

Risks to Drinking Water Quality in the U.S. and Benefits of Point-of-Use Filtration



EXECUTIVE SUMMARY

Drinking water in the United States is generally of high quality. Through regular monitoring and reporting, the U.S. Environmental Protection Agency (EPA) sets enforceable standards to protect public health by establishing limits on the levels of disease causing microorganisms and select chemical contaminants. Even with enforcement of stringent water regulations, concerns remain. Data from numerous studies and water quality reports continue to show an assortment of chemical and microbiological contaminants in drinking water. Part of the reason is that drinking water regulations apply at the point of production – the public water treatment facility. Once the water leaves the facility however, it may become re-contaminated as it travels through our nation’s aging water distribution infrastructure on its way to consumers. Contaminants may be naturally occurring or originate from various point and/or non-point sources of pollution, as well as through leaching or corrosion of materials that comprise distribution systems, such as metals or chemicals from pipe materials and fittings. Studies have reported increased rates and/or outbreaks of gastrointestinal illness in the U.S. linked with recontamination of treated water before it reaches consumers, due to deficiencies or large system disruptions in public water distribution systems. Water can also be degraded in the distribution system due to growth of bacteria on interior pipe walls and other surfaces in contact with drinking water, a phenomenon known as biofilms.

Many chemical contaminants in drinking water are not currently regulated by EPA nor removed by conventional drinking water treatment. Current drinking water treatment facilities are not designed to remove some contaminants, particularly non-regulated chemical contaminants originating from pesticides, personal care products and pharmaceuticals, which have been increasingly identified in drinking water at measurable concentrations due to advancing analytical capabilities. Numerous studies have identified various industrial or agricultural chemical contaminants in untreated and even in finished drinking water (after treatment and before distribution). Some of these chemical contaminants have been associated with health risks including increased risk of cancer, cardiovascular system disruption, liver problems, and potential harmful effects on reproduction, growth and development.

Perhaps even more concerning is the health risk for the more than 15 million U.S. residents who obtain their drinking water from domestic private wells, which are not covered by federal regulations. These private wells are mostly located in rural areas some of which are in/or near septic and/or agricultural areas and can thus be particularly vulnerable to microbial contamination due to fecal organisms from nearby agricultural activities or septic tanks.

Faucet-mounted water filters can serve as a final barrier treatment to reduce risks from a number of these chemical and microbial contaminants. Certain NSF-certified water filters can remove 93% to more than 99% of many contaminants found in drinking water.

We begin with a summary of radon emissions from natural stone countertops reported in the scientific literature; next, describe how ventilation influences levels of radon in indoor air of homes; then present estimates of radon levels in homes that could arise from natural stone countertops; and conclude by comparing those levels to the benchmark values mentioned above.

INTRODUCTION

Drinking water quality for the 270 million Americans served by a public water system is regulated by the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act. Rivers, lakes, and groundwater are the primary sources of U.S. drinking water. Before it is delivered to consumers it is treated to remove particles, such as soot and silt; chemicals; and bacteria. Through regular monitoring and reporting, EPA sets enforceable standards to protect public health by establishing limits on the levels of disease causing microorganisms and select chemical contaminants.

Public water systems are required to test drinking water regularly and provide monitoring data to EPA as well as publish annual updates on drinking water quality in their water system. These reports provide summary information about water quality measured previously, and they can vary in their quality and level of detail. These reports generally provide information on water quality immediately after treatment with only limited measurements at homes. The exceptions are lead and copper, which are measured at homes, but these results can be reported years after samples are collected.¹



Even with promulgation and enforcement of stringent drinking water regulations, concerns about drinking water quality are not uncommon as data from numerous studies continue to indicate the presence of various disease causing microorganisms and chemical contaminants in drinking water.^{2,3,4,5,6,7,8} Many of the contaminants can be introduced after water treatment, as illustrated in Figure 1. These contaminants can produce adverse health effects in consumers, especially to sensitive subpopulations including the elderly, children, pregnant women and those with compromised immune systems who may be at greater risk of adverse health outcomes.⁹

POINTS OF CONTAMINATION

Drinking water contamination can occur at the water source, at the treatment plant (if any), in the distribution system or at user end points.¹⁰ There are many hazards that may be present in drinking water due to inadequate treatment, intrusion from faults and breaks in distribution systems, and even from the disinfection chemicals used in drinking water treatment. Lawn chemicals, weed killers and insect repellants, such as DEET, have been found in source water resources, such as rivers or lakes.¹¹ Contaminants may be naturally occurring or originate from various point and/or non-point sources of pollution, as well as through leaching or corrosion of materials that comprise distribution systems, such as metals or chemicals from pipe materials and fittings.¹² Most often contaminants originating from natural sources are found into groundwater and leach from the adjacent geological material through which the groundwater passes.¹³

