

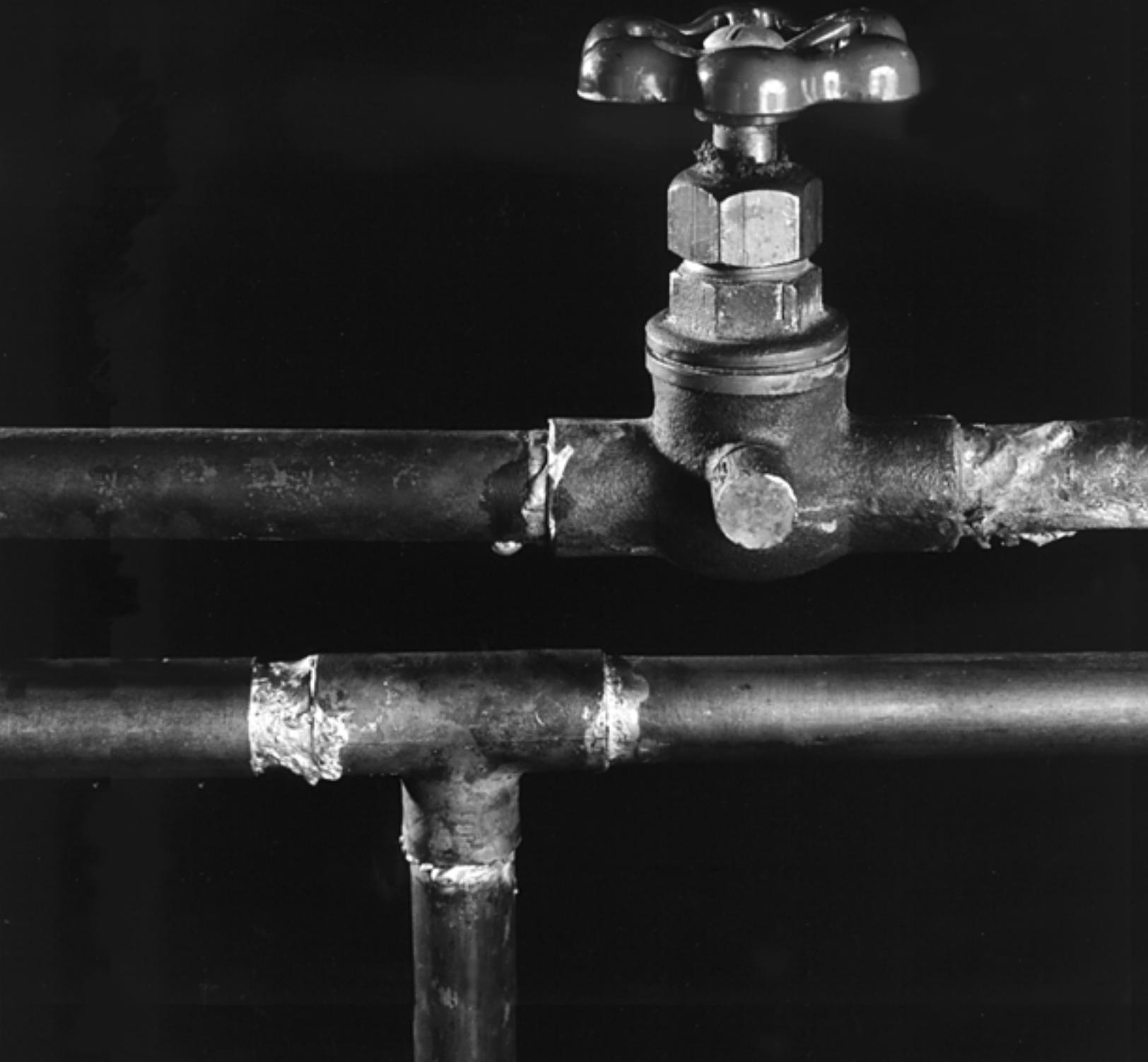
PENNSTATE



College of Agricultural Sciences
Cooperative Extension

EXTENSION CIRCULAR #416

LEAD IN DRINKING WATER



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WHERE DOES LEAD COME FROM?

