Project Title: Investigating the Quality of our Well Water

School: Exeter High School

Grade Level: 9th grade

Teacher: Debra Kimball

Project Partners: MDI Biological Laboratory, TUVA Labs, University of New Hampshire (Scott Greenwood began teaching at Seacoast School of Technology 2019-2020).

Teacher Profile: I have been a science teacher for over 25 years. I now primarily teach physical science to 9th graders. I have a strong commitment to citizen science, being active in a Harvard Forest project and as part of a team of volunteers for the NH DES VRAP program leading water testing on the rivers in my town. For the past 20 years I have involved students in citizen science projects.

I received my BS in Wildlife Biology. During my teaching certification, I took many more earth science and physical science courses to round out my experience. I later received a master's in environmental education.

My passions are farming and gardening, as well as birding and establishing native plant habitats.

I am concerned about groundwater protection and have participated in many workshops and activities on groundwater that led to my interest in the All About Arsenic project.

Summary: Data to Action is a citizen science project involving students in the monitoring of arsenic in well water in their communities and sharing that well water data with others by informing the public on the importance of well water testing. Over the past 4 years, I have collaborated with four other physical science teachers. This was our third time doing well water testing in the community (both staff and students submitted samples from throughout Southeast NH and a few from Southern Maine). We had just under 50 well water samples analyzed. Unfortunately, our samples were the last group to get sent in before the lab closed down due to Covid 19. Students were not able to analyze any 2020 samples this year as we went to remote teaching at that time. I sent out an email with a link to all students and staff that had taken water samples, so they were aware of the arsenic and other mineral levels in their well water.

We got a late start on the well water project this year- it took place from late January through late February. I met three times with Scott Greenwood and one time with Sarah to try to plan out an arsenic well water study. Scott and Sarah mentioned the possibility of other current grad students at UNH helping the students analyze data and perhaps building a simple water filter, but conflicts in schedules prevented that from happening. We initially had visions of guest speakers with an environmental engineering background to speak to some of the classes. Sarah had done her graduate study on the willingness of folks to get a water test and how to encourage them to follow through. We thought if college-age students could talk to students about the importance of water testing, this may encourage more students to get involved. Lots of ideas were discussed and emailed back and forth but, in the end, it fell apart- I got busy with end of semester commitments as did Scott and Sarah (who was defending her thesis and taking up a new job in Concord).

Once February came around and semester one was completed, all I could do was put out the well water data analysis project, which needed to be done by the end of February. This year the focus was on data literacy as well as integrating the state's 21st Century Goals. Our partner, Scott Greenwood, developed a tutorial for a Tuva data set and I walked through that data set together with the students- they did not create their own analysis; rather, we worked as a class to get introduced to Tuva and to use that sample tutorial. In hindsight, this should have been done in the fall, but it was not. From there, students explored the Tuva well water data set in a lab activity- a good preview to their project on well water data analysis.

Projects were submitted by the end of February (at least most were). I told the students we would take our research and data analysis and report out to the community both online and in-person, such as at our farmer's market. I reached out to Seacoast Eat Local who ran the market at our school once a month through April, but they could not decide on a date and kept pushing it off. Unfortunately, the Covid 19 shutdown and remote learning period began and it was difficult enough to try to teach part of the curriculum, never mind add in another project involving reaching out to the community. No community involvement happened at all.

Project Details:

- 100 9th grade students were involved in the project.
- Activities and Links:
    - https://www.nhpr.org/post/plan-halve-limit-arsenic-drinking-water-clears-nh-legislature#stream/0
    - Parts per million activity
    - Groundwater readings

