

A photograph of a sunset over a body of water. The sun is low on the horizon, creating a bright orange and yellow glow. The sun's reflection is visible on the water's surface. In the foreground, there is a dark silhouette of a plant with several thin, upright stems and small, dark seed heads. The overall scene is peaceful and scenic.

MOST*

Beautiful Earth Activity Module

An Introduction to Beautiful Earth

The following educational module has been designed to supplement the Beautiful Earth Grant that is funded by National Aeronautics and Space Administration (NASA). "The Beautiful Earth program integrates the live, Kenji Williams' Bella Gaia performance (www.bellgaia.com), while providing supplementary discussions with NASA scientists and hands-on workshops with museum staff and Native American educators who will provide diverse perspectives on relating to Earth systems."

The Onondaga Nation is a leader in our community around the healing and restoration of Onondaga Lake. They are deeply connected to Onondaga Lake and are committed to the clean up/ transformation process. This module highlight the Onondaga Nation's vision for this area as well as helps students look at how our water system is polluted. The module has three main activities and a demonstration contained within it. They can be completed separately or put together depending on the needs of the students and time constraints. It is designed for 3rd through 8th grade students. Part III lends itself to more sophisticated discussions pertinent to middle school levels.

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The Onondaga Nation and Their Connection to Onondaga Lake

“The Onondaga Nation is a member of the Haudenosaunee (“People of the Long House”), an alliance of native nations united for hundreds of years by traditions, beliefs and cultural values. Also referred to as the Iroquois Confederacy or Six Nations, the Haudenosaunee consist of the Mohawk, Oneida, Cayuga, Seneca, Onondaga Nations and Tuscarora Nations.”

The Onondaga Nation is known as the “People of the Hills”. The Onondaga Nation has a unique relationship with Onondaga lake. The following information shares the vision for a clean lake that the Onondaga Nation pursue.

“From time immemorial, our ancestors lived near Onondaga Lake. The Lake, its waters, plants, fish, shore birds, and animals are an intrinsic part of our existence.

Long ago, the Peacemaker brought together the five Nations on the shores of Onondaga Lake to bury the weapons of war and form our government. The Grand Council of the Haudenosaunee Confederacy meets at Onondaga Lake.

The Lake is the living sum of everything in its watershed: the fish, the people, the plants, the soils, the tributaries. Onondaga Lake provides water which should be safe for drinking. Fish and birds make their home in and around the Lake. Food and medicinal plants grow along the shores of the Lake. The Lake was a place for people to fish and hunt. It was a place for children to play and swim and learn. Delegations would arrive at Onondaga for Confederacy meetings by traveling along the Seneca River to Onondaga Lake.

We are carrying out our responsibility to the Lake. We take our children and grandchildren to important places around the Lake and teach them the proper names and stories for them. We have our own name for the Lake, one which conveys the respect and sacredness of the place and the proper relationship with it. Someday we hope to share this knowledge with our neighbors.

We will work to remove the contamination from the Lake and surrounding land. We will ensure that the Lake is clean enough to drink the water and eat the fish. We will strengthen our culture and begin healing.”

- From the Onondaga Nation’s **Lake Vision**

To read more about the Onondaga Nation’s clan **Lake Vision** go to: http://www.onondaganation.org/lake_vision.htm

“From the Haudenosaunee we can learn to:

- Be thankful for living on a planet so full of life.
- Look to the land, animals, plants, and natural forces as teachers and family.
- Honor those in the past by continuing a tradition of caring for our future generations.
- Think about how our actions will affect the lives of those not yet born.”

- “Mother Earth: What We Can Learn From the Haudenosaunee About Living On a Changing Planet”

Water Pollution: Filtration and Distillation

By: Byron Norelius

Types of Pollution

Garbage/Litter

This is probably the most recognizable form of pollution and can be easily spotted when present in the environment. It includes any kind of solid refuse dropped or dumped into environmental water sources (papers and plastics, appliances, etc). Local examples include Onondaga Creek or Onondaga Lake, and an important global example is the Great Pacific Garbage Gyre, a patch of floating trash the size of Texas.



Silt/Turbidity

Silt is the very fine, clay dust in soil. While silt is a rich (nutrient-wise) component of soil, when soil erodes the silt is so light that it remains suspended in the water column. This gives the water a muddy look and blocks light from penetrating the water. Without light, plant communities can suffer in heavily silted water. Silt slowly sinks out of the water column in still water, depositing a dense layer on lake and ocean bottoms which may actually suffocate aquatic invertebrates including arthropods, mollusks, and corals.



