

Project Title: Pelham Toxic Metal Results of Well Water

School: Pelham High School

Teacher: Janet Holden

Project Partners: Maria Flor Fahnestock, University of New Hampshire

Teacher Profile: I have been teaching science for twenty-five years everything from Kindergarten through college. I completed my undergraduate work at the University of New Hampshire with a degree in Food Chemistry. As a military spouse, I lived in Japan, the Philippines and Hong Kong before returning to the United States. While stationed in Wisconsin I interviewed for a chemistry position with the state monitoring arsenic in well water in the 1990s. I didn't take the job but that was the first time I had heard of drinking water in the United States having toxic metals in it. I've been interested in toxic metals in drinking water since then.

Objectives:

- Increase student awareness of toxic metals through citizen science.
- Increase awareness that not all drinking water in the U.S. is safe and what EPA limits mean.
- Increase community awareness through targeting elementary school education through PTA, literature, and citizen science.

Timeline:

September 12 and 13-

- Introduced toxic metal SEPA grant through Dartmouth and MDI- How do students want to be involved?
- What is the role of Citizen Scientists?
- Past results of well water testing in Pelham and Board of Selectman previous reports
- Play "PUR" water commercial on PUR Water Bar: <https://vimeo.com/188722887>

September 16 and 17-

- Elementary School agreed to work with the high school as citizen scientists.
- Homework: What articles from the "All About Arsenic" site and literature from New Hampshire Department of Environmental Services is best to send home with the elementary students?
 - What is in Your Well Water: https://www.des.nh.gov/organization/divisions/water/dwgb/well_testing/documents/well-testing.pdf
 - "Protect Your Family's Health" from New Hampshire Department of Environmental Services-will sent home with the elementary students. Pelham High School (PHS) students will deliver the literature for distribution.

September 17 –

- PHS invited to the Pelham Elementary PTA meeting at 6:30, students were there to hand out literature. A faculty member at the PTA suggested that during parent conferences we would see the largest population of parents. The PES Elementary Principal agreed, along with the Superintendent, to let PHS students talk to parents during conferences Oct. 21-24.

September 18-

- Ordered vials, parafilm

September 19-20 –

- Discussed Community Events Oct. 21-24. What do students feel this should look like?
 - Students decided to sign up for meeting parents at tables to register the families, others volunteered to process vials, a group of students wanted to make digital posters for the event.
 - I asked students how they thought we should try to get the vials back, after all these are elementary students. I discussed that the teachers shouldn't be in charge - students should be. A student suggested a bin for the vials at the office and children could drop them off as they came into the building. The building principal agreed to this.

October 10-

- Emailed U.N.H. professor Maria Flor Fahnestock geochemist scientist partner- we agreed to Skype the following week

October 18-

- Skyped with scientist partner about goals, Tuva, and the upcoming Community Event.
- Met with students after school to go over their individual roles at the upcoming Community Events.

Oct. 21-

- 3:30- 6:00 pm: Citizen Scientists handed out water vials, helped parents with registration forms and had them set up an account at "All About Arsenic" site.
- U.N.H. professor Flor Fahnestock assisted with registrations and answered questions. The same literature that was sent home with students was available at tables for parents, but it did not seem that any parents were familiar with it.

Oct 22-23-

- 3:30-6:00 pm: One group of students handed out literature another group spoke to parents as they entered the building. A third group sat at tables processing vials and registration.

- PHS Students showed the elementary children where the bin was for vial collection and others agreed to do the daily pick up at the elementary school of the vials.
- After school: students began checking on vials that had arrived, placed parafilm and baggies over each sample. An additional group of students took responsibility of the 120 mL samples, placing them in the freezer.

October 28-

- Daily collection of the vials continued until Monday, 10/28. First set of water vials shipped to MDI. The paper registration and a few vials left off after Monday were shipped the following week to MDI.
- Students divide themselves into groups based off research questions. They were responsible for researching the topic and writing that section of the final report and presenting it at Community Events:
 - Manganese
 - Arsenic
 - Uranium
 - Arsenic and manganese combination
 - Zero Water challenge- a group of students wanted to test whether Zero Water Filter really works
 - Brain Research Group- wanted to research the IQ changes in children exposed to arsenic levels above EPA recommended levels

January 2-3-

- Well water test results for Pelham in:
 - Classroom discussion on EPA limits – student research teams have class time and homework for their research. Teams responsible for dividing the work.

January 6-

- Responded to Tuva questionnaire. Explained to evaluators that the questionnaire took a long period of time to complete and that the questions were at a level that most high school science classes would not be using.

