



# WAYNE STATE UNIVERSITY

## STEM Day Lesson Plan

**Title:** How Do We Get Clean Drinking Water

**Subject Area:** Environmental Engineering

**Learning Activity Description:** Clean water is one of the most important fundamental human needs. Without access to clean water, tens of millions of people die every year from illnesses obtained by a water-related host. To prevent these illnesses, the impurities, bacteria, and other microbiological organisms must be removed from the water before consuming. Municipal water plants typically clean the water by aeration, coagulation, sedimentation, filtration, and disinfection.

**Lesson Activity Objective:** To demonstrate the procedures that municipal water plants may use to purify water for clean drinking water.

**Lesson Activity Outcomes:** To learn about the importance of clean drinking water and the processes involved to obtain it.

### Materials/Supplies Listed:

- 4 Liters of "Swamp Water" (2 cups of dirt mixed in 4 liters of water), 1 liter used for each group of students
- 4 Two-Liter Soft Drink Bottles (with cap that fits tightly), 1 bottle used for each group of students
- 8 Two-Liter Soft Drink Bottles (4 with its bottom cut off, 4 with its top cut off), 2 bottles for each group of students
- 2 Large Beakers or Measuring Bowls, 1 beaker on each end of table
- 4 Tablespoons of Alum, 2 tablespoons for each group of students
- 6 Cups of Fine Sand, 1 ½ cups for each group of students
- 6 Cups of Coarse Sand, 1 ½ cups for each group of students
- 4 Cups of Small Pebbles, 1 for each group of students
- 4 Coffee Filters, 1 for each group of students
- 4 Rubber Bands, 1 for each group of students

**Teacher Procedures** (Procedure From: Environmental Protection Agency. *Water* Filtration. Office of Water. Web: [www.epa.gov/safewater](http://www.epa.gov/safewater).):

1. Pour the "Swamp Water" into the two-liter bottle with a cap. Have students describe the appearance and smell of the water.
2. Aeration is the first step in the treatment process, adds air to water. It allows gases trapped in the water to escape and adds oxygen to the water. Place the cap on the bottle and vigorously shake the bottle for 30 seconds. Continue the aeration process by pouring the water into another bottle or the beaker, then pouring the water back and forth between them about 10 times. Once aerated, gases have escaped (bubbles should be gone). Pour your aerated water into your bottle with its top cut off.
3. Coagulation is the process by which dirt and other suspended solid particles to chemically "stick together" into floc (clumps of alum and sediment) so they can easily be removed from water. Add two tablespoons of alum to the aerated water. Slowly stir the mixture for 5 minutes. You will see particles

in the water clinging together to make larger clumps. This makes it harder for them to get through a filter at the plant.

4. Sedimentation is the process that occurs when gravity pulls the particles of floc to the bottom of the cylinder. Allow the water to stand undisturbed in the cylinder. Observe the water at 5-minute intervals for a total of 20 minutes. Write down what you see - what is the appearance of the water now? At a treatment plant, there are settling beds that collect floc that floats to the bottom, allowing the clear water to be drained from the top of the bed and continue through the process.

5. Construct a filter from the bottle with its bottom cut off as follows (see illustration below): a. Attach the coffee filter to the outside neck of the bottle with a rubber band. Turn the bottle upside down placing it in a beaker or cut-off bottom of a two-liter bottle. Pour a layer of pebbles into the bottle - the filter will prevent the pebbles from falling out of the neck. b. Pour the coarse sand on top of the pebbles. c. Pour the fine sand on top of the coarse sand. d. Clean the filter by slowly and carefully pouring through 3 L (or more) of clean tap water. Try not to disturb the top layer of sand as you pour the water.

6. Filtration through a sand and pebble filter removes most of the impurities remaining in water after coagulation and sedimentation have taken place. After a large amount of sediment have settled on the bottom of the bottle of swamp water, carefully - without disturbing the sediment - pour the top two-thirds of the swamp water through the filter. Collect the filtered water in the beaker. Pour the remaining (one-third bottle) of swamp water back into the collection container. Compare the treated and untreated water. Ask students whether treatment has changed the appearance and smell of the water.

**Preparation Time for Learning Activity:**

- 20 minutes to cut bottles, prepare swamp water, measure all materials, and set up stations

**Room set-up:** Fold up table with two stations on each end of table.

**Group Strategies** (example, group size, expected time for groups, etc.):

- 10 students per group, approximately 35 minutes if step 5 is completed while the "Swamp Water" is undergoing the sedimentation process from step 4

**Student Products/Artifacts/work pages:**

- Informational Flier on Clean Water

**Assessment Criteria/Rubric:** Ask students what are the procedures that municipal water plants may use to purify water for clean drinking water and what is the purpose for each procedure.

**Closing/Transition to next activity:** Remind students that the final water is not drinkable because the disinfection process at municipal water plants is not presented in this experiment. Ask students to think about how often they use water throughout their day and to be mindful of our access to clean water because not everyone has this privilege.