Filtering groundwater

»Lesson overview

In the previous lesson, students identified a range of substances that have to be removed from raw water before it is suitable for drinking. In this lesson, students build a filter to simulate the natural filtration process that occurs when water percolates through the ground. This is how most groundwater is cleaned naturally before it discharges into creeks and rivers or is stored in aquifers. This process is simulated in Session 2.

When students are considering the natural water cycle, an understanding of the concept of infiltration compared to run-off is vital for the development of a true awareness of how rainfall adds to the surface water (or not), and how it returns to the cycle through harvesting of our groundwater sources.

In Session 3, students use this filtering apparatus to simulate the use of techniques such as sand beds to filter water.

»Lesson objectives

In this lesson, students investigate how the natural cleaning process of ground infiltration can be employed as a technique in the treatment of drinking water.

»Opportunities for assessment

Students may be assessed for team participation such as:

- cooperated with fellow members
- contributed positively to group and pair activities
- listened respectfully to the ideas of others
- worked without distracting others.

Students' journal entries, such as observations recorded and the quality of labelled diagrams, can also be assessed.

»Equipment

Session 1

For the teacher

- pointed knife
- sealant

For each team

- five similar-sized soft drink bottles: cola bottles are best for this activity
- empty plastic milk bottle with lid
- plastic tube about 30 cm long (drinking straw may be substituted)
- gauze
- string
- soil
- sand
- pebbles
- scissors
- sealant

For each student

- student journal

Session 2

For each team

- soil column constructed in Session 1
- water

For each student

- student journal

Session 3

For each team

- soil column constructed in Session 1
- crushed coal or activated charcoal (available from aquarium shops)
- milk bottle
- extra soil
- water
- stopwatch

For each student

- student journal

»Lesson steps

Session 1—Building a filter

1. Divide the class into teams. Cut four cola bottles along the line just up from the base. Use the pointed knife to start the cut, then have students use scissors to cut around the line. This will give four bottles without a base.
2. Cut the fifth bottle around the line closest to the top. This will give a bottle with a base and without a neck.
3. Ensure that lids have been removed from all bottles. Cut squares of gauze to cover the necks of the four bottles, and tie in place with string.
4. Drill a hole about halfway up the side of the fifth bottle (has base, no top). Seal the end of the tubing in the hole. This bottle will be the base of the filter column.
5. Place the first neck bottle upside down into the base, and seal the junction. Half fill this first bottle with gravel.
6. Place the second neck bottle upside down into the base of the first and seal around the edge. Half fill this second bottle with sand.
7. Place the third neck bottle upside down into the base of the bottle containing sand, and seal around the edge. Half fill this third bottle with soil and sand mixture.
8. Place the fourth neck bottle upside down into the soil-sand bottle, and seal around the edge. Allow the sealant to dry, then half fill this fourth (topmost) bottle with soil.
9. Before students pour water to simulate rain through this soil column, ask them to predict the colour of the water when it reaches the bottom of the column. What other substances do they predict will be in the water? Ask students to record their ideas in their journal.

Session 2—Where does the rain go?

1. Explain that groundwater is a source of naturally stored water that is relied on in Australia for watering stock, irrigating crops and for domestic use. However, the water is often used without much knowledge of how much is stored or how it is replenished. In this activity, students model the way that water infiltrates the ground. For additional information, refer to *Background Information for Teachers*, available at ‹www.nrw.qld.gov.au/waterwise/education/units/teacher_background.html›, or Resource 4 in Unit 1 of the Years 6 and 7 materials.
2. Take the class outside on a sunny day. Use a rain bottle (bottle with holes in the base) to ‘rain’ onto a clear patch of ground. Discuss where the rain has gone. Discuss evaporation (being mindful of the misconception that rain disappears). Has all the rain evaporated? How do they know? Could the rain have gone somewhere else?
3. Ask students for ideas about what windmills do. (Windmills pump water from underground to the surface.)

Has anyone seen water coming from a windmill pump? What colour is it? Where does the underground water come from originally?

4. Introduce the 'soil column' constructed in Session 1. Discuss the cross-section of soil. Note the spaces between sand and gravel pieces. Discuss the bottle at the base. This could be seen as a crack or large gap in the rocks. Ask students again for their predictions about what will happen to the water that 'rains' on the column.

5. Students divide into their original teams and add water to the soil column. Discuss rain falling on the column.
   - What happens to the rain as it hits the soil? (Turns muddy.)
   - Is all the water evaporating? Or is some sinking into the soil?
   - What name can you give to the water found in the bottom of the bottle? (Discuss the term 'groundwater'.)

6. Explain that groundwater is the water from windmill pumps. Electrically operated pumps can also be used to access groundwater; these are called bores.

7. Students record their observations in their journals and include labelled diagrams to show what they have observed. Did their observations match their predictions? Discuss the results with students. Even though the water flows through a dirt layer, the sand and gravel layers are to 'clean' the water because they trap the dirt and vegetation particles as the water flows through.

8. Make any new entries on the class TWLH chart and discuss.

» Optional activity—Aquifer projects

Discuss the application of bores or windmills to your local area. You could ask students to research the Brisbane Aquifer Project, which is investigating the possibility of using groundwater to augment the water supply for Brisbane. Or they could research a local groundwater source such as the Atherton Subartesian Area near Mareeba, or the Great Artesian Basin in Western Queensland. Additional information is available from the following web pages:

Brisbane Aquifer Project
‹www.brisbane.qld.gov.au/BCC:BASE::pc=PC_2784›

Great Artesian Basin
‹www.nrw.qld.gov.au/water/gab/index.html›

Session 3—Filtering dirty water

1. In this session, the soil column model is used as a 'filter' allowing students to see how the natural cleaning process of ground infiltration can be employed as a technique in water treatment for drinking water.
2. The column could be modified by changing the top layer to crushed coal or activated charcoal. Ask students to place some soil in the milk bottle, fill it with water and shake to make dirty water.
3. Ask the students to predict what will happen to the dirty water as it passes through the soil column. How long will the water take to pass through the column? Ask the students to record their ideas in their journal.
4. Assign one team member as the timekeeper. Time how long it takes for the water to move through the column. Add the muddy water to the column gently. Observe the water as it travels down the column. Discuss what is happening.
5. Ask students to make observational notes in their journals.

   How long does it take? Have students measure and record the time taken at each stage.
6. Ask: 'What colour is the water in the bottom bottle? Why do you think that is? Is the water safe to drink at this point? Why or why not?' Ask students to justify their opinion in their journal. Make sure that they include the evidence that they are using to back up their opinion. Write an explanation of why the soil column is working this way.
7. Make any new entries onto the class TWLH chart and discuss.

» Curriculum links

Technology

Construct a model.

Mathematics

Measure data over time.