January 7-

- Molly Schaffler emailed following up on some questions for the webinar that Tuva would be hosting. I told her that the biggest problem I had in Tuva was creating a pie chart that could be color coded and with font large enough to be easily viewed. I explained to her that Pelham's Community Event is televised, and the graphs needed to be easily understood by the average viewer. Later that afternoon, she sent a hand drawn pie chart colored coded and asked if that would be what I was looking for.

January 9-10-

- Student research on arsenic, uranium, and lead due.

January 23-

- Participated in webinar on TUVA

January 24-

- Email communicated with our scientist partner to establish dates for potential Community Event in February, dependent on the Board of Selectman docket.

January 27-

- Introduced Tuva with the Toxic Metal Data
- Students worked on the Tuva tutorial

January 28-

- Dr. Kate Buckman emailed offering for Cindy Klevens, from the Department of Environmental Services, to speak about remediation at Pelham's Community Event.

January 29-

- Students created pie charts using Tuva for Community Event

February 3-

- Board of Selectman report is complete, but all the work cited must be double-checked.

February 10-

- Board of Selectman have placed us on the March 31 docket. Report is attached.

March 13-

- School suspended for the COVID-19 virus.

March 16 -

- Contacted the Board of Selectman to inform them students would not be able to participate at the March 31 Board meeting.

March 31-

- The Pelham Board of Selectman made the Pelham High School Well Water study public.

April 5-

- FaceTime meeting with Dr. Jane Disney over the SEPA Grant and where we have left off.

Objectives met:

- Increase student awareness of toxic metals through citizen science.
- Awareness that not all drinking water in the U.S. is safe.

- Student understanding of what EPA limits mean for health.
- Increase community awareness
 1. Literature handed out at Pelham Elementary School: Students felt only a few people would read the literature and Flor Fahnestock agreed- literature also sent home with students
 2. The Board of Selectman placed the report created by the students on their website
 3. The guidance department (through a community fund) purchased a ZeroWater filter for a family with limited income and high levels of arsenic and uranium.

Pelham High School
Honors Anatomy and Physiology
Pelham Toxic Metal Results of Well Water
Presentation to the Board of Selectmen
March 31, 2020

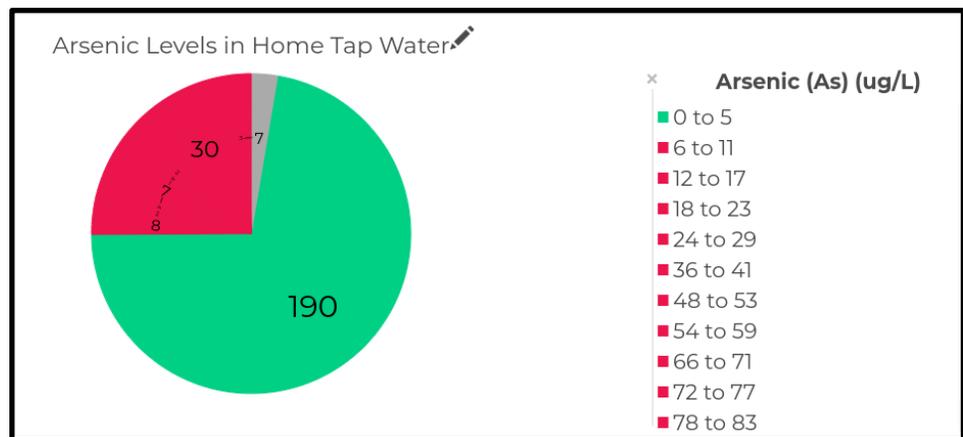
Introduction

Pelham High School's Anatomy and Physiology classes are taking part in the second year of a five-year Science Education Partnership Award (SEPA) grant program through Dartmouth College and the Mount Desert Island Biological Laboratory (MDI) titled "Data to Action." The SEPA project entails distributing vials for well water collection, water quality data analysis, interpretation of toxic metals, and community events. Students during the 2019-2020 school year distributed literature and vials for well water collection to elementary parents and students during Pelham Elementary Parent Conferences. The well water samples were delivered to MDI Lab and then tested at Dartmouth with the results uploaded into a scientific data site, *Anecdata*, by MDI Lab. Homeowners received a letter if their water had any metal that was above EPA or state limits; they received recommendations to have the water tested a second time and to contact the Department of Environmental Services in Concord with any questions.

