Water Activities

Teacher Resource Guide

Version 2 – 2022

Provided by

Colorado Springs Utilities®

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This Water Activities Teacher Guide is compiled and provided by Colorado Springs Utilities to assist with water education in the classroom. Thank you for promoting the value of water and teaching students how they can participate in a sustainable future.

The Water Activities Guide:

- Geared for 2nd – 8th grade students
- Over 30 hands-on activities easily implemented in the classroom
- Teacher information and answer keys
- Student worksheets
- Classroom kits available for select activities (within our service territory)
- Supports Colorado Department of Education Academic Standards
- Incorporates cross cutting common core standards
- Aligns with Statewide Water Education Action Plan

Colorado Springs Utilities is a community-owned, not for profit four service utility providing water, wastewater, electric and natural gas services to the Colorado Springs, Colorado area. We serve over 500,000 residents and numerous commercial, industrial, and military customers.

Find free educational resources at https://www.csu.org/Pages/Education.aspx or email us at communityrelations@csu.org

We hope you enjoy your complimentary Water Activities Teacher Resource Guide courtesy of Colorado Springs Utilities.

Credits: This guide and many of the activities herein were created by Birgit Landin, Community Education Specialist, Colorado Springs Utilities, with assistance from Sarah Wilson and Lisa Halcomb.

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Table of Contents

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrelations@csu.org

How to Use the Water Activities Guide

There are over 30 activities and a Resources & Ideas section included in this guide. Water activities have been categorized into six topic areas; divided by colored section dividers:

- **Earth's Water and General Facts** (green section)
- **Water Law and Management** (blue section)
- **Water Properties, Water Cycle, and Ecology** (orange section)
- **Watersheds, Stormwater and Water Quality** (red section)
- **Water Supply and Treatment** (purple section)
- **Water Use and Conservation** (yellow section)
- **Resources and Suggestions** (pink section)

Experiments are tallied on the Table of Contents and summarized on the Activity Cross-Reference Table. The **Activity Cross Reference Table** has activities listed by grade followed by topic area, and includes a brief description of the learning objectives, time commitment and type of activity. Use the Activity Cross Reference Table to quickly find activities to meet your classroom learning objectives, whether you have 15 minutes or several hours of time available.

Many of the activities have an asterisk (*) indicating that materials for these activities are available FREE from Colorado Springs Utilities for schools located within our service territory. You can arrange to pick up the materials kit at our Conservation & Environmental Center, 2855 Mesa Rd., Colorado Springs, CO 80904. Kits must be returned within a 2-week period.

If you have a water-related experiment or activity that you conduct with your students, please contact us so we can include it in future versions of the guide and share it with other teachers.

For more educational opportunities such as classroom presentations and facility tours, visit our Education page on our website at csu.org and contact us at communityrelations@csu.org.

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Activity Cross-Reference Table (Sorted by Grade)

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org.

Activity	Objective	Topic Area	Grade Level	Time Requirement	Activity Type	Page
Plant Transpiration Experiment	Students will be able to observe and measure the amounts of moisture naturally transpired by desert or drought tolerant and high-water requiring plants	Water Properties, Water Cycle, and Ecology	Pre-K-6	20 minutes and several days to observe	Experiment	187
Get to Know Your H_2O	Students learn about the source of their drinking water and our local water system	Earth's Water and General Facts	2-5	45 minutes	Read & answer questions	9
Water Wizard Facts	Students learn general facts about water, the water cycle, water supply in Colorado, water habitats, and water conservation	Earth's Water and General Facts	2-5	30 minutes	Test/quiz	23
Stormwater Soup*	Students learn how everyday behaviors impact water quality	Watersheds, Stormwater, and Water Quality	2-5	30 minutes	Teacher Demonstration	211
Pollution Patrol	Students learn about stormwater runoff, water pollution and ways they can help protect water quality through a word-libs game	Watersheds, Stormwater, and Water Quality	2-5	40 minutes	Video, discussion and word libs	217
Plant Adaptation Activity	Students learn about how plants have adapted to survive in our dry climate	Water Properties, Water Cycle, and Ecology	2-5	45 minutes	Game	167
Test Your Water IQ	Students answer questions about basic water facts to test their water knowledge	Earth's Water and General Facts	2-6	20 minutes	Test/quiz	19
Water Properties Experiments*	Students learn about water's unique properties of adhesion, cohesion, and surface tension	Water Properties, Water Cycle, and Ecology	2-6	40 minutes	Experiments	61
Around the Water Cycle-A Reader's Theater*	Students perform a reader's theater to reinforce concepts of evaporation, precipitation and condensation while using their reading and presentation skills	Water Properties, Water Cycle, and Ecology	2-6	15 minutes	Skit	71

Activity Cross-Reference Table (Sorted by Grade)

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Incredible Journey Water Cycle Dice Game*	Students recognize solar energy as the main driver for the movement of water on Earth; understand the movement of water within the water cycle	Water Properties, Water Cycle, and Ecology	2-6	30 minutes	Game	73
Water Cycle Inside a Balloon*	Explain the water cycle by showing evaporation, condensation, and precipitation	Water Properties, Water Cycle, and Ecology	2-6	15-20 minutes	Teacher Demonstration	149
Water Cycle in a Bag	Students observe the parts of the water cycle inside a clear bag	Water Properties, Water Cycle, and Ecology	2-6	30 minute set-up and several days to observe	Experiment	151
Water Cycle Relay	Students physically demonstrate the path a drop of water must take to complete the water cycle	Water Properties, Water Cycle, and Ecology	2-6	30 minutes	Relay	153
Cloud in a Bottle*	Demonstrate how clouds form in a low-pressure scenario	Water Properties, Water Cycle, and Ecology	2-6	20 minutes	Teacher Demonstration	155
Instant Snow*	Students learn about snow-water content, watch a polymer link with water to form a mixture and observe evaporation	Water Properties, Water Cycle, and Ecology	2-6	30 minutes	Experiment	159
Hard Water, Soft Water	Students observe, classify and order water samples according to their degree of hardness or softness	Watersheds, Stormwater, and Water Quality	2-6	30 minutes	Experiment, Graphing	209
Clean Up the Water!	Students determine the effect of various types of pollutants on water and ways to clean it up	Watersheds, Stormwater, and Water Quality	2-6	45 minutes	Experiment	223
Water Filtration Experiment - Making Drinking Water	Students will be able to describe the methods of purifying water as used by the pioneers, as well as those being used today by water treatment facilities	Water Supply and Treatment	2-6	30 minutes	Experiment	241

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Activity	Objective	Topic Area	Grade Level	Time Requirement	Activity Type	Page
Water Uses Worksheet	Students keep track of their daily water use	Water Use and Conservation	2-6	15 minutes class time plus homework tracking use at home	Math	273
Fire & Flooding*	Students learn how run-off from a high intensity burn area differs from an unburned soil area and impacts a watershed	Watersheds, Stormwater, and Water Quality	2-8	40 minutes	Experiment	199
Downstream Users Game – We All Share the Water*	Students pass water “downstream” from one cup to another to understand that we all use the same water and that we need to use it wisely so there will be enough for others who also depend on this resource	Water Law and Management	2-8	20 minutes	Game	41
Water Watchers	Students learn the best ways to conserve water	Water Use and Conservation	3-5	40 minutes class time and homework assignment	Discussion, Experiment, Math	261
Engineering a Water System*	Students learn components of a raw water system and how it works	Water Supply and Treatment	3-8	25 minutes	Game	229
How Water Loss Affects Biodiversity	Learn how the lack of water affects plants, animals, and people	Water Properties, Water Cycle and Ecology	4-6	40 minutes	Read and answer questions	189
Pass the Jug	Students will understand historical and current aspects of water law and gain an understanding of how water rights are allocated in Colorado	Water Law and Management	4-8	40 minutes	Game	47
Leaky Faucet Lab Worksheet	Students use math skills to measure a dripping faucet and determine the amount of water lost	Water Use and Conservation	4-8	30-45 minutes	Math	271

Activity Cross-Reference Table (Sorted by Grade)

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org.

Activity	Objective	Topic Area	Grade Level	Time Requirement	Activity Type	Page
Cost of Water	Students learn the amount of residential water use in Colorado Springs and calculate the cost for various water needs	Water Use and Conservation	4-8	30 minutes	Math	275
Water Rights in Colorado – Trading Game*	Students learn the complexities of water rights in Colorado through a trading game	Water Law and Management	4-8	40 minutes	Game	33
Cathodic Protection*	Learn how Utilities protects metal pipes from excess corrosion by using a sacrificial anode	Water Supply and Treatment	4-12	30 minutes	Experiment	249
Water Conservation Wizard	Use the student worksheet to have students learn about Colorado Springs Water Systems	Water Use and Conservation	5-8	45 minutes plus home testing	Test/quiz	279
Suggested On-line Resources	Resources and Suggestions	Resources and Suggestions	Varied	Varied	Varied	289
Water Activities and Ideas	Resources and Suggestions	Resources and Suggestions	Varied	Varied	Experiments, Games	291
Pikes Peak Library District Books List	Resources and Suggestions	Resources and Suggestions	Varied	Varied	Reading	293
Water Music	Resources and Suggestions	Resources and Suggestions	Varied	Varied	Varied	297

EARTH'S WATER and GENERAL FACTS

(Green Colored Section)

- Get to know your H_2O
- Test your Water IQ
- Water Wizard Facts

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Teacher info and answer key

Get to Know Your H_2O

Grade level: 2nd – 5th
Standard/ GLE Code: SC.2.3.2, SC.5.3.4
Time commitment: 45 minutes
Materials Needed:
How Much Water? – globe, 1 gallon jug or container, teaspoon, 100 macaroni pasta, beans or small items (per student), student page, green, blue, red markers (optional)
Where Does Your Water Come From? – Red, blue and green markers

Educational Messages:

- Students learn water amounts on Earth.
- Students learn about the source of their drinking water and our local water system.
- Students use math skills to count, graph and estimate %.
- Students read and answer comprehension questions.

Because water covers three-quarters of the earth's surface, it might appear that there is plenty to go around and that we will never run out of this valuable resource. In reality, however, we have a limited amount of useable fresh water. Here in Colorado Springs, water is a scarce resource that is brought in from the Rocky Mountains 100 miles away.

Suggested format:
Get to Know Your H2O has two parts – Part 1 - **"How Much Water?"** and part 2 - **"Where Does Your Water Come From?"**. The first is a discussion and demonstration of the amounts and types of water on earth and the second is a reading assignment to learn about Colorado Springs water supply. After reading the passage, students will answer questions about the reading assignment.

Part 1 - How much Water?

- Show an Earth globe and have students guess how much of the Earth's surface is covered in water (70%).
- Explain that there are four general types of water on Earth (salt water, frozen water, groundwater and surface water). Have the students count out 100 macaroni, beans or small items and estimate how many would represent the four types of water. They can enter estimate percentages of each kind on their worksheet in their Student Workbook, then discuss with their neighbor and write in a 2nd estimate.
- Discuss the difference between salt and fresh water and that people, plants and animals need fresh water to live. Watch this four-minute video on the percentage of fresh water on Earth: https://www.youtube.com/watch?v=oaQCiwzjnCM (see next page)
- Conduct the water amounts demonstration with your students. After the demonstration, have the students write in the actual percentages of each type of water (97% salty, 2% frozen, 0.8% groundwater, 0.2% surface water). They can color the pasta pieces per type of water and arrange them graphically and/or string them into a necklace.
- Initiate a class discussion on the importance of water and why it needs to be protected.

Part 2 – Where does your water come from?

- Ask students if they know where the source of their drinking water comes from.
- Have the students read their Get to Know Your H2O student page and answer the questions.

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Teacher Demonstration – How much water?

- If 100 gallons represented all of the water on earth: 97 gallons would be salt water – almost 39 buckets of water (2.5 gal buckets)
- 2.5 gallons would be ice (glaciers, ice caps) – one bucket of water
- 0.4 of a gallon would be groundwater – 6 ½ cups of water
- 0.02 of a gallon would be surface water (all the rivers, lakes, wetlands and clouds/vapor) on Earth – less than 1/2 cup of water!

