benefits are often not precisely quantifiable, in practice we observe a broad spectrum of enforcement activities from monitoring and reporting to informal enforcement to legal proceedings resulting in fines or imprisonment. At the moment the popular perception is that regulators are not doing enough to enforce laws and falling short of stated policy goals.

This paper investigates the effectiveness of enforcement of one set of environmental regulations pertaining to water pollution. While drinking water quality has long been associated with the outbreak of various diseases and human mortality, research has focused almost exclusively on developing countries and has emphasized the huge benefits of providing drinking water and sanitation infrastructure (Olmstead 2010). More recently, a series of *New York Times* articles highlighted the extent to which violations in established drinking water standards are relatively common in the US, and that their number has increased significantly over the last decade (Duhigg 2009). The same time the newspaper found that fewer than 3% of all violations resulted in significant fines or punishment, thereby suggesting a low degree of enforcement. This appears to be confirmed by a memorandum released by the Environmental Protection Agency which states that: "water in the United States is not meeting public health and environmental goals" and "the level of enforcement activity is unacceptably low"(Jackson 2009).

This paper provides a number of innovations. We document for the first time the impact of different drinking water violations on infant health outcomes at birth at a national level, which represents an important step towards quantifying the benefits of enforcement. Our focus on infant health outcomes reflects the recent emphasis placed in the economic literature on understanding the impact of pollution on fetal and infant health. This avoids the inherent identification challenges in quantifying the impact of pollution on cancer and other diseases for which the precise biological mechanisms are poorly understood and depend on long run exposure and unobserved behavioral factors (Currie, Ray and Neidell 2011). Since the observed violations occur in spite of the existence of water quality regulations, the measured health impacts represent the effect of drinking water contamination *net* of the deterrent effect of regulation. The presence of statistically significant health effects thus reflect the cost of imperfect enforcement. We show that notification requirements are insufficient to induce compliance. Furthermore, we show that individuals exposed to drinking water contaminants engage in a substantial degree of avoidance behavior, but their efforts are insufficient to compensate for the adverse effects of exposure. While substitutes such as bottled water exist, these are costly and individuals fail to respond to the health hazards derived from less salient contaminants. Once exposure has occurred medical treatment may also not be sufficient to detect and mitigate the adverse health effects. This paper however does show that enforcement activities by state and federal regulators can be very effective at minimizing exposure and the negative health effects even when the enforcement activities are informal and don't make use of the full extent of the law. This indicates that regulators have a substantial degree of bargaining power that can be used efficiently to induce compliance with existing regulations and deter further contamination.

2 Drinking Water: Regulating Contaminants

The US population consumes drinking water from a public water system (PWS), defined as an entity that provides piped water to at least 25 people for at least 60 days each year (EPA 2009). In contrast to the energy sector the supply is highly fragmented. The majority of the population (over 268 million) receive their drinking water from one of over 50,000 community water systems which provide drinking water year-round. Over 100,000 other water systems are also recorded as providing water for part of the year, such as camp grounds or schools with their own water supply.

The Safe Water Drinking Act (SDWA) was enacted in 1974 and is aimed at protecting human health. Among other things, the act granted the Environmental Protection Agency (EPA) the authority to establish regulations for drinking water in order to protect human health.[1] The EPA has set up regulations on drinking water in order to mitigate the amount of substances that have potential adverse health effects on humans. The EPA enforces a number of thresholds for which violations are triggered; these thresholds vary according to the severity of the health effects of each contaminant and the amount of each that is necessary to be considered harmful.

While the drinking water in the US is safe compared to that in Third World countries, it is important to note that although these regulations are in place they do not eliminate all appearances of contaminants. A wide variety of water contaminants are still found in US drinking water, both naturally occurring and man made, that have serious effects on human health and in particular on fetuses and newborns. Infants are particularly susceptible because their immune systems are not fully developed and they have a high water intake relative to their bodyweight (Postma, Butterfield, Odom-Maryon, Hill and Butterfield 2011).

Contamination can happen for a variety of reasons. Bacterial contamination usually results from human or animal waste. Chemical contamination results from industrial discharges or runoff from fertilizer and herbicide usage. Lead and copper

[1] For a detailed discussion, see the Online Appendix which summarizes the main aspects of the regulatory framework for enforcing the SDWA.

contaminations occurs as a result of the household plumbing erosion. Radionuclides contamination is usually a result of the decay of natural or man-made radiation emitting mineral deposits.

Monitoring. The regulatory framework distinguishes between the maximum contaminant level goal (MCLG), which corresponds to the level of a contaminant below which no health risks are known to exist, and the maximum contaminant level (MCL), which corresponds to the maximum level of a contaminant allowed in drinking water. Regulation aims to enforce an MCL value for a contaminant as close to the corresponding MCLG as possible while taking into account the available treatment technology and implementation costs. At the moment, the EPA regulates over 90 contaminants in several categories: micro-organisms, inorganic chemicals, organic chemicals, radionuclides and disinfection byproducts. Separate rules are established for the monitoring of the different contaminants, but broadly the process requires PWSs to collect samples at regular time intervals throughout the month. If a positive sample is detected (i.e. a sample for which the contaminant exceeds the MCL) additional samples will need to be collected immediately. The EPA sets precise rules on when a PWS is in violation of a specific rule as a function of several factors such as the type of PWS, the amount by which the MCL was exceeded and the number of samples that tested positive over a given interval.

Notification. The SDWA mandates that PWSs notify customers of drinking water violations. From the time a violation is detected the PWS has 24 hours, 30 days or 1 year to provide notification depending on the type and severity of contamination, as well as the implied health hazard. The EPA uses a tiered system to determine the timing of the required notification. Tier 1 violations require notification within 24 hours and it is triggered primarily by contamination with fecal coliform bacteria or *E. coli* as well as exceeding the MCL for nitrate/nitrite. Figure 1 in the Appendix presents a template notification, highlighting some of its manadated elements such as potential health effects and actions that consumers should take. Public notification must be issued through a variety of means from radio and TV to hand delivery. Tier 2 violations consist of all other MCL violations not covered by the Tier 1 notification requirements. Additionally, PWSs must mail an annual "consumer confidence report" which records the violations in all tiers. Tier 3 violations consist mostly of violations in the sampling, monitoring and reporting requirements and will be included in the annual report. Figure 2 provides an example of such an annual report.

Enforcement. The EPAs regulations are legally enforceable and the EPA itself and states may take actions against water systems that are not meeting safety standards. The enforcement framework is discussed in detail in the Online Appendix. The SDWA provides for a variety legal actions that can be taken in Federal District Court against PWSs found in violation of the SDWA and which can impose substantial financial penalties of up to $27,500 per day of violation. A recent investigation by the New York Times found that in 2008 more than 40% of the PWSs were in violation of the SDWA but less than 3% of the violations resulted in fines or significant punishments (Duhigg 2009). Anecdotal evidence attributes the lack of enforcement to limited budgets for enforcement and regulatory capture by influential industry lobby groups. At the same time the EPA has a number of informal enforcement methods available. A common approach involves issuing a "Notice of Violation (NOV)" to the state and the PWS informing them about the lack of compliance with existing regulations and threatening further action if appropriate actions are not taken within 30 days. The EPA states that "The NOV is a very effective tool in getting water systems back into compliance with the SDWA because systems receiving an NOV often contact the state to learn what needs to done to respond to the action. This begins a dialog between the system and the state which frequently leads to compliance without further formal actions or penalties."[2] In our data we observe that 12% of the violations resulted in at least one NOV being issued. While less than 1% resulted in legal action, we observe over 60 different types of informal enforcement actions being conducted by the EPA in dealing with violations.