Arsenic in Pelham Well Water

Arsenic Results- 263 homes have been tested since 2016 and 29% of homes have arsenic levels above 5 µg/L, which is the limit for safe drinking water in New Hampshire. Homes have tested as high as 199.99 µg/L. The percentage of homes with elevated levels of arsenic is down from the previous 31% in 2019.

Arsenic is a naturally occurring element and is primarily found in the earth's crust. Existing in two forms, arsenic is classified as inorganic when it is found in soil and groundwater, and organic when it is found in food, mainly fish and other seafood. The inorganic form of



arsenic is highly toxic; human exposure is typically presented through contaminated drinking water and contaminated water used for food preparations or industrial processes. Long-term exposure to arsenic can lead to a multitude of health effects (“Arsenic and Drinking Water from Private Wells”).

Acute effects of arsenic poisoning include vomiting, abdominal pain, and diarrhea, followed by possible muscle cramping and numbness/tingling in the extremities. Symptoms of long-term exposure to arsenic can be identified by the appearance of the skin, including color change, skin lesions, and patches on the feet and hands. Bladder and lung cancer can also result from arsenic exposure. Other health effects that can be caused by ingestion of inorganic arsenic are diabetes and developmental effects (“Arsenic”).

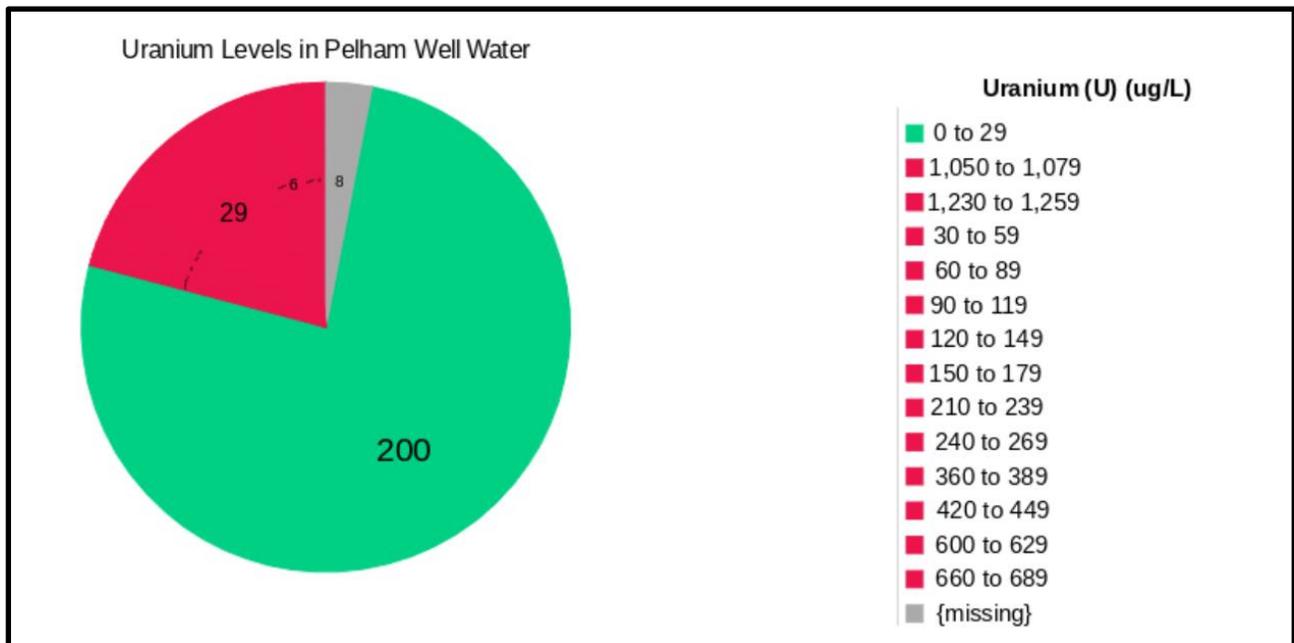
Arsenic is found in certain rock and mineral deposits and can dissolve into groundwater when water flows through the area. In addition, it is commonly used in preservatives, fertilizers, and glass; the industries manufacturing these products often neglect proper disposal procedures and dump chemicals containing arsenic into the water supply. Improper well-construction may lead to inadequate filtration and subsequent arsenic exposure through the well water (“Arsenic”).

Uranium in Pelham Well Water

Uranium Results-263 homes have been tested since 2016 and 25% of homes tested had levels of uranium above 30µg/L, which is the limit for safe drinking water in New Hampshire. Homes have tested as high as 1251.102 µg/L.

