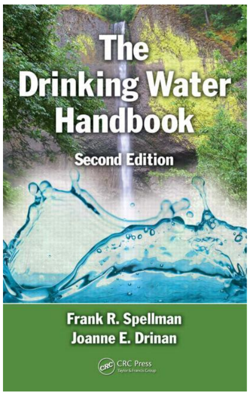


# The Drinking Water Handbook

Frank R. Spellman, Joanne E. Drinan

## Drinking Water Regulations

Publication details
https://www.routledgehandbooks.com/doi/10.1201/b12305-4
Frank R. Spellman, Joanne E. Drinan
**Published online on: 22 May 2012**

# 3

# *Drinking Water Regulations*

Some say we are a Regulation Nation. To a point we fully agree with this statement … and in most cases we feel these narrow-minded rules and regs are adverse and stymieing economic progress … which is sorely lacking at present. Again, we feel this way to a point. However, there is no point reached when it comes to maintaining personal safety and health. Thus, if we have to be a Regulation Nation to ensure the tap water we drink is clean, safe, and palatable then we say, "Please, regulate to the extreme, thank you very much!"

Drinking water regulations have undergone major and dramatic changes in the past two decades, and trends indicate that they will continue to become more stringent and complicated. It is important that all water system operators understand the basic reasons for having regulations, how they are administered, and why compliance with them is so essential.

**—American Water Works Association (1995)**

## Regulation Nation

As stated above, many consider us to be the Regulation Nation. In September 2011, Fox News published an online article entitled "Regulation Nation: Drowning in Rules, Businesses Brace for Cost and Time for Compliance." The article pointed out that, even though President Obama recently acknowledged the need to minimize regulations, the number appears to be growing. The Obama administration has introduced regulations at a rate equivalent to 10 per week. Whether you believe this is good or bad practice is not the point. The point is that adapting the workforce to the challenges of constantly changing regulations and standards for water treatment is a major concern. Drinking water standards are regulations that the U.S. Environmental Protection Agency sets to control the level of contaminants in the nation's drinking water. These standards are part of the Safe Drinking Water Act's multiple-barrier approach to drinking water protection.

Let's get back to that dirty little four-letter word, regulations. Why do we need regulations? Most of us would have little trouble answering this question, having no taste for anarchy. We regulate ourselves and others for a variety of reasons, but in our attempts to do so we generally strive to attain similar results. Most governments, for example, regulate their population to provide direction, to manage, to monitor, and to literally govern whatever it is they are attempting to regulate (including us). We also regulate to confine, to control, to limit, and to restrict ourselves within certain parameters to maintain the peace—with the goal of providing equal and positive social conditions for us all. Regulations are not foreign to us … we are literally driven by them from birth through our final internment—you could say that we are literally regulated to death.

Some regulations are straightforward. The 70-mph speed limit on some interstates is simple—the regulation establishes measurable limits. Other regulations are not so simple, such as regulations designed to ensure the safe and correct operation of nuclear reactors that are complex and difficult to meet. Whether straightforward or complex, however, enforcement presents special problems. As to safe drinking water regulations, we can only hope that the regulations in place to ensure our safety and health are more effectively enforced than that 70-mph speed limit.

In this chapter, we discuss U.S. federal regulations designed to protect our health and well-being: the so-called drinking water regulations. Control of the quality of our drinking water is accomplished by establishing certain regulations, which in turn require compliance within an established set of guidelines or parameters. The guidelines are the regulations themselves; the parameters are the water quality factors important to providing drinking water that is safe and palatable.

## Why Regulate?

Consider what might be an absurd question: "Why do we need to regulate water quality?" And another question that is perhaps a bit more logical: "Aren't we already regulated enough?" The first question requires a compound answer, the explanation of which we provide in this chapter—we hope it will clear the water, so to speak. The second question? We must answer this question with another question: "When it comes to ensuring a safe and palatable drinking water supply, are we (or can we be) regulated enough?" In this text, we concentrate on answering the first question because it goes to the heart of our discussion—the necessity of providing safe and palatable drinking water to the user.

Again, why do we need to regulate water quality? Let's start at the beginning. In the beginning (the ancient beginning), humans really had no reason to give water quality much of a thought. Normally, nearly any water supply available was only nominally naturally polluted. Exceptions existed, of course; for example, a prehistoric human flattened out on the ground alongside a watercourse to drink would not ingest too much of the water (as little of it as possible, in fact) if it was salty. Our intrepid (but thirsty) ancestor would probably move on to find another water source, one a bit more palatable.

Determining water's fitness to drink was a matter of sight, smell, and a quick taste. If the relevant criteria were met, the water was used. Our early kinfolk were likely to have gulped down water that looked perfectly clear, smelled all right, and did not taste all that bad. Later that day, though, the water could have made them become sick, very sick—sickened by waterborne pathogens that were residents of that perfectly clear, not too bad tasting water ingested a few hours earlier. Of course, early humans would not have had the foggiest idea what caused the sickness, but they would have become very sick, indeed.

Let's take a look at more recent times, at another scenario that helps illustrate the point that we are making here (Spellman, 1996, p. 65):

> An excursion to the local stream can be a relaxing and enjoyable undertaking. On the other hand, when you arrive at the local stream, spread your blanket on the stream bank, and then look out upon the stream's flowing mass only to discover a parade of waste and discarded rubble bobbing along the stream's course and cluttering the adjacent shoreline and downstream areas, any feeling of relaxation or enjoyment is quickly extinguished. Further, the sickening sensation the observer feels is not lessened but made worse as he gains closer scrutiny of the putrid flow. He easily recognizes the rainbow-colored shimmer of an oil slick, interrupted here and there by dead fish and floating refuse, and the slimy fungal growth that prevails. At the same time, the observer's sense of smell is alerted to the noxious conditions. Along with the fouled water and the stench of rot-filled air, the observer notices the ultimate insult and tragedy: The signs warn: "DANGER—NO SWIMMING or FISHING." The observer soon realizes that the stream before him is not a stream at all; it is little more than an unsightly drainage ditch. The observer has discovered what ecologists have known and warned about for years. That is, contrary to popular belief, rivers and streams do not have an infinite capacity for pollution.

This relatively recent scenario makes an important point for us: The qualities of water that directly affect our senses are the first to disturb us. This certainly was the case with ancient humans, before the discovery of what causes disease and waterborne disease in particular.

Even before the mid-1850s, when Dr. John Snow, in London, made the connection between water and disease (i.e., the waterborne disease cholera), rumblings could be heard in that city about the terribly polluted state of the Thames River. Dr. Snow's discovery of the connection between cholera and drinking water obtained from the Broad Street pump that was ingested by those who became ill or died lit the fire of reform, and revulsion set in motion steps to clean up the water supply. Since Snow's discovery, many subsequent actions taken to clean up a particular water supply resulted from incidents related to public disgust with the sorry state of the watercourse.

For example, in the 1960s, the burgeoning environmental movement found many ready examples of the deplorable state and vulnerability of America's waters. In Cleveland, the Cuyahoga River burst into flames, so polluted was it with chemicals and industrial wastes; historic Boston Harbor was a veritable cesspool; raw sewage spewed into San Francisco Bay. A 1969 oil spill off scenic Santa Barbara, California, proved an especially telegenic disaster, with oil-soaked seals and pelicans and miles of hideously fouled beaches. These and other incidents were disturbing to many Americans and brought calls for immediate reform.

Awareness of the state of our environment was at an all-time high. A grassroots crusade for environmental action was set into motion by the words of a brilliant writer, a writer whose penetrating scientific views and poetic prose captured the imagination of the nation. Rachel Carson became the flag bearer for our environment. By making the connections between isolated incidents and the actions of industry, research, and government, she brought the clear light of day into the dark abyss of environmental degradation, revealing widespread horrible environmental conditions and the future they could lead to.

The public lost trust in the ability of government and industry to self-govern with regard to choosing between money and the benefits of a clean environment for us all. Industry and government's close connections and financial self-interest were revealed as poor criteria for determining realistic levels of environmental protection. With Rachel Carson's *Silent Spring* came the sobering awareness that environmental conditions and the prevailing governmental attitude demanded radical change. Individual incidents disturbed many Americans to the point that they demanded immediate reforms.

