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AMERICAN WATER



A Mystery in History

The Case of Waterborne
Illness in Eider County

- **Grade Level:** 7 -12
- **Objective:** Students will research the potential contaminants and health effects of events set in the early 1900's in a community where water supplies were not disinfected
- **Subjects:** History, Environmental Science, Chemistry

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INTRODUCTION

The treatment of drinking water was first borne in 4000 B.C. from the desire to improve the aesthetics of water (taste, odor and appearance). It wasn't until much later that water treatment focused more on the need to improve the health of populations.

Though regulations have existed in the United States for over 100 years, it has only been within the last few decades that consistent guidelines, practiced enforcement and widespread technology have resulted in reliable water quality for the majority of municipal water supplies.

A variety of natural and anthropogenic contaminants have been identified to cause ailments that range from minor gastrointestinal distress to high fever to acute toxicity or chronic morbidity. Industrialization, the development of modern agricultural practices and the disposal of wastes into surface water and in the ground greatly increased exposure to biological, chemical and physical pollutants.

Today, the Environmental Protection Agency (EPA) sets standards for more than 100 potential contaminants in drinking water. And, as our environment changes and the potential threats to water quality change, the EPA updates its regulations based on scientific research. They research a number of unregulated contaminants as well to determine if they pose a concern for water quality.

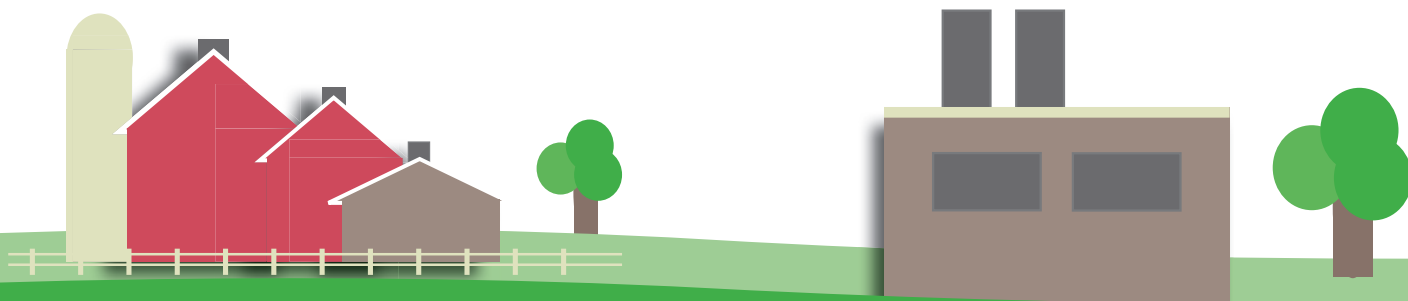
The following case study requires the student to engage in a careful review of the data presented, research potential causative agents and report on conclusions drawn.

DID YOU KNOW?

Chlorine was used for the first time as a primary disinfectant of drinking water in Jersey City, NJ in 1908.

MATERIALS NEEDED

- Piece of paper
- Pen or pencil
- Enclosed data sheets



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EXERCISE

The following letter is a correspondence from Dr. James Stamford, a physician from Philadelphia, to his brother-in-law Robert Eaton, a furniture maker, living 20 miles outside the city whose wife is suffering from ailments of unknown cause.

October 24, 1908

Dear Robert;

I do hope you are managing the children as my sister convalesces. The weather has finally turned here in the city. I do believe autumn is here to stay. Regarding my sister's illness, I have looked up the extent of her symptoms and although I have been unable to identify with certainty the cause, as the symptoms that you've described could be caused by a variety of reasons. I've listed some poisons below. I would also like to investigate the findings of a Dr. Robert Koch from Germany, regarding the cholera bacteria.

At this time I would like to request some information from you that may not be easily acquired, as I know you have both work and family commitments. However, it is only by reviewing detailed information on regional water access, local geography and industries in the area that I will be able to conclude with veracity the identity of the contaminant causing Molly's malady. Robert, you mentioned in your last letter that there were three other individuals suffering with similar ailments. Please let me know their place of residence, employment location and any other activities that may reveal something about their case. I will also require a map of surface features that includes any possible sources for harmful agents.