- Water filtration lab
- Exploring TUVA data set activity
- The NHDES put out the latest Environmental newsletter and in it are a few important drinking water articles including proposal to lower the arsenic level to 5 ppb- link for newsletter:
  - News
  - what's in your water? Why test?
- Tuva Data Links and help: https://arsenicdata.tuvalabs.com/dataset/195/
- General link to NHDES site on contaminants in well water and other useful state site links: Drinking Water/Ground Water Fact Sheets - Public Information and Permitting Unit
- Understanding Contaminants in Private Well water in NH: http://www.dartmouth.edu/~toxmetal/assets/pdf/wellwatertoolkit.pdf
- What is arsenic? Arsenic
- All about arsenic website by MDI and SEPA: http://www.allaboutarsenic.org/
- Arsenic and You website by Dartmouth College: https://www.dartmouth.edu/~ars enicandyou/
- USGS Arsenic info sheet: https://www.usgs.gov/mission-areas/water-resources/science/arsenic-and-drinking-water?qt-science_center_objects=0#qt-science_center_objects
- Water treatment and levels of arsenic found in water sources: https://www.dartmouth.edu/~arsenicandyou/water/treatment.html
- Drinking water-- Ground water—well: - https://www.epa.gov/privatewells#_ga=1.199430126.1325208417.1445355252

- Overview of Water Unit
  - Properties of Water
  - pH (acid/base)
  - water droplets traveling via the water cycle
  - Pollution of surface and groundwater
    - point sources-from a known source like a pipe in the river from a factory
    - nonpoint sources from across the land- manure, fertilizers, sediment
    - treatment of surface water before we drink it-general knowledge
    - treatment of waste water before it goes back out to the river-general knowledge

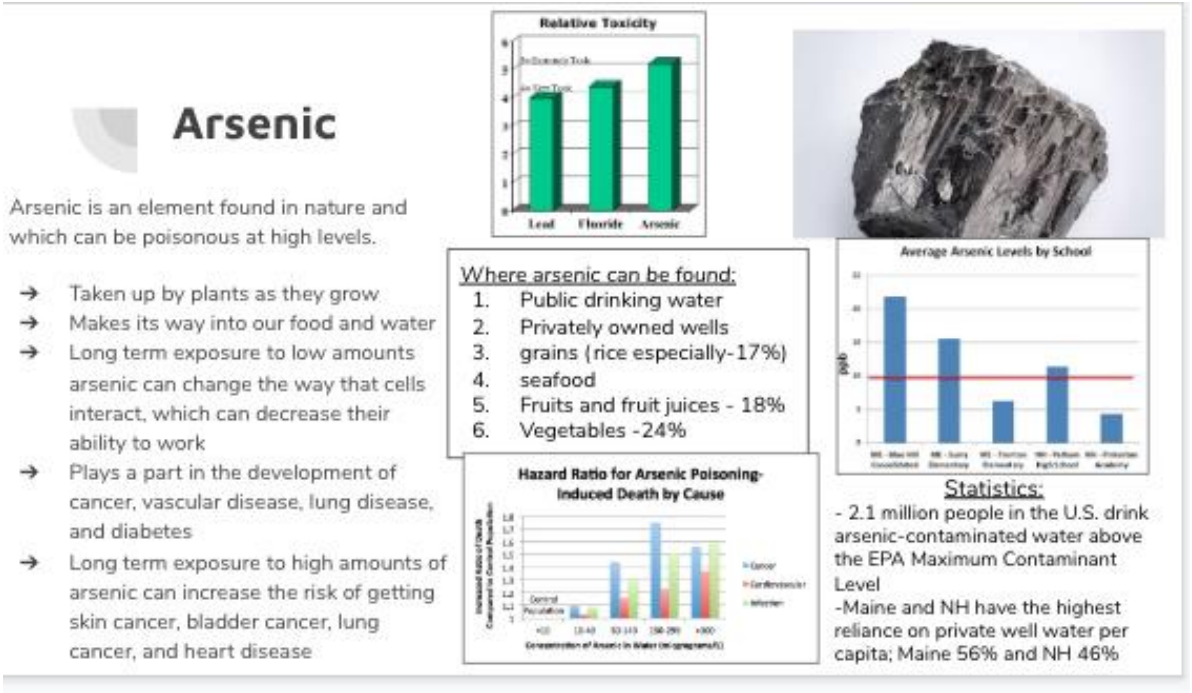
- *Investigating Arsenic and other Contaminants in well water using the TUVA dataset

