Edible Aquifer: 60 minutes

All content is modified from www.deq.idaho.org, “The incredible, edible aquifer”

Objectives:

- Students will assess analogies to the geologic formations of an aquifer
- Students will explore how water moves through various media, and changing rates of infiltration
- Students will investigate how pollution makes its way into the subsurface, and how it might end up in municipal water wells.
- Students will learn how human activity can affect the limited water resources that we rely on.

Materials (Class of 25)

- Chocolate sprinkles: 2 (3 oz.) containers
- Clear plastic cups: 25–30 (12 or 16 oz.) cups
- Clear soda (e.g., lemon-lime): 4 liters
- Crushed ice (the smaller the better): ≈1 bag
- Mini marshmallows: 1 (16 oz.) bag
- Chocolate chips: 4 (12 oz.) bags
- Puffed cocoa cereal: ≈1/4 cup per student
- Red Kool-Aid® (sweetened and dry): 4 small pkgs.
- Spoons: 25–30
- Straws (preferably clear): 25–30
- Vanilla ice cream: 25–30 single serving cups

Explanation

Engage the students and give background information (7 minutes):

Option 1

- Think Pair Share: Have the students pick 3 total vocabulary words to describe in their science journals (5 minutes). Students will work with partner/team to share their understanding of at least 2 described vocabulary words (5 minutes). Spend a 3 more minutes describing three key words to the class (highlighted below), and explain that remaining words will become more clear through this exercise.
    - On the board, write, ‘Turn to a partner and discuss the list of vocabulary words that are given **(*)**. After three minutes of discussion, have students share out the results of their discussions with the class. Spend no more than five minutes sharing out. Write pertinent ideas on the board as students share out.

Option 2

- Video summary of a karst aquifer:
    - Pair with Option 1: Inside an Edwards Aquifer Well video (2:39 minutes)
    - Substitute for Option 1 and 2: Drop inside the Edwards Aquifer video (7:21 minutes)

Vocabulary (*):

- **Aquifer**: A natural underground area where large quantities of ground water fill the spaces between rocks and sediment.

- **Confined Aquifer**: An aquifer overlain by one or more layers of impermeable rock or soil (aquitard/confining layer) that restrict water to within the aquifer.
- **Confining Layer:** An underground layer over an aquifer that is impermeable or significantly less permeable than the aquifer below it. It helps protect the aquifer from contamination and is usually made of rock and/or clay. Also called an "aquitard."
- **Conserving Water: Working to restrict practices that waste water (e.g. turning off water while brushing teeth).**
- **Porous:** Full of pores (small spaces). Water can easily pass through it.
- **Protecting Water**: Keeping the pathways and sources of water clear of pollutants/contaminants.
- **Saturated Zone**: An underground layer or area where water fills most of the pores (spaces) in the soil and rock.
- **Unconfined Aquifer**: An aquifer that is not overlain by a layer of impermeable rock or soil.
- **Unsaturated Zone:** An underground layer or area where air fills most of the pores (spaces) in the soil and rock.
- **Water Table**: The top of an aquifer.

Procedure:

Step 1. Fill a clear plastic cup 1/3 full (total) with a layer of **crushed ice** followed by a layer of mini **marshmallows** and **chocolate chips** similar to the diagram.

These represent gravels and sands that make up the aquifer. Notice the different sizes and shapes and how the pieces have spaces or "voids" between them.

Step 2. Add enough **soda** to almost reach the top of the layer.

The soda represents groundwater. Ask the students what they notice : the soda fills all of the spaces among the marshmallows, chocolate chips, and ice. The aquifer is now saturated with *soda; it is a "saturated zone." In an unconfined aquifer (see Step 3), the top of the saturated zone is called the "water table."*

Step 3. Add a layer of ice cream. (Optional.) (For a tight seal, gently spread out the ice cream to the inside edges of the cup and slightly up the sides using the back of a spoon.)

This layer, called a "confining layer" or an "aquitard," is impermeable or significantly less permeable than the aquifer below it (it is difficult for water to soak through). It helps protect the aquifer from contamination and is usually made of rock and/or clay. An aquifer under a confining layer is called a "confined aquifer." An aquifer without a confining layer or above a confining layer is called an "unconfined aquifer." Some aquifers, such as the Spokane Valley-Rathdrum Prairie Aquifer in north Idaho, do not have a confining layer. If your local aquifer does not (or even if it does) have a confining layer, consider omitting the ice cream or having half the class use ice cream and half not to compare the results.

Step 4. Add puffed cocoa cereal (or use more crushed ice) on top of the confining layer/water table.

This represents the unsaturated zone, the area where air fills most of the pores (spaces) in the soil and rock.

Step 5. Scatter chocolate sprinkles over the top.

The sprinkles represent the soil, which is very porous.

The aquifer is now complete. Your aquifers will probably be messy and not look like the picture on the front page. That's OK! Real aquifers aren't neatly layered either. Next you will explore how contaminants and wells interact with your aquifer. Have the students form a <u>hypothesis</u> of how the many might flow through the different layers of their aquifer. Write the hypotheses on the projector/board.

