Clean Water Challenge
Understanding Water Pollution Using Filters

Description:
In this lesson, students design their own water filtration system using a 2 litre plastic water bottle and various materials. They will test their filter by first running dirty water through the filter and examining the result. Food colouring will be added to the dirty water to represent specific types of chemical pollution that will be run through the filter as well. Students will become aware of how pollution moves through the soil and how it may be naturally filtered. Emphasis should be given to the fact that chemical pollution is a threat to aquatic habitats such as wetlands, and that natural filtration is not enough to eliminate harmful toxins from the environment.

The worksheets to be completed before the construction activity focus on how pollution filtrates through natural areas such as forests vs. bare soils, and the source of chemical pollutants. These worksheets are designed for students to examine and understand water pollution and filtrations. The pre-activity worksheets allow students to think about the results of their filter design before they conduct it (basic hypothesis creation) and afterwards.

Key Vocabulary: water scarcity, water cycle, renewable resource, evaporation, condensation, precipitation, run-off, percolation, coagulation, sedimentation, filtration, disinfection, watershed, wetland, contaminants, sediment, bacteria, pollution

Staffing: 1 educator

Resources:
- printed handouts
- pencil or pen
- specific materials for filter construction (details below)

Note: Supplies for this activity are not provided unless indicated by a *

Materials (per pair/group of students)
- 1 empty (clean), pre-cut 2 Litre plastic pop bottle. Teacher should cut water bottles before - encourage students to bring one from home!
- gravel/rocks
- coarse sand
- fine sand
- coffee filter *
- elastic band
- dirty water
- a maximum of 5 different food colouring colours (red, green, black (soy sauce), purple, orange)

*Do not throw out the plastic water bottles! Try and collect as many large gravel rocks as possible - to use next time! Sand, cotton balls, and filters will need to be replaced.

**Inform parents and students to bring a change of clothes and to wear clothes that can get dirty.

Learning Environment: In Classroom

Prep Time: 15 minutes (distributing handouts, cutting water bottles, separating other materials)

Length of Lesson: 45-60 minutes

Groupings: In pairs or groups of three
**Teaching/Learning Strategies:** reading through handout together and re-visiting knowledge/facts regarding water conservation; hands-on activity with creating water filter and examining how process works in nature

**Expectations:**

Assess impacts human chemical pollution may have on natural environments such as wetlands; understand how water is filtered in nature; review water cycle; understand how water is filtered by water treatment plans on the basic level; Students develop an awareness of chemicals and pollutants present in products used every day (i.e. shampoo, fertilizer) and consciously begin reducing the amount of chemicals they release into water.

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<td>Overall Expectations</td>
<td>1. Analyse the impact of human activities and technological innovations on human health</td>
<td>1. Analyse social and environmental impacts of forces acting on structures and mechanisms</td>
<td>1. Analyse the immediate and long-term effects of energy and resource use on society and the environment, and evaluate options for conserving energy and resources</td>
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<td>Specific Expectations</td>
<td>1.1 Assess the effects of social and environmental factors on human health, and propose ways in which individuals can reduce the harmful effects of these factors and take advantage of those that are beneficial</td>
<td>1.2 evaluate the impact of society and the environment on structures and mechanisms, taking different perspectives into account and suggest ways in which structures and mechanisms can be modified to best achieve social and environmental objectives</td>
<td>1.1 Analyse the long-term impacts on society and the environment of human uses of energy and natural resources, and suggest ways to reduce these impacts</td>
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<td>1.1 Evaluate the environmental impacts of processes that change one product into another product through physical or chemical changes</td>
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<td>1.2 Assess the social and environmental impact of using processes that rely on chemical changes to produce consumer products, taking different</td>
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Lessons in a Backpack

Grade 5: Water Protection

Based on the Georgian Bay Biosphere Reserve

Lessons in a Backpack program
perspectives into account and make a case for maintaining the current level of use of the product or for reducing it. propose ways in which individuals can improve energy conservation.