Drinking water Project PSCP Part 1
-- 50 points DUE DATE FEBRUARY 17th
GOAL : Students will be able to investigate levels of substances that occur in NH/Maine well water, why they are a concern, analyze the available well water data for a particular substance, understand how it affects humans, and /or determine how that substance might be lowered using filters.
Develop your Essential Question- How is (amount of a particular substance(s)?) affected by (location, well type,depth filter type……). (this format can be switched around)
Example: How does the well depth and type of well affect arsenic, manganese, and iron?
Or How is arsenic affected by the location and depth of a well and why does such a small amount lead to health affects.

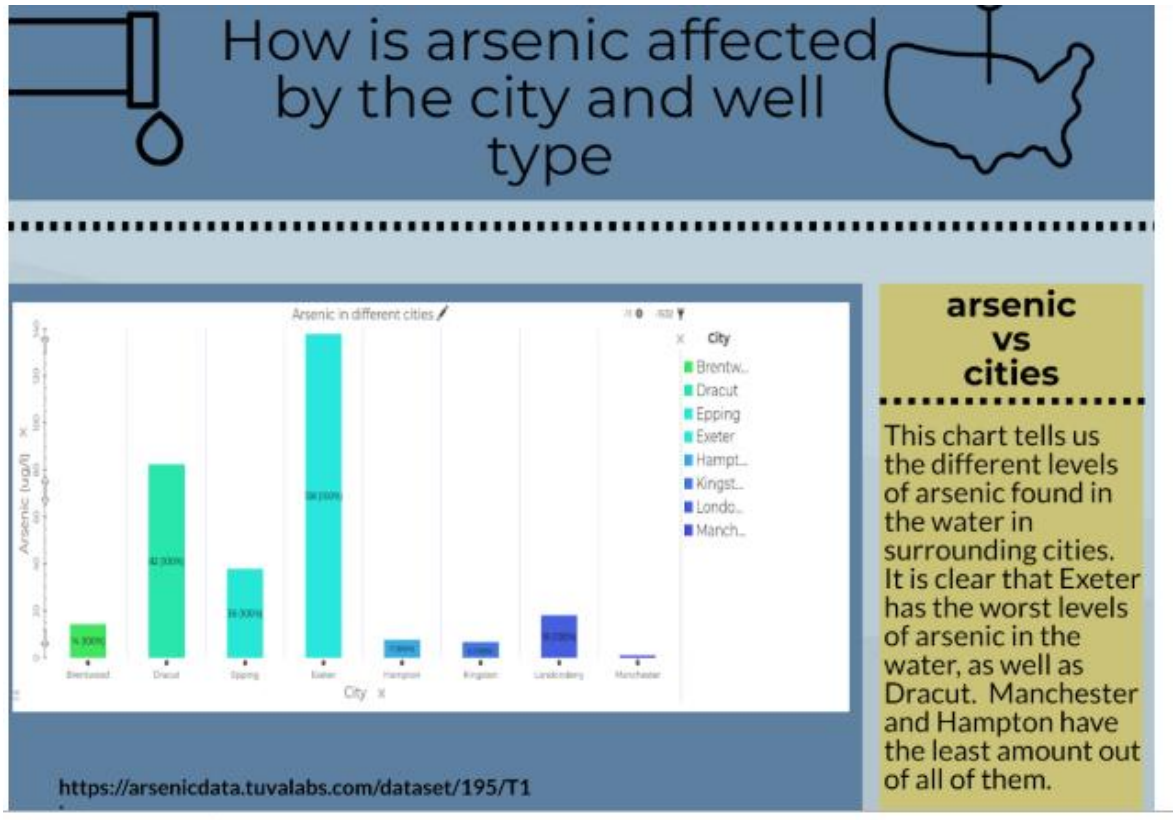
Science Core Competencies:
MAKE PREDICTIONS BASED ON DATA:

- **Data Analyses**. The following are from a few of the projects:

Two slides from Emma R's project:

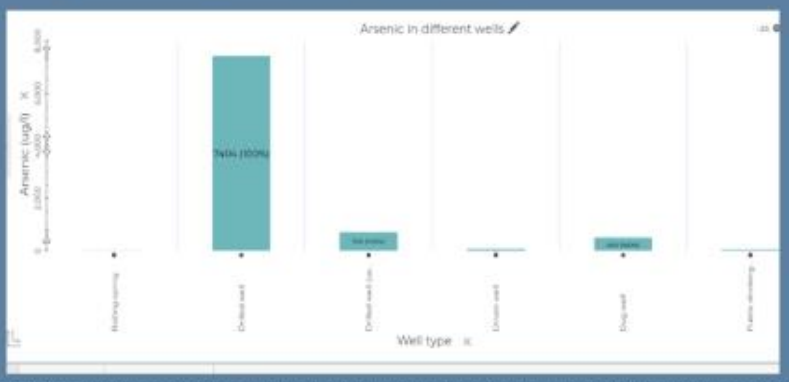


Screenshots of 2 slides of Isabella M's project:



This chart shows the levels of arsenic in different forms of wells. We can clearly see that the most amount of arsenic is found in a drilled well . While others such as a dug well or a drilled well (more than 50 feet deep)still have some , but not as much.

https://arsenicdata.tuvalabs.com/dataset/195/T1



similarities:

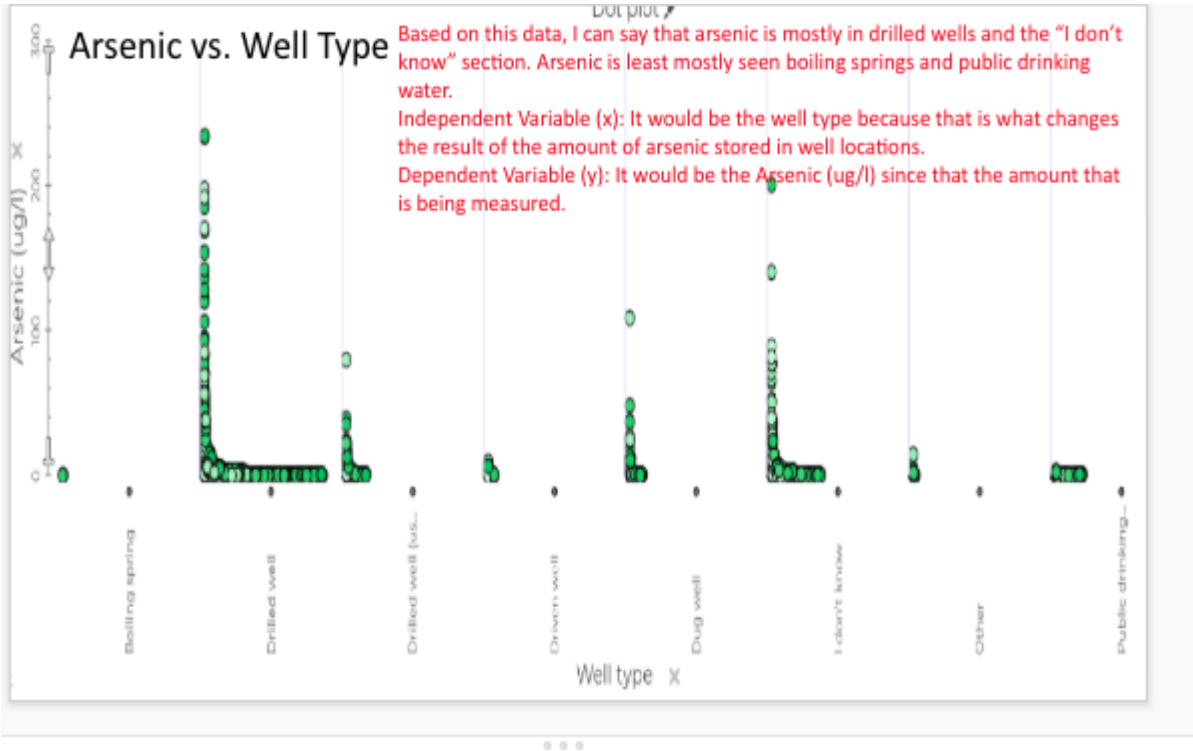
New Hampshire gets most of its water from the supply of groundwater and New Hampshire is known for having a heavy supply of naturally occurring arsenic in the ground. If there are drilled wells in New Hampshire that are very shallow they are more prone to a higher arsenic level. Levels of arsenic in Exeter are very high because as you can see in the picture, the most amounts of arsenic found in the ground are the Southeast part. Places such as Manchester are in a spot where there has been arsenic recorded so they don't need to be worried about drinking from the groundwater. The reason why the drilled well has the most arsenic in it is that they aren't deep enough. The farther you go with your well the cleaner your water will be, having the well so far up exposes it to the arsenic in the ground and other polutents that aren't natrally occurring.