2.1 Biological Mechanisms

While it is beyond the scope of this paper to discuss the impact of the various contaminants on human health in detail, it is important to acknowledge that the

[2] http://yosemite.epa.gov/r10/water.nsf/Drinking+Water/PWS+Compliance+Pgm

biological mechanisms are scientifically well established. The question that remains for us is if the resulting impact on human health is substantial enough to be detected in a large population study, especially in light of the current notification provisions and the easy (if costly) availability of a substitute in the form of bottled water.

To illustrate the relationship between contaminants and infant health outcomes we will focus on some of the most frequent (and dangerous) contaminants. Coliform bacteria include a variety of genera including *E. coli* and are the most frequent contaminant responsible for over 30% of the violations. These are known to have short-term affects in adults such as diarrhea and vomiting. However, babies are more susceptible to these bacteria since they have a suppressed immune system and thus are more likely to get a severe disease. A study by Jones, Peake, Morris, McCowan and Battin (2004) found that *E. coli* caused high mortality rates and low APGAR scores in babies with an early onset of E. coli sepsis. They found a 40% mortality rate and the median age at death to be 1 day. Other studies, such as Joseph, Pyati and Jacobs (1998), have noted cases where the mother was treated with ampicillin and the child died due to ampicillin resistant E. coli. This particularly troubling since a large amount of coliforms present in the water may lead to the increasing usage of antibiotics in adults to combat the mild health symptoms from E. coli. In the process, this increases the amount of antibiotic resistant bacteria, which for newborns can be severe or fatal.

The second most frequent form of contamination comes from nitrates and nitrites resulting from a variety of sources such as excessive fertilizer use, animal waste, erosion of natural deposits, and sewage. It has been well established that nitrates cause methemoglobinemia, more commonly known as *blue baby syndrome*. Infants are better at converting nitrates to nitrites; however they have a decreased amount of the enzyme cytochrome b5 reductase, which converts methemoglobin to hemoglobin. As a result, the babies have highly elevated levels of methemoglobin and thus less hemoglobin to transport oxygen typically causing cyanosis, a lack of oxygen (Postma et al. 2011). Furthermore, nitrates consumed by the mother do cross the placenta to the fetus. As a result babies are born with less oxygen in their blood and lower APGAR scores.

Among organic compounds many have been shown to cause fetal development retardation, birth defects and low birthweight. Tetrachloroethylane affects the development of the nervous system and is also associated with low birthweight (Fredriksson, Danielsson and Eriksson 1993); benzene and toluene cause both weight and skeletal development retardation (Kuna and Kapp 1981, Ungvry and Ttrai 1985); carbon tetrachloride exposure causes a significant decrease in fetal birth weight and length[3](Schwetz, Leong and Gehring 1974). Arsenic was shown to decrease birth weight and substantially increase the risk of stillbirth (Hopenhayn, Ferreccio, Browning, Huang, Peralta, Gibb and Hertz-Picciotto 2003, Llanos and Ronco 2009, Rahman, Vahter, Smith, Nermell, Yunus, El Arifeen, Persson and Ekstrm 2009). Mercury also crosses the placenta to the fetus and leads to neurological damage such as convulsions and uncontrollable muscle movement. Mothers exposed to mercury were nine times more likely to have a baby with neural tube defects.[4] It is also particularly noteworthy that prenatal exposure to most of the contaminants threatens neurological development in early childhood and infancy, including both cognitive abilities and motor development.

3 Data and Empirical Methods

We filed several Freedom of Information Act requests with the EPA and received detailed information on violations at the PWS level between 2001 and 2006. Each violation records the date of occurrence as well as the precise nature of the violation. Since the EPA monitors over 90 different contaminants we use the EPA designations to group them as follows: Total Coliforms (TCR), Nitrates, Lead/Copper, Volatile Organic Compounds (VOC), Synthetic Organic Compounds (SOC), Radionuclides, and Arsenic. Each class of contaminants has a different set of sampling rules but monitoring and recording is very similar by group. We are primarily interested in violations which could have an impact on fetal health and restrict our attention to MCL violations to the exclusion of other violations not directly associated with a health hazard, such as missing a reporting deadline.

For TCR violations we further distinguish between acute and MCL violations.

[3]http://water.epa.gov/drink/contaminants/basicinformation/carbon-tetrachloride.cfm
[4]http://www.epa.gov/teach/chem_summ/mercury_inorg_summary.pdf

An MCL violation occurs if more than 5% of the routine samples are total coliform positive. A violation is deemed acute if in addition to testing total coliform positive, one of the samples is also *E. coli* or fecal coliform positive. For TCR violations we also record major monitoring and recording violations.

We further distinguish between Tier1 violations consisting of acute TCR violations and MCL Nitrates violations, both of which require immediate notification, and Tier 2 violations consisting of all MCL violations which require 30 day notifications. All other violations are reported to consumers in the annual consumer confidence report.

In Table 1 we report count of all violations observed over the period 2001-2006 in the US. We observe 248,014 TCR violations, out of which 6,337 are acute. The second most common violations consist of violations of the Lead/Copper rule with 18,643 violations observed in the sample. Radionuclides violations are surprisingly common with 5,677 observed violations, while VOC and SOC violations are relatively rare with less than 500 cases observed. In Table 1 we also report summary statistics for violations occurring in US counties with populations over 100,000 persons for which natality data is available from the CDC as described below. Over the sampling period these counties experienced an average of 191 TCR violations and 5.48 Radionuclides violations. Looking at the 25th and 75th quantiles as well as the maximum number of violations per county we notice a rather skewed distribution of violations across counties. While most counties have a low number of violations over the sampling period, some counties have a large number of such violations. The 25th percentile of the distribution of Nitrates violations is 0, the 75th percentile is 2, but the maximum number of violations was 1,512. Thus while the mean number of Nitrates violations per county was 4.46, the standard deviation was 22.03. Figure 3 shows the geographic distribution of TCR and Radionuclides violations across the US over the sampling period. While we observe a broad geographic dispersion, violations appear to be more heavily concentrated in the South and South East, which will need to be accounted for in the empirical model.

In Table 2 we report summary statistics for live births by county-month for large US counties based on data obtained from the CDC Natality Files. Over 80% of all births in the US occur in these counties. For confidentiality reasons birth information is not available for smaller counties. We focus on two infant health outcomes at birth that are of particular interest to us, which as we have seen in the previous section, can be negatively affected by drinking water contaminants. The APGAR score ranges from 0 to 10 and is calculated 1 minute after birth. It measures five health criteria (appearance, pulse, grimace, activity, respiration). APGAR scores below 6 are considered low and generally indicate the need for additional medical attention. In our sample less than 1.5% of births in large counties are recorded as having had a low APGAR score. The second infant health outcome of interest is low birthweight, which occurs more frequently and was observed for 7.7% of births in large counties.

In our empirical analysis we also control for infant risk factors such as gender, twin birth, birthplace different than a hospital, and lack of prenatal care, an indicator for tobacco use, race, marriage status, and education of the mother and race of the father.

3.1 Empirical Strategy

Our main empirical strategy is to estimate the impact of exposure to drinking water contaminants during pregnancy on the number of births with low APGAR and low birthweight in a given county-month, while controlling for other health risks, parental characteristics, and county and time fixed effects. Our main empirical model is of the form:

$$Y_{i,t} = \beta_0 + \sum_k \beta_k Exposure_{i,t,k} + \gamma X_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}, \tag{1}$$

where $Y_{i,t}$ denotes the number of births with either low APGAR scores (below 6) or low birthweight, $X_{i,t}$ is a vector of county level controls for birth risk factors and which captures the percent of births that were male, twins, not in a hospital, received no prenatal care, where the mother smoked, the mother was black, the mother was not married, the mother did not attend college, and the percent of births where the father was black.

