

Toxic Metal in Well Water: A Study of Pelham, N.H. Water Quality

School: Pelham High School

Grade Level: 11 and 12th

Teacher: Janet Holden

Project Partners: MDI Biological Laboratory, Southern New Hampshire Area Health Education Center, and Dartmouth College

Teacher Profile: Janet Holden began teaching Biology at Pelham High School in 2006.

Summary:

In collaboration with Dartmouth College, Pelham High School was asked to be one of four New Hampshire high schools to collect well water and test it for a variety of metals. Although the project is focused on arsenic, other water contaminants, such as uranium, were tested as well, and the results were shared with the homeowners. Pelham High School had begun a water testing program in 2009 that tested the local Beaver Brook for nitrogen, ammonia, dissolved oxygen, pH, and salinity. Arsenic testing was too expensive for the school to include in the original study. This additional water test was very valuable demonstrating to students that it is not just the water quality for organisms and animals that people must be concerned about, but also individuals' drinking water.

Introduction:

Students began the collection process by offering information and free test kits to the Pelham Community at an informational table on Voting Day in the Spring of 2016. Water test kits that included instructions and vials were handed out to interested school families through the biology classes. Seventeen vials were not returned. Pelham offered two vials per household. One vial would be a sample of non-filtered water and the second vial, filtered water. Students were concerned that households could have inadequate filtration systems. The two tests would inform a resident if contaminants were in the well water, and if their filter was successfully removing them. A total of 32 homes had water tested in February of 2016. On November 8, 2016, additional water test kits were handed out and 71 returned for testing. After analyzing the data, students created a map that represented the absence or presence of arsenic and uranium at each test site. In addition, students investigated the geologic causes of these naturally occurring substances and the related health concerns.



Project Details:

- The monthly School News was emailed to families and the well water testing project was listed in the newsletter. Interested families had an email link to the high school for additional information and contact information.
- Students decided to use Pelham's voter registration map that divides Pelham NH into forty-two blocks, and they attempted to get water samples from each of the areas. In addition, a table with arsenic information and water collection tubes was available at the high school when it was used as a voting site both in February and November of 2016.
- Parent letters were prepared using the recommended format from the Toxic Metal Site; water collection tubes and parafilm were ordered.
- Students were assigned readings from the USGS article about NH and arsenic in well water.
- Students begin researching arsenic in water and were required for homework to find two arsenic resources other than the ones provided.
- Students worked collaboratively identifying appropriate research on the environmental impact of toxic metals in drinking water.
- Map of Pelham from the towns Assessors Office was enlarged and printed. Students chose to divide the community into a grid, with the goal of receiving a well water sample in each section of the community. Students had read articles discussing that in one development using well water, one house may have heavy metals and the next house may not. Despite that, students were still interested in seeing if there was a pattern based off of a geologic map.
- Reviewed "Talking Points" from Kathrin Lawlor (Education Coordinator sent "Talking Points" for students to use on February 9, 2016 at the voting polls). Students read the material and practiced presenting information to townspeople and encouraging them to complete a water test kit. Talking Points included the following:
 - While arsenic can come from both natural and manmade sources, most NH arsenic comes from bedrock. As a result, arsenic can be found in private well water.
 - According to the NH Department of Environmental Services, approximately *46% of the population depends on private wells for their drinking water.*
 - Unlike public water systems, which are maintained by towns/other groups, private well owners are responsible for testing and treating their well water.
 - According to NH Department of Environmental Services, 1 in 5 private wells in NH may contain unsafe levels of arsenic.
 - The large amount of bedrock throughout NH can be linked to the increased arsenic in well water, particularly in southeastern NH.
 - Arsenic can cause serious illness. Arsenic exposure has been linked to heart problems and various forms of cancer.
 - Children are especially vulnerable to the effects of arsenic.
 - Recent studies have shown that long term exposure, even at lower doses, can change the way cells function.
 - The maximum contaminant level (MCL) for arsenic in water is 10 parts per billion (ppb).
 - Since private well water is regulated by home owners, you need to test your well water today and then again every 3-5 years.

