EPA United States Environmental Protection Agency

ARSENIC AND YOUR DISTRIBUTION SYSTEM

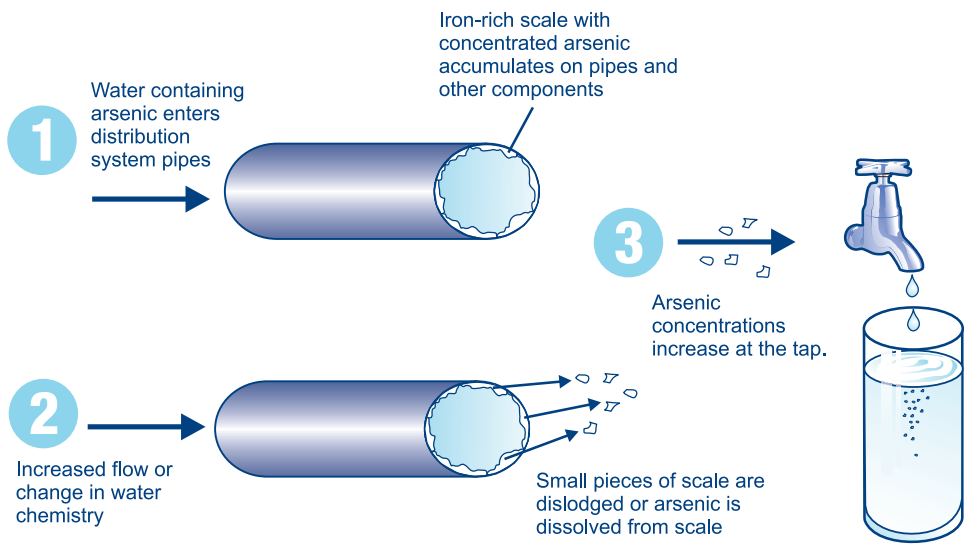
This fact sheet helps water system owners and operators understand and respond to issues that may arise with arsenic in the distribution system, or with distribution system concerns resulting from the installation of arsenic treatment. Although arsenic is measured at the entry point to the distribution system for compliance determinations, you should be aware that arsenic levels could increase in the distribution system at any time due to a number of factors. It is important to remember that any process changes, including chlorination, can impact your distribution system and the water quality at customers' taps.

Arsenic Can Build Up on and Release in Pipes and Storage Tanks

Public water systems with arsenic in their raw water may find that scales on pipes and other components in their distribution systems contain relatively high arsenic concentrations. These arsenic-rich scales can become dislodged and suspended in the water, and may be ultimately delivered to consumers.

Arsenic has been shown to attach to iron in distribution system pipes. Because iron is so effective at binding with arsenic, corrosion deposits can have high concentrations of arsenic solids. In a recent study, arsenic levels found in solids that were collected after pipe sections and hydrants were flushed were as high as 13.65 milligrams of arsenic per gram of solid. Most of the remaining solid was composed of iron.

How Arsenic Can Increase in Your Distribution System



Research is still needed to understand what water quality conditions cause arsenic in pipe scales to be re-suspended or dissolved back into the water. In the meantime, if you now have, or have had, arsenic in your raw water and your distribution system contains iron pipes or other iron components, realize that you may have arsenic buildup in scales.

It is known that even if your water has detectable levels of arsenic that are below the 0.010 mg/L MCL, and you have iron pipes or components in your distribution system, your system's pipes may have arsenic-rich scales attached to them. As long as the scales are not disturbed, they will remain attached to the pipes or other distribution system components. Certain conditions, such as flushing of mains or fire flow conditions, may result in those scales being sloughed off and suspended in the water, releasing the arsenic. Other conditions, such as changes in water chemistry, may result in some of the arsenic dissolving back into the water. Both of these situations could cause high arsenic levels at consumers' taps.

Arsenic Control Measures Can Affect Finished Water Quality

Public water systems installing arsenic treatment should be informed about possible changes to their finished water that may result from the arsenic treatment they install.For example, systems may need to adjust their finished water quality to address new concerns about corrosion. Changes in water chemistry due to using new sources, blending different source waters, or installing arsenic treatment are some of the factors that can affect distribution system water quality. In some cases, this may cause an increase in arsenic levels in the distribution system or create simultaneous compliance issues with other drinking water regulations.

