



**Title: Polluted Water STEM Challenge**

**Estimated Time: 1-2 periods**

**Core Ideas (GSE Standard and elements):**

**S3L2. Obtain, evaluate, and communicate information about the effects of pollution (air, land, and water) and humans on the environment.** a. Ask questions to collect information and create records of sources and effects of pollution on the plants and animals. b. Explore, research, and communicate solutions, such as conservation of resources and recycling of materials, to protect plants and animals.

**S6E6. Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.** a. Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives. b. Design and evaluate solutions for sustaining the quality and supply of natural resources such as water, soil, and air.

**Literacy Connections: Books**

The Curious Garden, Peter Brown  
The Garbage Barge, Jonah Winter  
Save the Arctic, Bethany Stall

**Literacy Connections: Close Reads**

Water Pollution Causes Problems ES  
Water Pollution Causes Problems MS

**Science and Engineering Practices:**

**Planning and Carrying Out Investigations:**

Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.

**Constructing Explanations and Designing Solutions:**

Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.

**Crosscutting Concepts:**

**Structure and Function:**

The way an object is structured/designed determines many of its properties and functions.

**Stability and Change:**

For designed systems, conditions that affect stability and factors that control rates of change are critical to consider and understand.

**STEM Challenge Overview:**

In this STEM Challenge, the student’s task is to build a filtering system that can be used to clean the water of a small town with a polluted water supply.

**Ask**

Ask students if they have ever heard of the [Great Pacific Garbage Patch](#). Show the short, but compelling, 3 minute video that highlights some of the causes and effects of water pollution.

<https://www.youtube.com/watch?v=1qT-rOXB6NI>

	Discuss how water is frequently polluted by human products such as litter, toxic chemicals, oil spills, industrial wastes, and human sewage.
<b>Imagine/Brainstorm</b>	Students <b>brainstorm</b> ideas for how they could design and construct a device that could remove pollution from the water. After brainstorming, they should consider the strengths and weaknesses of each idea.
<b>Plan/Design</b>	<p>In order to learn more about wastewater, have them read the article <b><i>Water Pollution Causes Many Problems</i></b> and discuss the three ways that wastewater is treated. While focusing in the process of filtration for this STEM Challenge, make sure to emphasize the other parts of this process.</p> <p>After learning about wastewater, have students test and evaluate some filtering materials before they <b>plan</b> and <b>design</b> a filtration system for a small town with a polluted water supply. Depending on the level of your students and the time you have for this challenge, you can make this open-ended or more of a guided inquiry for your students.</p>
<b>Create/Test</b>	Students follow their plan, and <b>create</b> their filtration system. Once it is created, students <b>test</b> their system in a measureable way to evaluate the effectiveness of their solution. In this case, they test to see how well their system filtered the pollution from the water. Their results should be recorded, organized, and analyzed.
<b>Improve</b>	After discussing and evaluating their results, students improve their solution, redesign their system, and re-test if possible.

### Teacher Notes:

With the new Georgia Standards of Excellence for Science, there is an increased emphasis on the design and development of solutions to practical problems. This STEM Challenge provides students with a chance to design and develop a functional filtration system while considering the larger problem of water pollution on our planet.

This challenge also provides a good opportunity to illustrate how this global environmental problem is closely linked to human activities. Human sources of pollution include litter, toxic chemicals, oil spills, industrial wastes, and human sewage. Water is frequently contaminated by human sewage that isn't treated before being released into the environment. Untreated wastewater contaminates lakes, streams, and rivers, and drinking it can cause a variety of diseases including typhoid fever and cholera. It is estimated that wastewater related diseases kill over 3.5 million people each year.

Fortunately, some wealthier countries are able to treat and clean wastewater before it returns to the natural environment. There are three main ways that wastewater is treated. As a first step, the sewage is allowed to settle in big tanks where it is exposed to oxygen by stirring or bubbling. This stirring causes many of harmful pollutants in the water to react with the oxygen in a way that cleanses the pollutants. Next, the wastewater is filtered to remove suspended particles and impurities that remain in the water. As a final step, the water is treated chemically (usually with chlorine) to kill any potentially harmful pathogens that remain like bacteria and viruses. While polluted water can be cleaned, it is expensive and difficult to do this properly.