## Clean Water Reform Is Born

To understand the history (and thus the impetus) behind the reform movement intent on cleaning up our water supplies, we can trace a chronology of some of the significant events precipitated by environmental organizations and citizens groups that have occurred since the mid-1960s:*

1. Americans came face-to-face with the grim condition of the nation's waterways in 1969, when the industrial-waste-laden Cuyahoga River caught on fire. That same year, waste from food-processing plants killed almost 30 million fish in Lake Thonotosassa, Florida.
2. In 1972, Congress enacted the Clean Water Act (after having overridden President Nixon's veto). The passage of the Clean Water Act has been called "literally a life-or-death proposition for the nation."

* Adapted from Anon., Clean water timeline, *The Planet Newsletter*, 4(8) (http://www.sierraclub.org/planet/199710/time1.asp).

The Act set the goals of achieving water that is "fishable and swimmable" by 1983 and zero discharges of pollutants by 1985, in addition to prohibiting the discharge of toxic pollutants in toxic amounts.

3. In 1974, the Safe Drinking Water Act (SDWA) was passed, requiring the U.S. Environmental Protection Agency (USEPA) to establish national standards for contaminants in drinking water systems, underground wells, and sole-source aquifers, in addition to several other requirements (see Section 3.5).
4. In 1984, an alliance of the Natural Resources Defense Council, the Sierra Club, and others successfully sued Phillips ECG, a New York industrial polluter that had dumped waste into the Seneca River. According to the Sierra Club's water committee chair, Samuel Sage, the case "tested the muscles of citizens against polluters under the Clean Water Act." During this same timeframe, the Clean Water Act Reauthorization Bill drew the wrath of environmental groups, who dubbed it the "Dirty Water Act" after lawmakers added last-minute pork and weakened wetland protection and industrial pretreatment provisions. Grassroots action led to most of these pork provisions being dropped. That same year also saw the highest environmental penalty to date—$70,000, which was imposed on Alcoa Aluminum in Messina, New York (for polluting the St. Lawrence River), as a result of a suit filed by the Sierra Club.
5. In 1986, Tip O'Neill, Speaker of the House of Representatives, stated that he would not let a Clean Water Act reauthorization bill on the floor without the blessing of environmental groups. Later, after the bill was crafted and passed by Congress, President Reagan vetoed the bill. Also in 1986, amendments to the Safe Drinking Water Act directed the USEPA to publish a list of drinking water contaminants that require legislation.
6. In 1987, the Clean Water Act was reintroduced. It became law after Congress overrode President Reagan's veto. A new provision established the National Estuary Program.
7. From 1995 to 1996, the House passed H.R. 961 (again dubbed the "Dirty Water Act"), which in some cases eliminated standards for water quality, wetlands protection, sewage treatment, and agricultural and urban runoff. The Sierra Club collected over 1 million signatures in support of the Environmental Bill of Rights and released "Danger on Tap," a report that revealed polluter contributions to friends in Congress who wanted to gut the Clean Water Act. Due in part to these efforts, the bill was stopped in the Senate.
8. In 1997, the USEPA reported that more than one-third of the country's rivers and half of its lakes were still unfit for swimming or fishing. The Sierra Club successfully sued the USEPA to enforce Clean Water

Act regulations in Georgia. The state was required to identify polluted waters and establish their pollution-load capacity. Similar suits were filed in other states; for example, in Virginia, Smithfield Foods was assessed a penalty of more than $12 million—the highest ever—for violating the Clean Water Act by discharging phosphorus and other hog waste products into a tributary of the Chesapeake Bay.

This chronology of events presents only a handful of the significant actions taken by Congress (with the helpful prodding and guidance of the Sierra Club and the National Resources Defense Council, as well as others) in enacting legislation and regulations to protect our nation's waters. No law has been more important to furthering this effort than the Clean Water Act, which we discuss in the following section.

**DID YOU KNOW?**

There are approximately 155,000 public water systems in the United States. The USEPA classifies these water systems according to the number of people they serve, the source of their water, and whether they serve the same customers year-round or on an occasional basis.

## Clean Water Act*

Concern with the disease-causing pathogens residing in many of our natural waterways was not what grabbed Joe and Nancy Citizen's attention with regard to the condition and health of the country's waterways. Instead, it was the aesthetic qualities of watercourses. Americans in general have a strong emotional response to the beauty of nature, and they acted to prevent pollution and degradation of our nation's waterways simply because many of us expect rivers, waterfalls, and mountain lakes to be natural and naturally beautiful—in the state they were intended to be, pure and clean.

Much of this emotional attachment to the environment can be traced back to the sentimentality characteristic of the popular literature and art of American writers and painters in the early 19th century. From Longfellow's *Song of Hiawatha* to Twain's *Huckleberry Finn* to the landscapes of Winslow Homer and the vistas of the Hudson River School painters, American culture abounds with expressions of this singularly strong attachment. As the saying goes: "Once attached, detachment is never easy."

* Much of the information contained in this section is from USEPA, Clean Water Act, U.S. Environmental Protection Agency, Washington, DC, 1996 (http://www.epa.gov/lawsregs/laws/cwa.html).

Federal water pollution legislation dates back to the turn of the century, to the Rivers and Harbors Act of 1899, although the Clean Water Act stems from the Federal Water Pollution Control Act, which was originally enacted in 1948 to protect surface waters such as lakes, rivers, and coastal areas. That act was significantly expanded and strengthened in 1972 in response to growing public concern over serious and widespread water pollution problems. The 1972 legislation provided the foundation for our dramatic progress in reducing water pollution over the past several decades. Amendments to the 1972 Clean Water Act were made in 1977, 1981, and 1987.

The Clean Water Act focuses on improving water quality by maintaining and restoring the physical, chemical, and biological integrity of the nation's waters. It provides a comprehensive framework of standards, technical tools, and financial assistance to address the many stressors that can cause pollution and adversely affect water quality, including municipal and industrial wastewater discharges, polluted runoff from urban and rural areas, and habitat destruction. The Clean Water Act requires national performance standards for major industries (such as iron and steel manufacturing and petroleum refining) that provide a minimum level of pollution control based on the best technologies available. These national standards result in the removal of over a billion pounds of toxic pollution from our waters every year.

The Clean Water Act also establishes a framework whereby states and Indian tribes survey their waters, determine an appropriate use (such as recreation or water supply), then set specific water quality criteria for various pollutants to protect those uses. These criteria, together with the national industry standards, are the basis for permits that limit the amount of pollution that can be discharged to a water body. Under the National Pollutant Discharge Elimination System (NPDES), sewage treatment plants and industries that discharge wastewater are required to obtain permits and to meet the specified limits in those permits.

---

***Note:*** The Clean Water Act requires the USEPA to set effluent limitations. All dischargers of wastewaters to surface waters are required to obtain NPDES permits, which require regular monitoring and reporting.

---

The Clean Water Act also provides federal funding to help states and communities meet their clean water infrastructure needs. Since 1972, federal funding has provided more than $66 billion in grants and loans, primarily for building or upgrading sewage treatment plants. Funding is also provided to address another major water quality problem—polluted runoff from urban and rural areas.

Protecting valuable aquatic habitat—wetlands, for example—is another important component of this law. American waterways have suffered loss and degradation of biological habitat, a widespread cause of the decline in the health of aquatic resources. When Europeans colonized this continent, North America held approximately 221 million acres of wetlands. Today, most of those wetlands are gone. At least 22 states have lost 50% or more of their original acreage of wetlands, and 10 states have lost about 70% of their wetlands.

The Clean Water Act sections dealing with wetlands have become extremely controversial. Wetlands are among our nation's most fragile ecosystems and play a valuable role in maintaining regional ecology and preventing flooding, while serving as home to numerous species of insects, birds, and animals; however, wetlands also represent significant potential monetary value in the eye of private landowners and developers. Herein lies the major problem. Many property owners feel they are being unfairly penalized by a Draconian regulation that restricts their right to develop their own property.

Alternative methods that do not involve destroying the wetlands do exist. These methods include wetlands mitigation and mitigation banking. Since 1972, when the Clean Water Act was passed, permits from the U.S. Army Corps of Engineers are required to work in wetland areas. To obtain these permits, builders must agree to restore, enhance, or create an equal number of wetland acres (generally in the same watershed) as those damaged or destroyed in the construction project.