Some of the many types of point sources of drinking water contaminants include: improperly disposed-of chemicals as well as human and animal wastes that can leach from sewage pipes serving homes or industrial

facilities; run off from agricultural activities; land application of chemicals including weed killers or other pesticides; leaks from improperly managed underground storage tanks.^{14,15}

Potable water (water that is safe to drink) produced by drinking water treatment plants can be contaminated during transfer through underground piping, which makes it difficult to identify damage in the systems that can allow contaminants to enter the drinking water distribution system. Public health investigations suggest that a large fraction of disease outbreaks are associated with faults or weaknesses in the associated water distribution system serving the impacted populations.¹⁶ Current regulatory requirements appear to be inadequate to reduce the large fraction of disease outbreaks related to drinking water distribution systems.¹⁷

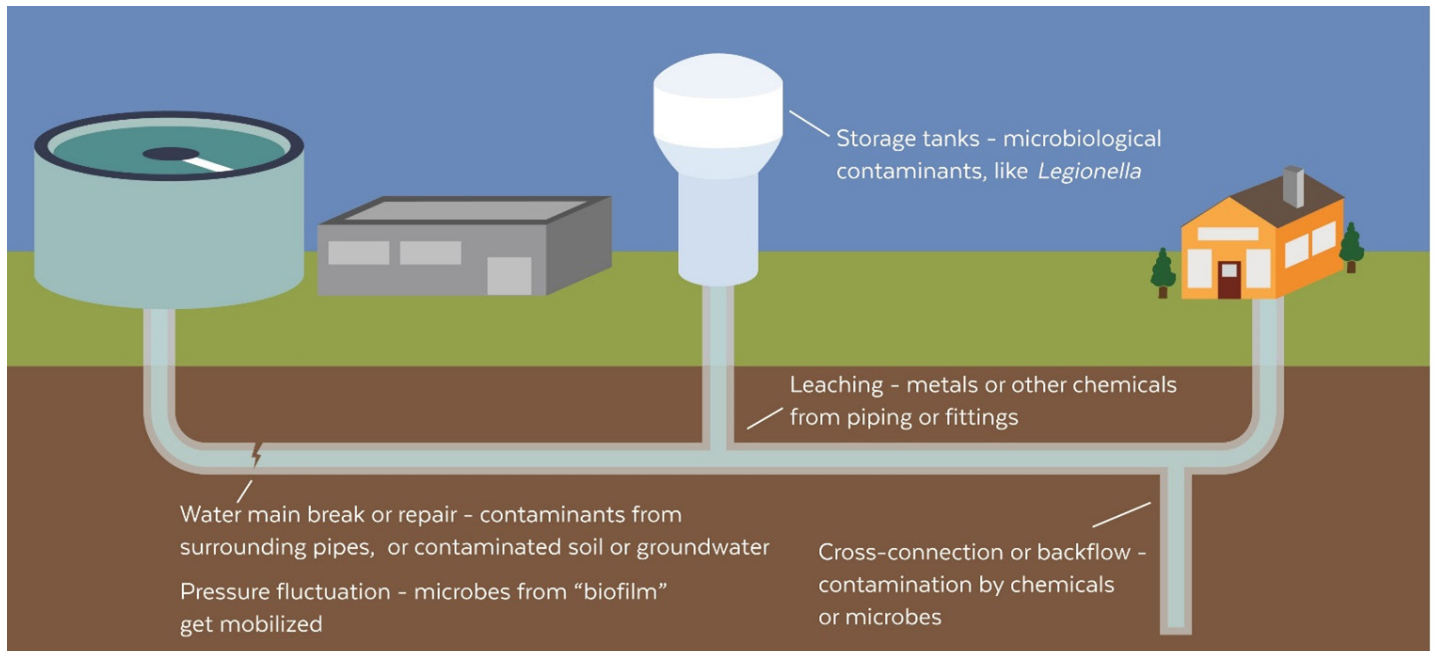


Figure 1. Points of potential contamination of drinking water after treatment.

The Centers for Disease Control and Prevention (CDC) report that water distribution system insufficiencies are likely the most important factor in drinking water-related outbreaks associated with public water systems.¹⁸ Furthermore, CDC attributes most cases of these waterborne illnesses to outbreaks that are never investigated. In 2006, the National Research Council (NRC) Committee on Public Water Supply Distribution Systems published a report on the public health risks associated with distribution system contamination. A major finding of the NRC’s review was that widespread corrosion associated with aging water infrastructure in the U.S. is a probable link to various distribution system deficiencies that may lead to spread of chemical or biological contamination.¹⁹