Lead has been used as an ingredient of gasoline, paint, glassware, metal pipes, and food containers, all of which have contained varying amounts of lead. Therefore, some lead can be found in the food, paint, soil, dust, housewares, and drinking water of many American homes.

Most of the average person's daily lead exposure occurs from food. Lead in food can result from leaching of lead from lead-soldered cans or from lead-tainted dust deposited on the food.

Leaded paint, although banned now, is still a major source of lead dust, especially in urban homes. Leaded gasoline, largely replaced by unleaded mixtures since the 1970s, has caused lead contamination of soil near roadways and in urban areas. However, lead-soldered tin cans are no longer widely used, and this important source of lead in food has been reduced.

Drinking water typically accounts for less than 20 percent of total lead exposure. In some cases, however, water has been

Lead contamination poses a serious threat to the safety of drinking water in Pennsylvania. This colorless, odorless, and tasteless metal can go virtually undetected in water.

At the same time, excessive amounts of lead place adults at higher risk for cancer, stroke, and high blood pressure.

At even greater risk are children, whose rapidly growing bodies absorb lead more quickly and efficiently.

Lead can cause premature birth, a reduced birth weight, seizures, behavioral disorders, brain damage, and a lower IQ level in children. As a result, the U.S. Environmental Protection Agency (EPA) considers lead the most serious environmental health hazard for children in the United States.

This circular answers common questions you may have about lead in drinking water. It also helps you determine if your drinking water contains too much lead and suggests ways to reduce lead in your water.

shown to contribute up to 40 percent of daily lead exposure. As controls have been placed on other sources, drinking water as a source of lead has steadily increased in overall importance over the past several decades.

HOW DOES LEAD GET INTO WATER?

In rare instances lead gets into water as a result of industrial activity. But lead is much more likely to enter water as it passes through household plumbing. Through corrosion, lead is dissolved from leaded solder and lead pipes in plumbing systems.

Lead corrosion also can originate from metal faucets and fixtures made from brass, which contains lead impurities. Research has shown that lead-based solders, present in 70 percent of American homes, and brass fixtures are the most significant origins of lead in tap water. Brass fixtures are especially important sources in homes with plastic water lines. Recent reports also have suggested that lead may originate from the corrosion of

brass fittings on certain types of submersible pumps used in groundwater wells.

The amount of lead corroded from metal plumbing generally increases as water corrosivity increases. Water corrosivity is controlled primarily by the water's acidity and calcium carbonate content. In general, acidic water that has a pH less than 7 and that is low in calcium carbonate is more corrosive than water that has a pH higher than 7 and that is high in calcium carbonate.

In addition to acidity and calcium carbonate, many other

factors can influence water's corrosivity. Soft water tends to be more corrosive than hard water, and warm water is more corrosive than cold water. The common practice of grounding electrical connections to water pipes also can increase lead corrosion. Despite these general rules, any kind of water—including hard, soft, acidic, or nonacidic—can contain dangerous amounts of lead.

Surveys have shown that corrosive water is a common natural problem in Pennsylvania. Groundwater and surface waters in Pennsylvania often originate from sandstones and shale rock types that naturally produce relatively acidic and soft water. Common exceptions are water supplies in limestone valleys. Here interaction with limestone produces less acidic water that is higher in calcium carbonate and is relatively noncorrosive.

Corrosive water acts to dissolve lead from pipes and solder while the water is in contact with the plumbing. Therefore, lead concentrations in drinking water usually are the highest in the first water out of the tap; they decrease as the water is run. If lead pipes, leaded solder, or brass fixtures are present, even relatively noncorrosive water can dissolve dangerous amounts of lead if the water sits in contact with these materials for an hour or more.