Rest assured, I will get to the bottom of this. Please take care of Molly, yourself and the children. Once I receive the requested information, I will set to work straight away on solving this case.

Most Sincerely,

James

P.S. Do give my regards to Mr. Cirelli. I was saddened by the news of his wife passing. Her death came as a surprise—the fatal disease acting so rapidly.

Possible Chemicals:

- Benzene
- Cadmium (Cd)
- Mercury (Hg)
- Nitrates
- Dichlorodiphenyltrichloroethane (DDT)
- Vinyl Chloride
- Toluene
- Carbon Tetrachloride

NOTE: This case study in this lesson plan isn't intended to be an accurate representation of the historical events of the time period.

KEY MILESTONES IN WATER TREATMENT

- 1500 B.C.: Egyptians used Alum to clarify the water.
- 1700s: Filtration was first used to remove suspended particles from the water.
- 1800s: Slow sand filtration was used in Europe.
- 1908: Chlorine was used for the first time as a primary disinfectant of drinking water in Jersey City, New Jersey. The use of disinfectants played a large role in reducing the number of waterborne disease outbreaks in the early 1900s.
- 1914: The U.S. Public Health Service set quality standards for for contaminants causing contagious diseases for water systems serving interstate carriers, such as ships and trains. These standards were revised and expanded in 1925, 1946 and 1962.
- 1974: The Safe Drinking Water Act was enacted. As a result of this legislation, more water suppliers began using some type of water treatment process to improve water quality.
- 1986 and 1996: SDWA amended and expanded.

Source: *The History of Drinking Water Treatment*, US Environmental Protection Agency

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EIDER COUNTY CASE STUDY

The below residents are all suffering with diarrhea, vomiting, muscle cramps and dehydration; some also are suffering from kidney malfunctions, headaches, fatigue and dizziness.

Molly Eaton: 41 year old carpenter employed, along with her husband, at Craftsmen Furniture Manufacturing along the South Eider River. The Eaton residence obtains drinking water from the small lake near their home. With the skills from his trade, Molly's husband constructed a wood pipe that carries water from the lake downhill by gravity to their home.

Regina Thomas: 22 year old daughter of Richard and Emily Johnson who own Bristol Farms. They are self-sufficient and grow their own crops for food. Regina spends much of her day in the field on the farm. The Thomas' farm brings in drinking water from the South Eider River that flows northwest past their property.

Harold Johnson: 68 year old retiree who moved to Eider County from the big city where he was a volunteer fire fighter for 30 years. Harold now spends much time fishing the area's rivers, lakes and ponds. The Johnson residence accesses water from the community water supplier.

Samuel Cirelli: 38 year old technician employed at the Fuel Waste Storage Site. His late wife also worked at Fuel Waste before she passed. The Cirelli home has a private well that accesses aquifer water from 60 feet below the surface.

Local Businesses

Eider Water Company: Small community water supplier serving the city of Eider. The source of supply is Eider Lake and the river. To treat the water, the system utilizes alum to clarify the water and remove particles as well as slow sand filtration. Plans are underway to add chlorine as part of the treatment process next year.

Craftsmen Furniture: A furniture manufacturing company managed by Robert Eaton. Employing 12 workers, the facility accesses water from the adjacent South Eider River.

Petroleum Refining Facility and Fuel Waste Storage Site: Refining crude oil into a variety of petro-chemicals and fuels, waste products from the process are stored in the adjacent storage depository prior to shipment by barge along the South Eider River. They obtain their water from private wells located on the property.

Coal Fired Power Plant: A new facility built in northern Eider County, coal is burned to produce electricity. Pollutants from the smokestacks are taken northeast by prevailing winds. They use electricity generated at their plant to pump water directly from Eider River.

Johnson's Bakelite Company: Provided with petro-chemicals from the refining facility, Johnson's Bakelite Company produces telephone handsets. They are the largest customer of Eider Water Company. Currently, the wastewater from manufacturing is pumped to an uncovered basin, which often floods and overflows into the nearby river.

Agricultural Areas

Bristol Farms: They are the largest dairy farm that supplies milk, cheese and beef to the surrounding communities. They also grow a variety of crops, including corn, soy and winter wheat. The farm uses Integrated Pest Management, but does store some pesticides on site, including Mercury, which is hand-applied. Organic fertilizers are also used on this farm.

