

Division of Science, Research and Technology

Research Project Summary

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Sources of Lead in Homes Served by Private Wells in Hunterdon County, NJ

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Abstract

Lead is one of the inorganic constituents required for testing in New Jersey's Private Well Testing Act. During the first two years of this new law, elevated lead levels in private well water were reported to the state. A study was initiated with researchers at Rutgers University to identify the source(s) of the lead in these private well water samples. The results of this study, conducted in Hunterdon County, indicate that plumbing is responsible for the lead in the water samples. Specifically, plumbing associated with the holding tanks appears to be the primary source of lead in the water samples collected.

Introduction

Lead has been found in private potable well water samples collected from locations throughout the State as part of the testing requirements of the Private Well Testing Act (PWTA). Because, in many instances, there is a potential source of contamination nearby, it is unclear whether the lead in the water samples is from plumbing materials or from the source water.

Some drinking water pipes, taps, solder and other plumbing components contain lead. Lead in the plumbing may leach into water and pose a health risk when consumed.

Exposure to lead is a significant health concern, especially for young children and infants whose growing bodies tend to absorb more lead than the average adult. Drinking water is one possible source of lead to this vulnerable population. Infants whose diets consist mainly of liquid can get 40 - 60% of their lead intake from water.

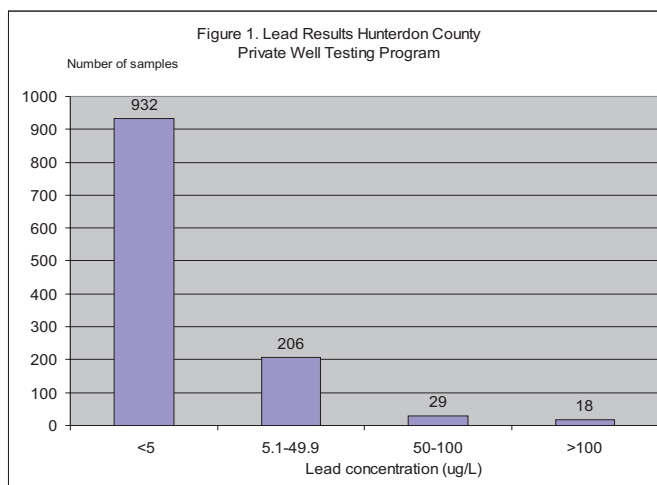
Although groundwater, which is the source of water for private well owners, may have little to no lead, water samples collected from home as part of the PWTA requirements have shown elevated lead levels, possibly due to the presence of lead and lead-containing plumbing materials in the houses. Sampling methods are significant in order to distinguish between lead emanating from source water and lead emanating from household plumbing.

Lead-containing plumbing materials are still available on the market. Some fixtures may still contain up to 8% lead, which is used as an alloying material in brass. For example, yellow brass contains 1-3% lead and red brass contains 5-6% lead. Depending upon the

corrosivity of the well water, the brass plumbing materials can leach lead at varying concentrations into the water.

Lead data from Hunterdon County is presented in Figure 1. Overwhelmingly, lead levels are below the January 2006 ground water quality standard of 5 ppb. However, lead concentrations in some well water samples exceeded the action level, with some water samples showing lead concentrations above 100 ppb. More intense analysis of the water samples with elevated lead levels show that the homes whose wells were sampled are not near areas where lead is likely to be a contaminant in groundwater.

Research conducted in the 1990s by scientists at NJDEP and Rutgers University have shown that lead in well water samples collected from homes served by private wells in NJ is most likely coming from plumbing. Further, this



research shows that the sampling method, sample volume and sampling location are vital in distinguishing between lead in the ground water versus lead coming from the plumbing.

Methods and Data Analysis

Numerous investigators have used inductively coupled mass spectrometry (ICP-MS) to determine lead (Pb) isotope ratios in various types of samples, both environmental (i.e., water) and human (i.e., blood). Specifically, studies have demonstrated accurate measurements of lead-206/lead-207 and lead-206/lead-208.

Previous studies funded by NJDEP using ICP-MS on groundwater and drinking water samples indicate that this is an effective method for identifying sources of lead to water.

ICP-MS was used to determine the concentrations of the elements (Cr, Fe, Mn, Co, Ni, Cu, Zn, As, Rb, Sr, Cd, Sb, Hg, Pb, Th, and U) and to determine the lead isotopes in tap water. The pH and temperature of the water samples were measured on site immediately after collection.

Volunteers were solicited through the Hunterdon County Health Department. Homeowners whose original lead sampling results were above the action level at the time (which was 10 ppb) were invited to participate in the study to further investigate sources of lead.

The water was not used in the house for at least eight hours before sampling and the water is described as being “first draw”. Standard Environmental Protection Agency (EPA) quality assurance (QA) and quality control (QC) practices were followed. All reagents used were of the highest quality for use with the high sensitivity elemental analysis method of ICP-MS. High-density polyethylene bottles that were used to collect all samples were cleaned by acid washing.

The analyses began by collecting 25-mL of water from the kitchen cold-water faucet using a slow flow rate. This water sample represents any elements that would be leached by the water that is contained within the faucet volume. While continuing flowing, the next sample was collected - a 125-mL - followed by a 1,000-mL (1 L) sample. This last one liter water sample represents water that is contained within the copper (Cu) pipe under the kitchen sink and soldered joints connecting the Cu pipe to the faucet water line. These samples are similar to the EPA’s “first draw” sample, the only difference being a total volume of 1,150-mLs instead of the EPA protocol of one 1,000-mL (1 L) sample. The three samples collected give a better lead resolution and allows for identifying the sources of lead in the first draw sample.