Landowners are given the opportunity to balance the adverse affects by replacing environmental values that are lost. This concept is known as *wetlands mitigation*. *Mitigation banking* allows developers or public bodies that seek to build on wetlands to make payments to a "bank" for use in the enhancement of other wetlands at a designated location. The development entity purchases "credit" in the bank and transfers full mitigation responsibility to an agency or environmental organization that runs the bank. Environmental professionals design, construct, and maintain a specific natural area using these funds.

The history of the Clean Water Act is much like that of the environmental movement itself. Once widely supported and buoyed by its initial success, the Clean Water Act has encountered increasingly difficult problems, such as polluted stormwater runoff and non-point-source pollution, as well as unforeseen legalistic challenges, such as debate regarding wetlands and property rights.

Unfortunately, the Clean Water Act has achieved only part of its goal. At least one-third of the U.S. rivers, one-half of the U.S. estuaries, and more than one-half of the lakes are still not safe for such uses as swimming or fishing. At least 31 states have reported toxins in fish exceeding the action levels set the Food and Drug Administration (FDA). Every pollutant cited in an USEPA study on chemicals in fish showed up in at least one location. Water quality is seen as deteriorated and viewed as the cause of the decreasing number of shellfish in the waters.

## Safe Drinking Water Act

When we get the opportunity to travel the world, one of the first things we learn to ask is whether or not the water is safe to drink. Unfortunately, in most of the places in the world, the answer is "no." As much as 80% of all sickness in the world is attributable to inadequate water or sanitation (Masters, 1991). The American ecologist William C. Clark probably summed it up best: "If you could tomorrow morning make water clean in the world, you would have done, in one fell swoop, the best thing you could have done for improving human health by improving environmental quality." It has been estimated that three-fourths of the population in Asia, Africa, and Latin America lack a safe supply of water for drinking, washing, and sanitation (Morrison, 1983). Money, technology, education, and attention to the problem are essential for improving these statistics and to solving the problem that this West African proverb succinctly states: "Filthy water cannot be washed."

Left alone, Nature provides for us. Left alone, Nature feeds us. Left alone, Nature refreshes and sustains us with untainted air. Left alone, Nature provides and cleans the water we need to ingest to survive. As Elliot A. Norse put it, "In every glass of water we drink, some of the water has already passed through fishes, trees, bacteria, worms in the soil, and many other organisms, including people. … Living systems cleanse water and make it fit, among other things, for human consumption" (Hoage, 1985). Left alone, Nature performs at a level of efficiency and perfection we cannot imagine. The problem, of course, is that our human populations have grown too large to allow Nature to be left alone.

Our egos allow us to think that humans are the real reason Nature exists at all. In our eyes, our infinite need for water is why Nature works its hydrologic cycle—to provide the constant supply of drinking water we need to sustain life—but the hydrologic cycle itself is unstoppable, human activity or not. Bangs and Kallen (1985) summed it up best: "Of all our planet's activities—geological movements, the reproduction and decay of biota, and even the disruptive propensities of certain species (elephants and humans come to mind)—no force is greater than the hydrologic cycle."

Nature, through the hydrologic cycle, provides us with an apparently endless supply of water; however, developing and maintaining an adequate supply of safe drinking water requires the coordinated efforts of scientists, technologists, engineers, planners, water plant operators, and regulatory officials. In this section, we concentrate on the regulations that have been put into place in the United States to protect our water supplies and ensure that they are safe, fresh, and palatable.

Legislation to protect drinking water quality in the United States dates back to the Public Health Service Act of 1912. With time, the Act evolved, but not until passage of the Safe Drinking Water Act (SDWA) in 1974 (amended 1986,

1996) was federal responsibility extended beyond intestate carriers to include all community water systems serving 15 or more outlets, or 25 or more customers. Prompted by public concern over findings of harmful chemicals in drinking water supplies, the law established the basic federal–state partnership for drinking water that is used today. It focuses on ensuring safe water from public water supplies and on protecting the nation's aquifers from contamination. Before we examine the basic tenets of the SDWA, we must define several of the terms used in the Act.

### SDWA Definitions*

*Action level (AL)*—The amount required to trigger treatment or other action.

*Best management practices (BMPs)*—Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States.

*Consumer Confidence Report (CCR) or annual drinking water quality report*—An annual water quality report that a community water system is required to provide to its customers. The CCR helps people make informed choices about the water they drink by letting people know what contaminants, if any, are in their drinking water and how these contaminants may affect their health. The CCR also gives the system a chance to tell customers what it takes to deliver safe drinking water.

*Contaminant*—Any physical, chemical, biological, or radiological substance or matter in water.

*Discharge of a pollutant*—Any addition of any pollutant to navigable waters from any point source.

*Exemption*—A document issued to water systems having technical and financial difficulty meeting national primary drinking water regulations; it is effective for 1 year and is granted by the USEPA due to compelling factors.

*Likely source*—Where a contaminant could have come from.

*Maximum contaminant level (MCL)*—The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

*Maximum contaminant level goal (MCLG)*—The level at which no known or anticipated adverse effects on the health of persons occur and which allows an adequate margin of safety.

*Maximum residual disinfectant level (MRDL)*—The highest level of a disinfectant allowed in drinking water.

* These definitions are adapted from 40 CFR 122.2, SDWA §1401, and CWA §502.

*Maximum residual disinfectant level goal (MRDLG)*—The level of a drinking water disinfectant below which there is no known or expected risk to health.

*Microbiological contaminants*—Used as indicators that other, potentially harmful bacteria may be present

*National Pollutant Discharge Elimination System (NPDES)*—The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, in addition to imposing and enforcing pretreatment requirements, under Sections 307, 402, 318, and 405 of the Clean Water Act.

*Navigable waters*—Waters of the United States, including territorial seas.

*pCi/L*—Picocuries per liter (measure of radioactivity).

*Person*—An individual, corporation, partnership, association, state, municipality, commission, or political subdivision of a state or any interstate body.

*Point source*—Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.

*Pollutant*—Dredged soil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials (except those regulated under the Atomic Energy Act of 1954), heat, wrecked or discarded equipment, rock, sand, cellar dirt, or industrial, municipal, and agricultural waste discharged into water. It does not include: (a) sewage from vessels, or (b) water, gas, or other material that is injected into a well to facilitate production of oil or gas, or water derived in association with oil and gas production and disposed of in a well, if the well used either to facilitate production or for disposal purposes is approved by authority of the state in which the well is located, and if the state determines that the injection or disposal will not result in the degradation of ground or surface water sources.

*Public water system (PWS)*—A system for the provision to the public of piped water for human consumption, if such system has at least 15 service connections or regularly serves at least 25 individuals.

*Publicly owned treatment works (POTW)*—Any device or system used in the treatment of municipal sewage or industrial wastes of a liquid nature which is owned by a state or municipality. This definition includes sewer, pipes, or other conveyances only if they convey wastewater to a POTW providing treatment.

*Recharge zone*—The area through which water enters a sole or principal source aquifer.

*Regulated substances*—Substances regulated by the USEPA and that cannot be present at levels above the MCL.

*Significant hazard to public health*—Any level of contaminant that causes or may cause the aquifer to exceed any maximum contaminant level set forth in any promulgated National Primary Drinking Water Regulations at any point where the water may be used for drinking purposes or which may otherwise adversely affect the health of persons, or which may require a public water system to install additional treatment to prevent such adverse effect.

*Sole or principal source aquifer*—An aquifer that supplies 50% or more of the drinking water for an area.

*Streamflow source zone*—Upstream headwaters areas that drain into an aquifer recharge zone.

*Toxic pollutants*—Pollutants that after discharge and upon exposure, ingestion, inhalation, or assimilation into any organism will, on the basis of the information available, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, or physical deformations in such organisms or their offspring.

*Treatment technique (TT)*—A required process intended to reduce the level of a substance in drinking water.

*Turbidity*—A measure of the cloudiness of water; turbidity is not necessarily harmful but can interfere with the disinfection of drinking water.

*Unregulated monitored substances*—Substances that are not regulated by the USEPA but must be monitored so information about their presence in drinking water can be used to develop limits.

*Variance*—A document issued to water systems having technical and financial difficulty meeting national primary drinking water regulations; it postpones compliance when such a delay will not result in an unreasonable risk to health.