1. Fill a gallon jug nearly full (97%) with water and explain that this water represents salt water (oceans and seas).
2. Add another splash to represent the 2% of water that is in the form of ice (glaciers, ice caps). At this point the jug should be just about full.
3. Add a smaller splash of water to represent the 0.8% of water that is underground in our aquifers (groundwater).
4. Finally, take one teaspoon of water and add it to the jug. Explain to students that this represents all the surface water (including rivers, streams, lakes, ponds, wetlands, etc.) in the world (0.2%). Most of the water we use in our everyday lives comes from rivers.
5. After you demonstrate the correct percentages of water in the world, have students fill in the actual amounts on their worksheet. Facilitate a discussion about their predictions and actual findings.
6. Discuss with students the fact that less than 1% of all the water in the world is available for human use (although 3% of the Earth's water is fresh, not all groundwater and surface water is available for use by humans).

A DROP IN THE BUCKET LESSON PLAN
From Project WET

Water can be both abundant and rare at the same time. Use this activity to help students understand that water is a limited resource.

Warm up: Have students estimate the proportion of water that they think is potable--not salty and not polluted. Record the students' estimates.

Step 1. Fill a 1-liter (1000 ml) cylinder or beaker with water and tell students that it represents all the water on earth.

Step 2. Ask students where most of the water on Earth is located. When they answer correctly with "in the oceans", pour out 30 ml of water into a 100 ml graduated cylinder. The 30 ml represents the fresh, un-salty water. The remainder in the large beaker is all salty. You can add a few shakes of salt to represent that.

Step 3. Ask if all of the 30 ml is available for consumption. When they guess no, ask why not. You may have to give hints to help them figure out that much of our fresh water is frozen in the polar ice caps. Now pour 6ml out of the 30 ml into a 10 ml graduated cylinder.

The 6 ml represents the fresh, unfrozen water. The remaining 24 ml is all frozen. Place an ice cube in that cylinder.

Step 4. Ask again if all of the 6 ml is available for consumption. Help the students to realize that much water is in clouds, soil and even in the bodies of plants and animals that is unavailable for use. Using an eyedropper, remove a single drop of water from the 6 ml and place it in your hand. This represents all the clean fresh water for everyone on Earth to use.

Step 5. Now rub your hands together to dry up the drop of water and point out how easy it is to lose our water resources if we do not take care of them.

Wrap up: Revisit the estimates they made before the activity. After going through the exercise, point out that the one drop was approximately .003 percent of all water. You can point out that if we multiply it out, we find that there are 7 million liters per person (based on a population of 6 million people). This may sound like a lot, but the problem is distribution. There are water rich and water poor areas. You can extend this activity by researching the amount of water it takes to produce a pair of blue jeans or a hamburger to see that 7 million liters of water per person isn't actually that much. Students could also calculate how much water they use in a day and in a year.

This is just one of the over 90 activities in the Project WET guide. Please visit the **Project WET** webpage: http://projectwet.org to find out more about this exciting program.

HOW MUCH WATER? ANSWER KEY

If 100 gallons represented all the water in the world, estimate how many of these gallons would be in each of the four distinct groups of water.

How much water is:	**1st Estimation** **(# of gallons out of 100)**	**2nd Estimation** **(# of gallons out of 100)**	**Actual Answer** **(# of gallons out of 100)**
Salt Water			97 gallons out of 100 (97%)
Frozen – Glaciers, ice caps, icebergs, etc.			2 gallons out of 100 (2%)
Groundwater			Less than 1 gallon out of 100 (0.8%)
Surface Water – Rivers, lakes, wetlands, clouds/vapor, etc.			Only 3.2 cups out of 100 gallons (0.2%)

- 1st Estimation – This is your own guess.
- 2nd Estimation – Now compare your guesses with a neighbor's guesses. Do you want to change any of your guesses? If you do want to change your guess, please enter your new answer in the 2nd column.
- Actual Answer – Now write down the actual answer that your teacher gives you.

Using the Actual Answers, lay out your pasta pieces on a flat surface as a graph or pie chart of the four types of water and draw a smaller-scale version of your results here.

Graph - don't forget to label your X and Y axis

Pie Chart – add a label and percentage to each slice of pie

Water Amounts Data:

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Part 2 – WHERE DOES YOUR WATER COME FROM?

A **reservoir** is a man-made lake used to store water.

Read the passage, then answer the questions below.

Communities in Colorado get their water from streams, lakes and reservoirs that are supplied by snowmelt and rainfall. The amount of water that is available for use varies from year to year and depends on snowpack in the mountains. In fact, about 80% of our water in town comes from snow that fell in the Rocky Mountains.

Everyone in the world lives in a watershed. A watershed is an area of land that drains into a stream or lake. Here in Colorado Springs we live in the Fountain Creek watershed which is part of the Arkansas River Basin. We use this water as part of the city water supply.

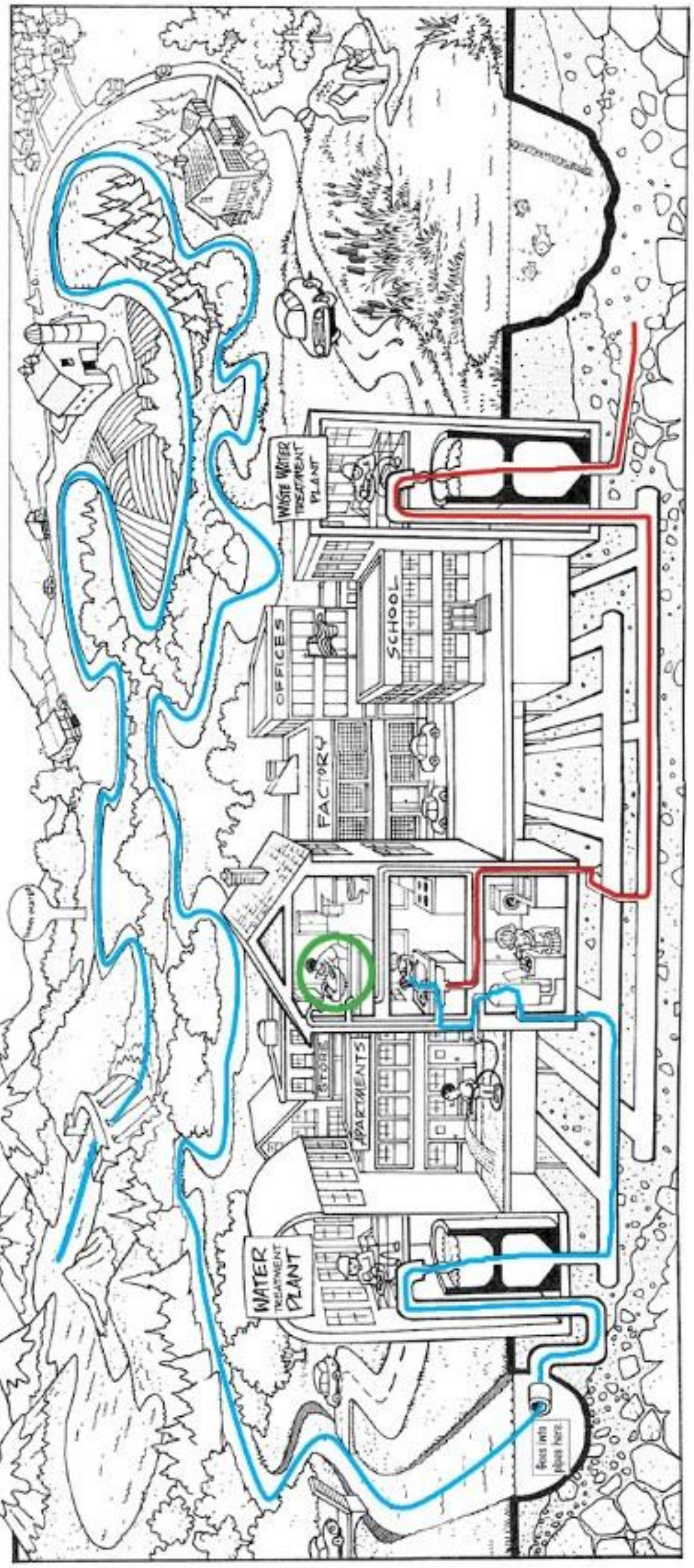
The Arkansas River Basin water available in town isn't enough for the size of our city so we also bring in water from the Colorado River and South Platte River Basins.

In fact, most of our drinking water comes from 100 miles away from the Western Slope of the Rocky Mountains through a series of tunnels, canals and pipes. The water is stored in reservoirs before it is treated and distributed in our community.

By cleaning and testing the water, Colorado Springs Utilities makes sure that we have safe, delicious water for drinking. Our water utilities do more than clean the water. They also fix leaky pipes and install new ones, monitor water levels in our waterways and much more!

The water used inside your house goes down the sanitary sewer pipe to the Water Resource Recovery Facility where it gets cleaned again

1. What percent of our water comes from snow? ___________80%________________ %
2. Write the name of the watershed you live in: ____Fountain Creek Watershed, which is part of the Arkansas River Basin Watershed
3. Name the three river basins that supply your water: _Colorado, Arkansas, South Platte
4. How far has some of your water traveled to get to town? _____100___ miles
5. What is the name of the utility company that supplies your drinking water? _____Colorado Springs Utilities (for students within Colorado Springs area)_______


WASTE WATER TREATMENT PLANT
SCHOOL
OFFICES
FACTORY
STORE
APARTMENTS
WATER TREATMENT PLANT

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Student worksheet

Get to Know Your H_2O

Materials Needed:

- 100 macaroni pasta, beans or small items
- Blue, red and green markers

Directions:

- Estimate amounts of salty, frozen groundwater and surface water on Earth.
- Use pasta pieces (or something small) to graph amounts.
- Watch the video, read about where your water comes from and answer questions.
- Complete the maze.

We have a limited amount of useable fresh water. In Colorado Springs, water is brought to town from the Rocky Mountains, over 100 miles away.

People plants and animals needs fresh water to survive. Fresh water is found in surface water (lakes, streams, rivers and wetlands), groundwater (underground in aquifers) or as frozen water stored in ice, glaciers, ice caps and snow.

Part 1 - HOW MUCH WATER IN THE WORLD?

Instructions:

1. Look at a globe or world map. Find where you live, locate the seven oceans and other surface water features.
   - Do you think there is more water or land on the globe? ________________________
   - Have you ever tasted salt water? Was it good? ______________________________
   - Is there more water beneath the surface of the ground that you cannot see on the globe? ____
2. Get 100 pieces of macaroni pasta, beans or other small items. These 100 items will represent all the water in the world. Let's pretend they are gallons of water. If 100 gallons represented all the water in the world, estimate how many of these gallons would be in each of the four distinct groups of water. Divide the pieces into each of the four water categories below. 1st Estimation – This is your own guess.
3. 2nd Estimation – Now compare your guesses with a friend's guesses. Do you want to change any of your guesses? ________ If you want to change your guess, please enter your new answer in the second column.
4. Actual Answer - Now write down the actual answer that your teacher gives you. Were you right? _________________
5. Color the pasta pieces according to type of water (coloring is optional) and arrange them into a graph or pie chart on a flat surface. Draw your results in smaller scale below.
6. Watch this four-minute video on the percentage of fresh water on Earth: https://www.youtube.com/watch?v=oaQCiwzjnCM

HOW MUCH WATER IN THE WORLD?

Estimate the percentage of water in each category

How much water is:	**1st Estimation – your guess** (# of gallons out of 100)	**2nd Estimation – your revised guess after talking to a friend** (# of gallons out of 100)	**Actual Answer – provided by your teacher** (# of gallons out of 100)
Salt Water – Oceans, seas			
Frozen Water – Glaciers, ice caps, icebergs			
Groundwater – aquifers, water underground			
Surface Water – Rivers, lakes, wetlands, streams			

Using the Actual Answers, lay out your pasta pieces on a flat surface as a graph or pie chart of the four types of water and draw a smaller-scale version of your results here.