4 Quantifying Health Outcomes

4.1 Notifications

4.2 Avoidance Behavior

5 Conclusion

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Table 1: Summary statistics of drinking water standards at county level over the sampling period 2001-2006.

	All counties	Big counties (N=521)					
	Total	Total	Mean	SD	25th	75th	Max
TCR (Any)	248014	99735	191.43	285.97	20	238	2216
TCR Acute	6337	2606	5.00	10.74	0	5	113
TCR MCL	50244	20566	39.47	64.03	4	48	658
TCR MR	191433	76563	146.95	239.26	9	167	1512
Nitrates	5476	2323	4.46	22.03	0	2	320
Lead/Copper	18643	8012	15.38	25.58	1	19	289
VOC	436	236	0.45	2.33	0	0	34
SOC	183	97	0.19	1.36	0	0	19
Radionuclides	5677	2857	5.48	26.09	0	0	261
Arsenic	1537	705	1.35	4.47	0	0	43
Tier 1	11813	4929	9.46	25.28	0	9	328
Tier 2	268153	109036	209.28	307.18	23	255	2385

Table 2: Summary statistics of monthly US natality data for large counties over period 2001-2006.

	Mean	SD	25%	75%
# Births	547.081	902.822	159	584
% Births (Low APGAR)	0.014	0.014	0.006	0.019
% Births (Low Weight)	0.077	0.031	0.057	0.094
% Male	0.512	0.041	0.494	0.531
% Twins+	0.033	0.018	0.021	0.044
% Not in Hospital	0.012	0.049	0.000	0.011
% No Prenatal Care	0.010	0.018	0.002	0.013
% Tobacco	0.108	0.079	0.046	0.159
% Black (Mother)	0.126	0.137	0.021	0.186
% Not Married	0.353	0.108	0.279	0.425
% No College (Mother)	0.458	0.185	0.377	0.578
% Black (Father)	0.093	0.087	0.025	0.133

Table 3: Baseline estimation results of the effects of water contaminants on birth outcomes.

	(1)	(2)	(3)	(4)	(5)	(6)
		Low APGAR			Low Birthweight	
TCR Acute	1.793*	1.893*		3.021	3.104	
	(0.901)	(0.938)		(2.714)	(2.671)	
TCR MCL		-0.335			-0.654	
		(0.529)			(0.878)	
TCR MR		0.0615			-1.488	
		(0.666)			(1.018)	
Nitrates	0.819*	0.821*		0.680	0.678	
	(0.388)	(0.388)		(0.507)	(0.508)	
Lead/Copper	-0.0477	-0.0470		0.0265	0.0337	
	(0.0306)	(0.0313)		(0.0843)	(0.0782)	
VOC	-0.191	-0.181		-1.026	-1.037	
	(0.383)	(0.379)		(0.864)	(0.863)	
SOC	3.756+	3.795+		5.086*	4.202*	
	(2.097)	(2.173)		(2.157)	(1.904)	
Radionuclides	0.0282**	0.0279**		0.0501**	0.0508**	
	(0.00831)	(0.00829)		(0.0159)	(0.0158)	
Arsenic	0.0577	0.0515		0.0786+	0.0735	
	(0.0356)	(0.0367)		(0.0474)	(0.0486)	
Tier 1			0.867*			0.813+
			(0.359)			(0.481)
Tier 2			-0.00711			0.0368
			(0.0264)			(0.0355)
Constant	0.589	0.597	0.593	-3.941**	-3.929**	-3.936**
	(0.712)	(0.712)	(0.712)	(1.238)	(1.232)	(1.239)
Observations	20,816	20,816	20,816	22,391	22,391	22,391
R-squared	0.226	0.226	0.226	0.706	0.707	0.706

Robust standard errors in parentheses: ** p<0.01, * p<0.05, + p<0.1

Additional controls include: gender, twins, mother's race and education, father's race, birth in hospital, no prenatal care and tobacco use.

Table 4: The impact of water contaminants on the of county level bottled water (log) sales.

	(1)	(2)	(3)	(4)
TCR Acute	0.350*	0.341*		
	(0.162)	(0.159)		
TCR MCL		0.0228		
		(0.0382)		
TCR MR		0.0269	0.0370	
		(0.0595)	(0.0608)	
Nitrates	0.226	0.226	0.226	
	(0.152)	(0.152)	(0.152)	
Lead/Copper	-0.00508	-0.00513	-0.00528	
	(0.0322)	(0.0322)	(0.0322)	
VOC	0.109	0.109	0.111	
	(0.135)	(0.135)	(0.136)	
SOC	0.432	0.430	0.428	
	(0.694)	(0.693)	(0.692)	
Radionuclides	-0.0894	-0.0894	-0.0895	
	(0.0734)	(0.0734)	(0.0734)	
Arsenic	-0.0339	-0.0337	-0.0342	
	(0.0294)	(0.0293)	(0.0293)	
Tier 1				0.281*
				(0.121)
Tier 2				-0.0466
				(0.0330)
Constant	-171.0	-171.0	-168.6	-167.2
	(106.9)	(107.0)	(106.9)	(106.9)
Observations	57,160	57,160	57,160	57,160
R-squared	0.568	0.568	0.568	0.568

Robust standard errors in parentheses: ** p<0.01, * p<0.05, + p<0.1
Additional controls for seasonality include splines over temperature and year-month indicators.

Table 5: Estimation results of the effects of water contaminants on birth outcomes in counties of mothers with at least a college education exceeds 25%.

	(1)	(2)	(3)	(4)	(5)	(6)
		Low APGAR			Low Birthweight	
TCR Acute	1.618	2.019+		0.415	0.859	
	(1.031)	(1.146)		(2.527)	(2.519)	
TCR MCL		-1.109+			-1.406	
		(0.670)			(1.542)	
TCR MR		-0.395			-0.536	
		(1.202)			(0.645)	
Nitrates	1.259**	1.264**		0.989**	0.999**	
	(0.252)	(0.251)		(0.265)	(0.265)	
Lead/Copper	-0.0278	-0.0231		-0.0619	-0.0561	
	(0.0710)	(0.0758)		(0.0437)	(0.0418)	
VOC	-0.412	-0.362		-0.597	-0.558	
	(0.498)	(0.483)		(1.115)	(1.101)	
SOC	-2.815	-2.587		-4.738	-4.490	
	(3.740)	(3.699)		(2.921)	(2.962)	
Radionuclides	-0.00756	-0.00359		0.124	0.131	
	(0.0506)	(0.0531)		(0.111)	(0.111)	
Arsenic	0.0769**	0.0626**		0.0421	0.0234	
	(0.0189)	(0.0224)		(0.0528)	(0.0582)	
Tier 1			1.277**			0.956**
			(0.244)			(0.287)
Tier 2			-0.0210			-0.0239
			(0.0543)			(0.0435)
Constant	-0.0177	0.00962	-0.0230	-5.585**	-5.549**	-5.578**
	(0.799)	(0.798)	(0.799)	(1.643)	(1.644)	(1.643)
Observations	11,862	11,862	11,862	13,178	13,178	13,178
R-squared	0.240	0.241	0.240	0.730	0.730	0.730

Robust standard errors in parentheses: ** p<0.01, * p<0.05, + p<0.1

Additional controls include: gender, twins, mother's race and education, father's race, birth in hospital, no-prenatal care and tobacco use.

Table 6: Estimation results of the effects of water contaminants on birth outcomes in counties of mothers who benefited from prenatal care exceeds 95%.