Oils

While oil does not readily mix with water and in fact floats on water, it causes significant environmental disturbance when spilled in water. Birds and mammals coming into contact with the oils become coated, reducing their ability to insulate themselves from water temperatures leading to hypothermia. If animals attempt to clean themselves they ingest the oil, causing damage to liver and kidneys, dehydration, and impaired digestion. As a layer floating on water, oil blocks light and impacts photosynthetic organisms in the water.



Thermal

Industrial processes such as power generation use water to absorb excess heat. When this heated water is released into the environment, it is considered thermal pollution. Abrupt changes in temperature of water in aquatic systems can cause changes to the ecosystem (which plants and animals can survive there), and also changes the amount of dissolved oxygen available to aquatic animals (cooler water can hold more oxygen). Thermal pollution in oceans has been implicated in coral bleaching and coral reef death.



MOST*

HELPFUL TERMS

Types of Pollution

Biological

Chemical

Distillation

Filtration

Garbage/Litter

Oils

Silt

Sewage

Thermal

Turbidity

Water Pollution: Filtration and Distillation

Biological

Organisms can be seen as pollution in some circumstances. Invasive species of plants and animals released into a new natural environment where they do not belong have the potential to be extremely well adapted to their new environment which almost always comes at the expense of native organisms. Examples of this in Central New York include Asian carp, Eurasian Watermilfoil, Water Chestnut, Phragmites, and Zebra Mussels. Population explosions of native organisms can be thought of as biological pollution. When nutrient levels in water rise as a result of sewage or fertilizer contamination, algal blooms occur. At high population levels the microorganisms use up the nutrients and then starve, dying off in large numbers. The decomposition of organic matter in water uses up dissolved oxygen, depleting the available air for animal life leading to deaths of fish and aquatic invertebrates.



Sewage

Sewage pollution occurs when untreated human waste is released into the environment. Sewage is organic matter and uses dissolved oxygen in the water to decompose. Sewage also provides nutrients for algal blooms which also result in oxygen depletion. As bodily waste, sewage also poses the danger of spreading pathogenic microorganisms (protists and bacteria, etc.) to large numbers of people if drinking water sources are contaminated. In Syracuse, we have a sewage pollution problem related to our antiquated sewage infrastructure, which couples street runoff entering storm drains with human waste from homes and buildings. During large rain events, the Metro Plant cannot treat the mixed rainwater and sewage fast enough. To prevent sewage from backing up into homes, combined sewage overflows (CSOs) open up along Onondaga Creek, releasing the excess rainwater/raw sewage combination directly into the environment.



Chemical

Chemicals are all around us, some are naturally occurring and some have been engineered by chemists. Chemical water pollution refers to the contamination of water sources with a concentration of chemical that is greater than the natural concentration of that chemical. Chemical pollution can be very dangerous in a water source, especially since many chemicals are soluble in water. Some of the chemicals we worry most about include heavy metals. Some of the more toxic of the heavy metals include lead, cadmium, and mercury. Chemical pollution in our water extends to pharmaceuticals, a recent study sampling water from around the nation identified trace quantities of a variety of prescription and over-the-counter drugs in the drinking water supply of many high-population areas around the country.



Nanotechnology

Nanotechnology may introduce a new source of pollution in our water. Manufacturing new materials on the Nano level may result in nano-sized waste. At one billionth of a meter to 10 billionths of a meter, nano-size pollutants may have unexpected properties such as increased reactivity, may be more difficult to filter out by traditional methods and pass more easily through living membranes. This science is so new, the potential damage to the human body and/or the ecosystem is unknown.



Demonstration 1

Information for the Teacher

MATERIALS NEEDED

Food-safe (only used for food science) chemistry apparatus for distillation

Bunsen burner or oil bath(Silicone oil)/hotplate for heat

Kool-Aid drink mix (a colored variety using sugar or syrups as opposed to sugarless sweeteners)

Water

Clean disposable pipettes

Students should be able to:

Describe the distillation process

Water is cleaned naturally both by the action of filters (sandy soils, peat bogs) and through a large-scale distillation of water. The water cycle constantly removes pure water from bodies of water through evaporation, leaving contaminating chemicals behind. Distillation works by boiling the water off of the chemicals and cooling it back to a liquid as it passes through chemistry apparatus.

The distillation process will take about twenty minutes to begin distilling (depending on your setup), so it should be started just before the filtration activity or prior to the demonstration if only using the distillation. First, set up the distillation apparatus as shown in the photo*. Mix enough Kool-Aid to fill your roundbottom flask around 2/3 full. Place setup so the flask is above Bunsen burner or in oil bath; begin running cold water through the condenser (either from a sink or from a fishtank pump in a bucket of ice water). Check the collecting beaker periodically for distillate, which will be clear.