Conversely, if your town's water distribution system and your home plumbing system do not contain lead pipes, lead solder, or brass fixtures, your drinking water probably does not contain significant amounts of lead.

HOW MUCH LEAD IN WATER IS TOO MUCH?

Recent guidance from the Centers for Disease Control suggests that blood lead concentrations over 10 micrograms per deciliter of blood ($\mu\text{g}/\text{dL}$) may indicate lead poisoning. Research has shown that blood lead concentrations increase by about 1 $\mu\text{g}/\text{dL}$ for every 5 micrograms of lead per liter of water ($\mu\text{g}/\text{L}$). At this conversion rate, 50 $\mu\text{g}/\text{L}$ of lead in water would produce an unacceptable 10 $\mu\text{g}/\text{dL}$ of lead in blood.

Therefore the EPA, allowing for lead contributions from other sources (e.g., food, dust, etc.), has determined that the maximum allowable concentration of lead in drinking water should be no more than 15 $\mu\text{g}/\text{L}$. (Many experts on lead toxicology believe the safe level should be 10 $\mu\text{g}/\text{L}$ or less, but for purposes of this discussion we will use the EPA's level of 15 $\mu\text{g}/\text{L}$.) Since lead serves no beneficial purpose in the human body, it is best if drinking water contains no lead.

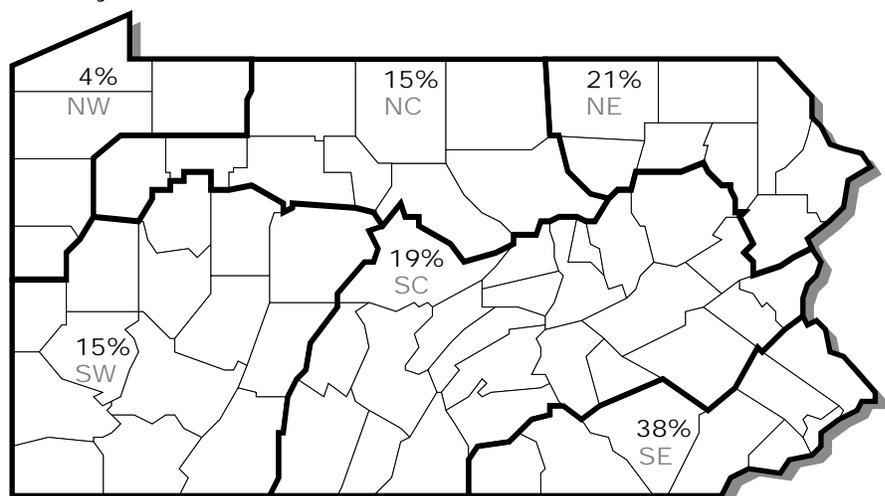
HOW COMMON IS LEAD IN DRINKING WATER?

The EPA estimates that about 40 million Americans are exposed to drinking water lead concentrations in excess of 15 $\mu\text{g}/\text{L}$. In Pennsylvania, the prevalence of leaded plumbing components and corrosive sources of water suggests that lead contamination is a common problem.

A survey of private water supplies (individual homes using groundwater wells and springs) across Pennsylvania found that about 20 percent contain unsafe lead levels of above 15 $\mu\text{g}/\text{L}$. The survey also found that lead in drinking water is a consistent problem in all regions of Pennsylvania (see map).

The prevalence of lead in public water supplies is difficult to know because it depends on how corrosive the source water is, whether lead distribution lines are used, and whether a home contains leaded plumbing materials. If your home is connected to a public water supply, you may wish to contact your water

Percentage of private water supplies having unsafe lead concentrations (greater than 15 $\mu\text{g}/\text{L}$) in each region of Pennsylvania.