Much of America’s existing drinking water distribution infrastructure, including pumping and storage components along with approximately 1 million miles of underground piping was built many years ago. According to the EPA, 30% of pipes in water systems serving more than 100,000 people are between 40 and 80 years old and approximately 9% of pipes in those systems are even older.²⁰ In its latest 2013 Drinking Water Infrastructure Needs Survey, the EPA projected a total capital improvement need of \$384 billion for investing in the public water infrastructure system over the next 20 years.²¹ In the American Society of Civil Engineers’ 2013 *Report Card for America’s Infrastructure*, the nation’s drinking water infrastructure was given a “D” grade stating

that “much of our drinking water infrastructure is nearing the end of its useful life.”²²

America’s aging drinking water distribution infrastructure is particularly vulnerable to contaminant intrusion through increasingly frequent water main/pipe breaks and repairs and other types of age-related deterioration, such as cross-connections, back-flow, leaching and pressure fluctuations as pipelines approach the end of their service lives.^{23,23,24,25,26,27,28,29,30,31} Lack of water pressure during physical breaches of pipes can allow external contamination to enter pipelines through the portals created.³²

The American Society of Civil Engineers estimates that 240,000 water main breaks occur annually in the U.S.,³³ presenting opportunities for disease causing microorganisms and chemical contaminants to enter water distribution systems. In Chicago alone, the number of water main breaks is approximately 260 per year.³⁴ Similarly, there were more than 500 water main breaks in New York City, the average repair requires more than 4 hours.³⁵ Philadelphia’s drinking water system dates back to 1801, and the city experiences more than 900 water main breaks per year³⁶ as does Los Angeles.³⁷ A dramatic water main break in 2014 flooded UCLA buildings with 20 million of gallons of water at a time when the city was experiencing a severe drought.³⁸

Hence, even water that is adequately protected and treated at the municipal treatment plant and is safe to drink as it exits the plant per current drinking water quality regulations may become contaminated within the miles of water distribution infrastructure as it travels to the tap. In fact, Tinker and colleagues (2009) found slightly greater risk of ER visits for gastrointestinal illnesses for individuals living in zip codes located further from the treatment plant compared to homes located nearer to the plant.³⁹ Links between waterborne disease outbreaks and distribution system deficiencies resulting in contamination have been well documented in the US.^{40,41,42}



Aging drinking water distribution system pipes lose significant amount of water through leaks and are often located near similarly aging wastewater and storm water pipes due to space constraints, which may leak wastes containing pathogens and chemicals into the nearby soil. When water pressure inside drinking water pipes goes below the outside pressure, liquid and soil material surrounding the pipe can enter the system through cracks or poorly sealed joints.^{43,44} Leaks in public water distribution systems account for more than 10% of finished water losses in the US, providing evidence of the potentially extensive occurrences of such intrusion pathways.⁴⁵ Studies have detected viruses and bacteria that serve as indicators of fecal contamination in soil and water surrounding drinking water pipes.^{46,47,48} During low or negative pressure conditions, uncontrolled cross-connections can allow non-potable water to enter the distribution system posing potential health risks.^{49,50,51, 52}

HAZARDS ASSOCIATED WITH DRINKING WATER

Based on available health risk data and information for potential of occurrence in finished drinking water, the EPA has set standards for maximum contaminant levels of 75 specific chemical contaminants in drinking water, intended to protect consumers from adverse health effects, but many chemical contaminants in drinking water

are not currently regulated by the EPA, including metals, industrial chemicals, pharmaceuticals, flame retardants, and numerous disinfection by-products.⁵³ Of 119 unregulated contaminants, an analysis of the toxicity and occurrence recommended at least 19 contaminants or groups of contaminants be a top priority for further regulation and/or study.⁵⁴ Some of these unregulated contaminants include known human carcinogens,⁵⁵ and conventional drinking water treatment processes are largely ineffective in removing many of these contaminants.⁵⁶

METALS: LEAD AND MERCURY

Drinking water contaminated with heavy metals has been associated with health risks. The EPA regulates common metals in drinking water including lead, mercury, arsenic, copper, cadmium, and chromium.⁵⁷ Metals such as arsenic, cadmium, and chromium can originate from natural sources such as underground rocks and soils. Besides natural sources, the majority of heavy metal contamination of drinking water lies in the industrial effluents from mining and construction activities that release large amounts of heavy metals into nearby ground water sources.⁵⁸ Metals are released during corrosion of the metal pipes used to carry water to consumers. According to the EPA, household plumbing materials such as pipes, solder, or plumbing fixtures are the most common sources of lead and copper in home drinking water.⁵⁹ Corrosive water may cause metals in these pipes or soldered joints to leach into drinking water. Lead can cause serious damage to the brain, kidneys, nervous system, and red blood cells. The age of plumbing materials — in particular, copper pipes soldered with lead — is also important. Even in relatively low amounts lead can be harmful. EPA regulations limit lead in drinking water to 15 parts per billion.⁶⁰ Since 1988 the regulation only allows “lead free” pipe, solder, and flux in drinking water systems. The law covers both new installations and repairs of plumbing. However, as discussed above, much of the plumbing infrastructure in many parts of the U.S. pre-dates the 1988 regulations. Old and poorly maintained