Graph - don't forget to label your X and Y axis

Pie Chart – add a label and percentage to each slice of pie

Water Amounts Data:

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Part 2 – WHERE DOES YOUR WATER COME FROM?

Read the passage, then answer the questions below.

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The water used inside your house goes down the sanitary sewer pipe to the Water Resource Recovery Facility where it gets cleaned again.

1. What percent of our water comes from snow? ____________________________ %
2. Write the name of the watershed you live in:

   ____
3. Name the three river basins that supply your water:

   ____

   ____

   ____
4. How far has some of your water traveled to get to town? _____________________ miles
5. What is the name of the utility company that supplies your drinking water?

   ____

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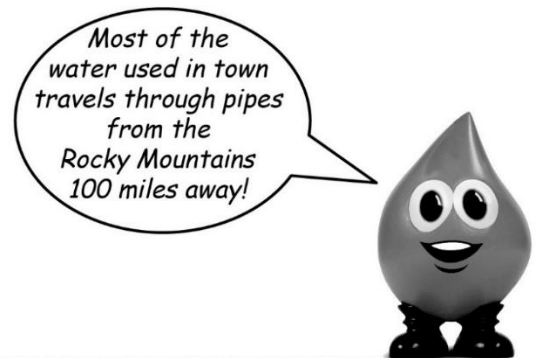
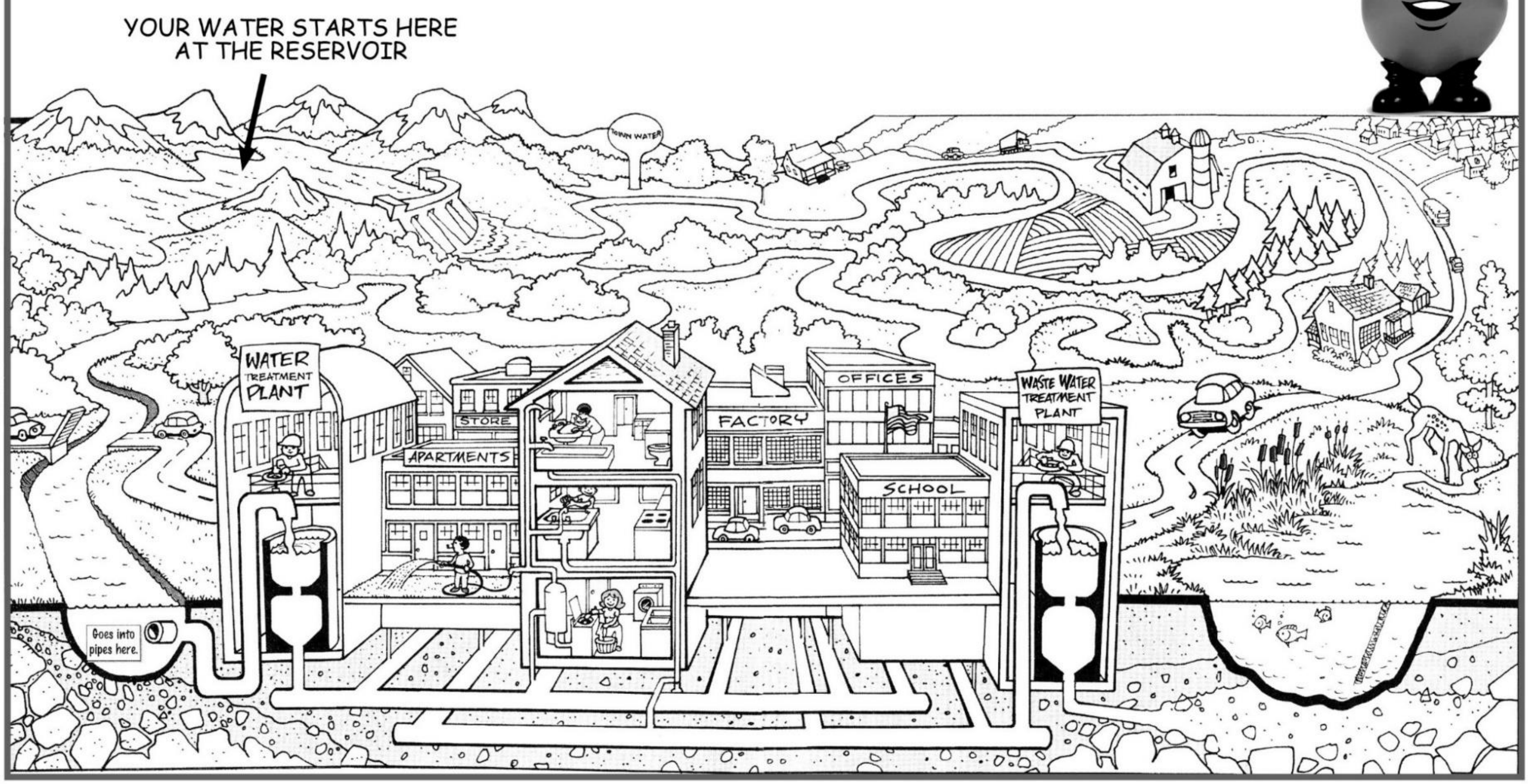
How Does Water Get to You?

1. Use a blue marker to trace the path of the water to the sink in the house.
2. Circle all the places where water is being used in the house.
3. Use a red marker to trace the path of the water after it has washed this person's hands.





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Teacher info and answer key

Test your Water IQ

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.2, SC.5.3.3
Time commitment: 20 minutes
Materials Needed:
- Student page – Test your Water IQ

Educational Messages:
- Students answer questions about basic water facts to test their water knowledge.

Test Your Water IQ - *Answer Key*

1. Water is composed of which 3 atoms? Hydrogen, Hydrogen, Oxygen (H_20)
2. True or False: Scientists believe about the same water exists on Earth today as when water was first formed billions of years ago. True
3. The 3 main parts of the water cycle are: Evaporation, Condensation, Precipitation
4. How much of the Earth's surface is covered in water? About 70%
5. What percentage of the Earth's water is salty? 97%
6. Of the fresh water on Earth, not all of it is available for human to use. Most fresh water is found in what form? Solid/frozen as ice, glaciers, ice caps, etc. (2%)
7. What percentage of your body is composed of water? Average of 70% (kids have more, adults have less)
8. How many days can you live without any water? 3 days
9. A gallon of water weighs how much? 8.34 lbs
10. Worldwide, how many people still lack access to clean water? 783 million (source: United Nations http://www.un.org/en/sections/issues-depth/water/)

Check answers to rate your Water IQ:
- 9-10 correct = High water IQ - Water Wizard!
- 6-8 correct = Moderately high-water IQ - Water Smart
- 3-5 correct = Medium water IQ - Water Wonderer
- 0-2 correct = Low water IQ – study to improve

Your Water IQ:

Source: Colorado Springs Utilities

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Student worksheet

Test Your Water IQ *(Fill in the answers and see how you rate)*

1. Water is composed of which 3 atoms? ___________, ___________, ____________

2. True or False: Scientists believe about the same water exists on earth today as when water was first formed billions of years ago.
   True
   False

3. The 3 main parts of the water cycle are:
   ____________________, _____________________, ____________________

4. How much of the Earth's surface is covered in water? ____________%

5. What percentage of the Earth's water is salty?
   a. 25%
   b. 53%
   c. 78%
   d. 97%

6. Of the fresh water on Earth, not all of it is available for human to use. Most fresh water is found in what form? _________________________________

7. What percentage of your body is composed of water? ___________%

8. How many days can you live without any water? __________ days

9. A gallon of water weighs how much?
   a. 2.1 pounds
   b. 4.8 pounds
   c. 8.3 pounds
   d. 10.6 pounds

10. Worldwide, how many people still lack access to clean water?
    a. 2 million
    b. 25 million
    c. 66 million
    d. 197 million
    e. 783 million
    f. 4 billion

Check answers to rate your Water IQ:

- 9-10 correct = High water IQ - Water Wizard!
- 6-8 correct = Moderately high water IQ - Water Smart
- 3-5 correct = Medium water IQ - Water Wonderer
- 0-2 correct = Low water IQ – study to improve

Your Water IQ:

Answers: 1. Hydrogen, Hydrogen, Oxygen (H_20); 2. True; 3. Evaporation, Condensation, Precipitation; 4. about 70%; 5. d. 97%; 6. Solid/frozen as ice, glaciers, ice caps, etc. (2%); 7. Average of 70% (kids have more, adults have less); 8. 3 days; 9. c. 8.3 lbs.; 10. e. 783 million (source: United Nations)

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Teacher info and answer key

Water Wizard Facts

<u>Grade level:</u> 2nd – 5th
<u>Standard/ GLE Code:</u> SC.2.3.2, SC.5.3.3
<u>Time commitment:</u> 30 minutes
<u>Materials Needed:</u>

- Water Wizard Facts Student worksheet
- Access to computer for Jeopardy water trivia game (optional)

Water is essential for life. Learning water facts can give students an appreciation for this valuable resource. In this activity, students test their water knowledge across several topics to see if they reach Water Wizard status and can become water ambassadors. Email us at communityrealtions@csu.org to receive a prize for your students who qualify as Water Wizards.

Educational Messages:

- Students gain water knowledge through answering 50 trivia questions.
- Topics include general water and water cycle knowledge, world and USA water facts, Colorado and Colorado Springs Utilities water trivia, ecology, use and water conservation.
- Students check their answers to see if they qualify as Water Wizards.
- Reinforce water knowledge through a water Jeopardy game (optional).

Photo source: Water Wizard USA

<u>Suggested format:</u>

1. Assign students to small groups to fill in the water trivia chart on the Water Wizard Facts Student worksheet.
2. Have students check their answers with the answer key. If they get at least 80% correct (40+ facts), they are Water Wizards and can be water ambassadors in their community to help educate others about the importance of this resource.
3. Reinforce water knowledge by playing the Water Jeopardy Game created by Richelle Gittens from Queen Palmer Elementary using Jeopardy Labs: https://jeopardylabs.com/play/2019-05-15-566#.XfkuyaGI8SQ.email

Answer Key on next page.

Colorado Springs Utilities
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Water Wizard Facts ANSWER KEY

	General Water & Water Cycle Trivia:	Answer:
1	True or false: the same amount of water exists on Earth today, as when Earth was first created.	True
2	What is water composed of?	H20 - 2 hydrogen atoms and 1 oxygen atom
3	What does the prefix Hydro mean?	Water
4	Name the three (3) physical forms of water.	Liquid, solid, and vapor (gas)
5	How much of the earth's surface is covered in water?	70%
6	How much of the water on earth is **usable** fresh water?	Less than 1%
7	How many pounds does a gallon of water weigh?	8.34 pounds
8	What's it called when the body is lacking adequate fluids?	Dehydration
9	About how much of the human body is composed of water?	70%
10	What is the name of the water cycle process by which water changes from a liquid to a vapor?	Evaporation
11	What is the name for the portion of the water cycle where solid liquid falls to the earth's surface?	Precipitation
12	What is the name of the water cycle process where water vapor changes to tiny liquid droplets and forms clouds?	Condensation
13	What is the energy source that drives the water cycle?	The sun
14	Precipitation can occur in several forms: Name four	Sleet, Snow, Hail, Rain
15	A type of precipitation is caused by raindrops passing through a freezing layer of air?	Sleet and hail
16	What is another name for a drainage basin?	Watershed
17	What is water stored in an aquifer called?	Groundwater
18	What is the alternate rise and fall of waters caused by the gravitational attraction of the moon and sun?	Tides
19	Large rivers of ice that never completely melt are called?	Glaciers

	World and USA water facts:	
20	What is the longest river in the world?	Nile
21	What is the largest lake in North America?	Lake Superior
22	What state is surrounded completely by water?	Hawaii
23	What state claims to have 10,000 lakes?	Minnesota
24	Which river cuts the Grand Canyon?	Colorado River
25	Which river system has had more impact on the development of the U.S. than any other?	Mississippi (covering 41% of the land mass of the continental U.S. and affecting 31 states and 2 Canadian provinces)

	Colorado and Colorado Springs Utilities water trivia:	
26	Name the Colorado state fish.	Greenback cutthroat trout
27	Most of Colorado's precipitation falls in which portion of the state?	The Rocky Mountains or Colorado's western slope
28	What is the significance of the Continental Divide as it relates to water?	The Continental Divide splits the direction of water flow in our country--either east to the Atlantic Ocean (including the Gulf of Mexico) or west to the Pacific Ocean.

