

Public Drinking Water Quality and Regulatory Guidelines That Impact Human Health

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Introduction

During the early twentieth century, scientists discovered that by providing safe drinking water infectious diseases could be avoided. Worldwide, nearly 2 million people die each year from diarrheal waterborne diseases. Of those 2 million deaths, 88 percent can be attributed to drinking unsafe water, inadequate sanitation and poor hygiene. About 1.1 billion people worldwide do not have access to an adequate supply of drinking water, and some 2.4 billion have no access to basic sanitation. Approximately, 80 percent of all infectious diseases in the world are transmitted through drinking water that has been contaminated either at its source or during transportation and storage. On a global scale, 1.8 million people die every year from diarrheal diseases, and of those deaths 90 percent are children under five.

Federal regulations were enacted to improve drinking water quality to address these concerns in the U.S. Prevention of diseases in drinking water has included removal

of harmful pollutants. The Safe Drinking Water Act (SDWA) passed by Congress in 1974 required the U.S. Environmental Protection Agency (EPA) to establish health-based goals to safeguard the nation's public drinking water supplies against both man-made and natural pollutants.

Drinking Water Regulatory Issues and Safety Guidelines

National drinking water standards apply to public water systems that receive their drinking water supply from treatment plants. However, there are no federal laws that require those who receive drinking water from a public water system to assess their water quality on a regular basis. Failure to monitor the quality of drinking water at destination sites may result in unsafe drinking water, especially in older buildings that have older plumbing and/or fixtures.

The EPA National Primary Drinking Water Regulations provide federal guidelines for enforceable drinking water standards of the

acceptable levels of various contaminants in drinking water (Table 1). The Arkansas Department of Health enforces these regulatory guidelines in the state of Arkansas. The EPA National Secondary Drinking Water Regulations provide additional drinking water guidelines that are non-enforceable for contaminants that may cause minor effects to humans (Table 2).

TABLE 1. EPA National Primary Drinking Water Regulatory Standards for acceptable maximum contaminant levels (MCL) of arsenic, copper, lead, *E. coli* and total coliform in drinking water are shown in this table. Target EPA MCL goal levels are also shown. These MCL goal levels represent EPA public health goals of levels for the potential contaminants shown.

National Primary Drinking Water Regulatory Standards		
	Milligrams Per Liter – mg/L	
Contaminant	MCL	MCL – Public Health Goal
Arsenic	0.010	0
Copper	1.3	1.3
Lead	0.015	0
<i>E. coli</i>	0	0
Total Coliform	5.0% positive samples limit for water systems that collect 40+ samples per month -one positive sample limit for water systems that collect less than 40 samples per month	0
Source: Environmental Protection Agency (EPA)		

TABLE 2. Environmental Protection Agency (EPA) National Secondary Drinking Water Regulatory Standards for acceptable maximum contaminant levels (MCL) of copper and iron in drinking water are shown in this table. These standards are not enforced by EPA, and EPA does not require states to comply.

National Secondary Drinking Water Regulatory Standards	
Contaminant	Milligrams Per Liter – mg/L MCL
Copper	1.0
Iron	0.3
Source: Environmental Protection Agency (EPA)	

Sources for Local Urban Public Drinking Water Systems

Groundwater is the drinking water source for approximately 80 percent of the public water systems of the United States. Approximately one-third of the United States population is serviced by these groundwater systems. The Sparta aquifer provides drinking water for much of eastern Arkansas. The Sparta aquifer extends from south Texas, north into Louisiana, Arkansas and Tennessee, and eastward into Mississippi and Alabama (Figure 1). Major users of the Sparta aquifer include municipalities and industries such as paper producers. Withdrawals by industry and municipalities from the Sparta aquifer began in the early 1900s. Many industries are located in eastern and southeastern Arkansas because of the abundance of high quality water from the Sparta aquifer. Many cities and communities rely exclusively upon the Sparta aquifer for their public water supply and use the water with minimal treatment. This aquifer is also used for irrigation of agricultural crops.

Significant Groundwater Contaminant Sources

The contamination of groundwater occurs both in nature and as a result of local human activities. Natural contamination of groundwater may include the breakdown of certain elements such as arsenic in the environment. Human activities that may cause groundwater contamination include industrial activities, hazardous waste sites, residential development and transportation. Nonpoint source pollution of groundwater sources originating from agriculture and animal husbandry are also a problem.