Step 6. Sprinkle Kool-Aid® over the top of the soil.

The Kool-Aid® represents contaminants on the ground (e.g., fertilizer). Does anything happen to the Kool- Aid® right away? (Usually nothing will happen.)

Step 7. Using a drinking straw, "drill" a "well" into the center of the aquifer.

Observe the aquifer and Kool-Aid®. What, if anything, happens when the well is drilled?

Step 8. Begin to "pump" the well by slowly sucking on the straw.

Watch the decline in the level of soda and observe what happens to the contaminants. Do contaminants (Kool-Aid®) leak through the confining area (ice cream) and get sucked into the well? If so, do more contaminants get into wells in confined or unconfined aquifers? (Applicable if your class made both; see Step 3.)

Step 9. Pour a small amount of soda over the top.

The soda represents precipitation. It recharges the aquifer (adds new water). Watch how the Kool-Aid® dissolves and moves into the aquifer. The same thing happens when contaminants are spilled on the ground. Do you think you could get the Kool-Aid® back out of the soda?

Discuss

1. What observations/results surprised you? What did not?
2. How did results compare among different aquifers? (Even if all students used the same option in Step 3, each aquifer will be somewhat different.)
3. What are the key differences of this model to a real aquifer? What are the key similarities? What parts of the activity were most/least like what would happen with a real aquifer? Why?
4. What happens if all of the water is pumped out of an aquifer? Where does more groundwater come from?

   How long do you think it would take? Is there always more groundwater, or could we run out?
5. Do you think a contaminated aquifer can be cleaned? If so, how?
6. How can we conserve (save) ground water? What specifically can kids do?
7. How can we protect groundwater (keep it clean)? What specifically can kids do?

Post-Class activity (homework):

Option 1

Have students explain an aquifer to a friend or family member outside of class. They should write a short paragraph on how it went including their memory of key vocabulary words, the importance of protecting water in an aquifer, and how the friend/family member responded to the explanation.

Option 2 (High School; §112.37 (3))

Students are assigned a news or journal article related to energy. The students are tasked with answering these questions (minimum 1 sentence response) about the article: What was the key takeaway from the article? Did it have a positive or negative outlook on water resources and/or consumption? Did the article use scientific evidence to evaluate the topic? Describe the connection between the environment and the water cycle described in your article. What is your overall opinion about the article?

Sources:

The Incredible Edible Aquifer (DEQ Idaho Website)

www.deq.idaho.gov

Texas Assessments of Academic Readiness Resources – TEKS

§112.16. Science, Grade 5, Adopted 2017.
(b) Knowledge and skills.
(2) Scientific investigation and reasoning. The student uses scientific practices during laboratory and outdoor investigations. The student is expected to:
(A) describe, plan, and implement simple experimental investigations testing one variable;
(B) ask well defined questions, formulate testable hypotheses, and select and use appropriate equipment and technology;
(C) collect and record information using detailed observations and accurate measuring;
(D) analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence;
(E) demonstrate that repeated investigations may increase the reliability of results;

§112.18. Science, Grade 6, Adopted 2017.
(b) Knowledge and skills.
(2) Scientific investigation and reasoning. The student uses scientific practices during laboratory and field investigations. The student is expected to:
(A) plan and implement comparative and descriptive investigations by making observations, asking well defined questions, and using appropriate equipment and technology;
(B) design and implement experimental investigations by making observations, asking well defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
(C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
(10) Earth and space. The student understands the structure of Earth, the rock cycle, and plate tectonics. The student is expected to:
(A) build a model to illustrate the compositional and mechanical layers of Earth, including the inner core, outer core, mantle, crust, asthenosphere, and lithosphere;
(B) classify rocks as metamorphic, igneous, or sedimentary by the processes of their formation;

§112.19. Science, Grade 7, Adopted 2017.
(b) Knowledge and skills.
(2) Scientific investigation and reasoning. The student uses scientific practices during laboratory and field investigations. The student is expected to:
(A) plan and implement comparative and descriptive investigations by making observations, asking well defined questions, and using appropriate equipment and technology;

(B) design and implement experimental investigations by making observations, asking well defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
(C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
(8) Earth and space. The student knows that natural events and human activity can impact Earth systems. The student is expected to:
(C) model the effects of human activity on groundwater and surface water in a watershed.

§112.20. Science, Grade 8, Adopted 2017.
(b) Knowledge and skills.
(11) Organisms and environments. The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to:
(A) investigate how organisms and populations in an ecosystem depend on and may compete for biotic factors such as food and abiotic factors such as quantity of light, water, range of temperatures, or soil composition;
(B) explore how short- and long-term environmental changes affect organisms and traits in subsequent populations; and
(C) recognize human dependence on ocean systems and explain how human activities such as runoff, artificial reefs, or use of resources have modified these systems.