29	Colorado is unique in that 8 rivers originate within the state: Name our four largest rivers.	Colorado, South Platte, Arkansas and Rio Grande
30	From where does our drinking water originate?	Melting snow and rainfall
31	What is the average yearly precipitation in Colorado Springs?	16 inches
32	The Colorado River drains through seven states. Name three of them.	Wyoming, Colorado, New Mexico, Utah, Arizona, Nevada, and California
33	What is a reservoir?	A human-made lake
34	What kind of energy is created by water flowing through turbines in a dam?	Hydroelectric
35	Name the 3 river basins that supply water to Colorado Springs	The Colorado, Arkansas, and South Platte Rivers
36	How many miles does your drinking water travel to get to Colorado Springs?	Up to 100 miles
37	When unwanted or dangerous substances get into our drinking water, we classify that water as?	Polluted or contaminated
38	Why isn't it safe to drink water directly from Colorado's streams, rivers, and lakes?	Stream water may contain things such as dirt and disease germs that can make you sick.
39	Where does our water go to be cleaned so that it is safe to drink?	Water treatment plant

Ecology and water:

40	What is Water Wise (aka Xeriscape) landscaping?	Attractive landscaping with plants that need less water.
41	What do we call plant and animal habitat near water?	Riparian
42	What organ do fish use to take oxygen from water?	Gills
43	What group of animals spend a portion of their lives breathing using gills and a portion using lungs?	Amphibians
44	What name is given to the bits of soil and rock that a river carries along and eventually drops to the bottom?	Sediment or silt

Water use and conservation:

45	On average, how many gallons of water a day does a Colorado Springs resident use?	78 gallons per person per day
46	What is a drought?	Long time period with lower than normal precipitation
47	For what purpose is the most water used by an average Colorado Springs resident?	Watering landscapes (37% of water used)
48	Which two appliances inside the home use the most water?	The toilet and clothes washer
49	A high-efficiency toilet uses how many gallons of water per flush?	About 1 gallon (range from .8 to 1.28 gallons)
50	How many gallons of water can you save by turning off the faucet while brushing your teeth and washing your hands?	10 gallons a day

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Student worksheet

Water Wizard Facts

Materials Needed:

- Pencil

How much do you know about water? Write down your best answers then compare with the answer key to see if you are a Water Wizard!

What you'll do:

- Test your water knowledge by answering 50 trivia questions.
- Check your answers.
- 80% correct or more makes you a Water Wizard!

Photo source: Water Wizard USA

	General Water & Water Cycle Trivia:	Your Answer:
1	True or false: the same amount of water exists on Earth today, as when Earth was first created.	
2	What is water composed of?	
3	What does the prefix Hydro mean?	
4	Name the three (3) physical forms of water.	
5	How much of the earth's surface is covered in water?	
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7	How many pounds does a gallon of water weigh?	
8	What's it called when the body is lacking adequate fluids?	
9	About how much of the human body is composed of water?	
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48	Which two appliances inside the home use the most water?	
49	A high-efficiency toilet uses how many gallons of water per flush?	
50	How many gallons of water can you save by turning off the faucet while brushing your teeth and washing your hands?	

For answers, see the Water Wizard Facts Teacher info and answer key. If you got more than 80% right (40+ correct), then you are officially a Water Wizard! Well done.

WATER LAW and MANAGEMENT

(Blue Colored Section)

- Water Rights in Colorado – Trading Game
- Downstream Water Users Game – We All Share the Water
- Pass the Jug

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Teacher info and answer key

Water Rights in Colorado – Trading Game*

Grade level: 4th – 12th
Standard/GLE Code: SS.2.3.1, SS.4.4.1, SS.5.2.2, SS.6.2.2, SS.HS.2.2
Time commitment: 40 minutes
Materials Needed:

- 30 envelopes
- 100 poker chips (50 white, 50 blue)
- Play money such as from Monopoly or Life
- 30 index cards
- Jelly beans (optional)

Educational Messages:

- Students learn about water rights in Colorado.
- Topics include beneficial use, senior vs. junior rights.
- Trading game teaches complexity of water rights and the need for collaboration.

- Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Objective: Learn the complexities of water rights in Colorado through a trading game.

Prep: Create water rights player cards and divide poker chips and money into envelopes.

Overview: Water in Colorado is treated as a property right that can be bought, sold, and traded. Students learn background information about Colorado water law and play a water rights trading game to understand the rules of these complex water laws.

Problem: Water is a scare resource in Colorado. How is water shared among users across the state, and who decides who gets the water?

Research/Background Information:

Colorado is known as a headwaters state because several rivers start here—up high in the Rocky Mountains. **In an average year, Colorado generates about 16 million-acre feet (maf) of renewable water** (source: Colorado Foundation for Water Education).

One acre foot (af) of water = 325,851 gallons of water; the amount of water that will cover 1 acre of land (about the size of a football field) at a depth of 1 foot. There are 43,560 cubic feet in 1 acre-foot of water. Sometimes you will see water rights referred to as cubic feet per second or cfs.

There are 19 states that rely on the water which originates here in Colorado. Because of Interstate Stream Compacts with these other states, Colorado can only keep about 1/3 of the water generated in our state. Population centers are not located in the areas of the state where water is more plentiful. Most of Colorado's precipitation falls on the western slope, west of the Continental Divide while the majority of the population lives on the more arid eastern side of the state.

History of water rights in Colorado: Colorado's first population increase primarily was miners from the east. There is more water on the east side of the US than here in Colorado where we average about 16 inches of rain annually. In the east, water use is tied to land ownership and water flowing past or located under your land can be used as long as you don't injure downstream users. That type of water use does not work as well in Colorado where there is so much less.

Imagine you are Miner 1 and have just used a lot of time and hard work to dig a diversion trench from the creek to your mining operation. Now Miner 2 starts diverting water upstream of you and takes all the water! That doesn't seem fair. Miners need food to survive in Colorado, so farmers were now attracted to Colorado, moved here, established their crops and began competing for that same, scarce water. Soon water wars broke out, so miners and farmers developed some "rules" around using water that have eventually became some of the most extensive and complex water laws in the country. These rules, or laws, are referred to as the Colorado Doctrine—begun in 1860 and legalized in 1969. The type of water law which governs our state is referred to as the Prior Appropriations Doctrine. The main points of this doctrine are:

1. All surface and groundwater are a public resource.
2. A water right is a right to use a portion of the public's water resources.
3. Water rights are not tied to the land.
4. "First in time, first in right."

All surface and groundwater are designated as a **public** resource**. A water right is a right to use a portion of the public's water resources.** To use a water right, you must be able to meet criteria such as establishing a beneficial use for that water, specifying where you will use that water, and confirming that there is enough water available for your use(s) without causing "harm" to other users.

Water rights are not tied to the land - Water rights are like any other property right. Imagine you purchase a house or a car; you own the right to the house or car and can sell or trade it as you like. The same is true for water rights; you own it and can transfer it. Water rights are not tied to land rights. This means that you can own a house and the property it sits on, but you can't use the water in the stream on your property, nor the groundwater beneath your property, without legally obtaining the rights to that water. On the other hand, you can own the rights to water unassociated with your property even though you don't own the land that the water flows through.

In Colorado, a water right is the right to apply water to a beneficial use. In general, to use water you must physically divert it via a well or surface water diversion. This means that water must be taken out of the river channel or from underground before you use it. Water rights owners may build facilities on the lands of others to divert, extract, move or store water. Water rights owners may also use streams, reservoirs, pipelines and aquifers to transport and store water. Colorado Springs Utilities owns several water rights in streams in the Rocky Mountains. We have several large pipelines that bring some of that water to town. We also let some of our water flow naturally down the Arkansas River and other waterways to make sure other water rights are not injured by our use of the water.

"First in time, first in right" – Water rights are assigned a priority (hence the name "appropriation" doctrine) once the water rights have been used and recognized by the Water Court. Generally, the oldest date of diversion has the superior right. This means that the first person to use the water is the senior water user and has the right to use the water first. Senior water rights have more assurance of receiving water than junior water rights in the case of a drought or water shortage. When water is scarce, the owners of senior water rights get to use their share first, even if it means the junior water rights holders get less or none.

The date of the claimed water right determines precedence—it doesn't matter if the holders are upstream or downstream.

One interesting fact about water rights dates is that the original priority date stays with the water right. Let's say Miner 2's water right date is 1890 and he decides to quit mining and sell his water right. The buyer of that water right retains the senior water right date of 1890. Senior water rights keep their value and are highly sought after for this reason. **The value of one-acre foot of water can vary from as little as $5,000 to upwards of $40,000.** A senior water right increases in value according to it seniority or decree date—an 1890 water right is generally far more valuable than a 1955 water right on the same river. The location of the diversion on a river also impacts the value of a water right. It would be very difficult (and costly) to move water diverted in southeast corner of the state to anywhere else, so even a senior water right in that area is not as valuable.

<u>How to gain a water right</u> – To obtain a water right, you can either buy an existing one, trade for an existing one, purchase a new water right, or adjudicate a previously unused water right. The State Engineer and the Water Court oversee water rights in the state of Colorado. Water must be appropriated: this means that you must define how much, when and where you will use the water. The Water Court will appropriate your water right in time, place, amount, and for what use. A new appropriation may not cause injury to other water rights.

- **Time** – Priority is determined by comparing existing, senior appropriations and potential, future junior appropriations.
- **Place** – Water must be diverted – physically removed from its natural channel or aquifer.
- **Amount** – You must declare how much water you will use, and when (what times of the year) you will use it.
- **Use** – Water must be put to a beneficial use.

<u>Beneficial Use:</u> By law, water must be put to a beneficial use. The Water Court and State Engineer decide if water use is beneficial. Recognized, beneficial uses under the prior appropriation doctrine include: augmentation; commercial; domestic; dust suppression; fire protection; flood control; industrial; irrigation; mined land reclamation; municipal; nature centers; power generation; produced water from gas production; recreation on reservoirs; release from storage for boating and fishing; snowmaking; stock watering; some recreation in-channel diversions; incidental fish and wildlife culture; Colorado Water Conservation Board held water rights for in-stream flows and natural lake levels.

<u>Types of water rights:</u> There are several types of water rights.

- **Direct Flow Rights** - Water is diverted and immediately put to beneficial use.
- **Storage Rights** - Diverted into a storage vessel for later use. This includes Reservoirs & Aquifer Storage and Recovery (ASR).
- **Groundwater Rights** – Tributary, Nontributary, Not-nontributary, Designated Groundwater Basins. These may require Augmentation Plans.
- **In-Stream Flow** - Colorado Water Conservation Board has water rights for habitat and piscatorial purposes. Recreational in-channel diversions are water rights for in-channel, non-consumptive recreational purposes and can only be held by limited entities.
- **Exchange Rights** – A way to optimize water rights and water use. A release of water to a downstream use, or call, in exchange for water taken at a different location. This enables the efficient reuse of waters among different uses and users. Exchange rights are a common water

management practice throughout Colorado and are adjudicated by the Court. Exchange rights allow the user to divert out of priority as long as the water is replaced without causing "injury." Exchanges can be done by physical or contract exchange, much like transfers between bank accounts.