*Waters of the United States*—(a) All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters that are subject to the ebb and flow of the tide; (b) all interstate waters, including interstate wetlands; (c) all other waters, such as interstate lakes, rivers, streams, mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce.

*Wetlands*—Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

## SDWA Specific Provisions

To ensure the safety of public water supplies, the Safe Drinking Water Act requires the USEPA to set safety standards for drinking water. Standards are now in place for over 80 different contaminants. The USEPA sets a maximum level for each contaminant; however, in cases where making this distinction is not economically or technologically feasible, the USEPA specifies an appropriate treatment technology instead. Water suppliers must test their drinking water supplies and maintain records to ensure quality and safety. Most states carry the responsibility for ensuring that their public water supplies are in compliance with the national safety standards. Provisions also authorize the USEPA to conduct basic research on drinking water contamination, to provide technical assistance to states and municipalities, and to provide grants to states to help them manage their drinking water programs. To protect groundwater supplies, the law provides a framework for managing underground injection compliance. As part of that responsibility, the USEPA may disallow new underground injection wells based on concerns over possible contamination of a current or potential drinking water aquifer.

Each state is expected to administer and enforce the SDWA regulations for all public water systems. Public water systems must provide water treatment, ensure proper drinking water quality through monitoring, and provide public notification of contamination problems. The 1986 amendments to the SDWA significantly expanded and strengthened its protection of drinking water. Under the 1986 provisions, the SDWA required six basic activities:

- *Establishment and enforcement of maximum contaminant levels (MCLs)*—As stated earlier, these are the maximum levels of certain contaminants that are allowed in drinking water from public systems. Under the 1986 amendments, the USEPA has set numerical standards or treatment techniques for an expanded number of contaminants.
- *Monitoring*—The USEPA requires monitoring of all regulated and certain unregulated contaminants, depending on the number of people served by the system, the source of the water supply, and the contaminants likely to be found.
- *Filtration*—The USEPA has criteria for determining which systems are obligated to filter water from surface water sources.
- *Disinfection*—The USEPA must develop rules requiring all public water supplies to disinfect their water.

- *Use of lead materials*—The use of solder or flux containing more than 0.2% lead or pipes and pipe fittings containing more than 8% lead is prohibited in public water supply systems. Public notification is required where lead is used in construction materials of the public water supply system or where water is sufficiently corrosive to cause leaching of lead from the distribution system or lines.
- *Wellhead protection*—All states are required to develop wellhead protection programs designed to protect public water supplies from sources of contamination.

The USEPA developed the *National Drinking Water Regulations* to meet the requirements of the SDWA. These regulations are subdivided into National Primary Drinking Water Regulations (40 CFR 141), which specify maximum contaminant levels (MCLs) based on health-related criteria, and the National Secondary Drinking Water Regulations (40 CFR 143), which are unenforceable guidelines based on aesthetic qualities, such as taste, odor, and color of drinking water, as well as on nonaesthetic qualities, such as corrosivity and hardness. In setting MCLs, the USEPA is required to balance the public health benefits of the standard against what is technologically and economically feasible. In this way, MCLs are different from other set standards, such as National Ambient Air Quality Standards (NAAQS), which must be set at levels that protect public health regardless of cost or feasibility (Masters, 1991).

---

***Note:*** If monitoring the contaminant level in drinking water is not economically or technically feasible, the USEPA must specify a treatment technique that will effectively remove the contaminant from the water supply or reduce its concentration. The MCLs currently cover a number of volatile organic chemicals, organic chemicals, inorganic chemicals, and radionuclides, as well as microorganisms and turbidity (cloudiness or muddiness). The MCLs are based on an assumed human consumption of 2 liters (roughly 2 quarts) of water per day.

---

The USEPA also creates unenforceable maximum contaminant level goals (MCLGs), which are set at levels that present no known or anticipated health effects and include a margin of safety, regardless of technological feasibility or cost. The USEPA is also required (under SDWA) to periodically review the actual MCLs to determine whether they can be brought closer to the desired MCLGs.

---

***Note:*** For noncarcinogens, MCLGs are arrived at in a three-step process. The first step is calculating the *reference dose (RfD)* for each specific contaminant. The RfD is an estimate of the amount of a chemical that a person can be exposed to on a daily basis that is not anticipated to cause adverse systemic health effects over the person's lifetime. A different assessment system is used for chemicals that are potential carcinogens. If toxicological evidence leads to the classification of the contaminant as a human or probable human carcinogen, the MCLG is set at zero (Boyce, 1997).

#### ***National Primary Drinking Water Regulations***

Categories of primary contaminants include *organic chemicals*, *inorganic chemicals*, *microorganisms*, *turbidity*, and *radionuclides*. Except for some microorganisms and nitrate, water that exceeds the listed MCLs will pose no immediate threat to public health; however, all of these substances must be controlled, because drinking water that exceeds the standards over long periods of time may be harmful.

***Note:*** As we learn more from research about the health effects of various contaminants, the number of regulated organics is likely to grow. Public drinking water supplies must be sampled and analyzed for organic chemicals at least every 3 years.

##### *Organic Chemicals*

Organic contaminants for which MCLs are being promulgated are classified into the following three groupings: *synthetic organic chemicals* (SOCs), *volatile organic chemicals* (VOCs), and *trihalomethanes* (THMs). Table 3.1 provides a partial list of maximum allowable levels for several selected organic contaminants. Synthetic organic chemicals are manmade and are often toxic to living organisms. These compounds are used in the manufacture of a wide variety of agricultural and industrial products. This group includes primarily PCBs, carbon tetrachloride, pesticides and herbicides such as 2.4-D, aldicarb, chlordane, dioxin, xylene, phenols, and thousands of other synthetic chemicals.

***Note:*** A 1995 study of 29 Midwestern cities and towns by the Washington, DC-based nonprofit Environmental Working Group found pesticide residues in the drinking water in nearly all of them. In Danville, Illinois, the level of cyanazine, a weed killer manufactured by DuPont, was 34 times the federal standard. In Fort Wayne, Indiana, one glass of tap water contained nine kinds of pesticides. The fact is, each year, approximately 2.6 billion pounds of pesticides are used in the United States (Lewis, 1996). These pesticides find their way into water supplies and thus present increased risk to public health.

Volatile organic chemicals are synthetic chemicals that readily vaporize at room temperature. Chemicals used in degreasing agents, paint thinners, glues, dyes, and some pesticides fall into this category. VOCs include benzene, carbon tetrachloride, 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and vinyl chloride.

**TABLE 3.1**

Selected Primary Standard Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs) for Organic Chemicals

| Contaminant | Health Effects | MCL/MCLG (mg/L) | Sources |
|---|---|---|---|
| Aldicarb | Nervous system effects | 0.003/0.001 | Insecticide |
| Benzene | Possible cancer risk | 0.005/0 | Industrial chemicals, paints, plastics, pesticides |
| Carbon tetrachloride | Possible cancer risk | 0.005/0 | Cleaning agents, industrial wastes |
| Chlordane | Possible cancer | 0.002/0 | Insecticide |
| Endrin | Nervous system, liver, kidney effects | 0.002/0.002 | Insecticide |
| Heptachlor | Possible cancer | 0.0004/0 | Insecticide |
| Lindane | Nervous system, liver, kidney effects | 0.0002/0.0002 | Insecticide |
| Pentachlorophenol | Possible cancer risk, liver, kidney effects | 0.001/0 | Wood preservative |
| Styrene | Liver, nervous system effects | 0.1/0.1 | Plastics, rubber, drug industry |
| Toluene | Kidney, nervous system, liver, circulatory effects | 1/1 | Industrial solvent, gasoline additive chemical manufacturing |
| Total trihalomethanes | Possible cancer risk | 0.1/0 | Chloroform, drinking water chlorination byproduct |
| Trichloroethylene | Possible cancer risk | 0.005/0 | Waste from disposal of dry-cleaning material and manufacture of pesticides, paints, and waxes; metal degreaser |
| Vinyl chloride | Possible cancer | 0.002/0 | May leach from PVC pipe |
| Xylene | Liver, kidney, nervous system effects | 10/10 | Gasoline refining byproduct, paint, ink, detergent |

*Source:* USEPA, *Is Your Drinking Water Safe?*, U.S. Environmental Protection Agency, Washington, DC, 1994; USEPA, *National Primary Drinking Water Regulations*, U.S. Environmental Protection Agency, Washington, DC, 2009.

