WRAP-UP

To wrap-up the investigation, bring your students together for a group discussion to help them understand why and how they achieved their results. It is important to share results so that everyone has a clear picture of what happened. To help you facilitate the discussion, review the explanation in "The Why and The How" using the Group Discussion questions as a guide.

GROUP DISCUSSION

Explain to students that scientists learn from each other through discussion, and they build upon the work of others to make new discoveries. Just as scientists come to conclusions based on the findings of their experiments, students will now come together as a group to share their results and make conclusions about the investigations they've conducted. Have students record their final results and the explanation in their journals.

Ask students:

- What surprised you?
- What new questions do you have?
- What are some threats to the water supply?
- Who do you think should be responsible for cleaning up polluted water?
- How would you go about enforcing the clean up?

The "Why" and the "How"

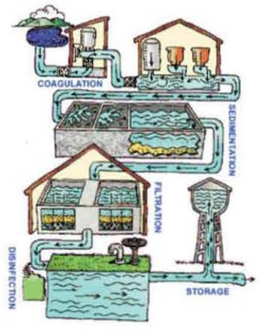
Humans alter the environment by dumping waste and other pollutants into rivers, streams and storm drains. Pollution creates poor water quality and destroys **biodiversity**, causing aquatic organisms to stop reproducing and die off.

Pollution enters water in different ways. When it rains, soil and other solid matter such as animal waste, sewage, leaves and grass clippings, and runoff from livestock farms wash away from plowed fields, construction sites and eroded river banks. Dirty water is not just unpleasant -- it is harmful to humans and aquatic life. Toxic chemicals can reduce the growth, survival, reproduction and disease resistance of exposed organisms, including humans.

Water treatment plants use different methods to filter and clean water, depending on the quality of the water that enters the facility. Groundwater is filtered naturally by aquifers and usually requires less treatment than water from lakes, rivers and streams. Treatment methods include disinfection with chlorine or other **chemicals** to kill any germs in the water.

In this investigation, we used the following treatment methods:

1. **Aeration:** Aeration is the first step in the treatment process in this investigation. Aeration adds air to the water sample, allowing trapped gases to escape and adding oxygen to the water.
2. **Coagulation:** Coagulation is the second step in the treatment process. When students added alum to the aerated water, this step allowed dirt and other suspended solid particles to mix together into a substance called **floc** that could easily be removed from the water.
3. **Sedimentation:** Sedimentation is the third step in the treatment process in this investigation. It occurs when gravity pulls the particles of floc to the bottom of the container. Water treatment plants have large beds that collect floc after it has floated to the bottom, allowing the clear water to be drained from the top of the beds and continue moving through the treatment process.
4. **Filtration:** Filtration removes most of the impurities remaining in water after coagulation and sedimentation steps. Water treatment plants use carbon filters and coarse sand filters to trap any remaining particles. In this investigation, the coffee filter helped remove large particles from the dirty water sample.
5. **Disinfection:** This is the final step in the water treatment process. Water treatment plants often add a disinfectant such as chlorine to kill any bacteria that may have entered the water during the treatment process. The water in this investigation was not disinfected and is not suitable for drinking".



water treatment process

U.S. Environmental Protection Agency

Curriculum Match-Up

- Research which sources contribute the most and the least amount of pollution.
- Get a map of your state or town and chart the pollution in the area using colored pins.
- Find out which methods are used to clean the water in your area.
- Contact programs in your state that monitor and assess water quality. Visit http://yosemite.www.epa.gov/water to learn more.
- Adopt a watershed in your state to protect and restore rivers, estuaries and wetlands in your area.

References:
The American Water Works Association.
The Soil and Water Conservation Society.
http://www.epa.gov/safewater/kids/watertreatmentplant/index.html
http://www.lenntech.com/Water-Purification-FAQ.htm
http://www.umich.edu/~gs265/society/waterpollution.htm
Department of Natural Resources and Environmental Sciences at the University of Illinois, Urbana; http://www.nres.uiuc.edu/outreach/esm_il_lo/esm.htm
http://www.afrpa.hq.af.mil/kelly/Terms/wterms.html
U.S. Geological Survey

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Water Treatment

Learning Objectives

Students will:

1. Develop methods to clean a polluted water sample.
2. Describe components of a water treatment process.
3. Learn how humans impact the Earth's freshwater supply.

