# BLUE HILL CONSOLIDATED SCHOOL

**Is Our Water Safe? Monitoring Surface Water and Ground Water Quality in Blue Hill, Maine**

**School**: Blue Hill Consolidated School

**Grade Level**: 7th and 8th

**Teacher**: Nell Herrmann

**Project Partners**: MDI Biological Laboratory, Healthy Acadia, Washington/Hancock County Agency, Dartmouth College

**Teacher Profile**: Nell Herrmann is a middle school science teacher at Blue Hill Consolidated School. She has taught for 16 years, always striving to make science interesting and accessible for her students. Before becoming a teacher, Nell studied Wildlife and Conservation Biology. She is passionate about sharing her love of the natural world with her students and has traveled extensively to better understand threats to oceans, rainforests, the Arctic and the Antarctic. After each educational adventure, Nell arrives back to her classroom eager to share new knowledge with her students. Nell is especially excited about the All About Arsenic project because it gave her students a chance to understand a local environmental threat, arsenic contamination of groundwater, as well as the opportunity to educate others in the Blue Hill community about this threat.

**Summary:** Blue Hill Consolidated School (BHCS) is located on the Mill Stream in Blue Hill, Maine. The Mill Stream runs through town and directly into the Blue Hill Bay. The stream is home to wildlife including beaver, minnows, frogs and macroinvertebrates. A large beaver dam is at the end of the nature trail that provides access to the stream. The nature trail is used by many students (Pre-K through 8) from BHCS and by students from George Stevens Academy, the nearby high school.

Students have been collecting water quality data at the Mill Stream since 2000, with a focus on pH, nitrate, dissolved oxygen, coliform bacteria, phosphate and turbidity. In addition, students have sampled the macroinvertebrate community since 2013. The results from our 2016 study indicate that water quality of the Mill Stream is not pristine, nor is it extremely polluted. The Mill Stream tested positive for coliform bacteria and also had slightly elevated levels of nitrate and phosphate. Tests for pH, dissolved oxygen and turbidity were within acceptable ranges, according to information provided in the LaMotte Water Quality Kit purchased with money from the grant.

Students found mayfly larvae, dragonfly larvae, midge larvae, stonefly larvae and other macroinvertebrates in the Mill Stream. In addition, minnows and tadpole larvae were abundant in the stream. Based on the macroinvertebrate data, students calculated the overall health of the stream as “fair” in terms of water quality.

It was interesting for students to think about the difference between groundwater and surface water; many of them did not have a clear understanding of where their own tap water came from at the start of this project. By the end of the project, students had a clear understanding of

groundwater and how it can be contaminated by bedrock and from runoff. Students brought in samples of tap water from their homes (a total of 77 samples were collected) and were intrigued, and somewhat alarmed, by the results of the data. The culminating event for this project was a community meeting at which students shared the results of their findings and told parents and other members of the community how to protect themselves against groundwater contaminated by arsenic.

Stream testing: Students tested at 4 sites on the Mill Stream for pH, nitrates, dissolved oxygen, coliform bacteria, phosphate and turbidity. Students also sampled macroinvertebrates and completed a diversity index to gain a stronger understanding of water quality.

Well water testing: Students collected 77 tap water samples. The samples were tested for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, lead, manganese, nickel, selenium, thallium and uranium. Our focus was primarily on arsenic; we knew in advance that water samples were likely to contain high levels of arsenic (above 10 ppb) because of the granite bedrock containing arsenic in our area. We also knew that pressure treated lumber and residual pesticides sprayed on blueberry fields in the past may influence our results.

This project helped students understand the difference between groundwater and surface water as well as sources of contamination for both.

**Project Details**:

- The project began with a survey about water quality to assess students' prior knowledge. Questions included:
    - Who keeps your drinking water safe?
    - What do the words water quality mean to you?
    - Where does the water you drink at home come from?
    - Where does your sewage go at home? (Once you flush the toilet, where does it go?)
    - What is a well? How does a well work?
    - What is "town water" or "public water" ?
    - How would you know if something was wrong with your water at home?

- After completing the survey, the students read an article about the Flint, Michigan water crisis (**http://www.dogonews.com/2016/1/20/the-water-crisis-in-flint-michigan**) and re-evaluated their initial answers. The article was a great starting point for students to think about and discuss how critical safe water is to daily life. The next day, I shared an image of students from Flint carrying bottled water to their homes and asked students to do a short written reflection, imagining they were one of the children in the picture below. This was a powerful exercise.

- Over the next several days, we used the Prentice Hall textbook, “Science Explorer: Earth’s Waters” to gain background information about groundwater. Vocabulary emphasized included:
    - pores
    - permeable
    - impermeable
    - saturated zone
    - water table
    - unsaturated zone
    - aquifer
    - well
    - recharge

- In addition, we drew a cross section of the ground, labeling the permeable layer, the saturated zone, the unsaturated zone, the impermeable layer, and the water table.
- To review, we watched a video clip produced by the U.S. Geological Survey. The clip can be found here: //**www.youtube.com/watch?v=oNWAerr_xEE**

- Next we did a fun lab activity called "Aquifer in a Cup," which is modified from a lesson in the Groundwater Education through Water Evaluation and Testing or "Get Wet" curriculum. The activity can be found here: **http://umaine.edu/mitchellcenter/files/2012/06/GET-WET-CURRICULUM-NE-USA-OCTOBER-2008.pdf**

- To strengthen student understanding of groundwater, we watched several short video clips on the topic:
    - **https://www.youtube.com/watch?v=uQRvN6MUajE#action=share**
    - **https://www.youtube.com/watch?v=oNWAerr_xEE**

- Throughout the time I worked on this project during my science classes, the English/ Language Arts (ELA) teacher had students reading “Flush,” by Carl Hiassen. Copies of the book were purchased with money from the grant. The focus of the book is environmental advocacy and how to appropriately fight for environmental safety. The students enjoyed the book, but I wished I’d had more time to collaborate with the ELA teacher to tie the book into my science classes.