***Note:*** VOCs are particularly dangerous in water. They are absorbed through the skin through contact with water—for example, every shower or bath. Hot water allows these compounds to evaporate rapidly, and they are harmful if inhaled. VOCs can be present in any tap water, regardless of location or water source. If tap water contains significant levels of these compounds, they pose a health threat from skin contact, even if the water is not ingested (Ingram, 1991).

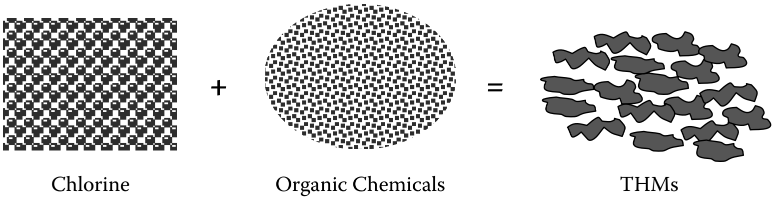


**FIGURE 3.1**
Trihalomethanes.

Trihalomethanes are created in the water itself as byproducts of water chlorination. Chlorine (present in essentially all U.S. tap water) combines with organic chemicals to form THMs (see Figure 3.1). They include chloroform, bromodichloromethane, dibormochloromethane, and bromoform.

**DID YOU KNOW?**

The abbreviation mg/L stands for milligrams per liter. In metric units, this is used to express the weight of a chemical dissolved in 1 liter of water. One liter is equal to about 1 quart, and 1 ounce is equal to about 28,500 milligrams, so 1 milligram is very small amount. About 25 grains of sugar weigh 1 milligram.

***Note:*** THMs are known carcinogens—substances that increase the risk of getting cancer—and they are present at varying levels in all public tap water.

*Inorganic Chemicals*

Several inorganic substances (particularly lead, arsenic, mercury, and cadmium) are of public health importance. These inorganic contaminants and others contaminate drinking water supplies as a result of natural processes, environmental factors, or, more commonly, human activity. Some of these are listed in Table 3.2. For most inorganics, MCLs are the same as MCLGs, but the MCLG for lead is zero.

*Microorganisms (Microbiological Contaminants)*

This group of contaminants includes bacteria, viruses, and protozoa, which can cause typhoid, cholera, and hepatitis, as well as other waterborne diseases. Bacteria are closely monitored in water supplies because they can be dangerous and because their presence is easily detected. Because tests designed to detect individual microorganisms in water are difficult to perform, in actual practice a given water supply is not tested by individually testing for specific pathogenic microorganisms. Instead, a simpler technique is used, based

**TABLE 3.2**

Selected Primary Standard MCLs for Inorganic Chemicals

| Contaminant | Health Effects | Maximum Contaminant Level (MCL) (mg/L) | Sources |
|---|---|---|---|
| Arsenic | Nervous system effects | 0.010 | Geological, pesticide residues, industrial waste, smelter operations |
| Asbestos | Possible cancer | 7 MFL[a] | Natural mineral deposits, air-conditioning pipe |
| Barium | Circulatory system effects | 2 | Natural mineral deposits, paint |
| Cadmium | Kidney effects | 0.005 | Natural mineral deposits, metal finishing |
| Chromium | Liver, kidney, digestive system effects | 0.1 | Natural mineral deposits, metal finishing, textile and leather industries |
| Copper | Digestive system effects | TT[b] | Corrosion of household plumbing, natural deposits, wood preservatives |
| Cyanide | Nervous system effects | 0.2 | Electroplating, steel, plastics, fertilizer |
| Fluoride | Dental fluorosis, skeletal effects | 4 | Geological deposits, drinking water additive, aluminum industries |
| Lead | Kidney, nervous system effects; toxic to infants | TT | Corrosion of lead service lines and fixtures |
| Mercury | Kidney, nervous system effects | 0.002 | Industrial manufacturing, fungicide, natural mineral deposits |
| Nickel | Heart, liver effects | 0.1 | Electroplating, batteries, metal alloys |
| Nitrate | Blue-baby effect | 10 | Fertilizers, sewage, soil and mineral deposits |
| Selenium | Liver effects | 0.05 | Natural deposits, mining, smelting |

*Source:* USEPA, *Is Your Drinking Water Safe?* U.S. Environmental Protection Agency, Washington, DC, 1994; USEPA 816-F-09-004, May 2009.

*Note:* The nitrate level is set at 10 mg/L, because nitrate levels above 10 mg/L pose an immediate threat to children under 1 year old. Excessive levels of nitrate can react with hemoglobin in blood to produce an anemic condition known as "blue babies." Treated water is sampled and tested for inorganics at least once per year (Nathanson, 1997).

[a] Million fibers per liter.

[b] Treatment techniques have been set for lead and copper because the occurrence of these chemicals in drinking water usually results from corrosion of plumbing materials. All systems that do not meet the action level at the tap are required to improve corrosion control treatment to reduce the levels. The action level for lead is 0.015 mg/L; for copper, it is 1.3 mg/L.

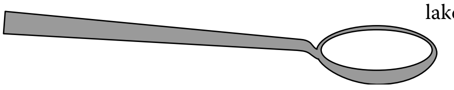


**FIGURE 3.2**
Viruses in a teaspoon of unpolluted lake water. (Adapted from Ingram, C., *The Drinking Water Book: A Complete Guide to Safe Drinking Water*, 1991, Ten Speed Press, Berkeley, CA, p. 17.)

on testing water for evidence of any fecal contamination. Coliform bacteria are used as indicator organisms whose presence suggests that the water is contaminated. In testing for total coliforms, the number of monthly samples required is based on the population served and the size of the distribution system. Because the number of coliform bacteria excreted in feces is on the order of 50 million per gram and the concentration of coliforms in untreated domestic wastewater is usually several million per 100 mL, it is highly unlikely that water contaminated with human wastes would have no coliforms. That conclusion is the basis for the drinking water standard for microbiological contaminants, which specifies in essence that, on the average, water should contain no more than 1 coliform per 100 mL. The SDWA standards now require that coliforms not be found in more than 5% of the samples examined during a 1-month period. Known as the *presence/absence concept*, it replaces previous MCLs based on the number of coliforms detected in the sample. Viruses are very common in water. If we removed a teaspoonful of water from an unpolluted lake, over 1 billion viruses would be present in the water (Figure 3.2). The two most common and troublesome protozoans found in water are *Giardia* and *Cryptosporidium* (or *Crypto*). In water, these protozoans occur in the form of hard-shelled cysts. Their hard covering makes them resistant to chlorination and chlorine residual that kills other organisms. We cover microorganisms commonly found in water in much greater detail in Chapter 6.

*Turbidity*

Turbidity, a measure of fine suspended matter in water, is primarily caused by clay, silt, organic particulates, plankton, and other microscopic organisms, ranging in size from colloidal to coarse dispersion. Turbidity in the water is expressed in *nephelometric turbidity units* (NTUs), which represent the amount of light scattered or reflected from the water. Turbidity is officially reported in standard units known as Jackson turbidity units, which are equivalent to milligrams per liter of silica (diatomaceous earth) that could cause the same optical effect. Turbidity testing is not required for groundwater sources.

*Radionuclides*

Radioactive contamination of drinking water is a serious matter. Radionuclides (the radioactive metals and minerals that cause this contamination) come from both natural and manmade sources. Naturally

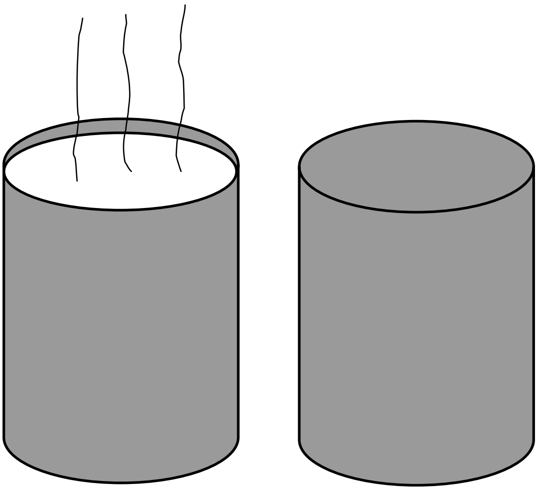


**FIGURE 3.3**
Radon.

occurring radioactive minerals move from underground rock strata and geologic formations into the underground streams flowing through them and primarily affect groundwater. In water, radium-226, radium-228, radon-222, and uranium are the natural radionuclides of most concern. Uranium is typically found in groundwater and, to a lesser degree, in some surface waters. Radium in water is found primarily in groundwater. Radon, a colorless, odorless gas and a known cancer-causing agent, is created by the natural decay of minerals. Radon is an unusual contaminant in water, because the danger arises not from drinking radon-contaminated water but from breathing the gas after it has been released into the air. Radon dissipates rapidly when exposed to air (see Figure 3.3). When present in household water, it evaporates easily into the air, where household members may inhale it. Some experts believe that the effects of radon inhalation are more dangerous than those of any other environmental hazard. Manmade radionuclides (more than 200 are known) are believed to be potential drinking water contaminants. Manmade sources of radioactive minerals in water are nuclear power plants, nuclear weapons facilities, radioactive materials disposal sites, and docks for nuclear-powered ships.