Table 1. Expectations of Learning Outcomes Based on Grade 5 Ontario Curriculum

**Background:**

**Sources of Water Pollution:**

Water pollution occurs when waste is added to a water body that significantly changes its chemical and biological composition. Sources can include oil, garbage, fertilizers, chemicals and sewage. Today, urban run-off is considered one of the leading sources of pollution within a city. Litter is another large contributor, with about 10% of all plastic produced per year eventually ending up in the ocean. Personal and household cleaning products, as well as industrial and agricultural chemicals are also dangerous as these are often synthetic. Unfortunately, we often do not fully understand the degree of damage man-made chemicals may have on the natural environment (Canadian Wildlife Federation, 2015).

**Water Pollution and Land:**

The amount and type of landcover within a watershed greatly determines the health of surrounding rivers, lakes and wetlands. As more undisturbed forested areas become subject to human development and other destructive activities, the overall impact on water quality becomes higher. Forests help maintain water quality by filtering water. Forests protect water by slowing run-off (catching water in leaves, stems, soil, and roots), keeping soils stable by means of large and intertwined root structures and filtering pollution. Wetlands improve water quality by trapping and storing valuable organic and nutrient-rich sediments. Developed lands such as urban and agricultural areas increase surface water and soil run-off therefore impairing the natural processes of filtration by wetlands and forests. Developed lands ‘load’ hundreds of different chemicals into our waterways. Sources include fertilizers, pet waste, road salt, detergents, manure etc. Removing vegetation removes the natural buffer offered along rivers and wetlands putting these habitats at great risk. Without buffers, soil erosion and pollutant loading both increases, further impairing the natural processes. A lack of vegetation also means less shade and a lack of strong root systems to keep soil in place (Vermont.gov, 2003).

**References**


Teaching and Learning

Activity #1 – Water Filtration Introduction (20 minutes), Construction (10 minutes) & Experimentation (15 minutes)

*Option to take the construction activity outside once introduction sheets are completed. Inform children to bring a change of clothes and wear clothes that can get dirty.

1. Divide class into pairs or groups. Follow handout along with students, highlighting this is a pre-activity to their water filter construction projects

*Note: Have water filter materials (i.e. sand, gravel) away from students at this point so they can focus on handout activity first

2. Once introduction handouts are complete, explain that each group will work together to design a water filter.

3. Construction Procedures: Each group will have (See materials) a pre-cut 2L plastic pop water bottle and equal amounts of the following materials gravel/rocks, coarse sand, fine sand (about 4 cups each), coffee filter (1-3), elastic band, dirty water in a beaker, coffee filter (1-3), elastic band, dirty water in a beaker.

   a. Remove cap, place coffee filter (students can choose to use 1, 2 or 3 filters) outside bottom of bottle, securing with an elastic band (see figure 1, 2)
   b. Place top of water bottle into other half as shown (see figure 1, 2)
   c. At this step, students will place materials in their filter in the order they decided on in the Part 1 Handout (i.e. from top: rocks, coarse sand, fine sand, coffee filter; OR from top: fine sand, coarse sand, gravel, coffee filter)
   d. Students may pour dirty water (1 large beaker) into filter and examine results
   e. Have students pour water into a separate beaker *tell students to be careful when dismembering filter
   f. Have students assemble filter again. This time, students pour dirty water (1 large beaker) that has a significant amount of food colouring added to it.
   g. Have students examine their results
A Clean Water Challenge: Let’s Build a Filter!

Did you Know? Plants and forests naturally filter water!

On the diagram below, put a star next to all the places that a forest can ‘catch’ water when it is raining. Place at least 4 stars on your diagram and explain below!

Example: The forest ‘catches’ water: in the leaves of the trees! (Draw a star beside the forest leaves/canopy)

The forest ‘catches’ water:

___________________________________

___________________________________

___________________________________

___________________________________

The forest ‘catches’ water

___________________________________

___________________________________

___________________________________

___________________________________

The forest ‘catches’ water

___________________________________

___________________________________

___________________________________

___________________________________

Can the forest store (hold) a lot of water? (yes or no) ________________

Why or Why Not?