	(1)	(2)	(3)	(4)	(5)	(6)
		Low APGAR			Low Birthweight	
TCR Acute	1.584*	1.752*		2.876	2.955	
	(0.726)	(0.807)		(3.351)	(3.339)	
TCR MCL		-0.583			-0.490	
		(0.612)			(0.987)	
TCR MR		-0.670			-1.228	
		(0.655)			(0.855)	
Nitrates	0.800*	0.801*		0.713	0.711	
	(0.384)	(0.385)		(0.537)	(0.538)	
Lead/Copper	-0.0348	-0.0317		0.103	0.108	
	(0.0368)	(0.0345)		(0.110)	(0.104)	
VOC	-0.00769	0.00702		-0.978	-0.977	
	(0.346)	(0.326)		(0.673)	(0.673)	
SOC	3.524+	3.105		5.744*	5.040*	
	(2.116)	(2.217)		(2.744)	(2.467)	
Radionuclides	0.0619*	0.0654**		-0.0352	-0.0282	
	(0.0247)	(0.0239)		(0.0985)	(0.101)	
Arsenic	0.0901**	0.0850**		0.0772+	0.0765+	
	(0.0243)	(0.0261)		(0.0434)	(0.0464)	
Tier 1			0.823*			0.820
			(0.361)			(0.513)
Tier 2			-0.0145			0.0649
			(0.0294)			(0.0981)
Constant	0.913	0.923	0.933	-3.801**	-3.793**	-3.815**
	(0.774)	(0.781)	(0.772)	(1.200)	(1.198)	(1.201)
Observations	18,632	18,632	18,632	20,580	20,580	20,580
R-squared	0.163	0.163	0.162	0.669	0.669	0.669

Robust standard errors in parentheses: ** p<0.01, * p<0.05, + p<0.1
Additional controls include: gender, twins, mother's race and education, father's race, birth in hospital, and tobacco use.

Table 7: The effects of water contaminants on birth outcomes interacted with an indicator variable for EPA enforcement actions that were taken during the period that the PWS was not in compliance with existing safe drinking water regulations.

	(1)	(2)	(3)	(4)	(5)	(6)
Enforcement (N/Y)		Low APGAR			Low Birthweight	
TCR Acute (N)	1.566	1.717		6.278**	6.187**	
	(1.359)	(1.357)		(2.193)	(2.240)	
TCR Acute (Y)	0.562	-0.0732		-5.416*	-5.465*	
	(1.132)	(1.056)		(2.580)	(2.631)	
TCR MCL (N)		-0.701			-0.823	
		(0.631)			(1.115)	
TCR MCL (Y)		1.012			0.102	
		(0.628)			(1.221)	
TCR MCR (N)		-0.0843			-1.615	
		(0.656)			(1.087)	
TCR MCR (Y)		2.300			4.497	
		(1.925)			(4.427)	
Nitrates (N)	0.803+	0.810+		1.430	1.403	
	(0.467)	(0.466)		(0.927)	(0.880)	
Nitrates (Y)	0.0420	0.0321		-0.712	-0.684	
	(0.583)	(0.582)		(0.995)	(0.956)	
Lead/Copper (N)	0.444**	0.446**		0.250	0.259	
	(0.0875)	(0.0856)		(0.346)	(0.337)	
Lead/Copper (Y)	-0.0650*	-0.0634*		0.0208	0.0275	
	(0.0288)	(0.0297)		(0.0895)	(0.0830)	
Radionuclides (N)	0.0434	0.0422		0.0222	0.0317	
	(0.0408)	(0.0414)		(0.121)	(0.124)	
Radionuclides (Y)	0.0121	0.0128		0.0435	0.0389	
	(0.0182)	(0.0185)		(0.0498)	(0.0506)	
Arsenic (N)	-1.232	-1.297		0.384	0.125	
	(1.199)	(1.189)		(1.556)	(1.558)	
Arsenic (Y)	1.034	1.074		-0.207	-0.0125	
	(0.917)	(0.908)		(1.178)	(1.178)	
Tier 1 (N)			0.969+			2.869+
			(0.542)			(1.515)
Tier 1 (Y)			-0.0996			-2.164
			(0.628)			(1.480)
Tier 2 (N)			0.134**			0.0263
			(0.0452)			(0.0993)
Tier 2 (Y)			-0.0406			0.0353
			(0.0257)			(0.0575)
Constant	0.603	0.610	0.591	-3.940**	-3.929**	-3.938**
	(0.713)	(0.713)	(0.712)	(1.238)	(1.231)	(1.238)
Observations	20,816	20,816	20,816	22,391	22,391	22,391
R-squared	0.227	0.227	0.226	0.707	0.707	0.706

Robust standard errors in parentheses: ** p<0.01, * p<0.05, + p<0.1
Additional controls include: gender, twins, mother's race and education, father's race, birth in hospital, no prenatal care and tobacco use. VOC and SOC are excluded because of the small number of observations.

Figure 1: Sample of a public notification with required elements.

DRINKING WATER WARNING

Springfield water has high levels of nitrate

4 - The population at risk

DO NOT GIVE THE WATER TO INFANTS UNDER SIX MONTHS OLD OR USE IT TO MAKE INFANT FORMULA

AVISO
NO USE EL AGUA PARA PREPARAR ALIMENTOS PARA BEBES

Este informe contiene información muy importante sobre su agua potable. Hable con alguien que lo entienda bien o llame al teléfono 555-1200 para hablar en español sobre este aviso.

Information for Spanish speakers

2 - When the violation or situation occurred

1 - A description of the violation or situation

Water sample results received June 22, 1999 showed nitrate levels of 12 milligrams per liter (mg/l). This is above the nitrate standard, or maximum contaminant level (MCL), of 10 mg/l. Nitrate in drinking water is a serious health concern for infants less than six months old.

What should I do?
DO NOT GIVE THE WATER TO INFANTS. *Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue baby syndrome.* Blue baby syndrome is indicated by blueness of the skin. Symptoms in infants can develop rapidly, with health deteriorating over a period of days. If symptoms occur, seek medical attention immediately.

3 - Potential health effects

5 - Whether alternate water supplies should be used

Water, juice, and formula for children under six months of age should not be prepared with tap water. Bottled water or other water low in nitrates should be used for infants until further notice. Springfield Water Company and the Springfield Health Department are providing free bottled water to families with infants. Water is available between 9 a.m. and 5 p.m. Monday through Friday at the Health Department office at the Town Hall. Water will be provided until the nitrate problem is resolved.

6 - Actions consumers should take

Do not boil the water. Boiling, freezing, filtering, or letting water stand does not reduce the nitrate level. Excessive boiling can make the nitrates more concentrated, because nitrates remain behind when the water evaporates.

Adults and children older than six months can drink the tap water (nitrate is a concern for infants because they can't process nitrates in the same way adults can). However, if you are pregnant or have specific health concerns, you may wish to consult your doctor.

7 - What is being done to correct the violation or situation

What happened? What is being done?
Nitrate in drinking water can come from natural, industrial, or agricultural sources (including septic systems and run-off). Levels of nitrate in drinking water can vary throughout the year. We'll let you know when the amount of nitrate is again below the limit.

We are investigating water treatment and other options. These may include drilling a new well or mixing the water with low-nitrate water from another source. We anticipate resolving the problem by July 15.

8 - When the system expects to return to compliance

9 - Name, phone number, and business address for more information

For more information, please contact John Smith of the Springfield Water Company at (602) 555-1212. This notice was prepared and distributed by the Springfield Water Company, 500 Main Street, Springfield.

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

10 - Standard distribution language

Figure 2: Consumer confidence report for Fresno, CA. Several contaminants were recorded, but only one triggered an MCL violation.