Is Arsenic in your Storage Tank?

Water systems may also find deposits of arsenic-rich particles in their storage tanks or at locations in their distribution system with low flows. If the flow is increased or a storage tank is drawn down to a low level, these arsenic-rich particles can get stirred up and transported to consumers' taps. This situation occurs primarily when iron media used in treatment are released into the distribution system, or when iron particles are not properly filtered out during iron removal treatment. If these treatment technologies are operated correctly, this should not be a problem for most water systems.

Is Your Ground Water System Installing Disinfection for Pathogen Control?

Water systems that disinfect their water should be aware of the possibility of an increase in arsenic concentrations in their distribution system, particularly if the water contains high concentrations of dissolved iron. When chlorinated, the dissolved iron forms particles on which arsenic can accumulate. As a result, high arsenic concentrations may occur in distribution system water even if arsenic concentrations in the raw water are below the MCL.

This happened to a small community water system in the Midwest that began chlorinating water from a series of wells that had raw water arsenic levels between 0.003 and 0.008 mg/L and iron concentrations up to 0.4 mg/L. At the same time, the system installed a polyphosphate feed system for corrosion control. Soon after chlorination began, the system received intermittent colored-water complaints from its customers with increasing frequency across the distribution system. Samples collected from several representative locations throughout the service area had a reddish-brown color and contained particles. A metals analysis showed high levels of copper and iron oxides in the finished water, along with arsenic concentrations approaching 5 mg/L. Because of the water's colored appearance, it was considered unlikely that customers would consume the water. Doctors and health care professionals were notified of the situation and instructed to watch for signs of arsenic poisoning.

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Researchers found that chlorinating the water caused the formation of ferri-hydroxide solids. The minimal arsenic present in the groundwater was being concentrated as it absorbed onto the solids. Copper oxide particulates also formed and were released. To some extent, the polyphosphates served a useful role by keeping iron in solution and counteracting the tendency for the iron oxides to form, but additional steps were needed. For six months the system alternated their chlorination schedule: on for one day then off two days. The system then returned to full-time chlorination, starting with a low distribution system residual of 0.2 mg/L and gradually increasing it to 0.5 mg/L. The system continued to flush water mains on a semi-annual schedule using a unidirectional approach. In the last year, the system received only one colored water complaint.

For more details on this case, see "Well Water Disinfection Sparks Surprises" by Steve Reiber and Glenn Dostal, Opflow Vol. 26 No. 3, March 2000.

Hypochlorination System

▸ Switching to a New Source or Blending Sources

If you plan on switching wells or blending sources to meet the arsenic MCL, remember that the new well's water may react differently in your distribution system than the water you were using before. Be sure you understand the new well's water quality characteristics like pH, alkalinity, and iron and manganese concentrations. Changes in these water quality parameters could impact lead and copper as well as arsenic levels, disinfection byproducts, and aesthetic characteristics like taste, odor, and color.

▸ Reducing pH During Treatment

Some arsenic treatment technologies require the pH to be reduced as a treatment step. If your system has adopted one of these techniques, be sure your pH is raised to a level that will not cause corrosion problems in your pipes. If you already have a corrosion control program in place, review whether you will need to adjust your corrosion chemical dose in response to any change in your water quality resulting from the installation of arsenic treatment. Keep in mind that adjusting the pH upward for lead and copper control may also cause arsenic to be released from scale on pipes and components.

▸ Installing a Treatment Technology that Uses Iron

If you have installed an arsenic removal treatment technology that uses iron, you should **not** see elevated levels of iron in the water entering the distribution system if the treatment technology is being operated properly. However, if the treatment technology has been recently installed and operational adjustments are still being made, you may see elevated iron levels after treatment. You may also see elevated iron levels if you are blending with iron-rich water. In these cases, keep in mind that arsenic adsorbs onto iron, and the iron may deposit in your pipes and storage tanks. This arsenic-rich iron could dislodge and be re-suspended in the water when flows increase. If this happens, consumers may receive pulses of water containing high levels of arsenic and iron, and should be warned not to consume the water if it appears rusty in color.