Water Rights Game

Students buy, sell, and trade water rights based on scenarios assigned to them on their player cards. Distribute the player cards with corresponding poker chips or play money, explain the goals, and then allow 10–15 minutes for students to trade, buy and sell. After the trading time is finished, review each players' result and distribute jellybeans based on how successful they were.

Player Cards (30 index cards):

Water Rights Holder Player Cards	Water Rights Purchaser Player Cards
Miner 1 – You came in 1870 and dug the trench from the stream to your mining claim. You have 3 white poker chips.	City of Peopleville – You need 10 water rights to keep your city green and pretty, and the City Board has approved $100K to buy rights.
Miner 2 – You started mining in 1910. You have 3 white poker chips.	City of Salida – You are the up-and-coming ski town in Colorado so you need to get 4 more water rights for now, but you only have $30K to spend.
Miner 3 – You joined the gold rush band-wagon later. You have 3 blue poker chips.	City of Pueblo – Your projected growth shows you need 6 water rights to meet demand. The Mayor has approved $100K to buy them.
Homesteader 1 – The Government encouraged you to settle the west by giving you free land with a stream running through it. You have 2 white poker chips.	City of Colorado Springs – To make sure you have enough water rights to get through the severe droughts anticipated with climate change you want to buy 15 water rights with $200K.
Homesteader 2 – The Government needs more white settlers in the west, so they gave you free land with a natural spring. You have 2 blue poker chips.	Electric City Power Plant – To generate electricity you need a lot of water! You must purchase 10 water rights to keep the lights on. After raising the rates, you have $150K to spend.
Farmer 1 – Your family came early to grow food for the miners. You have 10 white poker chips.	Save the Colorado – Your organization wants to keep water in the river to reach Lake Mead so that upper Colorado River water rights will not be jeopardized. You need 3 water rights and have $50K from members to make this happen.
Farmer 2 – You've been growing food in Colorado since the first settlers came. You have 10 white poker chips.	Computers R Us – Colorado has ultra-pure Rocky Mountain water which is great for making computer chips, so you need 4 water rights to open up a new chip-making factory. You have $100k to spend.

Farmer 3 – Your grandparents moved out to Colorado in 1930 to grow asparagus. You have 10 blue poker chips.	Farmer Newbie – You are starting an organic farm and need 10 water rights to grow your crops. You have borrowed $50K from the bank to buy them.
Farmer 4 – Your family has been farming in Colorado since 1950. You have 10 blue poker chips.	Aspen Millionaire – You want a beautiful Colorado mountain stream flowing through your backyard and have oodles of money ($200K) to buy the 3 water rights needed.
Farmer 5 – You gave up the corporate world after the stock market crash in 1987 and started farming in the later 1990s. You have 5 blue poker chips.	Rocky Mountain Bottle Water Co. – Pure Rocky Mountain water tastes so good! More water rights mean more profit. You want to buy 10 water rights and your parent company, Coke Products, is giving you $300K to buy them.
Rancher 1 – Your great-granddad was one of the first cowboys to herd cattle through Colorado. He decided to stay. You have 10 white poker chips.	RIFT (Rafters in the Flow) – Rafting and Kayaking is big business in Colorado. You need 5 water rights to keep the river flow high enough in the summer to avoid portages. You have $20K to spend.
Rancher 2 – Your family turned to ranching during the Great Depression of 1930. You have 10 white poker chips.	Fisherman Friends – Like the Rafter folks, you want the river to flow at higher levels to catch the "Big One." You want 5 water rights to keep the river levels high and have raised $20K from fishing derbies to buy them.
Rancher 3 – You are living the dream life of a real cowboy and bought a ranch in the later 1990s. You have 6 blue poker chips.	Monarch Ski Area – To keep up with the big ski areas, you need to start making snow. 5 Water rights ought to be enough to get the snow-making equipment started. You have saved $75K to buy the water rights.
Westside Water Collective – To make sure the valley communities had water, a group of citizens with foresight got together in the mid-1950s and bought water rights. You have 6 blue poker chips	Golfers United – Your organization envisions golf courses lining every river to make Colorado a high-altitude golfing haven. You need 5 water rights to get started and have received $100K from rich golfing buddies to buy the rights.
Unclaimed Water Rights – You have 10 blue poker chips for water in Colorado that no one has claimed yet.	Friends of SNIFF - The Stubby-Finned Floater Fish needs your help to prevent extinction! 5 water rights ought to keep river levels high enough to keep the fish from going belly-up. Your fundraising efforts have resulted in $20K to spend for water rights.

Water Rights Holders (they want to sell):
Water rights sell between $5,000-$40,000 per one-acre foot. A poker chip represents one-acre foot of water. The white-colored poker chips are the oldest and have senior rights. Students should sell these closer to the upper price range. The blue poker chips represent junior water rights and are typically sold on the lower end of the price range. Their goal is to make as much money as possible.

Distribute Poker Chips (50 white and 50 blue) into envelopes with the player cards, as follows: Water Rights holders:

1. Miner 1 (3 white chips)
2. Miner 2 (3 white chips)
3. Miner 3 (3 blue chips)
4. Homesteader 1 (2 white chips)
5. Homesteader 2 (2 white chips)
6. Farmer 1 (10 white chips)
7. Farmer 2 (10 white chips)
8. Farmer 3 (10 blue chips)
9. Farmer 4 (10 blue chips)
10. Farmer 5 (5 blue chips)
11. Rancher 1 (10 white chips)
12. Rancher 2 (10 white chips)
13. Rancher 3 (6 blue chips)
14. West-side water collective (6 blue chips)
15. Unclaimed water rights (10 blue chips)

Water Rights Purchasers (they want to buy):
Students should try to buy poker chips, preferably white ones with senior rights, for the best price they can negotiate. Students can collaborate with others, make deals, and even turn around and sell rights they just purchased to gain a better deal. Their goal is to purchase the maximum water rights at the least cost.

Water Rights purchasers:

1. City of Peopleville (need 10 chips/ $100K)
2. City of Salida (need 4 chips/ $30K)
3. City of Pueblo (need 6 chips /$100K)
4. City of Colorado Springs (need 15 chips/ $200K)
5. Electric City Power Plant (need 10 chips/ $150K)
6. Save the Colorado (need 3 chips/ $50K)
7. Computers R Us (need 4 chips/ $100K)
8. Farmer Newbie (need 10 chips/ $50K)
9. Aspen Millionaire (need 3 chips/ $200K)
10. Bottled water company (need 10 chips/ $300K)
11. RIFT -rafters and kayakers (need 5 chips/ $20K)
12. Fishermen Friends (need 5 chips/$20K)
13. Monarch ski area (need 5 chips/$75K)
14. Golfers United (need 5 chips/ $100K)
15. Friends of SNIFF (need 5 chips/ $20K)

Who won?

After the trading time is up, review each player's goal by having them read aloud their task, and tell what they accomplished. Optional - distribute jelly beans in quantities that reflect how well they met their goals.

Sample Script for Game Instructions:

1. Each of you will be a player in our Water Rights Game. Some of you will be water rights holders, such a farmer or miner. Some of you will be water rights purchasers who want to obtain water rights. The object of the game is to either sell or buy as many water rights as you can to be rewarded with the most jelly beans at the end.

2. Each of you will receive an envelope with either poker chips or play money and a player card describing who you are.

3. If you are a water rights holder, you will have poker chips in your envelope. Water rights holders include (say list below). Each poker chip represents 1 af of water. You can decide if you want to sell or trade your water rights. You may want to keep farming, and then not have any extra rights to sell, or perhaps you want to switch crops to something that needs less water and will have some extra rights to sell.

4. The poker chips have different colors - white and blue. The white –colored poker chips are the oldest and have senior rights. The blue poker chips are the junior water rights.

5. The rest of you will be water users and need to get water rights. You are the water rights purchasers such as cities, industry, farmers and special interest groups (give list). Your player card will tell you what amount of water rights you need to try to get, and you will have some play money to try to bargain for them.

6. You will have 5 minutes to buy, sell, and trade as many water rights as you possibly can. Water rights holders may want to consider the date of their "poker chip" in the price they ask for. And remember, once you sell your water right, you can't use that water anymore. Water rights purchasers may want to team up with each other to have more ability to convince the water rights holders to sell – a type of collective bargaining advantage.

7. Any questions? Let's get water (start game)!

8. Look at the amount of water rights you were able to obtain. Does it match what you needed? Did you have enough money? Were there enough water rights available to buy?

9. I'm going to divide up jelly beans based on how well you met your water rights goal.

Inquiry Questions

Can you really own the rights you have? That depends on whether you have proven that the water is for an acceptable beneficial use and is available to purchase without harm to other water rights holders. There are other stipulations as well: everyone who has player-cards for rafting, fishing, or for protecting fish or in-stream flows - you may not personally own water rights under the law.

Remember how water rights had to be water that was physically taken out of its natural setting? Rafting, fishing, and saving endangered fish are in-stream or in-channel water uses. Only the Colorado Water Conservation Board can own rights for habitat and piscatorial purposes. Recreational, in-channel diversions are water rights for in-channel, non-consumptive recreational purposes, and also are water rights that can only be approved by the Colorado Water Conservation Board, adjudicated in Water Court, and can only be held by a Local Government Entity. Local Government Entities include: county, municipality, city and county, water district, water and sanitation district, water conservation district, or water conservancy district.

Who were the municipalities? You bought water rights for projected population growth. You must provide data to the Water Court to show how you calculated your population growth, and you generally can't buy water rights beyond a 50-year projection.

Is the water use really beneficial? Let's look at the Aspen Millionaire (have the student with the Aspen millionaire player card read their card). Although (s)he had plenty of money to buy the water rights to maintain a pretty stream, the Water Court will deem that this is not a beneficial use. What about the other water rights purchasers such as the Rocky Mountain Bottled Water Co. or Golfers United? This is water that will be beneficially used, even though some people may think the use is unnecessary. If the Water Court approves it, then it is legal.

Some of you may have noticed that you had less money to purchase your water rights than others. For instance, the Golfers had lots of money compared to the smaller town of Salida and could buy the water rights away from the town. Doesn't seem fair, right? Which water use is more beneficial in your opinion? Under the law, both are beneficial uses, so it comes down to who can purchase the water rights.

Who gets the water in a drought? The water right holder with the most senior date gets priority. Let's say that Farmer 1 and Farmer 2 have the most senior rights and Peopleville only has junior water rights. Peopleville is located upstream of the farmers. The year is so dry that if the farmers use all the water they own, it would dry up the river. Can they take all the water and leave the town to thirst? By law, yes. Peopleville would have to let the water flow past them to the farmers. Now in reality, the farmers would probably make agreements with Peopleville to share the water, but legally they could take it all.

Miner 2 has abandoned his right…. now what? If a water rights owner stops using their water for longer than 10 years, the State can go through a process to declare that water right abandoned. The water right can then be claimed by someone else if the water is put to a beneficial use. A new priority date would be assigned to the water if it was put to a new beneficial use after abandonment.

Source: Colorado Springs Utilities

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Teacher info and answer key

Downstream Users Game – We All Share the Water*

Grade level: 2nd – 8th
Standard/GLE Code: SS.2.3.1, SS.4.4.1, SS.5.2.2, SS.6.2.2, SS.HS.2.2
Time commitment: 20 minutes
Materials Needed:

- Solid colored plastic cups – enough for 1/student (9 – 12 oz. work best)
- Water (about 1 cup)
- Some dirt

Educational Messages:

- Students pass water "downstream" from one cup to another to understand that we all use the same water and that we need to use it wisely so there will be enough for others who also depend on this resource.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Prep: Label the cups as "Colorado Springs Resident," "Pueblo Resident," "Farmer," "Rancher" and "Kansas Resident." You can also select other types of downstream water users. You will need two sets of cups with the same amount and type of label. For instance, for a class of 28 students, there will be 14 cups per set – with each set having 3 cups labeled Colorado Springs Residents, 3 labeled Pueblo Resident, 3 labeled Farmer, 3 labeled Rancher, and 2 labeled Kansas Resident.

