

## **Bow High School**

### **Clean Water**

#### **Grade 9-12**

#### **Brenda Mitchell, Pamela Cafasso and Amanda Guilbert**

**Project Partners:** Priyanka Chowdhury from the Biology Dept at Keen State College; Cynthia Klevens From Bow Clean Drinking Water Committee

**Teacher Profile:** I have been teaching since 1984. I graduated from the University of California in Berkeley with a Bachelor of Arts Degree in Microbiology. I earned a California teaching credential from San Francisco State College the next year. I received a Master's Degree in Administration and Supervision much later from Antioch University in Keene, NH. I have taught inner city general science at a middle school in San Francisco, biology, physical Science and chemistry at Pembroke Academy (my alma mater) and integrated science and technology, anatomy, chemistry and forensics at my current position at Bow High School.

I have redesigned our Chemistry curriculum around essential questions that have an ecological focus. The year starts with a look at water. Water is used as a vehicle to teach solubility, ionic and polar covalent compounds, separating mixtures and lab techniques. Each week an element is introduced. The Arsenic project fit in perfectly since the major ions in the water in Bow are Arsenic and Lead.

#### **Summary:**

We added the Arsenic project to the second unit of the year: water. Every Monday all year we introduce an element of the week. For this unit, we used water contaminant related elements. Leading up to the water sample collection, students were introduced to ionic compounds and polar covalent compounds. Solubility was also studied. Two labs were performed to purify foul water: filtration and distillation. Students were then introduced to the project and water samples were collected. After data was available, students looked at the data and a class discussion was held on safe levels and purification methods. Honors students created a science fair type presentation of the results, purification methods and health concerns of contaminants in drinking water. The Bow Clean Drinking Water committee was invited as were graduate students from Keene State College. Following the fair, the informational posters were put on display in the Learning Commons.

Next year we plan to do all we did this year and to add more data analysis with Tuva. Before the samples are collected students will look at this year's data, both from BHS and the project in general, and use that data to generate hypothesis.

#### **Project Details:**

The Arsenic project fit seamlessly into the curriculum. The elements of the week that were introduced during the two month unit on water were all issues in clean water. Arsenic, lead, radon, uranium, and chlorine are a few we used this year. Every Monday the element would be introduced with an emphasis on the location on the periodic table, the atomic structure, and the properties. The focal properties were those that related to the danger of these ions in drinking water and how to remove them. The presentations given to the students are included in a link below. Next year we hope to have in class demonstrations for several elements.

Students worked on two labs leading up to the water sample collection. First students designed their own filtration devices to clean water. Materials such as cotton, activated charcoal, filter paper and sand were provided and students could stack materials in cups to create a system. The purity of the water was measured using pH probes, conductivity, turbidity, and colorimetry before and after filtration. Students then purified water using distillation. Again purity was measured before and after. Distillation of the foul water

was then performed, testing the water quality before and after distillation. Students then compare the methods and do a general cost-benefit analysis. Next year we hope to focus more on the cost benefit analysis of home systems. This will involve a little extra research on the part of the students, but will be of more benefit for the families.

Immediately following these labs, students were asked to bring water samples from home for the Arsenic project. The samples were sent out to Darmouth for testing. When they returned, students looked at what was found in their water and at safe levels as described by the EPA. Home purification was discussed. Students brought in just under 100 samples to be tested for arsenic, lead, uranium and other contaminants. Some of the results were quite high in arsenic. We shared the graphs that students created with the Bow Water Committee which resulted in great discussions among the adults. Next year it would be great if we can get some of these committee members to come into class, virtually or in actuality, to have this discussion with the students. Perhaps we can generate a list of questions ahead of time to be addressed. Honors students (a self selected group) created a Fair for the Bow Community to share next steps. The Fair was held at the school before a grade K-12 music concert. Both the Bow Water Committee and students from Keene state also attended and had booths with information and demonstrations. Bow students made posters that ranged from careers in water purification to the dangers of specific contaminants to methods of purification. One student created graphs and analysis from the data in Anecdata. Students also created interactive booths to demonstrate the use of the wireless probes they used and demonstrated the NH program that guides consumers in choosing home purification methods. Sadly, although literally hundreds of parents and community members went past the displays, few stopped to interact. We did collect additional water samples from the passers-by. About 20 people stopped to interact with the display. The posters the students created are currently on display in the BHS Learning Commons. Next year we would like to display in the Baker Free Library as well.