Uranium is a naturally occurring radioactive element that can be found within the Earth's soil and sediments. In addition to this, wind and water erosion, as well as volcanic eruptions, can lead to the release of uranium from below the Earth's surface. Its presence in groundwater is mainly caused by the breaking down of minerals within the soil and sediment, which releases the uranium. Because of this, the drilled wells that obtain their water from the cracks in bedrock have the possibility to tap into the groundwater that contains this released uranium (“Uranium in Well Water”).

The severity of health effects depends on dosage, duration, contact, and exposure with uranium. Exposure to uranium through drinking water will first target the kidneys and can potentially lead to lung cancer (“Toxic Substances Portal”). It may also lead to a shortened lifespan because of these effects (“Water Treatment Solutions”). The Association for Toxic Substances and Disease Registry have also stated that over a long period of time, exposure to uranium can lead to a change in neurological behavior and chemical brain levels. Several studies have shown that species of rats and mice that have been exposed to unhealthy uranium levels eventually show decreased fertility and changes of chemicals in the brain (“Toxic Substances Portal”).

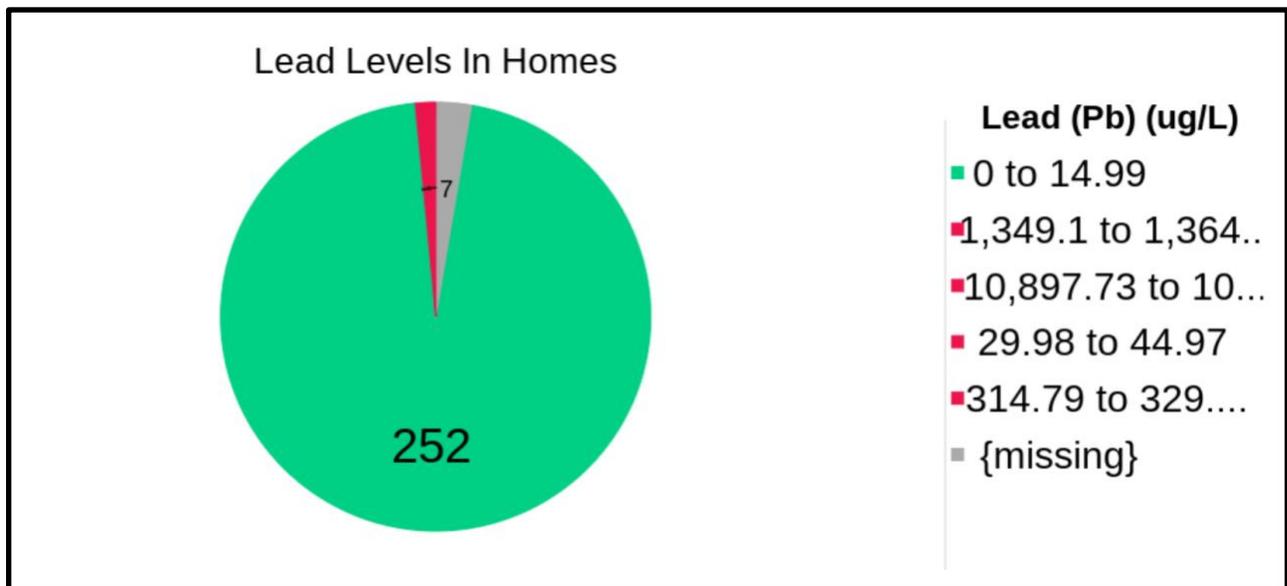


Lead in Pelham Well Water

Lead Results-263 homes have been tested for lead since 2016. Of the homes tested, 1.5% of the homes had levels of lead over 15 µg L, which is the EPA legal limit of lead in drinking water. The homes have tested as high as 10,910.64 µg L.

Lead is a naturally occurring metal found in the crust of the Earth. It is highly toxic and can act as a strong poison. Lead-contaminated water most often comes from the pipes of older homes. The water corrodes the lead-based pipes and faucets allowing it to enter the drinking water. Lead-contaminated water can result in many long-term health effects for the people who consume it, and it is much more of a prevalent threat than most people think.

Various health concerns are associated with drinking contaminated water. Children who are exposed to excessive amounts of lead in their water can experience behavior and learning problems, lower IQ, hyperactivity, slowed growth, hearing problems, and anemia. Adults who drink contaminated water experience cardiovascular effects such as increased blood pressure and incidence of hypertension, as well as decreased kidney function and reproductive problems. Pregnant women who drink contaminated water put their unborn children at risk of reduced growth and premature birth (“Basic Information about Lead in Drinking Water”).



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