

## Remediation and Consensus: Real-world Complexities

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**Grade Level:** 9-12

**Estimated Time:** 90 minutes

**Topics Covered:** Chemistry, Biology, Hydrology/Geology

**Standards and Benchmarks:** 11.2.4, 11.3.1, 11.3.2

### Goals:

- Students will understand that many disciplines of science are interconnected and are all involved in addressing issues of water quality
- Students will understand that arsenic and other contaminants can enter water resources through natural geologic processes or from human action

### Objectives:

- Students will be able to describe various ways that have been proposed to solve arsenic contamination problems, and their advantages and disadvantages

**Materials and Preparation:** Articles, maps and resources from the websites listed below, or local newspaper articles concerning an issue not described below.

## Background Information:

There are many local and regional contamination issues that have required problem-solving over the past few decades. These scientific problems are often very complex and involve diverse stakeholders. Relevant examples of water contamination in and around Maine and New Hampshire include:

1. **NH sues makers of PFAS chemicals for drinking water contamination:** In the spring of 2019, the Governor of New Hampshire and officials from the Department of Justice and Department of Environmental Services announced lawsuits against eight companies involved in manufacturing toxic PFAS chemicals for allegedly contaminating the state's drinking water.  
<https://www.nhpr.org/post/nh-sues-makers-pfas-chemicals-drinking-water-contamination>. More information about PFAS [here](#).
2. **ME-Mercury contamination in and along the Penobscot River.** The Mallinckrodt facility manufactured various chemicals in Orrington, Maine from 1967-2000. They were accused of discharging mercury into the Penobscot River and required to clean it up.  
<https://www.maine.gov/dep/spills/holtrachem/index.html>
3. **List of Federal Superfund sites in [Maine](#) and [New Hampshire](#).**

When soil and water near the surface is contaminated, there are several ways of removing contaminants:

Soil capping: Covering a contaminated site with a layer of clean soil

Phyto/bio remediation: Using plants or naturally occurring bacteria to break down contaminants and remove them from a substrate. If plants are used, they are disposed of carefully since they have accumulated some contaminants.

Soil rinsing: This is an expensive technique that involved removing the topsoil and literally washing it with hot water, sometimes mixed with a surfactant.

Immobilization: certain amendments can hasten natural biogeochemical processes that convert high levels of contaminants into inaccessible forms. One example is bacteria that methylate

arsenic compounds, making them inaccessible to most other organisms, therefore keeping them from being a significant risk.

When water in deep aquifers is contaminated, often the only way to deal with it is to treat the water once it gets to the surface. Water purification techniques include:

Filtration: When particulate arsenic compounds are removed. Some common filters include sand filters and porous ceramic filters. More technologically advanced filters use anion-exchange mechanisms to remove arsenic from water.

Adsorption: Water is run through certain compounds that can adsorb arsenic. Iron oxides adsorb arsenic strongly. Other compounds include activated alumina and iron coated sand. Simple devices can be made with an iron salt and activated charcoal.

Precipitation: Arsenic can often be precipitated out of solution with iron and aluminum compounds and then filtered from the water.

## Procedures

### Engage

Using a previously set up duckweed bioassay, have students look at the effects different concentrations of contaminants have on duckweed growth.

### Explore

Divide into pairs. Find one or two examples of groundwater contamination in your area:

- 1) Where is the contamination? What bodies of water does it affect?
- 2) What's the issue? Name the contaminant(s), where they came from, what the adverse effects are.
- 3) Who are the stakeholders involved?
- 4) What is being done to remediate the issue?

### Explain

Teacher can explain that duckweed is actually used in bioremediation of heavy metals. What happens to duckweed once the metals are taken up into the plant? What's the best way to dispose of it?

### Elaborate

Pair present their findings to the larger group. Is contamination natural or man-made? How does this influence the possible ways that contamination could be remediated?

### Evaluate

Have students research another water quality issue in their region and write up an analysis of the problem and proposed solutions. How does science play a role? What are the complexities?