Drinking water may be to blame for elevated blood lead levels in children. Flint, Michigan returns to Detroit water system

The drinking water system in Flint, Michigan has been the subject of much recent debate and concern after reports of increases in the number of children with elevated blood-lead levels after the city switched its water source to the Flint River. According to data released by local researchers at Hurley Medical Center in September 2015, the percentage of Flint children 5 and under with elevated blood lead levels nearly doubled after the switch from 2.1 to 4 %.

In 2014, the city stopped drawing water from Detroit’s water system and switched its water supply to the Flint River. According to the local health department, the water leaving the Flint Water Plant meets all federal and state requirements. However, the City of Flint has a documented problem with lead in its drinking water due to service and household lines that contain lead or lead solder. The Flint River water is likely more corrosive which can increase leaching of lead.

The local health department declared a public health emergency. It recommended that people not drink the water unless it had been tested for lead and it was being filtered through a National Sanitation Foundation (NSF) approved point-of-use filter certified to remove lead. Manufacturers donated thousands of POU filters, and the state set aside \$1 million for free point-of-use water filters for city residents.

After initial test results showing elevated lead levels at city buildings, including schools, the city of Flint initiated transition back to Detroit’s water system, which already has additional corrosion control.

Sources:

Genesee County Board of Commissioners. “Public Health Emergency Declaration for People Using the Flint City Water Supply with the Flint River as the Source.” October 1, 2015

Erb, Robin, and Kathleen Gray. “State to Tackle Unsafe Water in Flint with Tests, Filters.” Detroit Free Press October 2, 2015 <http://www.freep.com/story/news/local/michigan/2015/10/02/state-officials-outline-plan-flint-water/73200250/>

Mona Hanna-Attisha MD MPH. “Pediatric Lead Exposure in Flint, Michigan: A Failure of Primary Prevention.” Hurley Children’s Hospital, Michigan State University Department of Pediatrics and Human Development. Note data has not been peer-reviewed

World Health Organization. August 2015. “Lead poisoning and health”. <http://www.who.int/mediacentre/factsheets/fs379/en/>

Michigan Department of Environmental Quality, October 8, 2015. “Gov. Rick Snyder: Move back to Detroit water provides best protection for public health in Flint. <http://www.michigan.gov/deq/0,4561,7-135--366801--,00.html>

homes may be more likely to have lead pipes, joints, and solder. For example, thousands of homes in Boston are estimated to have lead service lines.⁶¹ However, newer homes are also at risk, since pipes, pipe fittings, plumbing fittings and fixtures can leach lead, even though they are considered to be “lead-free,” which by definition could contain up to eight percent lead before January 2014. According to EPA, these pipes can leach significant amounts of lead into the water for the first several months after their installation.⁶² The “lead-free” regulation has since been amended to 0.25% lead.⁶³

Pesticides and Other Industrial Contaminants in Drinking Water

Many studies have identified the presence of various industrial and/or agricultural chemical contaminants in

Chemical Spill, Elk River, Charleston WV

In January 2014, thousands of gallons of “crude MCHM” (4-methylcyclohexanemethanol) spilled into the Elk River upstream of the municipal water intake for Charleston, WV water treatment facility. This system is the primary drinking water source for 300,000 residents living in and around the city of Charleston, WV. More than 300 people sought emergency medical care for health effects attributed to exposure to contaminated water. A “Do Not Use” order was issued by the state, and the water system was shut down for more than five days.

Source:

<http://emergency.cdc.gov/chemical/MCHM/westvirginia2014/>

untreated and/or finished drinking water sources.^{64,65,66}

Chemical contaminants of greatest concern in drinking water related to agricultural pollution are pesticides of various types, many of which are not regulated contaminants, with no legally mandated limit. Many lawn chemicals, such as weed killers, and other pesticides can contaminate ground water or surface water systems that feed drinking water supplies. A 2009 USGS study of source water quality assessment for analysis of 258 anthropogenic organic compounds in 12 principal aquifers in the US aimed to characterize the extent to which compounds detected in the source water were present in the finished water (meaning water that has undergone treatment but before distribution).⁶⁷