From Ethan M's project:

by: Ethan MaKaDan

Essential Question

How is arsenic affected by well type and location? How does it positively/negatively affect us?



- I learned that some students naturally have an ability to navigate the Tuva data sets and those students utilized Tuva the most. However, there were some students who did not connect with the Tuva data sets and had difficulty making sense of the data and interpreting what they saw. I did have my two academic classes also try a modified well water data project- focusing on analyzing the data tables they created. I did not spend enough prep time to get them used to the program, and thus many had difficulty making sense of the data. These kids struggle with graphing and data analysis and in the future I would break the activity down, scaffold more, and add a few pre activities to help guide them.
- Our community meeting did not occur this spring due to Covid 19.
- Stipend:

  Personal funds: Envelopes to place all test kits in, more bottles and mailings. Science Dept funds: More filters for a simple water tests for a lab during semester 1, roll of parafilm wax with science dept funds My receipts are left at school and it luckily is not enough to be reimbursed. . I never ended up putting in for expenses last year as well - about the same amount of expenses

  My matching volunteer time would be planning the unit, contacting individuals to help out, organizing and getting the packets out to both staff and students, checking the lists to see who did or did not return kits, organizing the samples to get mailed out and then contacting all individual

via email on how to check their results and what the results mean. Approximately 50 hours of time

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Conclusion: The All About Arsenic project has fit into my teaching as a citizen science project involving students in the monitoring of water quality in their own homes and getting out the message of how important it is to test and understand how arsenic affects human health. New Hampshire just lowered the MCL of arsenic to 5 ppb from 10 ppb- this created a new talking point this year. While I love these types of projects because they have real connections for students, the science department jumped into NGSX and thus less time was devoted to this project. If I had more time, I would weave this into a NGSX lesson. The water unit was rolled out in late January and lasted until late February. We managed to squeeze in water properties, learn about ground water and possible contaminants, and get to the Tuva well water data analysis project. Most students did a stellar job on this project and many were getting ready to get the word out about what they had learned and to share their findings. Unfortunately, the community piece planned for March to April as an “on your own piece” for students did not occur due to Covid 19 and remote instruction.

References:

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http://www.allaboutarsenic.org/case-studies/

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https://arsenicdata.tuvalabs.com/dataset/195/

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Be well informed tool, NH DES, February 15, 2020
https://www4.des.state.nh.us/DWITool/ Drinking water sources,

NHDES Well Water fact sheet , February 15 , 2020,
https://www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-1-1.pdf

JPL Water Filtration Challenge, February 3, 2020
https://www.jpl.nasa.gov/edu/teach/activity/water-filtration-challenge/

Water filtration- how it works, February 3, 2020
https://www.explainthatstuff.com/howwaterfilterswork.html

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