Table 1: PRIMARY STANDARDS AND UNREGULATED CONTAMINANTS

Chemical Table	MCL	PHG (MCLG)	Fresno Average	Range of Detection's	MCL Violation	Last Sampled
Volatile Organic Contaminants						
cis-1,2-Dichloroethylene (ug/L)	6	100	0.06	nd - 2.2	NO	2011
Tetrachloroethylene (PCE) (ug/L)	5	0.06	0.34	nd - 4.8	NO	2011
Trichloroethylene (TCE) (ug/L) (1)	**5**	**1.7**	**0.24**	**nd - 6.7**	**YES**	**2011**
Synthetic Organic Contaminants						
Dibromochloropropane (DBCP) (ng/L) **(2)**	200	1.7	42	nd - 320	NO	2011
Ethylene Dibromide (EDB) (ng/L)	50	10	1.6	nd - 45	NO	2011
Inorganic Contaminants						
Aluminum (AL) (ug/L)	1	0.6	0.0004	nd - 0.09	NO	2011
Arsenic (As) (ug/L)	10	0.004	0.8	nd - 5.4	NO	2011
Barium (Ba) (mg/L)	1	2	0.040	nd - 0.22	NO	2011
Chromium (Total Cr) (ug/L)	50	(100)	2.440	nd - 12	NO	2011
Cyanide (ug/L)	150	150	0.0004	nd - .06	NO	2011
Fluoride (ug/L)	2	1	0	nd - 1.2	NO	2011
Nitrate (NO3) (mg/L)	45	45	20	0 - 45	NO	2011
Perchlorate (ug/L) **(3)**	6	6	0	nd - 9.2	NO	2011
Radionuclides (4)						
Gross Alpha (pCi/L)	15	n/a	2.51	-0.62 - 9.79	NO	2011
Radium 226 (pCi/L)	3	n/a	0.72	-0.12 - 3.84	NO	2007
Radium 228 (pCi/L)	5	0.019	0.51	0.043 - 0.074	NO	2011
Uranium (pCi/L)	20	0.5	5.89	nd - 16	NO	2007
Unregulated Contaminants (ICR, UCMR & Misc)						
DCPA Diacid + Monoacid	n/a		0.969	nd - 4.7	n/a	2004
Dichlorodifluoromethane (Freon 12)	n/a		0.780	nd - 34	n/a	2011
Trichloropropane (1,2,3-TCP) **(5)**	n/a		0.004	nd - 0.18	n/a	2011
tert-butly Alcohol (TBA)	n/a		0.1	nd - 3.2	n/a	2011
Disinfection Byproducts, Disinfectant Residuals, and Disinfection Byproduct Precursors						
Total Trihalomethanes (TTHM) (ug/L)	80	n/a	0.81	nd - 21	NO	2011
Haloacetic Acids (HAA5) (ug/L)	60	n/a	2.51	nd - 6.9	NO	2011
Chlorine (NAOCL) (mg/L)	4	4	0.81	nd - 2.5	NO	2011

Table 2: MICRO BIOLOGICAL CONTAMINANTS

Over 220 bacteriological samples are collected every month in Fresno's distribution system. In addition, over 300 bacteriological samples are collected from wells and treatment sites.

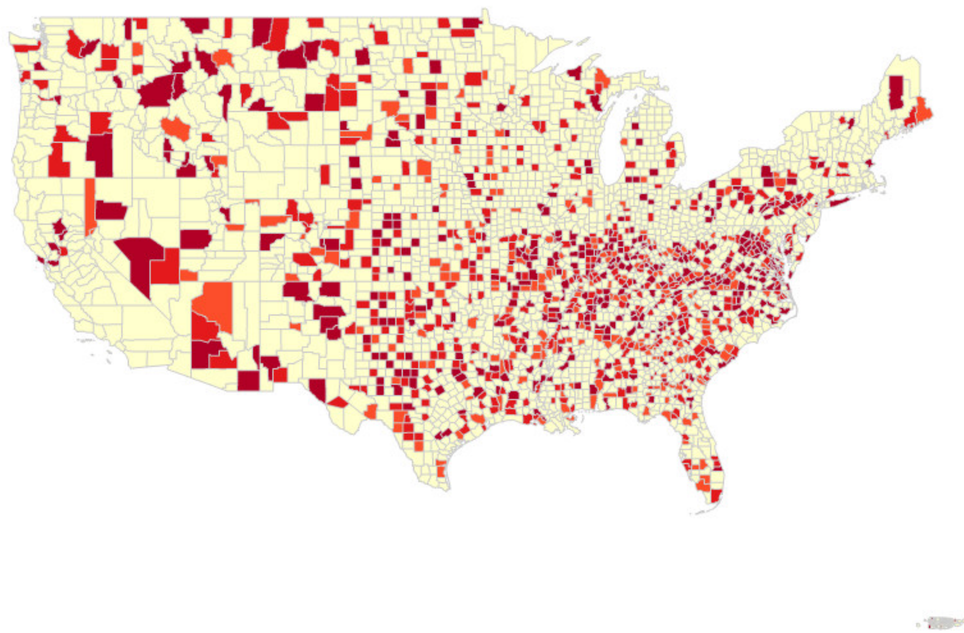
Contaminant	Highest No. of Detection's	No. of Months in Violation	MCL
Total Coliform Bacteria	2 of 298 or 0.67%	0	5%
E.coli	0	0	A routine sample is positive for E.coli and a repeat sample is positive for total, fecal or E.coli bacteria

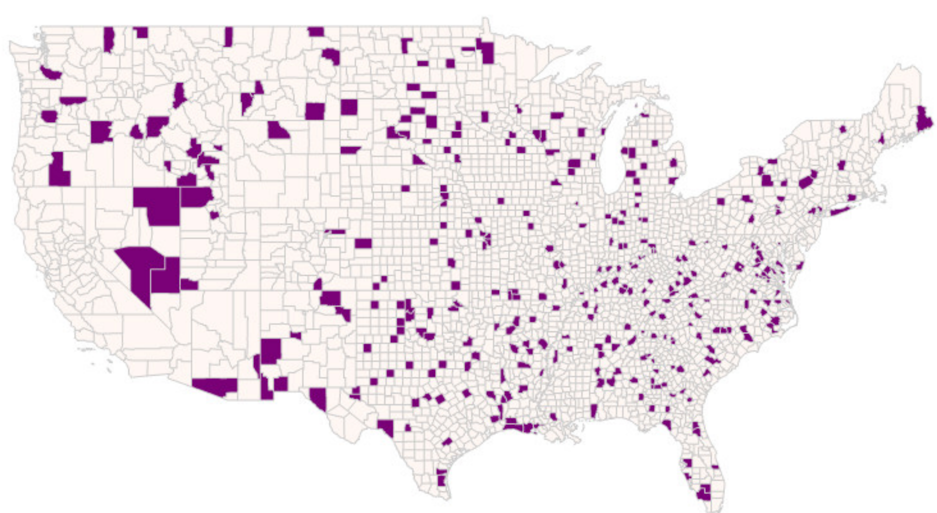
Table 3: LEAD AND COPPER

Lead and Copper samples are collected from wells, the distribution system and from inside residences.

Contaminant	No. of Samples Collected	90th Percentile Level Detected	No. of Sites Exceeding Action Level	Action Level	MCLG
Lead (ug/L) (Sampled in 2009)	50	2	0	15	0.2
Copper (mg/L) (Sampled in 2009)	50	0.17	0	1.3	0.3

Figure 3: County level contamination with acute TCR (top) and Radionuclides (bottom) over the period 2001-2006..





Online Appendix: **ENFORCEMENT OF THE SAFE DRINKING WATER ACT**

This Appendix briefly describes enforcement requirements of drinking water safety regulations for public water systems pursuant to the Safe Water Drinking Act (SDWA).[1] The details for the enforcement of SDWA provisions are found addressed in 42 U.S.C. § 300g-3 ("Enforcement"), EPA regulations, and EPA publications.