Results from that study indicated the presence of numerous herbicides and industrial chemicals in both source and finished water samples from selected sites. Among the detected contaminants were the herbicides atrazine, metolachlor, and DEET, as well as solvents such as perchloroethene (PCE) and trichloroethene (TCE).⁶⁸ According to the EPA, the major source of atrazine in drinking water is runoff from agricultural use of the herbicide.⁶⁹ Another study found atrazine in more than half of the 15 distribution systems they tested.⁷⁰ Atrazine is the most commonly used herbicide in the U.S. and has been linked with endocrine, cardiovascular and reproductive effects.^{71,72,73} Both PCE and TCE in drinking water have been associated with leukemia, non-Hodgkins lymphoma and several other cancers.^{74,75,76}

Disinfection By-products

Chemicals used in conventional disinfection at municipal treatment facilities, primarily chlorine or chlorine-based compounds, may react with naturally occurring organic materials in the source water to form disinfection by-products (DBPs) in finished water.^{77,78,79} Several DBPs found in drinking water are regulated by the EPA, the most common of which include trihalomethanes (THMs) and haloacetic acids (HAAs), which have been linked to cancer as well as nervous system and reproductive effects.⁸⁰

Pharmaceuticals/Personal Care Products

Chemical contaminants originating from pharmaceuticals and personal care products are being discovered in drinking water sources at measurable concentrations.^{81,82} These include prescription and over-the-counter

drugs, veterinary drugs as well as products used for personal and cosmetic reasons such as soaps, fragrances and cosmetics. Health effects associated with these low-level chronic exposures are unclear. Often referred to as “contaminants of emerging concern,” a number of studies have identified these compounds in not only source water but finished drinking water after undergoing treatment.^{83,84,85} Pharmaceuticals were detected in drinking water supplies serving 24 major US metropolitan areas, including New York and Philadelphia, as documented in a series of reports by the Associated Press published in 2008.⁸⁶

The EPA selected 100 compounds that are not currently regulated in drinking water and recommends monitoring and closer review due to frequency of occurrence in drinking water and potential adverse health effects, including endocrine disrupting effects.⁸⁷ Endocrine disrupting chemicals can interfere with the hormonal system of the body producing potentially harmful effects on reproduction, growth and development.⁸⁸ Bisphenol A or “BPA” is probably the most well-known compound suspected to have hormonal effects,⁸⁹ causing much concern to consumers in recent years. A 2009 published study conducted by the Applied Research and Development Center of Southern Nevada Water Authority screened the source, finished and tap water in 19 U.S. water utilities for pharmaceuticals and endocrine disrupting compounds and reported more than one-third of the samples of finished drinking water had detectable levels of atenolol and four other pharmaceuticals as well as atrazine, DEET and several other contaminants.⁹⁰ The researchers reported that two pharmaceuticals—the anti-epileptic drug phenytoin and the anti-anxiety medication meprobamate—were detected in greater than half of the 15 distribution systems sampled.⁹¹

Microbial Hazards in Drinking Water Associated with Gastrointestinal Illness in Consumers

Gastrointestinal illness is the most commonly reported illness in drinking water related microbial contamination events.⁹² Waterborne diseases can lead to serious

Algal toxin shuts down public drinking water system in Toledo, OH

In August 2014, the City of Toledo issued a “Do Not Drink” Advisory for all Toledo water customers – nearly half a million residents. Local water supplies were tested to assess contamination of the drinking water by the toxin microcystin. The toxin was produced by harmful algal blooms in Lake Erie, which is the city’s drinking water source.

Algae are microscopic organisms found naturally in surface water. Algal blooms are overgrowths of algae triggered by favorable environmental conditions combined with run-off of fertilizer, sewage effluent and manure. Wind and water currents can transport these blooms toward drinking water intakes at treatment plants.

Algae can cause odor, taste and color impacts to treated drinking water. Drinking contaminated water may result in abnormal liver function, diarrhea, vomiting, nausea, numbness or dizziness. This is especially true for the very young, the elderly and people with compromised immune systems.

Although there are no federal or state standards for acceptable levels of the toxins, the EPA has listed harmful algal blooms on a priority list for investigation and has issued Health Advisories for microcystin, which are not legally enforceable federal regulations but serve as informal technical guidance in protecting public health when contamination situations occur.

Toledo has since put an advance warning system in place for early detection of harmful algal blooms to allow adjustment of water treatment methods in response to algal blooms in source water.

Sources:

Ohio Environmental Protection Agency. “Harmful Algal Blooms (HAB) Information for Public Water Systems.” Division of Drinking and Ground Waters <http://epa.ohio.gov/ddagw/HAB.aspx>.

Environmental Protection Agency. June 2015. 2015 Drinking Water Health Advisories for Two Cyanobacterial Toxins.” Office of Water. http://www2.epa.gov/sites/production/files/2015-06/documents/cyanotoxins-fact_sheet-2015.pdf.