### *National Secondary Drinking Water Regulations*

The National Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color)

**TABLE 3.3**

National Secondary Drinking Water Standards

| Contaminant | Suggested Levels | Contaminant Effects |
|---|---|---|
| Aluminum | 0.05–0.2 mg/L | Discoloration of water |
| Chloride | 250 mg/L | Salty taste, corrosion of pipes |
| Color | 15 color units | Visible tint |
| Copper | 1.0 mg/L | Metallic taste, blue–green staining of porcelain |
| Corrosivity | Noncorrosive | Metallic taste, fixture staining, corroded pipes (corrosive water can leach pipe materials, such as lead, into drinking water) |
| Fluoride | 2.0 mg/L | Dental fluorosis (a brownish discoloration of the teeth) |
| Foaming agents | 0.5 mg/L | Aesthetic: frothy, cloudy, bitter taste, odor |
| Iron | 0.3 mg/L | Bitter metallic taste, staining of laundry, rusty color, sediment |
| Manganese | 0.05 mg/L | Taste, staining of laundry, black to brown color, black staining |
| Odor | 3 threshold odor number | Rotten egg, musty, or chemical smell |
| pH | 6.5–8.5 | Low pH—bitter metallic taste, corrosion<br>High pH—slippery feel, soda taste, deposits |
| Silver | 0.1 mg/L | Argyria (discoloration of skin), graying of eyes |
| Sulfate | 250 mg/L | Salty taste, laxative effects |
| Total dissolved solids (TDS) | 500 mg/L | Taste, possible relation between low hardness and cardiovascular disease, indicator of corrosivity (related to lead levels in water), damage to plumbing, limited effectiveness of soaps and detergents |
| Zinc | 5 mg/L | Metallic taste |

*Source:* USEPA, *Fact Sheet: National Secondary Drinking Water Standards*, U.S. Environmental Protection Agency, Washington, DC, 1991; USEPA, *Is Your Drinking Water Safe?* U.S. Environmental Protection Agency, Washington, DC, 1994.

in drinking water. A range of concentrations is established for substances that affect water only aesthetically and have no direct effect on public health. We present secondary standards in Table 3.3.

## 1996 Amendments to SDWA

After more than 3 years of effort, the Safe Drinking Water Act Reauthorization (one of the most significant pieces of environmental legislation passed to date) was adopted by Congress and signed into law by President Clinton on August 6, 1996. The new streamlined version of the original SDWA gives states greater flexibility in identifying and considering the likelihood for contamination in potable water supplies and in establishing monitoring criteria. It establishes increased reliance on “sound science” instead of "feel-good science," paired with more consumer information presented in readily understandable form, and calls for increased attention to assessment and protection of source waters. The significance of the 1996 SDWA amendments lies in the fact that they are a radical rewrite of the law that the USEPA, states, and water systems had been trying to implement for the past 10 years. In contrast to the 1986 amendments (which were crafted with little substantive input from the regulated community and embraced a command-and-control approach with compliance costs rooted in water rates), the 1996 amendments were developed with significant contributions from water suppliers and state and local officials and embody a partnership approach that includes major new infusions of federal funds to help water utilities—especially the thousands of smaller systems—comply with the law. In Table 3.4, we provide a summary of many of the major provisions of the new amendments, which are as complex as they are comprehensive.

## Implementing SDWA

On December 3, 1998, at the oceanfront of Fort Adams State Park, Newport, Rhode Island, in remarks by President Clinton to the community of Newport, a significant part of the 1996 SDWA and amendments were announced—the expectation being that the new requirements would protect most of the nation from dangerous contaminants while adding only about $2 to many monthly water bills. The rules require approximately 13,000 municipal water suppliers to use better filtering systems to screen out *Cryptosporidium* and other microorganisms, ensuring that U.S. community water supplies are safe from microbial contamination. In his speech, President Clinton said:

> This past summer I announced a new rule requiring utilities across the country to provide their customers regular reports on the quality of their drinking water. When it comes to the water our children drink, Americans cannot be too vigilant.
>
> Today I want to announce three other actions I am taking. First, we're escalating our attack on the invisible microbes that sometimes creep into the water supply. … Today, the new standards we put in place will significantly reduce the risk from *Cryptosporidium* and other microbes, to ensure that no community ever has to endure an outbreak like the one Milwaukee suffered.
>
> Second, we are taking steps to ensure that when we treat our water, we do it as safely as possible. One of the great health advances to the 20th century is the control of typhoid, cholera, and other diseases with disinfectants. Most of the children in this audience have never heard of typhoid and cholera, but their grandparents cowered in fear of it, and their great-grandparents took it as a fact of life that it would take away significant numbers of the young people of their generation. But as with so many advances, there are tradeoffs. We now see that some of the disinfectants we use to protect our water can actually combine with natural substances to create harmful compounds. So today I'm

> announcing standards to significantly reduce our exposure to these harmful byproducts, to give our families greater peace of mind with their water.
>
> The third thing we are doing today is to help communities meet higher standards, releasing almost $800 million to help communities in all 50 states to upgrade their drinking water systems … to give 140 million Americans safer drinking water.

### *Consumer Confidence Report Rule*

In his comments provided above, President Clinton mentioned the requirement of community water systems to put *annual drinking water quality reports* into the hands of their customers (see Table 3.4). While water systems are free to enhance their reports in any useful way, each report must provide consumers with the following fundamental information about their drinking water:

- *The lake, river, aquifer, or other source of the drinking water.* Consider the following actual report provided by a city we will refer to here as Capital City:

  > Capital City receives its raw (untreated) water from eight reservoirs, two rivers, and four deep wells. From these sources, raw water is pumped to one of the Department of Utilities' two water treatment plants, where it is filtered and disinfected. Once tested for top quality, Capital City drinking water is pumped on demand to your tap.

- *A brief summary of the susceptibility to contamination of the local drinking water source, based on the source water assessments by states.* Consider the following actual information provided by Capital City.

  > Contaminants that may be present in source (raw) water include
  >
  > – **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, wildlife
  >
  > – **Inorganic contaminants**, such as salts and metals, which can be naturally occurring or result from urban stormwater runoff, industrial or domestic; wastewater discharges; oil and gas production; mining; or farming
  >
  > – **Pesticides and herbicides**, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses
  >
  > – **Radioactive contaminants**, which can be naturally occurring or the result of oil and gas production and mining activities