I. Background of the SDWA

The SDWA was enacted in 1974, amended in 1986(reauthorized), 1988, and 1996 (reauthorized).[2] The act granted the Environmental Protection Agency (EPA) the authority to establish regulations for drinking water in order to protect human health.[3] The regulations adopted by the EPA are found at Code of Federal Regulations, Title 42, Chapter 6A, Subchapter XII, Part A, Sec. 300f et. seq.

II. Enforcement under the SDWA

A. SDWA Basics and The general enforcement scheme

The EPA's regulations are legally enforceable and the EPA itself and states may take actions against water systems that are not meeting safety standards. The EPA may issue "administrative orders, take legal actions, or fine utilities for violation of the standards."[4]

The SDWA's national primary drinking water regulations apply to the "public water systems" in each state. A public water system is defined as "a system for the provision to the public of water for human consumption through pipes or other

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[1] The SDWA provisions are codified in 42 U.S.C. §§ 300f-300j.
[2] SDWA Statute, Regulations and Enforcement, *available at* http://www.epa.gov/compliance/civil/sdwa/sdwaenfstatreq.html.
[3] *See* 42 U.S.C. § 300g-1(b)
[4] SDWA Statute, Regulations and Enforcement, *supra* note 2.

constructed conveyances, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals."[5] There are three categories of public water systems: community water systems (CWS),[6] transient non-community water systems (TNCWS),[7] and non-transient non-community water systems (NTNCWS).[8]

The SDWA requires compliance from every person "violating the National Primary Drinking Water Regulations or creating an imminent and substantial endangerment by contaminating a public water system or underground source of drinking water in the U.S."[9] A "person" is defined as "an individual, corporation, company, association, partnership, State, municipality, or federal agency (and includes officers, employees, and agents of any corporation, company, association, State, municipality, or Federal agency)."[10]

The SWDA provides for penalties for noncompliance. These are:

- A civil penalty under a judicial order not to exceed $25,000 for each day in which such violation occurs pursuant to 42 U.S.C. § 300g-3(b) (SWDA § 1414(b))[11]

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[5] 42 U.S.C. 300f(4).
[6] A "community water system" is a public water system that "(A) serves at least 15 service connections used by year-round residents of the area served by the system; or (B) regularly serves at least 25 year-round residents." *Id.* at (15).
[7] A "transient non-community water system" is a public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round." Public Drinking Water Systems: Facts and Figures, Environmental Protection Agency, *available at* http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm. Examples include schools, factories, office buildings, and hospitals that have their own water systems (last updated April 1, 2010). *Id.*
[8] A "non-transient non-community water system" is a public water system that "provides water in a place such as a gas station or campground where people do not remain for long periods of time." *Id.*
[9] SDWA Statute, Regulations and Enforcement, *supra* note 2.
[10] *Id.*
[11] § 300g-3(b) provides, in full, that, "The court may enter, in an action brought under this subsection, such judgement as protection of public health may require, taking into consideration the time necessary to comply and the availability of alternative water supplies; and, if the court determines that there has been a violation of the regulation or schedule or other requirement with respect to which the action was brought, the court may, taking into account the seriousness of the violation, the population at risk, and other appropriate factors, impose on the violator a civil penalty of not to exceed $25,000 for each day in which such violation occurs."

- A penalty under an administrative order not to exceed $5,000 for each day without a hearing, and not to exceed $25,000 with a hearing pursuant to 42 U.S.C. § 300g-3(g)(3) (SWDA § 1414(g)).[12]
- A penalty under emergency actions not to exceed $15,000 for each day in which such a violation occurs pursuant to 42 U.S.C. § 300i-1(a) (SWDA § 1431(b)).[13]
- A civil penalty of not to exceed $1,000,000 for tampering with a public water system and $100,000 for an attempt to tamper or threat to tamper with a public water system pursant to 42 U.S.C. § 300i-1(c) (SWDA § 1432).

B. SWDA Regulations and Requirements

The EPA has an extensive set of requirements for the enforcement of drinking water safety regulations. These regulations affect both states (in their monitoring capacity) and water systems. I will focus on the enforcement role of the EPA and states and certain responsibilities of public water systems pursuant to these regulations.

1. Primary Enforcement Responsibility

The SWDA provides that the states shall have "primary enforcement responsibility" if the state meets certain specified criterion.[14] Other entities, such as

[12] "Any person who violates, or fails or refuses to comply with, an order under this subsection shall be liable to the United States for a civil penalty of not more than $25,000 per day of violation." 42 U.S.C. § 300g-3(g)(3)(A). "In a case in which a civil penalty sought by the Administrator under this paragraph does not exceed $5,000, the penalty shall be assessed by the Administrator after notice and opportunity for a public hearing (unless the person against whom the penalty is assessed requests a hearing on the record in accordance with section 554 of title 5). In a case in which a civil penalty sought by the Administrator under this paragraph exceeds $5,000, but does not exceed $25,000, the penalty shall be assessed by the Administrator after notice and opportunity for a hearing on the record in accordance with section 554 of title 5." 42 U.S.C. § 300g-3(g)(3)(B). "Whenever any civil penalty sought by the Administrator under this subsection for a violation of an applicable requirement exceeds $25,000, the penalty shall be assessed by a civil action brought by the Administrator in the appropriate United States district court (as determined under the provisions of title 28)." 42 U.S.C. § 300g-3(g)(3)(C).
[13] "Any person who violates or fails or refuses to comply with any order issued by the Administrator under subsection (a)(1) of this section may, in an action brought in the appropriate United States district court to enforce such order, be subject to a civil penalty of not to exceed $15,000 for each day in which such violation occurs or failure to comply continues." 42 U.S.C. § 300i-1(b).

industries, may also qualify for primacy if they meet the primacy requirements. EPA regulations provide more specific criterion for determination of state primary enforcement responsibility.[15] States must apply for primary enforcement responsibility,

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[14] 42 U.S.C. 300g-2(A) provides the following: For purposes of this subchapter, a State has primary enforcement responsibility for public water systems during any period for which the Administrator determines (pursuant to regulations prescribed under subsection (b) of this section) that such State—
(1) has adopted drinking water regulations that are no less stringent than the national primary drinking water regulations promulgated by the Administrator under subsections (a) and (b) of section 300g–1 of this title not later than 2 years after the date on which the regulations are promulgated by the Administrator, except that the Administrator may provide for an extension of not more than 2 years if, after submission and review of appropriate, adequate documentation from the State, the Administrator determines that the extension is necessary and justified;
(2) has adopted and is implementing adequate procedures for the enforcement of such State regulations, including conducting such monitoring and making such inspections as the Administrator may require by regulation;
(3) will keep such records and make such reports with respect to its activities under paragraphs (1) and (2) as the Administrator may require by regulation;
(4) if it permits variances or exemptions, or both, from the requirements of its drinking water regulations which meet the requirements of paragraph (1), permits such variances and exemptions under conditions and in a manner which is not less stringent than the conditions under, and the manner in which variances and exemptions may be granted under sections 300g–4 and 300g–5 of this title;
(5) has adopted and can implement an adequate plan for the provision of safe drinking water under emergency circumstances including earthquakes, floods, hurricanes, and other natural disasters, as appropriate; and
(6) has adopted authority for administrative penalties (unless the constitution of the State prohibits the adoption of the authority) in a maximum amount—
(A) in the case of a system serving a population of more than 10,000, that is not less than $1,000 per day per violation; and
(B) in the case of any other system, that is adequate to ensure compliance (as determined by the State);
except that a State may establish a maximum limitation on the total amount of administrative penalties that may be imposed on a public water system per violation.