The next sample collected was from the standing water in the water tank. After this sample was collected, the kitchen tap was flushed for five minutes. This is referred to as the “kitchen flush.” The volume of water that was flushed was determined and recorded. The next group of samples was collected at the water tank using a known fast flow rate to

collect water from the well aquifer and the pipe. These samples were collected at 5-minute intervals. All water valves to the house distribution system were closed so as only to collect the water directly from the well. This collected water also bypassed any point of entry (POE) water purification systems. By measuring the water flow rate, the diameter of water pipe that went to the submersible pump, and the depth of well, these water samples were collected so as to definitely to be from the aquifer and the submersible pump. The pH and temperature of all water samples were measured on site.

Solder samples were collected from locations on the cold-water plumbing distribution system where accessible. Copper pipe samples were obtained by filing from the cold-water distribution system. Energy dispersive X-ray fluorescence (EDXRF) was used qualitatively and quantitatively to determine the lead concentration in the solder samples. If the solder contained lead, it was dissolved in dilute nitric acid and the lead isotope ratios measured to compare with the ratios in the water samples. Copper filings from the Cu pipe were dissolved in nitric acid, spiked with Tl, and the lead concentration and isotope ratios determined by ICP-MS. Samples were stored in coolers and delivered to the laboratory on the same day as collection.

At the laboratory, samples were spiked with high purity nitric acid to act as a preservative and with thallium as an internal standard before analysis by ICP-MS. Each sample was analyzed in triplicate

Results

For this project, sequential water samples were collected from thirteen (13) houses served by private wells in Hunterdon County, NJ. The results indicate that the highest concentrations of lead in the water came from the first 25 milliliters of tap water collected from the cold water tap - from the faucet fixture itself. The second highest concentration of lead in the tap water came from a sample collected at the water tank drain valve.

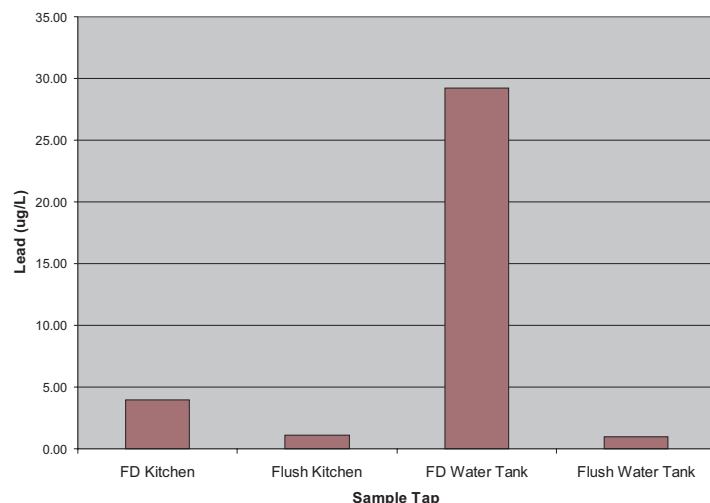
The average total lead concentration in first draw kitchen samples was 4 µg/L, and the corresponding flushed kitchen sink sample was 1 µg/L. The water sample collected after the kitchen had been flushed but before the downstairs water tank was flushed from the valve draining the water tank contained an average of 29 µg/L of lead. The corresponding lead level for the flushed water tank sample was 1 µg/L. Isotopic analyses confirmed that the source of the lead in both the kitchen tap water sample and the water tank sample was the fixtures themselves. Small volumes of water in contact with lead-containing material in these valves and fixtures are capable of accumulating lead when in contact with each other for several hours.

Older homes had lead-based solder and generally had the highest lead concentrations in the tap water. Lead isotope ratio analyses showed that the sources of lead in the water are derived from the plumbing fixtures. The fixtures (faucet and valves) were composed of brass that contains up to 8% lead. The lowest concentrations of

lead in the samples were found in the extended flush samples collected at the water tank drain valve. This water represents water derived from the aquifer.

replaced or the homeowner adopt a “flushing” protocol for consumption of water from the tap.

Figure 2. Total Lead in Water Samples



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Discussion and Conclusions

It is recommended that sampling be that of EPA method in which 1 liter of first draw kitchen tap water be collected after the water has been sitting for at least 8 hours. The lead measured in this sample will reflect lead contributions from the plumbing distribution system. The second sample should be collected at the water tank drain valve and the system has been flushed for 5 minutes. All water valves to the house distribution system should be closed and any water purification systems bypassed. The pH and temperature of the water should be measure on site.

Of the other elements analyzed, barium was the highest concentration element in the samples and reflects the source of the host rocks from the aquifer.

All future homes constructed in New Jersey that wish to use well water as the primary source of drinking water in the house, should use plumbing materials that meet the new NSF/ANSI Standard 61. In addition, homes built prior to 1998 can reduce the amount of lead in their tap water by replacing existing faucets and valves with those that meet the NSF/ANSI Standard 61.

For the private well testing act requirements, it is important that samples collected reflect what the law has required – measurement of lead in the aquifer water. In the past, samplers have “flushed” the plumbing at the kitchen tap and then collected the water sample from the holding tank. In effect, this is a first draw sample reflecting lead in the valve draining the holding tank. Samplers should collect water samples from the taps that were actually flushed in order to get a lead measurement that is reflective of aquifer water.

For public health, homeowners should check the types of faucet fixtures are in place to ensure they are lead-free. If they are not lead-free, it is recommended that the fixtures be

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