**TABLE 3.4**

Summary of Major Amendment Provisions for the 1996 SDWA Regulations

| | |
|---|---|
| Definition | *Constructed conveyances*, such as cement ditches, used primarily to supply substandard drinking water to farm workers are now SDWA protected |
| Contaminant regulation | Old contamination selection requirement (USEPA regulates 25 new contaminants every 3 years) was deleted.<br>USEPA must evaluate at least 5 contaminants for regulation every 5 years, addressing the most risky first, and considering vulnerable populations.<br>USEPA must issue *Cryptosporidium* rule (enhanced Surface Water Treatment Rule) and disinfection byproduct rules under agreed deadlines. The Senate provision giving industry veto power over USEPA's expediting the rules was deleted.<br>USEPA is authorized to address "urgent threats to health" using an expedited, streamlined process.<br>No earlier than 3 years after enactment and no later than the date USEPA adopts the State II DBP rule, USEPA must adopt a rule requiring disinfection of certain groundwater systems and provide guidance on determining which systems must disinfect. USEPA may use cost–benefit provisions to establish this regulation. |
| Risk assessment, management, and communication | Requires cost–benefit analysis, risk assessment, vulnerable population impact assessment, and development of public information materials for USEPA rules.<br>Allows but does not require USEPA to use risk assessment and cost–benefit analysis in setting standards. |
| Standard setting | Cuts back Senate's process to issue standards from three to two steps, deleting the requirement of Advanced Notice of Proposed Rule Making.<br>Risks to vulnerable populations must be considered.<br>Has cost–benefit and risk–risk as discretionary USEPA authority. "Sound Science" provision is limited to standard setting and scientific decisions.<br>Standard is reevaluated every 6 years instead of every 3 years. |
| Treatment technologies for small systems | Establishes new guidelines for USEPA to identify best treatment technology for meeting specific regulations.<br>For each new regulation, USEPA must identify affordable treatment technologies that achieve compliance for three categories of small systems: those serving 3301 to 10,000, those serving 501 to 3000, and those serving 500 or fewer.<br>For all contaminants other than microbials and their indicators, the technologies can include package systems as well as point-of-use and point-of-entry units owned and maintained by water systems.<br>USEPA has 2 years to list such technologies for current regulations and 1 year to list such technologies for the Surface Water Treatment Rule.<br>USEPA must identify best treatment technologies for the same system categories for use under variances. Such technologies do not have to achieve compliance but must achieve maximum reduction, be affordable, and protect public health.<br>USEPA has 2 years to identify variance technologies for current regulations. |

| | |
|---|---|
| Limited alternative to filtration | Allows systems with fully controlled pristine watersheds to avoid filtration if USEPA and state agree that health is protected through other effective inactivation of microbial contaminants.<br>USEPA has 4 years to regulate recycling of filter backwash. |
| Effective date of rules | Extends compliance time from 18 months (current law) to 3 years, with available extensions of up to 5 years total. |
| Arsenic | Requires USEPA to set new standard by 2001 using new standard setting language, after more research and consultation with the National Academy of Science (NAS). The law authorizes $2.5 million/year for 4 years for research. |
| Sulfate | USEPA has 30 months to complete a joint study with the Federal Centers for Disease Control (CDC) to establish a reliable dose–response relationship. Must consider sulfate for regulation within 5 years. If USEPA decides to regulate sulfate, it must include public notice requirements and allow alternative supplies to be provided to at-risk populations. |
| Radon | Requires USEPA to withdraw its proposed radon standard and to set a new standard in 4 years, after NAS conducts a risk assessment and a study of risk-reduction benefits associated with various mitigation measures. Authorizes cost–benefit analysis for radon, taking into account costs and benefits of indoor air radon control measures. States or water systems obtaining USEPA approval of a multimedia radon program in accordance with USEPA guidelines would only have to comply with a weaker "alternative maximum contaminant level" for radon that would be based on the contribution of outdoor radon to indoor air. |
| State primacy | Primacy states have 2 years to adopt new or revised regulations no less stringent than federal ones; they are allowed 2 or more years if USEPA finds it necessary and justified.<br>Provides states with interim enforcement authority between the time they submit their regulations to USEPA and USEPA approval |
| Enforcement and judicial review | Streamlines USEPA administrative enforcement, increases civil penalties, clarifies enforceability of lead ban and other previously ambiguous requirements, allows enforcement to be suspended in some cases to encourage system consolidation or restructuring, requires states to have administrative penalty authority, and clarifies provisions for judicial review of final USEPA actions. |
| Public right to know | "Consumer Confidence Reports" provision requires consumers be told at least annually: (1) the levels of regulated contaminants detected in tap water; (2) what the enforceable maximum contaminant levels and the health goals are for the contaminants (and what those levels mean); (3) the levels found of unregulated contaminants required to be monitored; (4) information on the system's compliance with health standards and other requirements; (5) information on the health effects of regulated contaminants found at levels above enforceable standards and on health effects of up to three regulated contaminants found at levels below USEPA enforceable health standards where health concerns may still exist; and (6) USEPA's toll-free hotline for further information.<br>Governors can waive the requirement to mail these reports for systems serving under 10,000 people, but systems must still publish the report in the paper. |

**(continued)**

**TABLE 3.4 (continued)**

Summary of Major Amendment Provisions for the 1996 SDWA Regulations

| | |
|---|---|
| Public right to know (cont.) | Systems serving 500 or fewer people need only prepare the report and tell their customers it is available.<br>States can later modify the content and form of the reporting requirements.<br>The public information provision modestly improves public notice requirements for violations (such as requiring prominent newspaper publication instead of buried classified ads). States and USEPA must prepare annual reports summarizing violations. |
| Variances and exemptions | Provisions for small system variances make minor changes to current provisions regarding exemption criteria and schedules.<br>States are authorized to grant variances to systems serving 3300 or fewer people but need USEPA approval to grant variances to systems serving between 3301 and 10,000 people. Such variances are available only if USEPA identifies an applicable variance technology and systems install it.<br>Variances are granted only to systems that cannot afford to comply (as defined by state criteria that meet USEPA guidelines) through treatment, alternative sources, or restructuring, and when states determine that the terms of the variance ensure adequate health protection. Systems granted such variances have 3 years to comply with its terms and may be granted an extra 2 years if necessary, and states must review eligibility of such variances every 5 years thereafter.<br>Variances are not allowed for regulations adopted prior to 1986 for microbial contaminants or their indicators.<br>USEPA has 2 years to adopt regulations specifying procedures for granting or denying such variances and for informing consumers of proposed variances and pertinent public hearings. They also must describe proper operation of variance technologies and eligibility criteria. USEPA and the Federal Rural Utilities Service have 18 months to provide guidance to help states define affordability criteria.<br>USEPA must periodically review state small system variance programs and may object to proposed variances and overturn issued variances if objections are not addressed. Also, customers of a system for which a variance is proposed can petition USEPA to object.<br>New York may extend deadlines for certain small, unfiltered systems in nine counties to comply with federal filtration requirements. |
| Capacity development | States must acquire authority to ensure that community and nontransient, noncommunity systems beginning operation after October 1, 1999, have the technical, managerial, and financial capacity to comply with SDWA regulations. States that fail to acquire authority lose 20% of their annual state revolving loan fund grants.<br>States have 1 year to send USEPA a list of systems with a history of significant noncompliance and 5 years to report on the success of enforcement mechanisms and initial capacity development efforts. State primacy agencies must also provide progress reports to governors and the public. |

| | |
|---|---|
| | States have 4 years to implement strategy to help systems acquire and maintain capacity before losing portions of their Sanitation Revolving Loan Fund (SRLF) grants.<br>USEPA must review existing capacity programs and publish information within 18 months to help states and water systems implement such programs. USEPA has 2 years to provide guidance for ensuring capacity of new systems and must describe likely effects of each new regulation on capacity.<br>The law authorizes $26 million over 7 years for grants to establish small water systems technology assistance centers to provide training and technical assistance. The law also authorizes $1.5 million/year through 2003 for USEPA to establish programs to provide technical assistance aimed at helping small systems achieve and maintain compliance. |
| Operator certification | Requires all operators of community and nontransient, noncommunity systems be certified. USEPA has 30 months to provide guidance specifying minimum standards for certifying water system operators, and states must implement a certification program within 2 years or lose 20% of the SRLF grants.<br>States with such programs can continue to use them as long as USEPA determines they are substantially equivalent to its program guidelines.<br>USEPA must reimburse states for the cost of certification training for operators of systems serving 3300 or fewer people, and the law authorizes $30 million/year through 2003 for such assistance grants. |
| State supervision program | Authorizes $100 million/year through 2003 for public water system supervision grants to states.<br>Allows USEPA to reserve a state's grant should USEPA assume primacy and, if needed, use SRLF resources to cover any shortfalls in public water supply system (PWSS) appropriations. |
| Drinking water research | USEPA is authorized to conduct drinking water and groundwater research and is required to develop a strategic research plan and to review the quality of all such research. |
| Water return flows | Repeals the provision in current law that allows businesses to withdraw water from a public water system (such as for industrial cooling purposes), then to return the used water—perhaps with contamination—to the water system's pipe. |
| Enforcement | Expands and clarifies USEPA's enforcement authority in primacy and nonprimacy states and provides for public hearings regarding civil penalties ranging from $5000 to $25,000.<br>Provides enforcement relief to systems that submit a plan to address problems by consolidating facilities or management or by transferring ownership.<br>States must obtain authority to issue administrative penalties, which cannot be less than $1000/day for systems serving over 10,000 people.<br>USEPA can assess civil penalties as high as $15,000/day under its emergency powers authority. |

*Source:* Based on USEPA, *The Safe Drinking Water Act Amendments of 1996: Strengthening Protection for America's Drinking Water*, U.S. Environmental Protection Agency, Washington, D.C., 2011 (http://water.epa.gov/lawregs/guidance/sdwa/theme.cfm).