Ohio Environmental Protection Agency. September 2015. Potential for Blue-Green Algae in Ohio River, State Urges Precautions over Holiday Weekend. News Release. <http://www.epa.state.oh.us/News/OnlineNewsRoom/NewsReleases/TabId/6596/ArticleId/811/language/en-US/potential-for-blue-green-algae-in-ohio-river.aspx>.

City of Toledo Ohio. July 2015. “Information for the General Public during Harmful Algal Bloom Season.” <http://toledo.oh.gov/media/186281/hab-faqez-js-7-31-15.pdf>.

acute, chronic and sometimes fatal health consequences, especially for people who have compromised immune systems. The CDC reports that 32 outbreaks with 431 cases of water borne diseases were linked to U.S. water supplies during 2011-2012, the latest years for which data are published.⁹³ The NRC (2006) reported that there is likely underreporting in the CDC surveillance system of outbreaks involving homeowner systems, since most sporadic cases and small clusters of waterborne disease are not likely reported.⁹⁴

A number of studies have reported increased rates and or outbreaks of gastrointestinal illness in the U.S. linked with recontamination of treated water before it reaches consumers due to deficiencies and or large system disruptions in public water distribution systems.^{95,96,97,98,99} Specific system deficiencies commonly associated with entry of disease causing microorganisms in the distribution system include low or negative pressure conditions due to cracks or non-sealing joints in pipes, cross-connection/back-siphonage, broken or leaking water mains, contamination during storing and contamination of mains during construction/repair.^{100,101,102,103} In a recent study conducted by the University of California Berkeley's School of Public Health, directly consuming tap water was associated with low-level, background gastrointestinal illness in settings where distribution systems are documented to have routine deficiencies, such as water outages, loss of pipe integrity, low-pressure events or inadequate disinfectant residual.¹⁰⁴

Furthermore, non-disinfected drinking water from public groundwater wells has been associated with contamination by human enteric (meaning intestinal) viruses, suggesting that populations served by such systems may be exposed to waterborne viruses and experience gastrointestinal illness as a result.^{105,106,107} Greater than 147,000 public water systems supply groundwater to more than 100 million people in the US. The majority of these public water systems produce water without disinfection since disinfection of groundwater is not a regulatory requirement as it is for surface water supplies.¹⁰⁸ A study of non-disinfected public groundwater systems in Wisconsin found higher virus levels in drinking water following distribution system events, including pipe installation, valve exercising, and cutting open mains.¹⁰⁹ Borhardt et al. (2012) measured intestinal viruses in the drinking water of 14 Wisconsin communities supplied by non-disinfected groundwater and estimated that 6 to 22% of acute GI illnesses could be attributable to viruses in drinking water.¹¹⁰



Biofilms May Harbor Hazardous Bacteria

Drinking water can also be degraded due to growth of bacteria on interior pipe walls, storage tanks, and other surfaces in contact with finished water, a phenomenon known as biofilms.^{111,112} Biofilms can form throughout interior pipe surfaces within a distribution system, and they can act as reservoirs for microbial pathogens.¹¹³ According to the NRC, water distribution systems are prone to biofilm formation regardless of the purity of the water, pipe materials or type of disinfectant used.¹¹⁴ Bacteria growing in biofilms can subsequently detach from the pipe walls and become released into the drinking water to reach consumers' taps on an intermittent or ongoing basis resulting in potential health risks.^{115,116} Important categories of microbes that can grow in biofilms include fecal indicator bacteria such as *E. coli*, enteric viruses like noroviruses and parasitic protozoa such as cryptosporidium.¹¹⁷

Hazards in Private Wells

Perhaps even more concerning is the health risk for the more than 15 million Americans who obtain their drinking water from domestic private wells, which are not covered by federal regulations.^{118,119} Individual homeowners with private wells are responsible for ensuring that their water is safe from contaminants. Contamination events involving private wells can be unnoticed due to a lack of monitoring and reporting.¹²⁰ The CDC reports that deficiencies at points outside of the domain of water utilities (e.g., private wells and plumbing systems) accounted for almost a quarter of outbreaks in 2009-2010.¹²¹ Many homeowners do not regularly test their well water, making any changes in water quality unnoticed except perhaps for factors that affects taste or odor.