- Testing your water from arsenic only can cost only \$15-25.
 - If you have not tested your well water for other contaminants, you should do so.
 - You can test your well through private well water testing laboratories or the state public health laboratory
 - You cannot rely on your neighbor's test results. Many people assume if their neighbor has low arsenic, they will also. That is NOT the case. Each well should be tested.
 - If you have unsafe levels of arsenic, you can decide whether to install a treatment system or switch to an alternate drinking source.
 - You cannot boil arsenic out of your water.
 - There are experts in NH to answer your questions:
 - NH Department of Environmental Services
 - Dartmouth Superfund
 - DHHS Lab
 - Private Well Water Companies
 - The NH Department of Environmental Services has recently created a webpage called "Be Well"
 - Many people comment that they have been drinking their well water all their lives and they are fine. You cannot tell if your water is arsenic-free by taste. You cannot see, smell or taste arsenic. In addition, health effects can take a while to appear or exposure can compound other health issues.
 - You can also be exposed to arsenic through food sources. Some rice and/or rice products have high arsenic amounts.
- Students communicated to the public issues surrounding well water in NH at Pelham's voting station in February of 2016. Paula Smith (Pelham's Community Health Partner assigned for the project from the Southern New Hampshire Area Health Education Center), was at the high school on voting day to provide assistance with the well water information. The registration forms with the vial numbers written at the top were available on voting day. Individuals were asked to drop off the samples in a box at the front of the school within one week.
 - A student was assigned to go through the registrations and match them with the vials, and anyone who had not turned in the vials by the deadline was contacted by telephone. If an individual did not answer the phone, a message was left reminding individuals to turn in their samples.
 - Students began registering the vials online. In addition, they took the registration addresses and matched them back to the grid map of the community. The first vials were delivered to the Dartmouth lab. Pelham High School planned to pass out half the vials in the Spring and the other half in November.
 - Students were presented with the arsenic forum site and how to download the Excel spreadsheet with the water test results. Students in small groups were asked to create a plan to evaluate the data and how to present the data to the community. Groups had thought of a variety of methods to evaluate the data:
 1. Use all the data
 2. Use only Pelham data
 3. Use only select toxic metals
 4. Convert or not convert the units between EPA units and the MDI lab units.

- Only the Pelham data was used.
 1. Class members considered the audience (local townspeople could see the results of their work).
 2. Individuals in the town would most likely pay attention if only Pelham was discussed.

SUMMARY- March 2016			
	Sample A	Sample B	All Samples
Manganese	21.4%	28.6%	23.8%
Arsenic	35.7%	42.9%	38.1%
Uranium	7.1%	0.0%	4.8%

SUMMARY- Nov. 2016			
	Sample A	Sample B	All Samples
Manganese			21.43%
Arsenic			22.86%
Uranium			28.57%

Sample A- vials with filters

Sample B – vials without filters

Results of the November 2016 water samples had eleven samples where the unfiltered water had reduced levels of toxic metals compared to the filtered samples. These samples were run twice to verify accurate results. As a result, students chose to only record total number of homes with unsafe levels of metals regardless of whether they had a filter or not.

Discussion:

What my students learned:

Although many students had known that arsenic was a poison and could be found in water, no one had been aware of a local issue. In addition, the fact that uranium could be found in drinking water was even more surprising to most students. I believe what many students found unbelievable was when their own parents did not want the water tested. Many students discovered that parents didn't want to know because they would have to disclose any negative tests if they went to sell their home. Another surprise to the students who attended the Selectmen meeting was that only new construction with wells had to have the water tested before the sale of the home. In class students described what they were walking away with from the well water testing. One student stated "When I was trying to register people on election day I talked about arsenic. A person in the line said 'Everyone knows about arsenic.' That is when I asked if they were concerned about uranium? After I said something about uranium people started asking for registration sheets."

What I Learned:

I had not been aware of how many people in N.H. rely on well water. I believe all the science teachers at our school were aware of arsenic, but not how common it was in well water. The chemistry teachers in particular were shocked about uranium in water and quickly did research to verify it is found locally. In addition, when I attended the consortium on arsenic I was surprised at the levels found in rice.

What I would do differently:

- The first discussion in all classes that participated was on the registration process and if it worked effectively. Students from all blocks spoke on their level of comfort or their lack of comfort. Two students discussed that they were not at all comfortable approaching adults or asking them to come to the table to look at toxic metal literature.
 - a. As a result, in the future students would practice appropriate approaches to adults and have practiced a basic script introducing the literature and water testing.
- At one point the table in February had been left unattended and a set of registration papers were missing and a pair of unlabeled vials.
 - b. As a result, students agreed the table must be manned at all times with a minimum of two individuals unless there was an emergency.
- MDI Biological Laboratory sent preprinted labels with a spot for the vial # and date of sample. Students discussed that at times, when they were copying the vial # down on the registration forms, they were not sure all of them were correct.
 - c. As a result, students thought it would be better to prewrite the vial # at the top of the registration forms and have them already on vials packaged as a group.
- Looking at the results between the first water testing and the second water testing, there seemed to be a better return of vials after uranium was discussed. I believe that many people hear a radioactive element and they become anxious, arsenic just doesn't make people anxious. If we were participating again I would suggest to students to begin the water discussion with uranium, then talk about arsenic.

Conclusion:

I believe this has been a project that was valuable to high school students, providing authentic data collection and demonstrating many issues scientists have collecting data. I'm concerned that we have only reached a little over a hundred homes, a small fraction of the town population. I also have become deeply concerned at the lack of understanding some residents have about toxic metals. A member of the school had their water tested and asked if I would take a look at the results MDI had mailed to their home. The results were very high in arsenic, manganese, and uranium. I explained that although I could tell what the metals were, and dangers, I could not help with a filtration system. This educated person, knowing the water is unsafe to drink, still uses it for herself and family members, but gives her pets bottled water.

References:

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