When there is enough distillate, show students a sample of the unprocessed Kool-Aid and the results of the distillation. Review why Kool-Aid represents chemical pollution (that it includes is made of three major chemical parts: artificial colors, artificial flavors, and sugars) and ask which of those chemicals can they see has been removed. The color was the only visible chemical, so we know it was removed. Next, ask students how they can test for artificial flavors. The most common response seems to be, "Taste it!" There is an easier way to check for flavors, since flavor and scent are so closely linked (ask students if they have ever had their nose stuffed up when sick and had food taste funny). Have a few students (or all of them, if possible) smell the sample to test for scents/flavors. They should be able to identify the correct flavor from the carried-over scent. Flavor is a volatile compound and boils off with the water, so distillation cannot remove it.

The last chemical, sugar, is a taste test. Students attempt to taste for sweet, but often get confused between a sweet taste and a fruity flavor. Since we know that the flavor will be present (from our smell test), try asking what it would taste like if the sugar came across in the clear liquid. Hopefully they get to the answer, "Just like regular Kool-aid." If sugar is not present in the distillate, then, it should taste like flavored water. Ask for taste volunteers after reviewing that we should never taste test a scientific experiment unless we know for sure that the equipment and materials we use are clean and safe. Use a disposable pipette to squirt a bit of the distilled water into volunteers' mouths. The solution should taste fruity, but flat and not sweet. Sugar is left behind (though artificial sweeteners like sugar alcohol may come across).

While the removal of the color and the sugar are complete (and thus dramatic) in this demonstration, a key point to make is that not all of the chemicals in Kool-Aid are removed. Distillation, or at least a simple distillation like the one demonstrated here, is not a perfect way to purify water. The product, also, is water without dissolved salts and compounds that give water its natural taste, so the taste of "pure" water is not necessarily a pleasant one.

Part 1: Solution to Pollution

Topography and Pollution

MATERIALS NEEDED

Trays or plastic covers
8.5 x11 sheets of paper
Colored pencils or markers
Used motor oil
Grape Kool-Aid
(sweetened with sugar)
Sprinkler bottle
Glitter

Students should be able to:

Design a terrain
Describe the impact of three types of pollution

What to do:

The surface of the earth varies widely all over the world. In this activity, you will explore the ways the layout of land affects pollution by creating mountains, valleys, streams, lakes, and towns.

1) Using the 8.5 by 11 sheet of paper, crumple this up into a ball. Undo the crumpled paper and slightly flatten onto your tray.



2) Using markers place roads, waterways, lakes and towns on your terrain. Make a key to show what each color represents.

3) Sprinkle glitter on your terrain to represent solid pollution like plastics.



4) Drop a few drops of motor oil on your road area to represent oil pollution or oil spills.

5) Add a little Kool-Aid by sprinkling the dry crystals on your terrain. This will represent chemical pollution that dissolves in water.

6) Use the sprinkler bottle to rain on the whole environment. It should rain enough to create small pools of water.



Note what is happening to the environment.
Write your response on the worksheet.

Part 2: Solution to Pollution

Water Filtration

MATERIALS NEEDED

1-liter soda bottle,
sliced into 2 pieces

Activated charcoal/activated
carbon (pet store charcoal)

Cotton/polyester filling

Sand

Coffee filter

Rubber band

Glitter

Used motor oil or vegetable oil

Kool-Aid drink mix
(a colored variety using
sugar or syrups as
opposed to sugarless
sweeteners)

Water

Clear plastic cup

Plastic spoon

Science journal

Students should be able to:

Describe 7 types of pollution

Build a simple water filter

Describe the distillation process

What to do:

Because there are so many different things that can be considered water pollution, there are many systems used to clean polluted water. In this activity, you will explore the effectiveness of different filter materials by constructing your own filters and filtering water contaminated with up to three different types of pollution.

- 1) Each group should have a 1-liter plastic bottle cut into two pieces, the funnel-like top part of the bottle will house the filter, and the bottom will collect the filtered water. Secure a small piece of paper coffee filter to the open mouth of each funnel with a rubber band to prevent sand and charcoal from falling through.
- 2) Your group will be given a set of filter materials to test: polyester filling, sand, and activated carbon. You will choose one, two or three of the filter materials to test in your filter design. You will also choose the order of materials to place in your funnels.
- 3) When you are finished building your funnel filter, pipette the polluted water in to the filter system.
- 4) When water has come through the filter, you can compare to the unfiltered portion to see how well your filter materials worked.