Due to lack of federal regulation, private wells can be particularly vulnerable to microbial contamination. Most private well owners reside in rural areas some of which are in or near septic and/or agricultural areas.^{122,123} Two recent studies identified drinking of contaminated well water as a risk factor for enteric infections in children.^{124,125} In addition, the spores of parasites, such as *Cryptosporidium* and *Giardia* may be found in well water, potentially producing disease in vulnerable populations.¹²⁶ *Cryptosporidium* is the most resistant among known pathogens to commonly used forms of chemical disinfection in the U.S.¹²⁷ *Giardia* is also found in water that has been contaminated with feces from infected humans or animals.¹²⁸ Both organisms are protected by an outer shell that allows them to survive outside the body for long periods of time and makes them tolerant to chlorine disinfection.^{129,130} Infections by either organism can cause diarrhea, dehydration, weight loss, abdominal pain, fever, nausea, and vomiting.^{131,132} While not usually fatal in healthy individuals, these diseases can be incapacitating in sensitive populations. According to the CDC, ingestion of untreated drinking water is one of the risk factors for gastrointestinal illness caused by *Cryptosporidium* and *Giardia*.^{133,134} A 2014 study in central New Mexico reported that the presence of onsite wastewater systems, such as septic systems, and private wells might be associated with an increased risk of *Cryptosporidium* infection.¹³⁵

BENEFITS OF FAUCET-MOUNTED WATER TREATMENT DEVICES

While many uncontrolled hazards can be found in public and private drinking water systems as well as private wells, point of use (POU) filtration devices can serve as a final barrier treatment to reduce risks from a number of these contaminants as illustrated in Figure 2. POU filtration devices, particularly faucet-mounted activated carbon and carbon block* units, can effectively remove chemical and biological contaminants commonly missed by conventional treatment or introduced into drinking water during transport to the tap as represented in Figure 1. Certain people may benefit most from POU, particularly sensitive populations based on age (children, elderly), other illnesses, compromised immune systems, or genetic factors. Some of the factors that can impact water quality at the tap include:

- GEOGRAPHIC LOCATION
- PROXIMITY TO LOCAL WATER POLLUTION SOURCES

*Carbon block filters consist of "extremely small particles of activated carbon that are fused together into a solid block with uniform pore size." These filters have greater surface area for removing drinking water contaminants than standard granular activated carbon filters. (Silverstein, I. 2006. Investigation of the Capability of Point-of-Use/Point-of-Entry Treatment Devices as a Means of Providing Water Security. U.S. Environmental Protection Agency, Office of Research and Development, National Homeland Security Research Center. EPA/600/R-06/012.)

- NEAR HOME IMPACTS (SUCH AS BACKFLOW)
- QUALITY OF SOURCE WATER PRIOR TO TREATMENT AT CONVENTIONAL TREATMENT PLANTS
- CONTAMINATION DURING MOVEMENT THROUGH PIPING SYSTEMS
- HOUSEHOLD PIPING AND PLUMBING FIXTURES

Not all of these factors can be controlled by current drinking water systems, which is why POU filtration at the tap may provide an added level of protection against a large number of these contaminants. Commonly used granular activated carbon and carbon block filters are known to be highly effective at removing organic chemicals and certain metals as well as particles, including parasitic cysts, such as those formed by giardia and cryptosporidium.¹³⁶ Such filters undergo rigorous testing to achieve NSF certifications (NSF/ANSI 53 Drinking Water Treatment Units –Health Effects). For example, lead can enter drinking water in older water systems or piping to the home, and NSF-certified carbon block filters can remove more than 99% of lead in drinking water (NSF/ANSI 53).

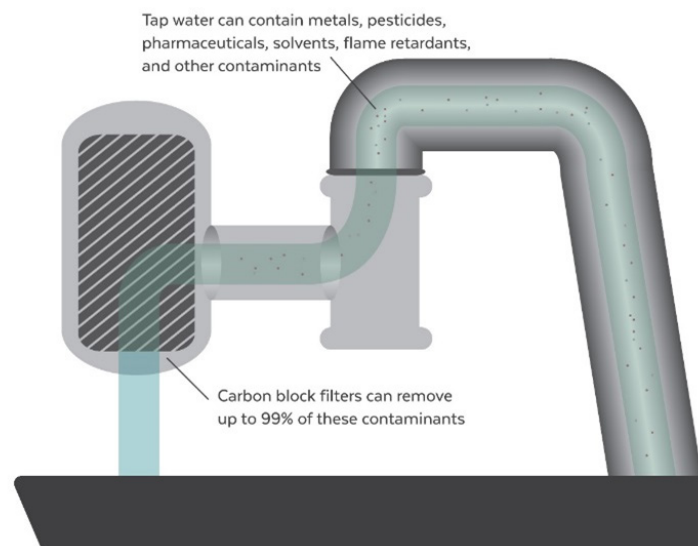


Figure 2. Point-of-use filtration for removing drinking water contaminants.