Vocabulary Ventures

aquatic
aquifer
biodiversity
carcinogenic
chemical
coagulation
disinfectant
ecological
fertilizer
filtration
floc
pollutant
pollution
potable
sedimentation
solvent
water treatment

Every ecosystem, community, person and animal on Earth needs clean water to live. Only 3% of water on the Earth is freshwater; and 2/3 of freshwater is frozen in glaciers and polar ice caps. Humans use water for many different purposes, including agricultural, industrial, household, recreational and environmental activities. Almost all of these activities require freshwater.

Unfortunately, we often pollute water with contaminants when we use it. Because water is a good **solvent** (it dissolves lots of substances), it picks up all sorts of **pollutants**, including bacteria, fertilizers, oils and dirt. Humans have a responsibility to treat, or clean, water after polluting it.

Water treatment makes water safer for people to use by eliminating some pollutants such as sediments and bacteria. However, heavy metals and other **carcinogenic** (cancer-causing) substances are more difficult to remove. In 1902, Belgium became the first country to use chlorine to clean a public water supply. Today, almost every city in the world treats their drinking water. But, many rural communities lack the resources to build water treatment facilities, so clean water is not always available to drink.

treated tap water

The Egyptians were the first people to document how they cleaned water. These records date back more than 1,600 years. The most common ways of cleaning water in 400 A.D. were boiling it over a fire, heating it in the sun, or by dipping a heated piece of iron into it. They would also filter boiling water through sand and gravel.

Removing metals and other pollutants from water can be a difficult and often impossible task. Communities and businesses must find ways to keep harmful chemicals and other pollutants out of the water supply.

water treatment plant

Time Needed to Conduct Investigation

This investigation has three parts.

Organize and set up materials: 10 minutes
Introduce the lesson: 5 minutes
Conduct the investigation: 45 minutes
Student journaling/group reflection: 10 - 15 minutes
Total estimated time: 70 - 85 minutes

Investigation: To Drink or Not to Drink?

Materials

For groups of three or four
Student journals and writing tools

NOTE: Invite students to help prepare the dirty water sample in advance by mixing 1½ cups of potting soil with 2 liters of water in a clear 2-liter soda bottle (top cut off) or other container.

Part 1
- 16 oz cup of dirty water sample
- Measuring spoons and cups
- One coffee filter
- One rubber band
- One table
- Cotton fabric or cheesecloth
- Funnels
- Paper towels
- Screen remnants
- Nylon stockings
- Plastic containers of various sizes

Part 2
- Materials from Part 1
- 2-liter dirty water sample
- Two 2-liter colorless plastic soda bottles (one with a tight fitting cap)
- One 2-liter colorless plastic soda bottles with the top cut off
- Two tablespoons of alum powder
- Large spoon
- Clock with second hand or a stopwatch

Part 3
- Materials from Parts 1 and 2
- One 2-liter colorless plastic soda bottle with the bottom cut off
- One unused coffee filter
- One rubber band
- One 2-liter colorless plastic soda bottle with the top cut off
- 1½ cups fine sand (white play sand or beach sand)
- 1½ cups coarse sand (multipurpose sand)
- 1 cup small pebbles (washed natural color aquarium rocks work best)
- Two liters of clean tap water

Part 1
Pollution Solution

In this investigation, students will explore methods used to clean water. Students will work in groups to find a way to clean their polluted water sample. They can use any of the materials on the table to develop a method to remove the pollutants.

GET READY!

Ask students to make observations about the dirty water sample. How does the water look? Smell? Remember to use the wafting method to draw the odors toward your nose.