[15] *See* 40 C.F.R. § 142.10-12. The current requirements for primacy are as follows:

- The State must have regulations for contaminants regulated by the national primary drinking water regulations that are no less stringent than the regulations promulgated by EPA. States have up to 2 years to develop regulations after new regulations are released by EPA.
- The State must have adopted and be implementing procedures for the enforcement of State regulations.
- The State must maintain an inventory of public water systems in the State.
- The State must have a program to conduct sanitary surveys of the systems in the State.
- The State must have a program to certify laboratories that will analyze water samples required by the regulations.
- The State must have a laboratory that will serve as the State's "principal" lab, that is certified by EPA.
- The State must have a program to ensure that new, or modified, systems will be capable of complying with State primary drinking water regulations.
- The State must have adequate enforcement authority to compel water systems to comply with NPDWRs, including:
  - the authority to sue in court;
  - right to enter and inspect water system facilities;
  - authority to require systems to keep records and release them to the State;
  - authority to require systems to notify the public of any system violation of the State requirements; and
  - authority to assess civil or criminal penalties for violations of the State Primary Drinking Water Regulations and Public Notification requirements.
- The State must have adequate record keeping and reporting requirements.
- The State must have adequate variance and exemption requirements as stringent as EPA's, if the State chooses to allow variances or exemptions.

demonstrating compliance with the appropriate SWDA provisions and EPA regulations to determine primary enforcement responsibility according to the procedures specified by the EPA.[16]

Either the EPA or a primacy state may initiate actions requiring the State to "revise its approved State primacy program."[17] The EPA must approve any change to a primacy state's program.[18]

2. EPA's enforcement powers in primary/non-primary States

In primary states, when the EPA finds that a public water system is not in compliance with applicable regulations or schedules (and neither a variance nor an exemption applies), they "shall so notify the State and such public water system and provide such advice and technical assistance to such State and public water system as may be appropriate to bring the system into compliance with the requirement by the earliest feasible time."[19] However, if more than thirty days after notification have elapsed and the state has not yet taken appropriate enforcement actions, the EPA "shall issue an order under subsection (g) of this section requiring the public water system to comply with such applicable requirement or the Administrator shall commence a civil action under subsection (b) of this section."[20]

- The State must have an adequate plan to provide for safe drinking water in emergencies like a natural disaster.
- The State must have adopted authority to assess administrative penalties for violations of their approved primacy program.

Primacy, EPA, *available at* http://water.epa.gov/lawsregs/rulesregs/sdwa/primacy.cfm (last updated March 16, 2010).

[16] 42 U.S.C. § 300g(2).

[17] 40 C.F.R. § 142.12(a).

[18] 40 C.F.R. § 142.12.

[19] 42 U.S.C. § 300g-3(a)(1).

[20] *Id.* at (a)(2).

In non-primary states, when the EPA finds that a public water system is not in compliance with applicable regulations or schedules (and neither a variance nor an exemption applies), the EPA "shall issue an order under subsection (g) of this section requiring the public water system to comply with the requirement, or commence a civil action under subsection (b) of this section."[21]

Nothing in the SWDA diminishes "any authority of a State or political subdivision to adopt or enforce any law or regulation respecting drinking water regulations or public water systems, but no such law or regulation shall relieve any person of any requirement otherwise applicable under this subchapter."[22]

3. Judicial Enforcement

The EPA may bring a civil action in US District Courts to require compliance with any applicable requirement, with an administrative order (made pursuant to 42 U.S.C. § 300g-3(g)), or with any schedule or other requirement imposed pursuant to a variance or exemption granted under section 300g–4 or 300g–5 if it respects state primacy (in the manner described above) or it is requested by the Chief Executive of the state in which the non-compliant public water system is located or if requested by an agency with primary enforcement responsibility.[23]

4. Administrative Orders

The EPA may issue administrative orders requiring compliance under any case in which it may be able to initiate a civil action. These include the enforcement provisions

[21] *Id.* at (b).
[22] 42 U.S.C. § 300g-3(3).
[23] 42 U.S.C. §300g-3(b).

(42 U.S.C. § 300g-3) and the records and inspection provisions (42 U.S.C. § 300j-4).[24] In primacy states, these orders shall not take effect until "after the Administrator has provided the State with an opportunity to confer with the Administrator regarding the order."[25]

5. Variances and Exemptions

States with primary enforcement responsibility may issue variances and exemptions (in a manner no less stringent than SWDA requirements.[26] Non-primary states may apply to the EPA for such variances and exemptions.[27]

6. Notice Requirements

i. Annual Reports

Pursuant to the SWDA, primary states, the EPA, and community water systems are required to issue reports annually.[28] The EPA, in consultation with other interested parties, may require additional reports from community water systems. Community water systems must issue an annual "consumer confidence report."[29]

ii. Additional Notification

Public water systems must provide notification for the following: any failure to comply with a maximum containment value or treatment requirement thereof, or to monitor as required by §300j-4; if the public water system is subject to a variance;

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[24] 42 U.S.C. § 300g-3(1).
[25] 42 U.S.C. § 300g-3(2). See 42 U.S.C. § 300g-3(2) and 300g-3(3) for additional requirements for administrative orders.
[26] 40 C.F.R. § 142.20(a).
[27] *Id.*
[28] 42 U.S.C. § 300g-3(c)(3)(A)-(C).
[29] 42 U.S.C. § 300g-3(c)(4). This section also provides the requirements of these reports.

notice of the concentration level of any unregulated contaminant required by the EPA.[30] The form of the notice is largely determined by the EPA,[31]but the SDWA provides for special notice for violations by a public water system that have "the potential to have serious adverse effects on human health as a result of short-term exposure."[32] This notice shall be distributed "as soon as practicable after the occurrence of the violation, but not later than 24 hours after the occurrence of the violation."[33]

Pursuant to these requirements, the EPA has developed a tiered system for public notification by public water systems. The three tiers are as follows:

> Tier 1, for violations and situations with significant potential to have serious adverse effects on human health as a result of short-term exposure. Notice is required within 24 hours of the violation. Tier 2, for other violations and situations with potential to have serious, but not immediate, adverse effects on human health. Notice is required within 30 days, or as soon as possible, with extension of up to three months for resolved violations at the discretion of the State or primacy agency. Tier 3, for all other violations and situations not included in Tier 1 and Tier 2. Notice is required within 12 months of the violation, and may be part of a single annual report, including in some cases the annual CCR already required by EPA.[34]

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[30] 42 U.S.C. § 300g-3(c)(1).
[31] 42 U.S.C. § 300g-3(c)(2)(A).
[32] 42 U.S.C. § 300g-3(c)(2)(C). This section also provides certain requirements of the form of this notice.
[33] *Id.*
[34] Final Drinking Water Public Notification Regulations, EPA, *available at* http://water.epa.gov/lawsregs/rulesregs/sdwa/publicnotification/upload/fsfinaldwpnregulations.pdf (last visitied, December 27, 2010).