- We used an EnviroScapes model, purchased with the grant money to model and reinforce concepts about groundwater.

- After the basics of groundwater were taught and reinforced, students collected water samples from home and I mailed them to Dartmouth's Toxic Metals Research Program for analysis.

- Once the samples were analyzed, Duncan Bailey and Anna Farrell from MDI Biological Laboratory came to visit my classroom to help students use the data portal and to understand the results. Bobbi Harris and Maria Donahue from Healthy Acadia also came to visit, describing to students the importance of water testing and how their organization can help people with high levels of arsenic in drinking water. This visit was written up in the local newspaper: **http://weeklypacket.com/news/2016/may/5/students-water-samples-show-high-levels-of-arsenic/#.V5Ad_jmDGko**

- After students had an understanding of their results, they began planning the community event. Students prepared flyers and hung them around town to advertise. In addition, they prepared and practiced their presentations. They took all of this vey seriously and I was proud of their effort and eagerness to succeed.

- The community event took place at BHCS on 5/26 at 5:00 p.m. All of the 7th graders were there, along with their parents and other interested community members. Project lead, Dr. Jane Disney was at the meeting, along with Anna Farrell and Duncan Bailey from Mount Desert Island Biological Laboratory. Community partner Bobbi Harris spoke briefly about the importance of water testing and support offered by Healthy Acadia and a representative from Washington/Hancock County Agency was also present. At the event, students presented the results of the well water tests, as well as Power Point presentations and tri-fold displays describing what they'd learned about arsenic in groundwater. Presentation titles included: Facts About Arsenic, Private Drinking Wells, Effects of Arsenic on the Human Body, and Testing Your Well Water for Arsenic. The meeting was well attended and the feedback students received was positive. Many people from the community thanked me directly for coordinating this project and the students felt proud of the opportunity to educate their parents and teachers.

- After the community event, we completed our monitoring project at the Mill Stream. This was a great opportunity for students to explore the health of surface water in our community.

**Mill Stream Water Quality Monitoring Average Results:**

| | |
|---|---|
| pH | 6 (slightly acidic) |
| nitrate | 5 ppm (slightly elevated) |
| dissolved oxygen | 4 ppm (moderate- will support aquatic life) |
| coliform bacteria | positive |
| phosphate | 1 ppm (slightly elevated) |
| turbidity | 20 jtu (slightly cloudy/silt present) |

**Mill Stream Macroinvertebrate Monitoring Results:**
These are the results from a test done at one of our four sites on the Mill Stream. The other three sites had similar data. The total index value is at this site 12, which indicates the water quality is fair. Larger numbers of pollution sensitive organisms at a site indicate higher water quality. While there were some pollution sensitive macroinvertebrates in the Mill Stream, there were other organisms in the somewhat sensitive and pollution tolerant categories, indicating that the water quality of the Mill Stream is not pristine.

| Species/Type | Number of Individuals | Category |
|---|---|---|
| Stonefly Larvae | 1 | Pollution Sensitive |
| Beetle Larvae | 1 | Somewhat Pollution Sensitive |
| Dragonfly Larvae | 3 | Somewhat Pollution Sensitive |
| Aquatic Worms | 1 | Pollution Tolerant |

**Blue Hill Data**:
Of the 77 samples from Blue Hill, the range was from 0.01 ppb to 223.49 ppb.

Averages per well type:

| | |
|---|---|
| Dug | 0.84 ppb |
| Drilled | 25.152 ppb |
| Unknown | 16.675 ppb |

**Discussion**:

What my students learned:
My students learned a great deal from this project. I surveyed them before the community event and received many great quotes from kids including:

- "This project is a good way to tell people what could happen to them if their water is contaminated."
- "It is important to know about your environment. It is important to know about where you live."
- "I've learned that arsenic can get in the water from bedrock."
- "I have learned that the quality of groundwater can impact your health."
- "This project shows that people have to know about their environment in order to protect themselves."
- "I have learned that groundwater can be contaminated, even if it has no color to it."
- "I feel good that we are helping people figure out more about their water."
- "I think it is cool that we can help people with arsenic contaminated water."
- "We are helping by educating about arsenic."
- "We need to know more about the environment so we can make it as safe as possible. If we know about arsenic, we can make our water safer."
- "I have learned that groundwater can be contaminated easily."

What I learned:
I learned a great deal about arsenic in groundwater and where it comes from. Prior to participating in this project, I had a very limited understanding of the topic. I also learned that my students are eager to act as science communicators and that they care about the impact of the natural world on their health. I was delighted to step back and let the students take ownership of the community event.

What I would do differently:
Mostly I wish I'd had more time to pull things together. I also wished I'd had the students complete some water quality monitoring in Blue Hill Bay, which is the place the Mill Stream ends. I wish I'd been able to figure out ways for the kids to manipulate the data in the data portal in more meaningful and complex ways. It was great to see the maps that Duncan developed and kids were very interested to see where and how arsenic levels varied on the Blue Hill peninsula. It would have been interesting if we'd been able to figure out patterns in the data.

Conclusion:
Overall, this project was a very powerful learning experience for my students and for me. I was able to use grant money to buy materials that will last for years to come and I will continue to think about effective ways to educate kids about watersheds, groundwater, and water quality. I am extremely grateful for this opportunity.

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