In the STEM Challenge itself the students' task is to build a filtration system that could be used by the people in a small town with a polluted water supply. Student should begin by testing and evaluating a

variety of materials that they think might work as effective filters. Once their analysis is complete, they should use their results to design a filter that will remove as much pollution as possible.

**Suggested materials for students to use: (per group)**

2 plastic bottles (16-20 oz) pre-cut ½ way, piece of cheesecloth (or gauze), rubber band, cotton balls, coffee filter, napkin, tissue, sand, gravel or small pebbles, measuring device, small cups, sample of polluted water.

**Polluted water recipe: (1 liter per class)**

Add some of the following materials to 1 liter of water to make a sample of “polluted” water. Mix well.

Soil, bits of plastic and paper (litter), bits of leaves or grass, cooking oil, pepper, glitter, food scraps (egg shells, peels, shells).



## Vocabulary Cards:

### water

a transparent liquid that forms seas, lakes, and rivers



### dissolve

to become surrounded by a liquid



### pollution

a substance in the environment that has harmful effects



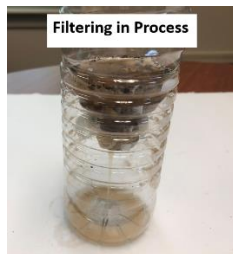
### wastewater

water that has been used in the home or other place



### filter

a device that removes impurities from a liquid



### engineer

to design, build, and improve things

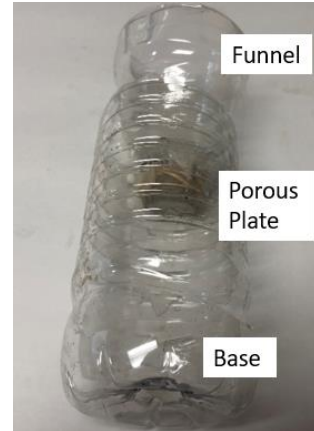


**Part 1:**

**Can you build a model filtering system that can be used to clean the water of a small town with a polluted water supply?**

**Testing different filtering materials:**

1. After learning about filtration, **plan** and **design** a simple filtration system that can clean a sample of polluted water.
2. Using the materials provided, **construct** your filtration system. Your system should include a **base**, a **funnel**, and a **porous plate** (cheesecloth).
3. Choose at least 3 different materials that you think would make good filters and try filtering a 50 ml sample of polluted water using each of the materials separately.
4. After filtering each one, evaluate the overall quality of the filtering and write down your observations.

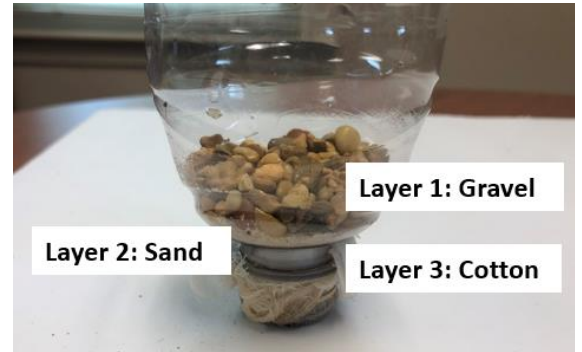


Type of Filter	Quality of Filtering					Observations:
	Poor				Excellent	
Coffee Filter	1	2	3	4	5	
Paper Towel	1	2	3	4	5	
Napkin	1	2	3	4	5	
Cotton Balls	1	2	3	4	5	
Sand	1	2	3	4	5	
Gravel	1	2	3	4	5	

## Part 2:

### Planning and designing a filtration system.

1. **Plan** and **design** a simple filtration system that can clean a sample of polluted water.
2. Using your results from Part 1, construct a multiple layer filter within the funnel of your system. The filter should include least 3 layers arranged in the way that you think will be most effective.
3. Once the filtration system is constructed, carefully **test** it by filtering a 50 ml sample of polluted water through the system. Evaluate the overall quality of the filtering and write down your observations.



Drawing of our water filter (label each layer).	Quality of Filtering					
	Poor				Excellent	
		1	2	3	4	5
	Observations:					

### Evaluating and Improving:

1. As a group, **evaluate** the effectiveness of your design and discuss how you would change your design moving forward to **improve** the performance of your filtering system. If time permits, make these improvements and re-test.

Drawing of our improved water filter (label each layer).	Quality of Filtering					
	Poor				Excellent	
		1	2	3	4	5