___________________________________

___________________________________

___________________________________

(Vermont.gov, 2003)
Does water stay in the forest for a long time? (yes or no) _____________
Why or Why Not?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

What if there is no forest? Put a start on the diagram where the earth can ‘catch water’ (Vermont.gov, 2003)

Can earth without forest store (hold) a lot of water? (yes or no) ________________
Why or Why Not?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Does water stay in earth without forest for a long time (yes or no) _____________
Why or Why Not?
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
Now that you have learned about how water is cleaned in nature use the pictures below to answer questions about water pollution and its sources.

Chemical pollutants run-off into water and pollute and cause harm to natural environments. You will be using different food colouring to represent various chemical pollutants.
Using the diagram below, fill out the **SOURCES** of pollution in the bubbles:

Using the diagram below, list examples of items or activities that may release pollutants into the environment:

Now you are ready to start building your water filter!
Build Your Own Water Filtration System!

Group Member Names:

______________________________________________________________________

Read all instructions before building the filtration system.

**Step 1:**

**Materials:**
- water bottle
- gravel/rocks
- coarse sand
- fine sand
- coffee filter
- elastic band
- dirty water

**Step 2:** Remove cap, place coffee filter outside bottom of bottle & secure with elastic.

Use (circle choice)  1 coffee filter,   2 coffee filters, 3 coffee filters

We think that using ______ coffee filter(s) will:

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

**Step 3:** Place top of water bottle into other half as shown below

**Step 4:** Remember your materials: gravel/rocks, coarse sand, fine sand

Place the materials in this order (from top to bottom) DRAW IT!

Top:________________________________
Middle:____________________________
Bottom:____________________________
Step 5. Answer the questions below.

a. This group thinks the water at the end of the filter will be (circle one):

Very dirty (dark brown)  Slightly dirty (light brown)  Clear

b. ***After we build our water filter and did the experiment, the water was:

Very dirty (dark brown)  Slightly dirty (light brown)  Clear

Step 6. Answer the questions below. Once your filtration system is built, pour dirty water and the chemical pollutant into the top of your filter.

There are 5 different ‘chemical pollutants’ to run through your filter.

a. This group will choose colour:

b. This group thinks the water at the end of the filter will be (circle one):

Very dirty with colour  Slightly dirty with colour  Clear with colour  Clear

c. ***After we build our water filter and did the experiment, the water was:

Very dirty with colour  Slightly dirty with colour  Clear with colour  Clear

Remember, you will use a different food colour to represent chemical pollutants.
Think about what pollutant each colour may represent (there is no wrong answer!)

a. The source of RED food colouring: _________________________________
b. The source of GREEN food colouring: _______________________________
c. The source of BLACK food colouring: _______________________________
d. The source of PURPLE food colouring: _______________________________
e. The source of ORANGE food colouring: _______________________________

WHEN YOU HAVE READ THE INSTRUCTIONS: Go Back to Step 1 and build your filter - Remember to Answer 5 b and 6 c after you are finished.
Teacher Guide/ Answer Sheet

On the diagram below, put a star next to all the places that a forest can ‘catch’ water when it is raining. Place at least 4 stars on your diagram and explain below! Example: The forest ‘catches’ water: in the leaves of the trees! (Draw a star beside the forest leaves/canopy)

(Vermont.gov, 2003)

The forest ‘catches’ water 1) leaves (catches rainfall)
The forest ‘catches’ water 2) leaves takes water out from the atmosphere
The forest ‘catches’ water 3) forest floor (soil, stem, leaves; more shade = less evaporation)
The forest ‘catches’ water 4) roots of large trees, as well as smaller plants on forest floor
The forest ‘catches’ water 5) water is held in the soil (roots hold water, and take up water! Water is also held within animals and plants, as well as within other structures such as fallen logs, fungus)
Can the forest store (hold) a lot of water? (yes or no) YES
Does water stay in the forest for a long time (yes or no) YES – because plants (roots) hold soil in place (less erosion) so the water stays saturated in the soil profile

What if there is no forest? Put a start on the diagram where the earth can ‘catch water’
-Students may place a star on the surface. Emphasize that there is little water storage able to happen here, because of the lack of plants and large trees (no large roots to hold soil and water underground! This leads to more evaporation and run-off)

(Vermont.gov, 2003)

Can earth without forest store (hold) a lot of water? (yes or no) NO
Does water stay in earth without forest for a long time (yes or no) NO – because there are no natural structures (roots, leaves, fallen leaves) for the water to filtrate through slowly – so water runs off from this area quickly and does not have a chance to be cleaned!