Source: Swistock, Bryan R., William E. Sharpe, and Paul D. Robillard, "A Survey of Lead, Nitrate, and Radon Contamination of Private Individual Water Systems in Pennsylvania," *Journal of Environmental Health* 55 (5), pp. 6–12.

company to determine if lead is a problem in your community. You also may want to have your tap water tested.

HOW SHOULD YOU TEST YOUR WATER FOR LEAD?

Because lead is colorless, odorless, and tasteless in water, the only sure way to determine if your water contains lead is to have the water tested. Testing water for lead is a complex process that must be done by a qualified laboratory.

A list of state-certified water testing laboratories is available from your county extension office. Costs for testing normally range from \$15 to \$100.

You should collect two water samples, including a “first-flush” sample and a “running” sample. Collect the first-flush sample first thing in the morning from water that has sat in the plumbing system overnight. This sample determines if lead accumulates in your water as it sits in contact with the plumbing system.

Collect the running sample after allowing the water to run for one minute. This sample determines if the plumbing system is the source of your lead problem. A lead concentration that remains above 15 µg/L after the water has run for one to two minutes indicates that lead is probably present in the water before it enters the household plumbing. The lead may originate from industrial activity, from corroding submersible pump parts, or from corroding lines in a public water system.

It is best to have your water samples analyzed for “total lead” rather than “dissolved lead.” Many laboratories will recommend the dissolved lead test

because it is cheaper, but this test does not analyze for particulate lead, which can only be measured using the “total lead” test.

Laboratories sometimes use different units in their report, and your results may be difficult to interpret. The most common units are µg/L (which is equal to parts per billion, or ppb) and mg/L (equal to parts per million, or ppm).

If your test result is reported in µg/L or ppb, then you should compare it with the safe drinking water standard of 15 µg/L. If your result is reported in mg/L or ppm, then the comparable drinking water standard is 0.015 mg/L.

WHAT REGULATIONS CONTROL LEAD IN DRINKING WATER?

In 1992 federal regulations were created to control lead in public water supplies. The regulations require that water suppliers monitor tap water lead concentrations in high-risk homes they serve.

If more than 10 percent of these homes exceed 15 µg/L of lead, the water supplier must provide public education on the lead problem, and the water must be treated at a treatment plant to make it less corrosive. In addition, the lead service lines owned by many water companies must be replaced over the succeeding 15 years.

As a result of these actions, homeowners connected to public water supplies may see reductions in their tap water lead levels in the near future. The overall goal of these new regulations is to ensure that greater than 90 percent of the households connected to public water supplies contain less than 15 µg/L of lead in their drinking water.

While these regulations will help reduce drinking water lead concentrations in homes using public water supplies, they will not entirely eliminate the problem. The variability of household plumbing systems within communities may mean individual homes still contain dangerous drinking water lead concentrations, even while most of the community does not have a problem. Also, the regulations provide little protection for homeowners with private water systems such as drilled wells, springs, and cisterns.

The 1991 Pennsylvania Lead Ban extended lead regulations to private water systems by banning the sale of leaded solder and leaded pipe, and by limiting the lead impurities that can be used in faucets and other plumbing fixtures. The regulations intend that plumbing systems constructed after January 1, 1991, in homes using public or private water systems not contain lead components.

Only new homes served by public water suppliers, however, are subject to an inspection of their plumbing system. If your home plumbing system is made of copper pipe and was installed before January 1, 1991, it is likely that lead solder was used.

Although regulations are in place to control lead in drinking water, only water testing of each home can determine the actual presence of lead. If you are concerned about lead in your drinking water, you should arrange for a water test regardless of whether you use a public or a private water supply. Also, because of the large variability in lead levels among homes, you should have your water tested for lead no matter what the levels in neighboring houses.

WHAT CAN YOU DO TO REDUCE LEAD IN YOUR DRINKING WATER?

If your first-flush water test result is greater than 15 µg/L, you should take corrective action.

Lead can be removed from water through numerous treatment methods depending on the cost and effort you are willing to expend.