Research/Background Information:
Colorado is known as a headwaters state because the headwaters, or starting point, of several rivers begin in the Rocky Mountains. **In an average year, Colorado generates about 16 million-acre feet of renewable water** (source: Colorado Foundation for Water Education).

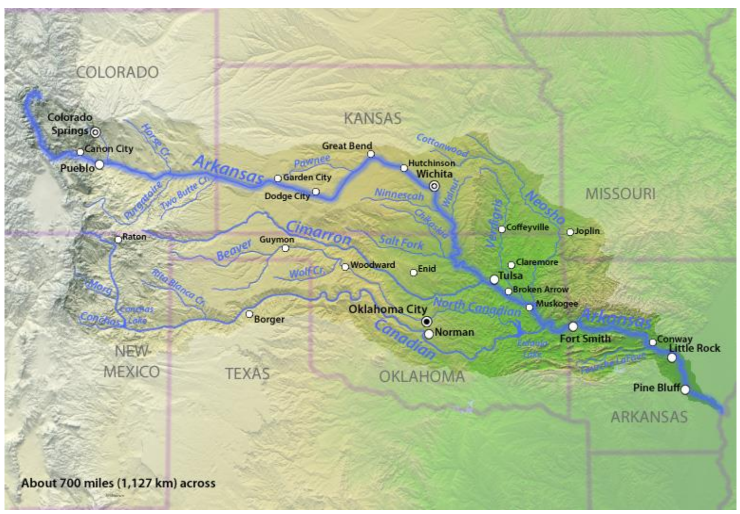
One-acre foot (af) of water = 325,851 gallons of water which is the amount of water that will cover 1 acre of land (about the size of a football field) at a depth of 1 foot.

Colorado has a semi-arid climate and for its growing population, water is limited. Citizens of Colorado do not have exclusive rights to water that originates in Colorado as that water also flows through many other states (19 states rely on water that comes from Colorado). With long-standing water agreements between states (Interstate Stream Compacts), Colorado only keeps about 1/3 of its water (source: Colorado Foundation for Water Education, Citizens Guide to Colorado Water Law).

The water collected, cleaned, and delivered to customers by Colorado Springs Utilities is primarily “surface” water that is collected from snow melt and runoff in the mountains. An average of about 60%-70% of the water used in town is actually imported from the western side of the Continental Divide 100 miles away in the Rocky Mountains. *Note: the reason transmountain water diversions are used is because population centers are not located in the areas of the state where water is most plentiful. Most of Colorado’s precipitation falls on the western slope of the Continental Divide while the majority of the population lives on the more arid eastern plains of the state.*

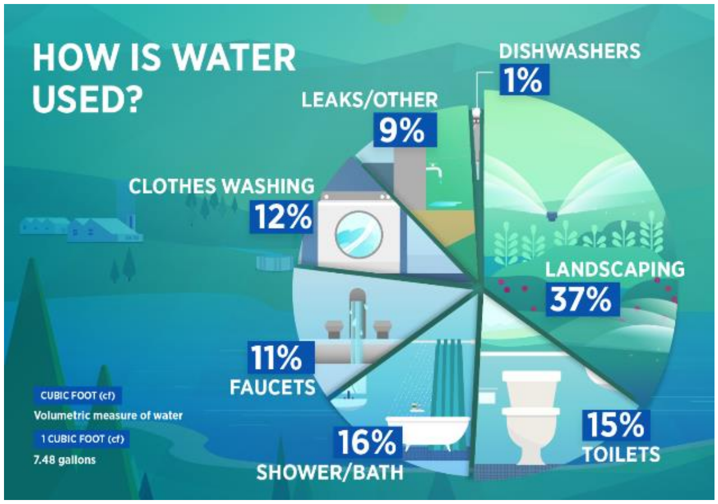
The remaining amount (about 30%-40%) comes from the Arkansas River or is collected locally off Pikes Peak closer to town. Colorado Springs is in the Fountain Creek watershed, which is a tributary to the Arkansas River.

After the water is used here in town, what is left (i.e. the Return Flows) will eventually flow down Fountain Creek and back to the Arkansas River. The Arkansas River flows from Colorado into Kansas, Oklahoma and Arkansas. Once in Arkansas, the river joins the Mississippi River, which flows south through Louisiana and reaches the Atlantic Ocean via the Gulf of Mexico.



Most of the water in town is considered “first use” water, meaning we are at the top of the watershed, and use the water before other users such as farmers, communities, or industries, use it. Those downstream from Colorado Springs also depend on this same water.

A typical Colorado Springs resident uses 78 gallons of water per day, as shown below:



95% of the water used **inside** a home for such activities as showering, cooking, cleaning and toilets, will return to Colorado Springs Utilities to be treated and cleaned at one of our Water Resource Recovery Facilities. Ten percent of the treated water will be reused in town for non-drinking purposes, primarily for irrigation of City parks and golf courses, or to generate electricity at the Drake Power Plant. The remaining 90% of the treated water will be released into Fountain Creek.

The water used **outside** the home for landscaping (37%) will not return to Colorado Springs Utilities' Water Resource Recovery Facility to be cleaned and discharged for reuse downstream. This water will either be used by plants or evaporate, some will soak into the ground and eventually replenish the stream, and some will runoff directly back to the creek. A total of about 10%-15% of the water used for irrigation will eventually get back to the stream system.

Overall, about 60% of the water you use will make its way back to the natural stream system. This is known as Return Flow. It is these Return Flows that make up the supply of downstream users, as part of an overall interconnected river system.

Instructions for the Downstream Users Game:

- Divide the students into two groups and have them line up.
- Each student is given a plastic cup labeled as Colorado Springs Resident, Pueblo Resident, Rancher, Farmer or Kansas Resident, in that order.
- Pour about 4 oz. of water into the first Colorado Springs Resident cup on each team. Instruct the students that they must keep some water in their cup to represent the water they use and pour the remaining water into their neighbor's cup. They are not allowed to pour back any water.
- Inform the adults with the group that they should let the kids do the activity without coaching. Often the first time the game is played the kids at the end of the line won't get any water, which gives the tour facilitator the opportunity to talk about using only as much water as we need. If the adults interfere too much, the opportunity to learn this key message is reduced.
- Repeat until the end of the "line" is reached, which is the last farmer downstream. Chances are that the last folks didn't get any water.
- Have students look into each other's cups and discuss how their water habits/use affect everyone downstream. Discuss what happens if the ranchers and farmers don't have enough water to produce food.
- Repeat the game again under drought conditions by only giving the starting players half the water (2 oz.). Discuss ways to conserve water and share in a drought so everyone gets enough.
- This game can be conducted again by adding "pollution" – some dirt – at some point in the system to discuss the effect of stormwater runoff, pollution sources and water quality.

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Inquiry Questions

Who gets the water if there isn't enough? Water in Colorado is treated as a property right that can be bought, sold and traded. The water right holder with the most senior date (the oldest water right) gets priority. Let's say that Farmer 1 has the most senior rights and City 1 only has junior water rights. The year is so dry that if Farmer 1 uses all the water they have a right to; it would dry up the river. Can they take all the water and leave the town to thirst? By law; yes. The farmers could make agreements with the city to exchange, share or lease the water, but legally they could take it all. So this is why cities build large reservoirs to hold water for use in dry years. Now picture a reverse scenario: City 1 has the senior rights and could dry up the Farmer's field. That is not a good solution because the people in the City depend on the Farmer for food. Again, stakeholders collaborate wherever possible to make sure everyone's basic needs are met, particularly in an emergency.

Colorado Springs Utilities must ensure that enough of the water we use is reclaimed and sent downstream so the water rights holders downstream receive their share, and everyone can use the water. If we recycle and reuse too much water, we can make other users downstream run short. If we don't do a good job of recapturing and reusing enough, we can make our own supply short.

What is the best way to conserve water? As a typical residential water user, take a look at the Water Use chart above. Most of the water is used for landscaping, which is water that does not go to downstream users. The best way for a resident to conserve water is to use water more efficiently or convert their yard to water wise landscaping, also known as Xeriscape. Water wise landscapes use less water by incorporating plants that can live with less water, and includes interesting features such as rocks, pathways and groundcovers that don't need water. What uses the most water inside the home? Showering and toilets use the most water with 16% and 15% respectively. To save water in the shower, limit your time to five minutes and install efficient watersense shower heads. Check your toilets for leaks every year and fix them. Consider upgrading to a water efficient toilet (older toilets use between 3 – 5 gallons per flush; newer ultra-efficient toilets use .8 gallons). Flush the toilet only when necessary.

Is downstream water quality bad? The quality of the water in Colorado Springs is very good, especially because we are some of the first users of the water so there hasn't been much chance for pollution to be introduced. Pollution can be anything that reduces water quality such as sediment from stormwater runoff, trash, some minerals, chemicals, bacteria, etc. All communities clean their water at a water treatment plant so it's safe to drink, but if the quality of water coming into the treatment plant is poor, then it is much harder and more expensive to clean. All of us need to do our part to keep the quality of the water as clean as possible. The best way to protect water quality is not to flush chemicals or medicines down the drain, limit chemical use or spills outdoors, such as fertilizer, pesticides, oil, antifreeze, salt, etc., pick up trash, and clean up dog poop.

Conclusion:

We are part of a very large interconnected and interdependent water system and many others are dependent on us being responsible stewards of the water. Because we are at the top of the watershed, many people downstream depend on the water we use. All of us are responsible to protect this precious resource by using it wisely.

Source: Colorado Springs Utilities

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Teacher info and answer key

Pass the Jug

Grade level: 4^{th} – 8^{th}
Standard/GLE Code: SS.2.3.1, SS.4.4.1, SS.5.2.2, SS.6.2.2, SS.HS.2.2
Time commitment: 40 minutes
Materials Needed:

- 3-5 oz. cups (initially one per student)
- Water jug (filled)
- Funnel
- Water user cards (copy and cut)
- Food coloring
- Salt or sugar
- Ice cubes

Educational Messages:

- Students will understand historical and current aspects of water law and gain an understanding of how water rights are allocated in Colorado.

Background: In the mid-nineteenth century, gold and silver were found in the Sierra Nevada and the Rocky Mountain ranges. Miners had an urgent need for water to work their claims. Unfortunately, there wasn't much water to be found or perhaps it was located far from their claim, or the stream didn't run year-round. To promote peace and certainty, the miners developed an approach to water rights that was closely related to mining rights. The first to stake and work a claim owned the mine. The same held true for water rights—development (staking) was followed by use (working). This type of water law became known as the Prior Appropriation Doctrine. As the West was settled, these same principles were applied to agriculture, municipalities and industries.

Water rights are used to allocate or distribute water in an organized and systematic manner. A water right in Colorado is considered a vested right, similar to property rights. Therefore, rights can be bought and sold. It is important to note that it is the right to use the water, not a right to own the water. There are several types of water right doctrines in the United States. Colorado and many of the western states have adopted the Prior Appropriation Doctrine of water law. This law basically says, "first come, first served" or "first in time is first in right." In other words, whoever uses the water first has the prior or first right to the supply of available water. If all the water in a stream is allocated, no new users will be allowed. Water rights are given an appropriation date (the older the date, the more senior and usually more valuable the right). Each right specifies the amount or quantity of water that can be used, a description of uses (irrigation, municipal uses etc.) and location of those uses. If a holder of a water right does not use or exercise that right within a certain period of time (multiple years), she or he risks loss or abandonment of those rights.

In recent years, many changes have occurred that have added new dimensions to water rights and water allocation programs. Irrigated agriculture is a large consumer of water and often holds the more senior rights. Individuals and corporations invest millions of dollars in irrigation systems to produce food for our nation. Cities also need water to meet the needs of residents, businesses and industries. Water for recreation and fish and wildlife is receiving growing attention. Many communities depend on water resources for energy production. In response to these demands, policy makers are being pressured to reshape traditional water allocation patterns.