Greenfield Farms: Owned by a large agricultural company, the farm is also used as an experimental site. New crop varieties, fertilizer and pesticide applications are developed and tested on fields that grow different crops every year. The property recently began using several new chemicals for pest control, including one that was first synthesized in the late 1800s. It wouldn't be until 1939 that it was first recognized as an effective pesticide.* Runoff from the farm drains into the North Eider River.

Geographic Considerations

All rivers on the map flow northwest. The soil is largely composed of loose unconsolidated material that holds ample supplies of freshwater in aquifers.

**Please note: the scenarios in this lesson plan are fictitious, and are to be used solely for the purposes of this lesson plan.*

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EIDER COUNTY MAP



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TASKS

1. Research each of the eight chemical agents listed in the letter. Determine which chemicals are possible contaminants in the water supplies of the region.
2. For each of the chemicals, establish the symptoms that would manifest as a result of drinking water contamination.
3. For each of the industries and agricultural sites, determine common contaminants associated with each activity.
4. Given the choices and your review of the chemicals and industries included in the case study, determine which pollutant is causing the health issues in the four cases in Eider County. Describe how the contaminant could have entered the water supply.

QUESTIONS

1. Are the pollutants referenced in this activity regulated by the federal government? If so, what are the limits on their presence in drinking water? Which have since been banned and why?
2. From the activity, which industries would be easiest to monitor for release of contaminants? Explain your response.
3. Which would be most difficult to monitor? Explain your response.
4. From your research, identify another possible contaminant from one of the industries that could have entered the river or aquifers. Describe this pollutant.
5. How might contaminants that enter aquifers behave differently from those that enter surface waters? How would one attempt to remediate in both cases?

EXTENSIONS

- What industries or activities in your watershed pose potential hazards to drinking water supplies. Research these activities and describe the means used to avoid contamination.
- Contact your state's department of environmental protection agency to determine if a source water assessment has been conducted for your community's water supply. This SWA identifies potential contaminants and their sources. This information can sometimes be found in your community water system's Consumer Confidence Report.

NOTES

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DEFINITIONS

- **Aquifer:** Porous, water-saturated layers of sand, gravel, or bedrock that can yield an economically significant amount of water.
- **Industrialization:** The process of social and economic change that transforms a primarily agricultural society into one based on the manufacturing of goods and services.
- **Integrated Pest Management (IPM):** Combined use of biological, chemical and cultivation methods in proper sequence and timing to keep the size of a pest population below the size that causes economically unacceptable loss of a crop or livestock animal.
- **Non-point Source (NPS) Pollution:** Refers to diffuse contamination that does not originate from a single discrete source.
- **Organic Fertilizer:** Naturally occurring fertilizers include manure, slurry, worm castings, peat, seaweed, humic acid, brassin and guano. Sewage sludge use in organic agricultural operations in the U.S. has been extremely limited and rare due to USDA prohibition of the practice (due to toxic metal accumulation, among other factors).
- **Pollutant:** A particular chemical or form of energy that can adversely affect the health, survival or activities of humans or other living organisms.
- **Point Source Pollution:** Contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch.
- **Water Contaminant:** A water pollutant found in drinking water supply or water source.

RESOURCES

- <http://water.epa.gov/drink/contaminants/index.cfm>
- Environmental Protection Agency Site for Drinking Water Contaminants

COMMENTS

We want to know what you think. Feedback and/or suggestions for improving this lesson plan can be e-mailed to joi.corrado@amwater.com.

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In a world where everything we touch frequently changes, water is our constant. We've never stopped needing it to drink, to cook, to clean, to live. We'll always need it for sanitation, for fire protection, for watering our lawns and washing our cars.

It's easy to take water for granted. And because so many do, we don't.

We are scientists, environmentalists, innovators, and protectors. We are also residents and employees in the communities we serve. We understand how important, how precious, and how critical water is to daily life.

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A special thanks to Ron Smith for developing the core content of this lesson plan. Ron Smith, a science educator from NJ, has been teaching biology, environmental science and interdisciplinary studies in the classroom, lab and field for 18 years. It was important for us that our lesson plans be crafted by an educator for educators. We appreciate his hard work.

Last updated: 12-2010