The most simple and inexpensive method is to flush your plumbing system by running the water for one to two minutes before drinking it. Flushing is only necessary if the water has been in contact with the plumbing for at least one hour.

Flushing your plumbing system is recommended only if the lead concentration in your running water sample was less than 15 µg/L. It may not be effective in apartment buildings with complex plumbing systems or in homes on public water sources

where lead service lines are the source of the lead. In these cases, tap water concentrations of lead may exceed 15 µg/L even after several minutes of running the water.

If flushing proves effective, you can conserve water by flushing the plumbing system in the morning and storing water in bottles for use during the rest of

the day. Only flushed water from the cold water tap should be used for drinking and cooking, since hot water can dissolve lead more quickly than cold.

If excessive lead concentrations persist after flushing, or if flushing is an undesirable method, there are numerous alternatives for reducing lead exposure.

Homeowners who have a groundwater well with a submersible pump may want to have the pump checked. If some of the pump's



Letting the water run for 1–2 minutes is the easiest and cheapest way to reduce lead levels in drinking water. This method is effective for reducing lead levels below 15µg/L in more than 90 percent of cases.

metal parts are corroding, they could be contaminating the groundwater with lead.

Acid-neutralizing filters can be installed to reduce water corrosivity by adding calcium and by increasing the pH of the water. Unlike other treatment options, these filters act to prevent lead from entering the water rather than removing it at the tap. They

do this by producing a thin scale that prevents the lead from being dissolved from the pipes and solder inside the plumbing system. These units normally cost \$500 to \$1000 and may cause a noticeable increase in the hardness of your water.

Reverse osmosis units and activated alumina filters are very effective in removing lead once it is in the water. These units typically are attached to the kitchen tap and treat only the

water from that tap. Costs vary from \$300 to \$900. Reverse osmosis units of this size can produce only a few gallons of treated water per day.

Distillation units, also normally placed on the kitchen counter, are effective in removing lead from drinking water. However, they are relatively expensive to operate and produce only a gallon or so of water per day, depending on their size.

Contrary to some claims, water softeners are not recommended for lead removal. Softeners are inefficient lead removal devices,

and they usually are installed in the plumbing system ahead of the piping and fixtures where most of the lead originates. Also, softened water is more corrosive than unsoftened water. Thus in some cases softeners could actually cause an increase in tap water lead concentrations.

Other treatment devices such as granular activated carbon

(GAC) filters can remove lead, but their efficiency is questionable. GAC filters, for instance, are only efficient at removing lead when the water pH is near 7. Small, inexpensive countertop filter units are being marketed for lead removal, but prospective buyers should beware of salespersons who will not substantiate their claims or who use devices that involve questionable treatment methods.

Furthermore, excessively small units are limited in the amount of time that the filter is effective in removing lead. A National Sanitation Foundation (NSF) seal on treatment equipment is one method of ensuring that the unit has been tested for adequate removal efficiency. A NSF seal does not guarantee, however, that the filter will be effective after many months of continuous use, and filter replacement is always



A National Sanitation Foundation (NSF) seal on treatment equipment shows that the unit has been tested for adequate removal efficiency.

required periodically.

The most effective and most expensive lead removal method is to replace the leaded components in the plumbing system with nonleaded components. This procedure most often involves replacing copper pipes and lead solder with plastic PVC pipes. Only plastic PVC pipes approved for home plumbing use, as indicated by the letters NSF-pw

appearing on the side of the pipe, should be used for replacement.

Replacing home plumbing components will be effective only if the source of the lead is within the home plumbing system. If the lead originates from lead service lines within a public water system, this method may be of limited benefit.

FOR MORE INFORMATION

Lead in drinking water presents a complex problem for consumers of public and private water supplies. If you have questions concerning testing and removal of lead from your drinking water, contact your local office of the Pennsylvania Department of Environmental Resources, your county office of Penn State Cooperative Extension, or the county or state health department.

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