Procedure:
Arrange the students' seats in rows or around a table. Pass out the cups. Starting at one end, have each student fill their cup and pass it on to the next student. There should not be enough water to fill all the cups. Ask students to express how they feel (those who received water and those who did not). Discuss what might happen during a drought, flood or normal precipitation year. Have the students come up with a plan to redistribute the water and play the game again, observe the results. Empty the cups back into the jug.

Now the students will simulate how water is allocated in Colorado. Read the description of the Prior Appropriation Doctrine in the Background section of this activity. Randomly pass out the cards. Explain that these cards represent a water right. The rights are numbered in the upper left-hand corner. The student with number 1 was the first to move into the area and acquire a right to use the water, the student holding the number 2 card the second, etc. Pass out additional cups if needed.

Each student should read aloud their card and pour, in order of seniority (1st, 2nd, 3rd, etc.), their rights (water) into their cups. When water runs out have the students express their opinion about this system. How would they alter it? Are there ways to redistribute the water without harming another's water rights? Increased storage with delayed releases, temporary lease agreements between farmers and municipal users and conjunctive groundwater and surface water use are examples of ways to redistribute the water without negative impacts to individual water rights.

Extension:
To simulate fluctuations in stream flow from year to year, change the amount of water in the jug. To demonstrate how pollution affects water users, add a drop of food coloring to those activities that may have an impact on quality. Use sugar or salt to represent invisible pollutants. Have the students list how water quantity impacts water quality. Add ice cubes to extend the amount of time water is available for consumption. How does this relate to snow pack? What happens to stream flow when the snow pack melts? Allow the students to buy or sell part or all of their water rights. What are the social and economic effects on the individuals or on the town?

The book "Water Rights in a Nutshell" by David Getches further explains the Prior Appropriation Doctrine as well as the other types of water laws in the United States. After reviewing the different types of Doctrines, have the students discuss the relationship between climate and water law. Would the Riparian Doctrine used in the Eastern United States work in Colorado?

Source: Project WET; 1993 The Watercourse and Western Regional Environmental Educational Education Council (WREEC)

Number 1	Number 2
I am a descendent of the first homesteader that moved into the area. I own a dairy goat farm and grow alfalfa. Use 2 cups	My ancestor was on the way to California during the great gold rush but got distracted by the flowers. While picking daisies, she found a huge deposit of copper ore and started a copper mining company. My family runs this lucrative operation. Use 1 1/2 cups
Number 3 My great, great-grandmother came out to teach the children of the copper miners. I still live on the property she bought and need water for personal needs. Use ½ cup	**Number 4** I represent a small community of families who work in the mine. We use water for domestic and irrigation purposes. Our water needs may grow as the town grows. Use 3 cups

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Number 5 **My grandparents left their farm in Iowa to start a farm in Colorado. The crops I grow helps to meet the needs of our community. My grandfather is still living and resists using modern farming practices.** **Use 5 cups**	**Number 6** **To avoid the competition in the big city, my father moved his coat hanger factory to this growing community. The industry provides a means of income for community members.** **Use 2 cups**
Number 7 **I represent a hydroelectric company that is situated upstream of the town. The water the plant uses passes through the dam to generate electricity. (Show this by pouring water back into the jug.)** **Give 3 cups**	**Number 8** **I represent a town that grew as more people escaping the city moved to the countryside. Consequently, our town has become a city. We use water for domestic and irrigation purposes.** **Use 3 cups**

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Number 9 **I am a high tech farmer who has moved in to supply food to the growing community.** **Use 2 cups**	**Number 10** **I have decided to start an industry that I think meets a growing need: shoulder pad storage racks.** **Use 1 cup**
Number 11 **I am a fourth generation rancher. I use the water for irrigating pastures and watering stock.** **Use 1 cup**	**Number 12** **I own a ski resort. The money from tourists brings in a lot of revenue to our town. I need to store the water so I can make snow early in the season or in case of low snowpack.** **Use 3 cups**

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Number 13 **I am an organic gardener. I grow pesticide free produce for the community.** **Use 2 cups**	**Number 14** **I represent a local naturalist society. I use the water for fish and wildlife benefits.** **Use 1 cup**
Number 15 **I represent the local flood control agency. I manage a dam that contains flood waters. I do not have to have a water right to store flood waters. My dam protects people and property downstream. The reservoir is used by fishermen and boaters. (This is represented by pouring water back into the jug.)** **Give 2 cups**	**Number 16** **I am a representative of the State of Nebraska. Our interstate compact with Colorado states that you will give us a certain quantity of water at the state line.** **Use 2 cups**

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Number 17 **I represent a local resort owner. I need water in the reservoir to keep my paying customers happy. While I do not own any water rights, I have an interest in water management.** **Use 2 1/2 cups**	**Number 18** **I represent the country of Mexico. We are downstream of your country. In order to assure water for my country's use, we entered into an international compact. The United States must deliver a certain amount of water at the border to ensure smooth relations between our countries.** **Use 3 cups**

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WATER PROPERTIES, WATER CYCLE and ECOLOGY

(Orange Colored Section)

- Water Property Experiments
- Around the Water Cycle – A Reader's Theater
- Incredible Journey Water Cycle Dice Game*
- Water Cycle Inside a Balloon
- Water Cycle in a Bag
- Water Cycle Relay
- Cloud in a Bottle*
- Instant Snow*
- Plant Adaptations
- Plant Transpiration Activity
- How Water Loss Affects Biodiversity

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Teacher info and answer key

Water Property Experiments*

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.1.1, SC.4.1.5, SC.5.1.1, SC.MS.1.5
Time commitment: 40 minutes
Materials Needed:

- See individual experiment descriptions below

Educational Messages:

- Through various experiments, students learn physical water properties including:
    - Cohesion and adhesion
    - Surface tension
    - Capillary action
    - Water molecules

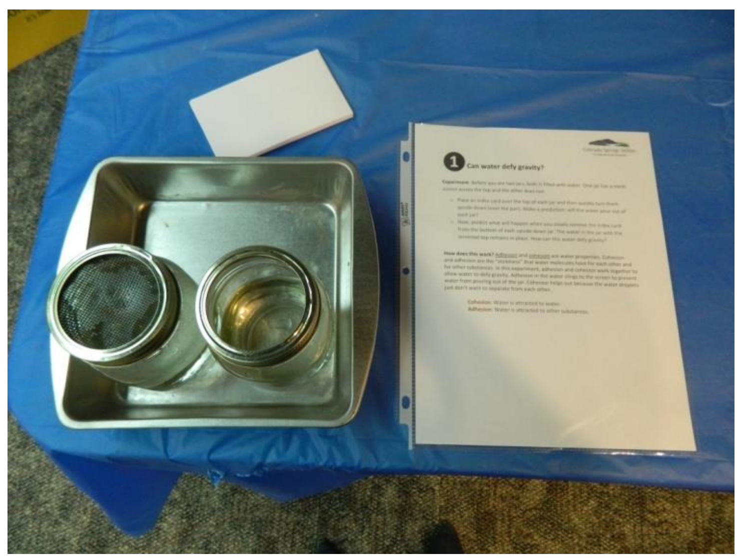
Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Experiment #1 – If you turn over a cup of water, will it spill?

Follow these steps to find out.

You will need:

- Two, ½ full jars of water, one with a screen over the lid;
- blank index cards;
- a pan to catch the water.



Step 1: Place an index card over the top of each jar and then quickly turn them upside down (over the pan). Make a prediction: will the water pour out of each jar?

Step 2: Now, predict what will happen when you slowly remove the index card from the bottom of each upside down jar.

The water in the jar with the screened top remains in place!

How does this work? <u>Cohesion</u> and <u>adhesion</u> are the "stickiness" that water molecules have for each other and for other substances. Adhesion allows water to cling to the screen to prevent water from pouring out of the jar. Cohesion helps out because the water droplets don't want to separate from each other.

Experiment #2 - How many drops of water fit on top of a penny?

Follow these steps to find out.

You will need:

- one pan or plate
- a few pennies to place in the bottom of the pan
- two pipettes
- a small glass of water

Step 1: Predict the number of drops of water you can place on top of the penny before that water overflows.

Step 2: Fill a pipette with water from the glass and try to place as many water drops on a penny as you can without the water spilling over.

We were able to fit between 20 and 30 drops on one penny. How about you?

Why does the water drop form a mound of water on top of the penny? In this experiment, cohesion allows the water droplets to cling to each other and defy gravity. There is stronger cohesion between the water molecules than the attraction of the water molecules to the air so it appears that water has a “skin” holding many drops on top of the penny.

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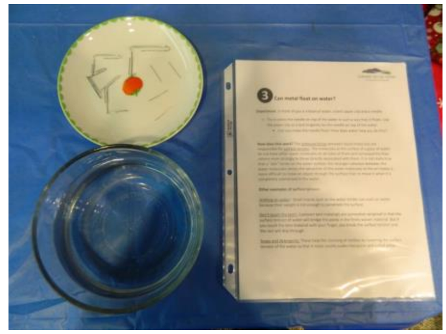
Experiment #3 – Can metal float on top of water?

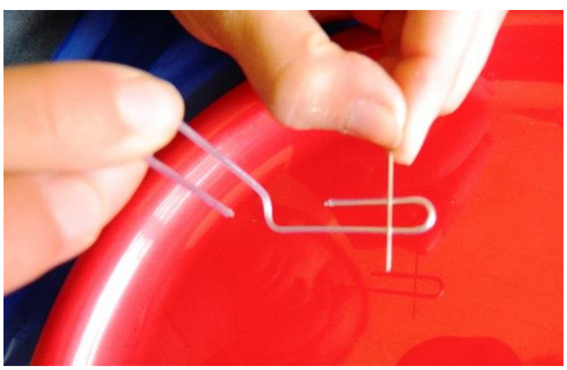
Follow these steps to find out.



You will need:

- Some push pins
- some paper clips bent to work as a tool
- a bowl of water.

Step 1: You have needles and paper clips on a plate. The paper clips are bent to use as a tool.



Step 2: Pick up one side of the paper clip and place a needle on the other.

Step 3: *Carefully bring the needle over the bowl and gently place the needle on top of the water so that it floats.*

NOTE: pins will not work as well once they are wet—dry them off each time.

Could you make the needle float?

How does this work? The cohesive forces between water molecules create surface tension. The molecules at the surface of a glass of water do not have other water molecules on all sides of them so they attach more strongly to those next to them. This creates surface tension at the surface of the water that is strong enough to hold up objects such as the pin.

Other examples of surface tension:

Walking on water**:** Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface tension.

Don't touch the tent! Common tent materials are somewhat rainproof in that the surface tension of water will bridge the pores in the finely woven material. But if you touch the tent material with your finger, you break the surface tension and the rain will drip through.

Soaps and detergents: These help the cleaning of clothes by lowering the surface tension of the water so that it more readily soaks into pores and soiled areas.

Experiment #4 – Can water flow uphill?

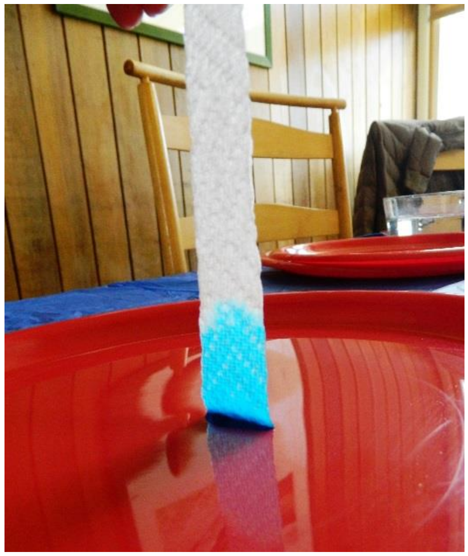
Follow these steps to find out:

What you need:

- Small strips of paper towel
- a cup
- 3 pipette droppers
- a plate to hold dyed blue water (use dye tablet or food coloring).