▸ Using Activated Alumina or Enhanced Coagulation with Alum

If you plan on using activated alumina or enhanced coagulation with alum to treat your water, consider testing the water periodically for aluminum in the distribution system. While not a concern in terms of health effects, aluminum concentrations as low as 0.05 mg/L can result in customer complaints about particles or color in their water.

How Can I know if Arsenic is a Problem in My Distribution System?

Drinking water regulations require public water systems to monitor for arsenic at the **entry point** to the distribution system. There is no federal requirement for systems to monitor for arsenic **within** the distribution system. You may, however, want to test your distribution system water for arsenic to be sure that the water being delivered has arsenic levels below the MCL. If you decide to monitor your distribution system, consider testing for arsenic at

locations where the settling and accumulation of iron solids or pipe scales are likely (i.e., areas with cast iron pipe, ductile iron pipe, or galvanized iron pipe).

If your water system has installed some form of arsenic treatment, keep in mind that the treatment you installed may change the water quality in other ways. It might cause the water to react differently in the distribution system. Depending on the kind of treatment you've installed, consider what distribution system problems might result.

A change in the taste, odor or appearance of the water at customers' taps may be the first indication of a problem. Some water quality parameters to consider monitoring, depending on your arsenic treatment technology, include iron, pH, manganese, alkalinity, and aluminum.

How Can I Prevent Arsenic Accumulation in My Distribution System?

There are a number of management techniques that can be used to help keep arsenic levels low in the distribution system. They include:

- Optimize treatment operations for turbidity removal.
- Check finished water pH and alkalinity after arsenic treatment is installed. If they have changed, consider whether corrosion control practices need to be modified.
- Adopt a unidirectional flushing program for water mains.
- Clean and maintain your storage tank(s).
- Optimize distribution system operations to minimize water age. This practice will prevent sediment accumulation and water quality deterioration.
- Operate valves and hydrants to avoid sudden changes in flow direction or velocity. This practice will prevent the resuspension of sediments into the water column.
- Monitor arsenic levels at drinking water taps, hydrants, and low flow dead-end areas.

What Should I Do if Distribution System Arsenic Levels are High?

▸ Consider Notifying the Public

Even if your water system has not violated the arsenic standard, you may want to notify consumers that you have detected arsenic levels in the distribution system exceeding the MCL. If you make such notice, consider using the following standard public health effects language for arsenic:

> ***Some people who drink water containing arsenic in excess of the MCL over many years could experience skin damage or problems with their circulatory system, and may have an increased risk of getting cancer.***

You may also want to explain how you plan to fix the problem. For example, if you plan on cleaning or flushing the distribution system to remove scale from the pipes, explain briefly what you will be doing, when you'll be doing it, and when you expect the problem to be addressed.

▸ Consider Distributing EPA's Consumer Fact Sheet on Arsenic

EPA has developed the fact sheet *Arsenic in Your Drinking Water—Just the Facts for Consumers* that explains the health risks associated with having elevated levels of arsenic in your drinking water. This fact sheet is available on the web at **http://www.epa.gov/safewater/arsenic/basicinformation.html**. Color copies are also available by calling the Safe Drinking Water Hotline at 1-800-426-4791. Consider distributing the fact sheet as part of your public education effort if you think you have arsenic problems in your distribution system.

For More Information on Managing Your Distribution System:

Distribution Systems: A Best Practices Guide (EPA# 816-F-06-038)

AWWA. 2004. AWWA Standard G200-04: Distribution Systems Operation and Management. Denver, CO.

Lytle, D. A.; Sorg, T. J.; Frietch, C. 2004. Accumulation of Arsenic in Drinking Water Distribution Systems. *Environ. Sci. Technol. 38*(20); 5365-5372.

Distribution System Research – **http://www.epa.gov/nrmrl/wswrd/dw/dsr.html**