All Chemistry teachers had their students do these labs:

[filtration of foul water](#) and [distillation of foul water](#)

Here are the weekly "Element of the Week" presentations for the water unit

[Element of the week](#) presentation for this unit

The [summative assessment](#) for element of the week for the year

Here is an advertisement for the water fair that went to all parents at BHS

[Advertisement](#) for the Water Fair. The Fair was not heavily attended. While many parents walked by and smiled, only about 15-20 interacted at any of the booths or studied a poster.

The posters still on display in the Learning Commons do attract both student, teacher and parent interest.

Here is the [sign up](#) for Honors Students who did the "content" of the Fair

[Data set for Bow/Dunbarton](#) as assembled by students

[Page](#) that students used for research (from Google Classroom)

The stipend was used to purchase wireless probes from PASCO. These can be used in conjunction with the probes BHS already owns and easily connect via bluetooth to a phone or a chromebook. The application Sparkvue is used to help calibrate, collect data and to graph the data. The probes purchased were a turbidity and colorimetry probe, a probe to test for phosphate and a probe to test for ammonium. We have found that the portability of the probes is awesome and that larger groups of students can use only one probe of each type easily when it is set up as a station.

**Discussion:**

The students have become very thoughtful about water and issues around fresh potable water. The midterm exam lab asks students to use precipitation to remove ions from water. In past years students struggled to connect this with “real life”. This year there were few issues!

The classes had several discussions about the politics of potable water. Teenagers have a keen sense of justice and they were quite upset that builders and past home owners did not have to report Arsenic levels to new families/owners.

How to remediate water systems was a new topic for us. Students were quite keen on discussing this, especially when the results of the water tests were in! I know that they enjoyed being able to educate their parents and to advise them on possible purchases! Community members were excited to discover that whole house systems were not necessary to remove arsenic.

Management of all the samples, registration and checking results were the biggest challenges for me. Working with Cindy Klevens was a true pleasure: she taught me much about water issues and remediation. The entire committee was fabulous with the students. I would like to increase the student-committee contact next year. Perhaps the committee members would serve as mentors or interview contacts for the honors projects next year. Priya was a great resource and our conversations about reaching students and community were empowering. The demonstrations her students brought need to be videotaped next year!

**Conclusion:** We tested more wells in Bow and Dunbarton through this project than our local Water Committee does in five years. That is staggering. The schools are a wonderful way to not only learn about water issues but to reach community members and encourage them to take action. The Water Committee and I have resolved that even when this project is over, we will continue to do our part and make low cost testing available through the Chemistry students.

*Dear Mrs Mitchell, Mrs Cafasso, and BHS Chemistry Honor Students,*

*On behalf of the Bow Drinking Water Protection Committee, thank you so much for inviting us to participate in the Arsenic Fair at the high school on Tuesday, March 12th. It was a pleasure talking with you and your students about their projects regarding common drinking water contaminants in Bow and Dunbarton. Your efforts to increase community awareness of this critical aspect of our environment is a valuable contribution to our town and greatly appreciated!!*

*The BDWPC is a volunteer committee involved in a number of activities in support of groundwater resource protection and safe drinking water for our residents. We invite you and your students' participation in our programs or collaboration on projects of mutual interest. We have a webpage with our current projects on the town website [www.bownh.gov](http://www.bownh.gov) and meet at the town hall the first Monday of each month from 5:30-6:30 p.m. You and the students are welcome to join us at any time!*

*Best wishes for the rest of the school year and thank you again,*

*Cynthia Klevens, P.E. / for Bow Drinking Water Protection Committee*