PREDICT

Invite students to make predictions about their ability to clean their polluted water sample. Ask students:
- What challenges do you think you will encounter?
- Which pollutants in your water sample are the most difficult to remove? Why?
- Should you try to remove each pollutant separately or all together at once?

PROCEDURE

Give students 7 - 10 minutes to try to clean their water sample using the materials provided. Ask students to share and document their filtration methods.

OBSERVE

Ask students:
- What were some techniques that you used to clean the water?
- Which materials did you use to try to clean your water sample? How well did they work?
- Were your filtration techniques successful? Why or why not?

Allow students to share their ideas and try to clean their water sample for an additional five minutes. Ask students:
- Did you try any new techniques to clean the water?
- Which new materials did you use to try to clean your water sample?
- How successful were your filtration methods?

Part 2
Make it Clean, Make it Safe

Students will now learn how communities clean water at water treatment plants. Share with students that water is cleaned to make it safer for activities such as drinking, cooking and cleaning. Water treatment can eliminate pollutants such as sediment and bacteria.

PROCEDURE

1. Have students set aside their dirty water sample from Part 1.
2. Using the funnel, students should pour half of the 2-liter dirty water sample into the 2-liter bottle with a cap.
3. Place the cap on the bottle and shake it for 30 seconds.

4. Next, students should pour the water into another 2-liter bottle using a funnel, and pour the water back and forth between the bottles approximately 10 to 15 times.
5. Once the gases have escaped (the bubbles will stop forming), have students pour the water into the bottle with its top cut off.
6. Next, students should add two tablespoons of alum powder to the water.
7. Have students slowly stir the mixture for 3 - 5 minutes.

OBSERVE

Students should let the water sit undisturbed in the container for 5 minutes, then make observations about their water samples for the next 10 minutes. Students should record the following observations in their student journals.
- How does the water sample look now?
- Is anything floating in the water?
- Are there layers in the water sample?

TIP
Students will see particles forming larger clumps in the water. Alum is used to help particles to clump together, making it harder for waste to get through a filter at a water treatment plant. These clumps float to the top as a "sludge" and are skimmed off the surface fo the water.

Part 3
Make a Water Filter

In this part of the investigation, students will construct a filter using the bottle with no bottom.

water filter set-up

PROCEDURE

1. Using a rubber band, students attach the coffee filter to the outside neck of the bottle with the bottom cut off.
2. Students should then place the bottle neck-side down into the cut-off bottom of a 2-liter bottle, which will serve to catch the filtered water.
3. Next, have students pour a layer of pebbles into the bottle with the bottom cut off.

NOTE: the filter will prevent the pebbles from falling out of the neck of the bottle.

4. Students should pour the coarse sand on top of the pebbles.
5. They should then pour the fine sand on top of the coarse sand.
6. Students should slowly and carefully pour 2 liters of clean tap water through the filter to rinse it. Students should be sure not to disturb the top layer of sand as they pour the water.
7. Students should discard the tap water that collects in the catcher after it has gone through the filter and then replace the catcher to its original position.
8. After a large amount of **sediment** has settled to the bottom of the dirty water sample to which the alum powder was added, students should carefully pour the cleaner top part of the dirty water sample (without the clumps) through the filter so that collects in the catcher.
9. After the dirty water has gone through the filter completely, students should set aside the catcher containing the filtered water.
10. They should set aside the portion of the dirty water sample that ***was not*** poured through the filter, so that they can compare it to the filtered sample.

OBSERVE

Now, have students make and share observations about the filtered and unfiltered water samples.
- How does your water sample look? Smell?
- Has the filtration process changed your dirty water sample?
- Do you think your water sample is safe for drinking? Bathing? Cooking?
- Compare the water samples from Part 1 and Part 2. What are the differences? Similarities?
- What is the most difficult substance to remove? Why do you think that is?

SAFETY TIP
Inform students that the final step at the treatment plant is to add disinfectant to the water to kill any harmful organisms. Disinfectants are strong chemicals, so we are not using them in this investigation. The water that was just filtered is not safe to drink.