Additional Questions:

What can the above picture tell us about water pollution and nature? A: It is difficult to filter pollutants out of the water by natural ways; alternative answer: pollutants easily end up in ground water or run-off and may enter our watershed

What will happen when all the polluted water filters down into the watershed? A: The water will not be pure, and will have pollutants within it; the water will need to be cleaned before we can use it

Project: Build Your Own Water Filtration System

We think that using 3 coffee filter(s) will: (Possible answer): make the water cleaner

Chemical pollutants run-off into water and pollute and cause harm to natural environments. You will be using different food colouring to represent various chemical pollutants.

Using the diagram below, fill out the SOURCES of pollution in the bubbles: 
Using the diagram below, list examples of items or activities that may release pollutants into the environment:

Chemical pollutants may come from...
- Agriculture
- Urban Areas
- Cleaning Products (i.e. detergent)
- Garbage (i.e. plastic)
- Cars (salt, fuel, etc.)
- Industry
- Mining
- Agriculture

How can water pollution be prevented? A: Have children discuss what they can do to prevent pollution. *Focus on reducing water pollution in large scale (i.e community) & small scale (i.e. in their own homes). Try and relate answers to diagram above.

- Agriculture: you can prevent pollution from this source by buying local foods that take less gas and fuel to get to you. Go to a local farmers market where you know what types of chemicals were used on the food you are buying.

- Urban Areas: Try to use public transport or your bike so that less fuel (smaller chance of gas leaks) is used overall; use natural cleaning products; do your laundry 1x a week to prevent large amounts of detergent from entering water; recycle plastic and compost to reduce the amount of garbage created.

- Mining/Industry: These industries provide us with materials we use to build things – all things! Such as radios, cars, chairs, refrigerators! You can try and buy recycled/used appliances or furniture, even clothing! If you buy something used instead of new, there will be a smaller need/demand for these industries to keep producing items and extracting materials from the earth.

...Remember, you will be using different food colouring to represent various chemical pollutants. Think about what type of chemical pollutant each colour may represent (*there is no wrong answer!*)
Teacher may explain what type of pollutant is represented by each of the food colourings, asking children to elaborate on sources of these pollutants in their community (i.e. Businesses downtown apply salt to the roads in winter; there is a golf course outside of town that uses pesticides on its grass...)

a. The source of RED food colouring may represent pesticides
b. The source of GREEN food colouring may be garden fertilizers
c. The source of BLACK food colouring may be gas, oil, dust, salt run-off
d. The source of PURPLE food colouring: may be household chemicals (i.e. cleaning products, chemicals in soap)
e. The source of ORANGE food colouring: may be leachate (extremely toxic matter formed in landfills)

Questions for during/after water filtration experiment:

What do the plastic water bottle and the materials inside represent? A: Portions of earth with different soil types – these exist in nature!

What are some possible areas our water could move to if the plastic water bottle was in real life? A: The water could move as groundwater, or if there was a large storm event, it could be runoff (surface water)

Where does the water from any portion of the earth eventually drain into? A: A watershed; an area of land which all water drains to the same location

Which water in the container was cleanest and clearest? A: Have children examine other water bottle filters and results from around the class. **Remind children that although water may appear clear, there are tiny microbes/bacteria in the water that we cannot see that may be dangerous to human health.

How does water filtration work with the pollutants present, compared to the water filtration without? What was different? A: The water filtered through, but it was the colour of the food colouring

What does this mean in terms of water pollution? A: It is difficult to filter pollutants out of the water by natural ways; alternative answer: pollutants easily end up in ground water or run-off and may enter our watershed

What will happen when all the polluted water filters down into the watershed? A: The water will not be pure, but will have pollutants within it

How can water pollution be prevented? A: Have children discuss what they can do in their everyday lives to prevent pollution. *Focus on reducing water pollution in large scale (i.e. community) & small scale (i.e. in their own homes). Try and relate answers to diagram above.