Solution to Pollution Worksheet

Name: _____

Date: _____

Parts 1 and 2

- 1) From your paper terrain, what occurred when the rain came down on your environment? Talk about what happens to each of the three types of pollutants introduced onto the terrain.
- 2) Explain how you designed your filter. Draw and label your filter. Label where the three types of pollutants were found.



- 3) Explain the water purification process. (Talk about the three types of pollutants used.)

Solution to Pollution Worksheet

Name: _____

Date: _____

Part 3

1) Identify the types of pollution found in Onondaga Lake.

2) What are the sources of these pollutants?

3) What is currently being done to assist with the cleanup of Onondaga Lake?

4) Explain the role of the Onondaga Nation on the Onondaga Lake cleanup process.

Research

Take the research question provided by your teacher and work to answer the question with as much depth as possible. You can begin with some of the websites listed on the resource page and expand to include your own findings.

Materials needed:

Research question

Computer lab

Library resources



Can you find
Onondaga Lake
on this image
from NASA?

Research Resource Page

The following websites may assist in this process:

Onondaga Nation

<http://onondaganation.org/>

Onondaga Lake Partnership

<http://www.onlakepartners.org/>

DOE Onondaga Lake Clean Up

<http://www.dec.ny.gov/chemical/8668.html>

Onondaga Lake Improvement Project

<http://www.lake.onondaga.ny.us/>

Onondaga Lake

http://en.wikipedia.org/wiki/Onondaga_Lake

Haudenosaunee

<http://www.nmai.si.edu/education/files/HaudenosauneeGuide.pdf>

Onondaga Faithkeeper, Oren Lyons

<http://www.youtube.com/watch?v=quuA99ggOZ4>

ESF Center for Native Peoples and the Environment

<http://www.esf.edu/nativepeoples/>

United Nations Environmental Program: Indigenous Peoples

<http://www.unep.org/indigenous/>

Lecture on Land Restoration

<http://www.peacecouncil.net/NOON/commonfuture/II/12FindingCommonGround.htm>

Onondaga “Brighten the Chain” Land Claim Video

http://www.onondaganation.org/news/vid_brighten.html

Additional Resources:

The Milton J. Rubenstein Museum of Science & Technology Planetarium show:

“Mother Earth: What We Can Learn From the Haudenosaunee About Living On a Changing Planet”

Information for the Teacher

Activity Teacher Notes:

Part 1

- 1) Students should look at their paper and identify areas that are hills and valleys. From there have them think about where water might stream and collect. Ask them about where roads might be located and people's homes or villages.
- 2) Discuss the impact of humans on the landscape (roads, dams, parks, houses, etc.)
- 3) Review the types of pollution and have them name the glitter (plastics/solids), kool-aid (chemical), and the oil.
- 4) To help with the oil it is a good idea to have an adult drop just two or three drops of used motor oil onto the terrain. It is amazing how much this will pollute the environment. Be careful not to overpower the system with oil pollution.

Part 2

- 5) Students should be given a brief introduction to the activity explaining what a filter does and giving some starter ideas as to how to build one (diagram of funnel filter with layers of filter materials as a possible filter design.)
- 6) Students pipette the water from the water on the terrain into the filter system. Continue to pipette until a few tablespoons of water are running through the filter.
- 7) Students can be encouraged to look around at other groups filters to see what others have done and what the different results from the filters might be.
- 8) During our programs, most students are left with clear water in their collecting cup that is tinged blue or purple. When smelling the water, students may notice both an oil and grape smell. Glitter has always successfully been removed by the filter, as have visible clumps of oil. Students can make a claim that the oil and kool-aid are harder to remove than the glitter. Since oil is technically a chemical, this activity may convey that if chemicals are dissolved in water, they can be the hardest to remove by filtration.
- 9) Discuss: Which was easier polluting or cleaning up the water? Did you successfully clean up the pollution? Where did most of the pollutant end up? Would you drink the water (why or why not)? What pollutants were easier to filter out? Which were more difficult and why?

Part 3

- 10) Link the learning from this activity to the Onondaga lake pollution and cleanup process by having the student's complete research and answer the worksheet questions. Try dividing the class into four groups and have each focus on one question.

New York State Standards

Standard 1:

Scientific Inquiry

Key idea 1: s1.1a, s1.1c, s1.2a, s1.3, s1.4

Key Idea 2: s2.1c, s2.1d

Skills: Observing, describing

Engineering Design

Key Idea 1: T1.4a, T1.5a, T1.5b

Key Idea 5: 5.2

Standard 7:

Key Idea 1: 1.1

Identify Cause and effect relationships

Use indicators and interpret results

Standard 4:

Key Idea 7: 7.1e, 7.2a