Tier 1 violations require notice to be given by "media outlets such as television, radio, and newspapers, post their notice in public places, or personally deliver a notice to their customers in these situations."[35]

Table 1: Tier 1 Notice (required within 24 hours)[36]

- Fecal coliform maximum contaminant level (MCL) violation (any repeat sample positive) or failure to test for fecal contamination after total coliform test is positive (greater than 5% of repeat samples)[37]
- Nitrate/nitrite/combined nitrate and nitrite MCL violation or failure to take confirmation sample[38]
- Chlorine dioxide maximum residual distribution level (MRDL) violation (greater than 0.8 mg/L) in distribution system or failure to take repeat samples in distribution system[39]
- Exceedance of maximum allowable turbidity level resulting in an MCL or treatment technique (TT) violation,[40] when the State or EPA determines a Tier 1 notice is warranted
- Special public notice for non-community water systems with nitrate exceedances between 10 mg/l and 20 mg/l, when allowed to exceed MCL (10 mg/l) by the State
- Waterborne disease outbreak or other waterborne emergency
- Other situations as determined by the primacy agency

Table 2: Tier 2 Notice (required within 30 days unless extended to 90 by state)[41]

- All other MCL, MRDL, and TT violations not identified as a Tier 1 notice
- Monitoring and testing procedure violations, when the primacy agency requires a Tier 2 (rather than Tier 3) notice
- Failure to comply with variance and exemption (V&E) conditions

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[35] Basic Information, EPA, *available at* http://water.epa.gov/lawsregs/rulesregs/sdwa/publicnotification/basicinformation.cfm (last updated May 3, 2010).
[36] Final Drinking Water Public Notification Regulations *supra* note 34.
[37] Drinking Water Contaminants, EPA, http://water.epa.gov/drink/contaminants/index.cfm#1 (last updated November 4, 2010). A routine sample that tests positive for fecal coliform or E. coli triggers repeat samples. If any repeat sample tests positive for total coliform, the system has an acute MCL violation. A routine sample that tests positive for total coliform but tests negative for fecal coliform or E. coli triggers repeat samples. If any repeat sample then tests positive for fecal coliform or E. coli, the system has an acute MCL violation. Basic Information about Pathogens and Indicators in Drinking Water, http://water.epa.gov/drink/contaminants/basicinformation/pathogens.cfm.
[38] The MCL for nitrate is 10 mg/L while the MCL for nitrite is 1 mg/L. Drinkign Water Contanimants, *supra* note 37,
[39] The MLDG for Chlorine dioxide is 0.8 mg/L. *Id.*
[40] For systems that use conventional or direct filtration, at no time can turbidity (cloudiness of water) go higher than 1 nephelolometric turbidity unit NTU), and samples for turbidity must be less than or equal to 0.3 NTU in at least 95 percent of the samples in any month. Systems that use filtration other than the conventional or direct filtration must follow state limits, which must include turbidity at no time exceeding 5 NTU. *Id.*
[41] *Id.*

Table 3: Tier 3 Notice (required within a year)[42]

- All other monitoring or testing procedure violations not already requiring a Tier 1 or Tier 2 notice
- Operation under a V & E
- Special public notices (i.e., exceedance of the fluoride secondary maximum contaminant level (SMCL); announcing the availability of unregulated contaminant monitoring results)

7. Additional Enforcement Provisions

The SWDA requires the EPA to hold hearings pursuant to certain actions.[43] The SWDA also provides for noncompliant water systems to consolidate to avoid certain penalties.[44]

III. Appendix

A. Maximum Containment Levels

Tier 1 MCL, MRDL, TT public notice requirements are highlighted in yellow. All other MCL, MRDL, TT violations require Tier 2 notice.

Table III.1 MICROORGANISMS		
Contaminant	**MCLG (mg/L)**	**MCL or TT (mg/L)**
Cryptosporidium	zero	TT
Giardia lamblia	zero	TT
Heterotrophic plate count	n/a	TT
Legionella	zero	TT
Total Coliforms (including fecal coliform and E. Coli)[45]	zero	5.00%
Turbidity	n/a	TT
Viruses (enteric)	zero	TT

Table III.2 DISINFECTION BYPRODUCTS

[42] *Id.*
[43] *See* 42 U.S.C. § 300g-3(f).
[44] *Id.* at (h).
[45] Note that Tier 1 notice is required only for Fecal Coliform violation. Fecal Coliform violation occurs for positive test of presence of fecal coliform.

Contaminant	MCLG (mg/L)	MCL or TT (mg/L)
Bromate	zero	0.01
Chlorite	0.8	1
Haloacetic acids (HAA5)	n/a	0.06
Total Trihalomethanes (TTHMs)	n/a	0.08

Table III.3 DISINFECTANTS		
Contaminant	**MCLG (mg/L)**	**MCL or TT (mg/L)**
Chloramines (as Cl2)	MRDLG=4	MRDL=4.0
Chlorine (as Cl2)	MRDLG=4	MRDL=4.0
Chlorine dioxide (as ClO2)	MRDLG=0.8	MRDL=0.8

TABLE III.4 INORGANIC CHEMICALS		
Contaminant	**MCLG (mg/L)**	**MCL or TT (mg/L)**
Antimony	0.006	0.006
Arsenic	0	0.010 as of 01/23/06
Asbestos (fiber >10 micrometers)	7 million fibers per liter	7 MFL
Barium	2	2
Beryllium	0.004	0.004
Cadmium	0.005	0.005
Chromium (total)	0.1	0.1
Copper	1.3	TT; Action Level=1.3
Cyanide (as free cyanide)	0.2	0.2
Fluoride	4	4
Lead	zero	TT; Action Level=0.015
Mercury (inorganic)	0.002	0.002
Nitrate (measured as Nitrogen)	10	10
Nitrite (measured as Nitrogen)	1	1
Selenium	0.05	0.05
Thallium	0.0005	0.002

Table III.5 ORGANIC CHEMICALS		
Contaminant	**MCLG (mg/L)**	**MCL or TT (mg/L)**
Acrylamide	zero	TT
Alachlor	zero	0.002
Atrazine	0.003	0.003
Benzene	zero	0.005

Benzo(a)pyrene (PAHs)	zero	0.0002
Carbofuran	0.04	0.04
Carbon tetrachloride	zero	0.005
Chlordane	zero	0.002
Chlorobenzene	0.1	0.1
2,4-D	0.07	0.07
Dalapon	0.2	0.2
1,2-Dibromo-3-chloropropane (DBCP)	zero	0.0002
o-Dichlorobenzene	0.6	0.6
p-Dichlorobenzene	0.075	0.075
1,2-Dichloroethane	zero	0.005
1,1-Dichloroethylene	0.007	0.007
cis-1,2-Dichloroethylene	0.07	0.07
trans-1,2-Dichloroethylene	0.1	0.1
Dichloromethane	zero	0.005
1,2-Dichloropropane	zero	0.005
Di(2-ethylhexyl) adipate	0.4	0.4
Di(2-ethylhexyl) phthalate	zero	0.006
Dinoseb	0.007	0.007
Dioxin (2,3,7,8-TCDD)	zero	0.00000003
Diquat	0.02	0.02
Endothall	0.1	0.1
Endrin	0.002	0.002
Epichlorohydrin	zero	TT
Ethylbenzene	0.7	0.7
Ethylene dibromide	zero	0.00005
Glyphosate	0.7	0.7
Heptachlor	zero	0.0004
Heptachlor epoxide	zero	0.0002
Hexachlorobenzene	zero	0.001
Hexachlorocyclopentadiene	0.05	0.05
Lindane	0.0002	0.0002
Methoxychlor	0.04	0.04
Oxamyl (Vydate)	0.2	0.2
Polychlorinated biphenyls (PCBs)	zero	0.0005
Pentachlorophenol	zero	0.001
Picloram	0.5	0.5
Simazine	0.004	0.004
Styrene	0.1	0.1
Tetrachloroethylene	zero	0.005
Toluene	1	1
Toxaphene	zero	0.003

2,4,5-TP (Silvex)	0.05	0.05
1,2,4-Trichlorobenzene	0.07	0.07
1,1,1-Trichloroethane	0.2	0.2
1,1,2-Trichloroethane	0.003	0.005
Trichloroethylene	zero	0.005
Vinyl chloride	zero	0.002
Xylenes (total)	10	10

RADIONUCLIDES		
Contaminant	**MCLG (mg/L)**	**MCL or TT (mg/L)**
Alpha particles	zero	15 picocuries per Liter (pCi/L)
Alpha particles	zero	4 millirems per year
Alpha particles	zero	5 pCi/L
Alpha particles	zero	30 ug/L as of 12/08/03