More recently NSF developed a testing standard for “emerging contaminants” that includes tests of POU filters for removal of pesticides, pharmaceuticals, and other chemicals that are unregulated but nonetheless commonly found in drinking water (NSF/ANSI 401 - Testing for Emerging Contaminants/Incidental Compounds). For example, bisphenol A (BPA) is a compound in plastics that has been shown to mimic estrogen in some animals,¹³⁷ leading consumers to be concerned about exposure to BPA, particularly for infants and pregnant women. Some NSF-approved faucet-mounted filters can remove more than 97% of bisphenol A in controlled laboratory tests. Point of use carbon block filters can be effective at removing the many contaminants, including bisphenol A, that public drinking water treatment systems are simply not intended to remove or that are unable to remove, including:

- PESTICIDES, SUCH AS WEED KILLERS AND INSECTICIDES
- INSECT REPELLANT, SUCH AS DEET

- SEDIMENTS
- CHLORINE AND DISINFECTION BYPRODUCTS FORMED DURING TREATMENT AND TRANSMISSION OF WATER TO HOMES
- OTHER METALS AND CORROSION PRODUCTS FROM THE DISTRIBUTION SYSTEM AND HOME PLUMBING
- DISEASE-CAUSING MICROBIOLOGICAL ORGANISMS – LIKE CRYPTOSPORIDIUM AND GIARDIA
- SOLVENTS, SUCH AS PAINT THINNER OR DEGREASER
- FLAME RETARDANTS
- CHEMICAL CONTAMINANTS, INCLUDING POSSIBLE ENDOCRINE DISRUPTORS
- PERSONAL CARE PRODUCTS
- PHARMACEUTICALS

Many of the “emerging contaminants” as well as other unregulated contaminants have only started being measured in recent years. EPA requires public water systems to measure levels of “unregulated contaminants” every two to four years. Results from around the country show variability in the detection of compounds by region. For example, in the Boston, MA drinking water system, testing in 2008 for 31 compounds, including pharmaceuticals, hormones/endocrine disrupting compounds, and the mosquito repellent “DEET” did not identify any of these compounds above the laboratory detection limit.¹³⁸ In contrast, in the City of Chicago Emerging Contaminant Study conducted in 2009-2011,¹³⁹ DEET was found in 31-60% of samples and the heart medication Atenolol was found in 11-30% of samples. While the long-term health consequences of trace levels of prescription drugs, hormones, and other chemicals, like flame retardants, in drinking water are unclear, treatment at the home may help to reduce exposures.

Granular activated carbon and carbon block filters are not a perfect solution to reducing risks from drinking water. Some limitations of POU devices have been identified, including growth of bacteria within the filters and decreased flow over time, filters without UV or other antimicrobial components cannot treat bacteria or viruses. However, with proper use and maintenance of filters these devices can significantly reduce exposures to many drinking water contaminants.

ABOUT THE AUTHORS

Bemnet Gessesse, M.P.H., is a Staff Scientist within the Education and Commercial Division at EH&E. She provides key services in diverse capacities involving field support, litigation support, literature review support, research and development of written deliverables for clients across a number of sectors, including the aviation industry, education, commercial real estate, construction, hospitals, laboratories, manufacturing plants, biomedical research facilities and pharmaceutical environments. Ms. Gessesse is involved in projects of wide scope and has participated in the assessment of various indoor air quality parameters, including volatile organic compounds, particulates, bacteria, and fungi as well as various industrial hygiene exposure assessments of physical, chemical, and biological hazards. Ms. Gessesse also has experience in the evaluation of mold and water damage remediation.

Theodore A. Myatt, Sc.D., received his doctorate in Environmental Health, with a focus on exposures to environmental microorganisms, from the Harvard School of Public Health. His research focused on exposures to infectious microorganisms in the workplace. Additionally, he earned a Master of Environmental Management from the Nicholas School of the Environmental at Duke University. He is currently the Director of Research Integrity at the University of Rhode Island.

David L. Macintosh, Sc.D., CIH, is Chief Science Officer at EH&E. Dr. MacIntosh oversees the scientific aspects of projects conducted by scientists, industrial hygienists, and engineers who specialize in diagnosing and analyzing the complex relationships among sources, pathways, and receptors of environmental stressors that influence health in the built environment. His recent activity has focused on problematic building materials, ambient air quality, heavy metals, naturally occurring radioactive materials, persistent organic pollutants, and risk analysis training materials. Dr. MacIntosh is also an Adjunct Associate Professor of Environmental Health at the Harvard School of Public Health where he teaches a course on exposure assessment.

Kathleen Ward Brown, Sc.D., is a Staff Scientist in the Advanced Analytics division of EH&E. Dr. Brown's work focuses on exposure assessment, indoor air quality, epidemiology and public health. Recent work has involved coordinating assessments of potentially contaminated building materials; assessing exposures to contaminants in air, soil, and drinking water; and preparing risk assessments to evaluate potential health risks associated with exposures. Dr. Brown has conducted personal exposure studies as well as indoor and outdoor air pollution studies. She has experience recruiting study subjects, preparing reports for institutional review boards, preparing quality assurance plans, managing field staff, preparing and analyzing data, and presenting results.

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