Significance of Arsenic Contaminants in Drinking Water

Arsenic is more prevalent in groundwater sources rather than surface water sources like lakes. Small communities often use groundwater for drinking water. Long-term exposure to arsenic can cause a

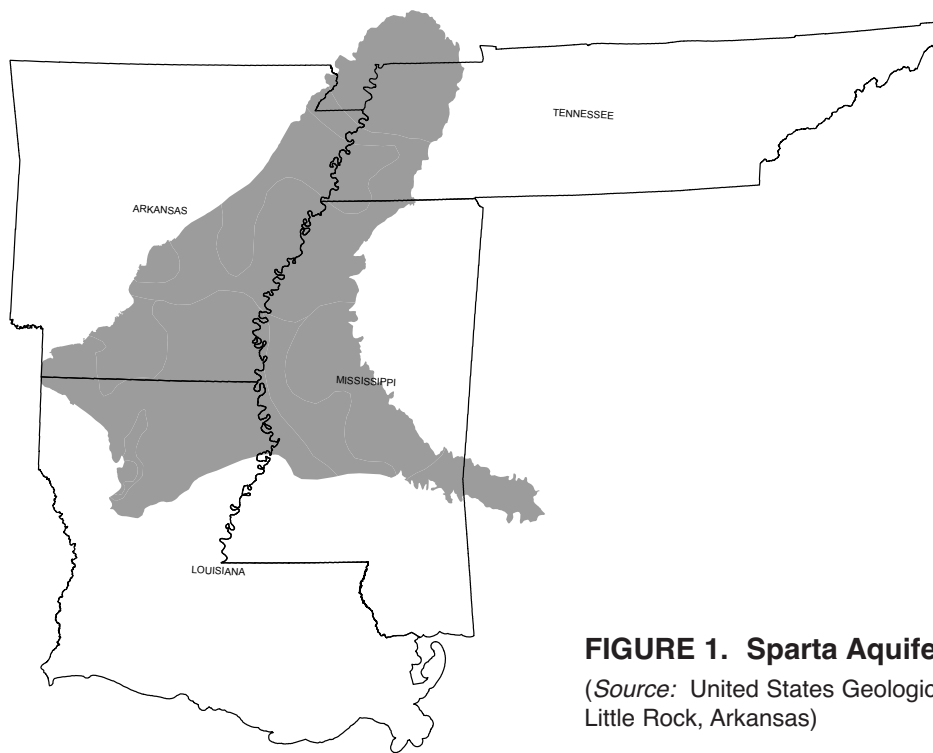


FIGURE 1. Sparta Aquifer Boundaries

(Source: United States Geological Survey, Little Rock, Arkansas)

wide range of diseases such as cancer, diabetes, skin disease and chronic cough. Arsenic may also cause toxic effects in the liver, kidney, cardiovascular system and the peripheral and central nervous system. The standard for arsenic in drinking water was revised from the 50 ppb standard set in 1975 to the current EPA standard of 10 ppb in 2001. Arsenic remains a potential health hazard in both urban and rural settings across the U.S. From 2004 to 2009, approximately 1,724 U.S.-regulated water systems serving over 11 million people exceeded the current 10 ppb standard.

Significance of *E. coli* and Total Coliform Contaminants in Drinking Water

Exposure to waterborne pathogens such as *Escherichia coli* (*E. coli*) and total coliforms may occur more frequently than previously believed. The presence of a waterborne contaminant such as the bacteria *E. coli* may remain undetected in a primary drinking water source. As a result of human consumption from that primary drinking water source on a regular basis, those who drank from that water

source regularly may have a potential immunity to the contaminant. Those who consume water from that same water source on an irregular basis, such as visitors, and develop waterborne illness may be a better indicator of the presence of a waterborne contaminant such as *E. coli* at that drinking water source. The assessment of drinking water quality relies predominantly on bacteriological characterization of a water sample where total coliforms, fecal coliforms and *E. coli* are classical indicators.

Over a five-year period, 40,000 of 156,000 ground-water systems in the U.S. failed the maximum contaminant levels for total coliforms at least once. Of all waterborne disease outbreaks between 1991 and 1998 in the U.S. in which a bacterial agent was identified as the cause of disease, coliform bacteria were present in the water samples.