- *How to get a copy of the water system's complete source water assessment.* Consider the following taken from Capital City's Consumer Confidence Report (annual drinking water quality report):

  > For a copy of the water system's complete source water assessment and questions regarding this report contact Capital City's Water Quality Lab at xxx-xxx-xxxx. For more information about decisions affecting your drinking water quality, you may attend Capital City city council meetings. For times and agendas, call Capital City Clerk's Office at xxx-xxx.xxxx.

- *The level (or range of levels) of any contaminant found in local drinking water, as well as USEPA's health-based standard (maximum contaminant level) for comparison.*
- *The likely source of that contaminant in the local drinking water supply.*
- *The potential health effects of any contaminant detected in violation of an USEPA health standard and an accounting of the system's actions to restore safe drinking water.*
- *The water system's compliance with other drinking water-related rules.*
- *An educational statement for vulnerable populations about avoiding* Cryptosporidium.
- *Educational information on nitrate, arsenic, or lead in areas where these contaminants may be a concern.* With regard to the levels of contaminants, their possible sources, and the levels detected in local drinking water supplies, consider the information provided by Capital City to its ratepayers in the city's annual drinking water quality report for 2011, which is shown in Table 3.5.
- *Phone numbers of additional sources of information, including the water system and USEPA's Safe Drinking Water Hotline (800-426-4791).*

This information supplements public notification that water systems must provide to their customers upon discovering any violation of a contaminant standard. This annual report should not be the primary notification of potential health risks posed by drinking water; instead, it provides customers with water quality information from the previous year.

**TABLE 3.5**

Capital City's Annual Level of Contaminants Found in Local Drinking Water (2011)

| Regulated Substances | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Substance** | **Likely Source** | **Capital City's Measured Range** | **Capital City's Average Level** | **Capital City's Highest Level** | **Maximum Contaminate Level (MCL)** | **Maximum Contaminate Level Goal (MCLG)** | **Unit** | **Meets USEPA Standards** |
| Barium | Erosion of natural deposits | 27–40 | 33 | 40 | 2000 | 2000 | ppb | Yes |
| Chloramine | Drinking water disinfectant | 0.4–5.2 | 3.3 | 5.2 | 4[1a] | 4[1b] | ppm | Yes |
| Fluoride | Added to prevent tooth decay | 0.1–1.2 | 0.8 | 1.0[2] | 4 | 4 | ppm | Yes |
| Gross beta activity | Erosion of natural deposits | 3.3–3.8 | 3.6 | 3.8 | 50[3] | 0 | pCi/L | Yes |
| Haloacetic acid | Disinfection byproducts | 19–62 | 41 | 42[4] | 60 | NA | ppb | Yes |
| Nitrate as nitrogen | Disinfection byproducts, runoff | 0.12–0.45 | 0.26 | 0.45 | 10 | 10 | ppm | Yes |
| Radium 226/228 | Erosion of natural deposits | ND–08 | ND | 0.8 | 5 | 0 | pCi/L | Yes |

**(continued)**

**TABLE 3.5 (continued)**

Capital City's Annual Level of Contaminants Found in Local Drinking Water (2011)

| Regulated Substances | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Substance** | **Likely Source** | **Capital City's Measured Range** | **Capital City's Average Level** | **Capital City's Highest Level** | **Maximum Contaminate Level (MCL)** | **Maximum Contaminate Level Goal (MCLG)** | **Unit** | **Meets USEPA Standards** |
| Total organic carbon | Occurs naturally in environment | 1.9–3.4 | 2.5 | 3.1[2] | TT[5] | NA | ppm | Yes |
| Trihalomethanes | Disinfection byproducts | 20–90 | 45 | 48[4] | 80 | NA | ppb | Yes |

[1a] MRDL.
[1b] MRDLG.
[2] Highest monthly average for calendar year.
[3] USEPA considers 50 pCi/L to be the level of concern for beta particles.
[4] Highest running average of quarterly compliance samples for the calendar year.
[5] Treatment technique or a required process intended to reduce the level of contaminate in drinking water.

**Unregulated Monitored Substances**

| Substance | Likely Source | Capital City's Range | Capital City's Average Level | Capital City's Highest Level | Maximum Contaminant Level (MCL) | Unit |
|---|---|---|---|---|---|---|
| Aluminum | Erosion of natural deposits; also from addition of treatment chemicals at the water treatment plant | 0.01–0.08 | 0.05 | 0.08 | NA | ppm |
| Diethylphthalate | Personal care products and plastics | ND–2.1 | ND | 2.1 | NA | ppm |
| Manganese | Natural in the environment | ND–0.02 | ND | 0.02 | NA | ppm |
| Nickel | Corrosion of plumbing materials | ND–2 | ND | 2 | NA | ppb |
| Sodium | Natural in the environment; also from addition of treatment chemicals at water treatment plant | 9.24 | 15 | 24 | NA* | ppm |
| Sulfate | Natural in the environment | 23–31 | 27 | 31 | NA | ppm |

*For physician-prescribed "no-salt" diets, a limit of 20 ppm is suggested.

**Additional Information**

The substances listed below are not regulated by the USEPA; however, the Water Quality Lab receives calls about them and provides this information as a service to our customers.

| Substance | Capital City's Range | Capital City's Average Level | USEPA's Suggested Limit | Unit |
|---|---|---|---|---|
| Alkalinity | 13–39 | 26 | NA | ppm |
| Chloride | 10–47 | 18 | 250 | ppm |
| Hardness | 31–63 | 46 | NA | ppm |
| pH (acidity) | 6.7–9.5 | 7.7 | 6.5–8.5 | pH units |
| Silica | 6–9 | 6 | NA | ppm |
| Total dissolved solids | 100–133 | 114 | 500 | ppm |

## References and Recommended Reading


AWWA. (1995). *Water Quality*, 2nd ed. Denver, CO: American Water Works Association.

Bangs, R. and Kallen, C. (1985). *Rivergods: Exploring the World's Great Wild Rivers*. San Francisco: Sierra Club Books.

Boyce, A. (1997). *Introduction to Environmental Technology*. New York: Van Nostrand Reinhold.

Clark, W.C. (1988). Speech, Racine, Wisconsin, April.

Hoage, R.J., Ed. (1985). *Animal Extinctions: What Everyone Should Know*. Washington, DC: Smithsonian Institution Press.

Ingram, C. (1991). *The Drinking Water Book: A Complete Guide to Safe Drinking Water*. Berkeley, CA: Ten Speed Press.

Lewis, S.A. (1996). *Safe Drinking Water*. San Francisco: Sierra Club Books.

Masters, G.M. (1991). *Introduction to Environmental Engineering and Science*. Englewood Cliffs, NJ: Prentice Hall.

Morrison, A. (1983). In third world villages, a simple handpump saves lives. *Civil Engineering*, 53(10):68–72.

Nathanson, J.A. (1997). *Basic Environmental Technology: Water Supply, Waste Management, and Pollution Control*. Upper Saddle River, NJ: Prentice Hall.

Spellman, F.R. (1996). *Stream Ecology and Self-Purification: An Introduction for Wastewater and Water Specialists*. Lancaster, PA: Technomic.

USEPA. (1991). *Fact Sheet: National Secondary Drinking Water Standards*. Washington, DC: U.S. Environmental Protection Agency.

USEPA. (1994). *Is Your Drinking Water Safe?*, USEPA 810-F-94-002. Washington, DC: U.S. Environmental Protection Agency.

USEPA. (2009). *National Primary Drinking Water Regulations*, USEPA 816-F-09-004. Washington, DC: U.S. Environmental Protection Agency.