Significance of Copper, Iron and Lead Contaminants in Drinking Water

High levels of lead exposure can cause stomach and intestinal distress, and liver or kidney damage. Lead may enter into drinking water through

plumbing or fixtures while in transit from water treatment plants to destination. Lead in drinking water is not a new problem. Lead has been used over time to produce pipes to carry water and later was used to solder iron and copper pipes. Lead and copper found in drinking water are generally connected to the leaching of internal plumbing materials. The longer the drinking water is in contact with the plumbing components, the greater the potential of the lead and copper leaching into the water. There is an increase in the likelihood of elevated lead levels at the tap when drinking water is in contact with plumbing components for extended periods of time.

Lead in drinking water has been a common concern in many countries including the U.S. Lead can enter treated water systems through leaching from plumbing, including tin-lead solder brass fittings, within the municipal water distribution system or inside the buildings at the destination. Two important factors influence lead levels in drinking water systems: stagnation and outlet design. Stagnation plays a key role in leaching where lead plumbing, solder or fixtures exist. Water delivered after overnight stagnation and even after shorter periods of non-use, such as between morning and midday, can contain elevated lead levels through the progressive release of lead from plumbing.

The human body cannot use lead, but will absorb and store it in various tissues, primarily bones and teeth. Lead also circulates in the blood. Infants and children absorb 40-50 percent of ingested water-soluble lead, whereas adults absorb 3-10 percent. Diets deficient in calcium, iron and/or zinc appear to increase the amount of lead that is absorbed and stored. Genetic factors that affect the efficiency of iron or calcium absorption are another factor. Exposure to cigarette smoke and lead ingestion on an empty stomach are also factors. People can excrete a small amount of the lead they breathe or swallow, but efficiency of excretion depends on age.

Although copper is essential in the diet for human health, high intakes of copper have toxic effects. Copper poisoning causes anemia and liver

disease. It is important to control the concentration of copper in natural waters and industrial wastes. The absence of calcium oxide layers in new water pipes is a factor contributing to high levels of copper in drinking water. Many water quality parameters, including pH, alkalinity, sulfate, chloride, phosphate, silicates, natural organic matter, dissolved oxygen, disinfectant residuals and temperature, can affect iron and copper release under specific conditions in drinking water distribution systems.

Significance of Pharmaceutical Contaminants in Drinking Water

Pharmaceuticals have been discovered in surface waters, groundwaters and treated drinking water. There are three main ways that household pharmaceuticals enter the environment: (1) excretion after ingestion, injection or infusion; (2) removal of topical medications during bathing; and (3) disposal of unwanted or leftover pharmaceuticals.

When a prescription drug is taken by a person, only a portion of the active ingredients of the drug is metabolized. The non-metabolized portion of that drug is excreted by the person. The drug then enters the environment through waste discharges and improper disposal of unused or expired drugs. The non-metabolized drugs enter wastewater treatment plants and ultimately enter the drinking water supply even after treatment. The drug that enters the environment reaches receiving streams that carry it to lakes and rivers. These drugs not only enter surface water, but also enter into the groundwater supply.

Despite rising fears over the presence of pharmaceuticals in drinking water, there is currently little evidence associating them with adverse human health risks. Ecosystems appear to be more at risk for indirect exposure to pharmaceutical drugs than humans. There is growing evidence that pollution from pharmaceuticals can be a severe threat to the environment. For example, exposure to 17 α -ethinyl estradiol (EE2), a steroid hormone used in contraceptives, can cause the feminization of fish and

amphibians. A wide range of pharmaceuticals used in human medicine have been found in treated sewage, rivers, seawater, and rarely, in groundwater and drinking water.

Conclusion

Water is a precious renewable natural resource. In an effort to preserve the quality of this natural resource for human consumption, the Safe Drinking Water Act provided EPA with the authority to develop enforceable regulatory guidelines known as the National Primary Drinking Water Standards and non-enforceable guidelines known as the National Secondary Drinking Water Standards. The National Primary Drinking Water Standards are intended to protect the public from exposure to contaminants that may cause health problems, especially as a result of long-term exposure. The National Secondary Drinking Water Standards are intended to provide guidelines for contaminant limits of pollutants that may cause minor health effects or undesirable taste of water. Drinking water quality preservation is important for human health.

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