Step 1: Fill the dropper with blue-dyed water and place a small pool of that water on the plate.

Step 2: Take one piece of the paper towel and hold it upright in the blue pool of water.



Water flowed uphill!

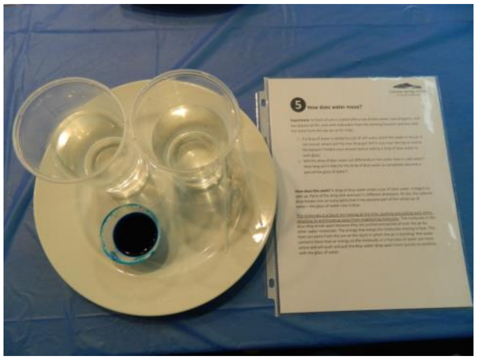
How does this work? Not only does water tend to stick together in a drop (cohesion), it sticks to glass, cloth, soil, and, luckily, to the fibers in a paper towel (adhesion). Dip a paper towel into a glass of water and the water will "climb" and keep going up the towel until the pull of gravity is too much for it to overcome. This is called capillary action.

Capillary action is around us every day:

When you spill your glass of water on the kitchen table you rush to get a paper towel to wipe it up. First, you can thank surface tension, which keeps the liquid in a nice puddle on the table, instead of a thin film of sugary goo that spreads out onto the floor. When you put the paper towel onto your mess the liquid adheres itself to the paper fibers and the liquid moves to the spaces between and inside of the fibers.

Plants and trees couldn't thrive without capillary attraction. Plants put down roots into the soil which are capable of carrying water from the soil up into the plant. Water, which contains dissolved nutrients, gets inside the roots and starts climbing up the plant tissue. As water molecule #1 starts climbing, it pulls along water molecule #2, which, of course, is dragging water molecule #3, and so on.

Experiment #5 – Is water always moving?



Follow these steps to find out:

What you need:

- A tall glass of water
- 2 pipette droppers
- a small container of blue water on a plate (use dye tablet)

Step 1: Fill a dropper with blue-dyed water and add a drop to the clear glass of water.

Step 2: Predict how each colored water drop will combine with the clear water. Does the drop of water stay near the top or sink to the bottom?

Are you surprised at what actually happens? How long does it take for the drop of water to completely become part of the glass of water?

How does this work? The molecules in a liquid are moving all the time, pushing and pulling each other, attaching to and breaking away from neighboring molecules. The molecules in the blue drop break apart because they are pushed and pulled all over the jar by other water molecules. The energy that keeps the molecules moving is heat. This heat can come from the sun or the room in which the jar is standing.

All particles have energy. Atoms are the smallest pieces of matter; they are made of particles (protons and electrons). When atoms are grouped together, these groups are called molecules. Water is a molecule made up of two hydrogen atoms and one oxygen atom (H_2O).

Source: Colorado Springs Utilities

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Teacher info and answer key

Around the Water Cycle – A Reader's Theater*

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.1, SC.4.3.1, SC,5.3.4, SC.MS.3.6
Time commitment: 15 minutes
Materials Needed:

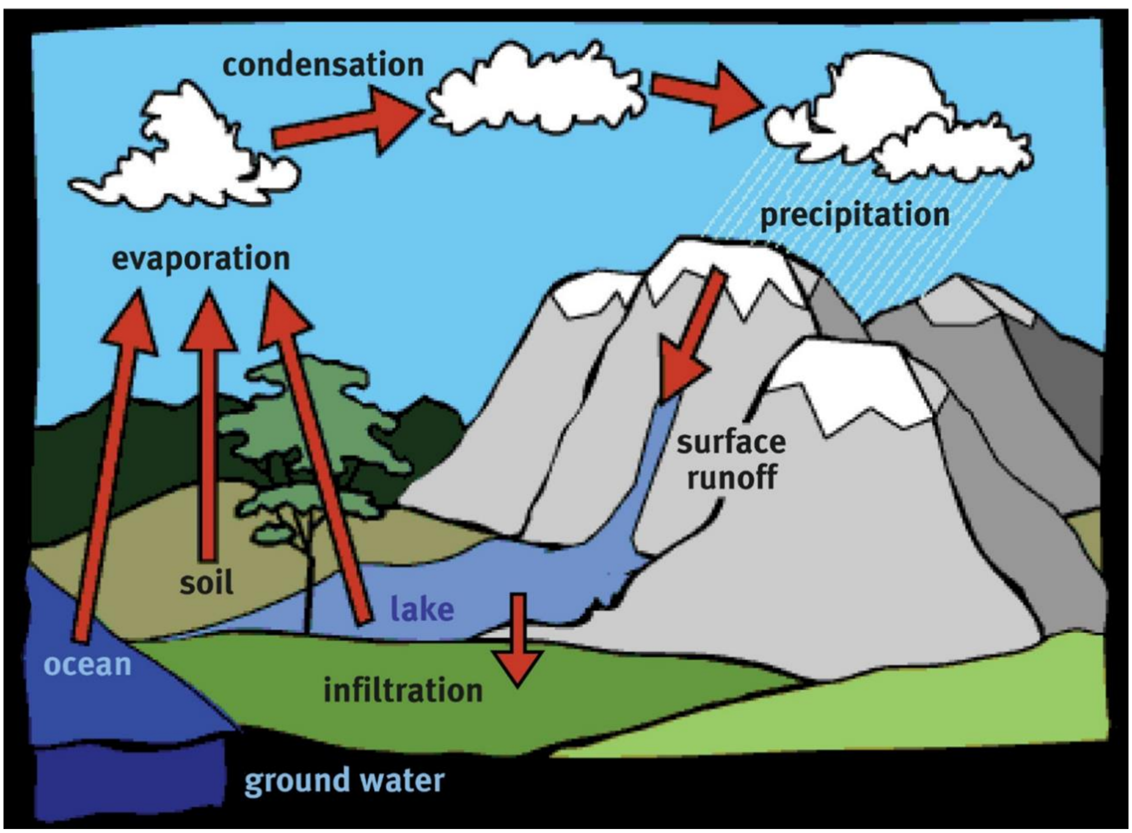
- 8 copies of the Reader's Theater scripts (optional – highlighted for each part). See next page for script.

Cast: Six Water Drops (1, 2, 3. 4, 5, 6), the Sun, and a Little Kid

Educational Messages:

- Students perform a reader's theater to reinforce concepts of evaporation, precipitation and condensation while using their reading and presentation skills.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org



Around the Water Cycle Reader's Theater Script:

Cast: Six Water Drops (1, 2, 3, 4, 5, 6), the Sun, and a Little Kid

Water Drop 1: Here we are, hanging around in this lake.

Water Drop 2: Yeah, this is the life!

Water Drop 3: Hey! Look behind that cloud! Guess who that is??

Drops 1, 2, 3: It's the sun! Yay! Evaporation!!! (lift arms)

Sun: Hey guys! I told you I would see you again soon! What have you been doing?

Water Drop 1: I've been in the ocean! I saw a lot of fish!

Water Drop 2: I've been hanging around on the sides of Dr. Pepper cans and tea glasses. Yummy!

Water Drop 3: Here are the others! Hi guys!!

Drops 4, 5, 6: Hi! How are you?

Water Drop 4: I haven't seen you guys since the dinosaurs were here!

Water Drop 5: I just got off a surfboard!

Water Drop 6: Really? I just came from a dog's bath. He shook me in the air!

Water Drop 4: It is really getting cold up here! Gather around everybody. We need to condense!

All Drops: BBRRRRRRR!!! I'm freezing! A-CHOOOO!

Water Drop 5: It's getting crowded. We're getting heavy!

Water Drop 6: Ah, my favorite part: Precipitation!

Water Drop 1: Yeah, and my favorite kind – snow!

Little Kid: Yeah! It snowed last night!! I'm going to build a snowman!

Water Drop 2: Tee Hee Hee!! That tickles!

Water Drop 3: I'm getting smushed here!

Water Drop 4: Hey, you guys are crushing me!

Little Kid: Wow! My snowman looks great! I'm going inside to eat lunch.

Sun: Well, that was a nice nap, but now I have to do my work. Guess I better thaw out those little guys.

All Drops: We're melting!! We're melting!! (all drops fall down)

Water Drop 4: Hey guys, we all ended up in a puddle together!

Water Drop 5: And look who's up in the sky!

Sun: Hi guys!

Water Drop 6: The Sun! Here we go again!!

All Drops: Evaporation! Condensation! Precipitation!

Source: Printed with permission of Sarah Wood and her class at Ralis Elementary School, Texas

Teacher info and answer key

Incredible Journey Water Cycle Dice Game*

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.1, SC.4.3.1, SC,5.3.4, SC.MS.3.6
Time commitment: 30 minutes
Materials Needed:

- Water cycle poster
- 9 - 2" x 2" styrofoam or wooden block cubes and cover with templates attached
- 9 station ids (clouds, lake, animal, soil, ground water, river, ocean, plant, glacier) attached.
- Chenille stems, 1 per student
- Plastic beads in yellow and nine other colors
- Student worksheet
- Pencils

Educational Messages:

- Students recognize solar energy as the main driver for the movement of water on Earth.
- Students simulate the movement of water within the water cycle.
- Students roll the cube to determine where their water drop will land and collect a colored bead from that station. At the end, Students will have a bracelet of colored beads representing the variety of pathways that water can follow.
- Students can write a story reflecting their unique journey.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Prep: Make station dice using the templates provided in this guide. There are two versions included, for either younger students or advanced students. Place the 9 station IDs with corresponding dice around the room. Set container of beads at each location. See "My Incredible Journey Story" student page for suggested bead and location pairings.

Background: The same amount of water exists on Earth now as it did when Earth was created. How can that be? Water is constantly cycling from salty ocean water into clouds, into fresh water as rain, which flows back to the oceans. This is called the water cycle (show the water cycle poster.) The water cycle has five parts: evaporation & transpiration, condensation, precipitation, infiltration and surface run-off. The water cycle works because of the energy from the sun. The sun heats the Earth and changes water into a gas called water vapor; this process is called Evaporation. Plants also release water vapor from their leaves, and this is called Transpiration. Another way that water can change from liquid into water vapor is by respiration from animals. The water vapor rises into the sky where it clings to dust particles. The colder air up high turns the gas back into liquid water droplets that group together to make clouds. This is called Condensation. Eventually the clouds gather more water than they can hold, and the water falls back to earth as rain or snow. This is called Precipitation. The precipitation either infiltrates (soaks) into the ground, or runs off the surface into streams, rivers, and lakes which eventually flow back to the ocean where the process starts over again.

Guiding questions: Ask students to list different places water can go as it moves through and around the earth. What drives the water cycle? What provides the energy to move water from the ocean to the atmosphere? Tell the students that they are surrounded by water all the time in the form of water vapor. Ask students to think of evidence to support this fact. (For example, what happens to their breath when they go outside on a cold winter day?)

Activity Steps:

1. Tell students they are going to be water molecules moving through the water cycle and that they will create a bracelet and write on their student page to keep track of their movements.
2. Point out the station locations around the room – these are places through which water can move (clouds, plants, animals, rivers, oceans, lakes, ground water, soil, and glaciers.)
3. Take a moment to have various students read out loud some example pathways from the cube faces.
4. Give each student a chenille stem and yellow bead that they twist onto the end. The yellow bead represents the sun.
5. Have students chose a station to begin and add a bead from that station to their bracelet. Students write this location under 1. On their student page.
6. Students line up behind the cube at their station and roll the cube. They will move to the location indicated on the label facing up. If they roll "stay," they take a bead and move to the back of the line to try again.
7. Students should keep track of their movements by taking one bead from the station and placing it on their bracelet and noting their journey in their student page. (Students should take one bead for each turn, including "stays.")
8. Continue game until time is up, usually 5 minutes or so.
9. Use the "My Incredible Journey" page for students to write a story about their journey.

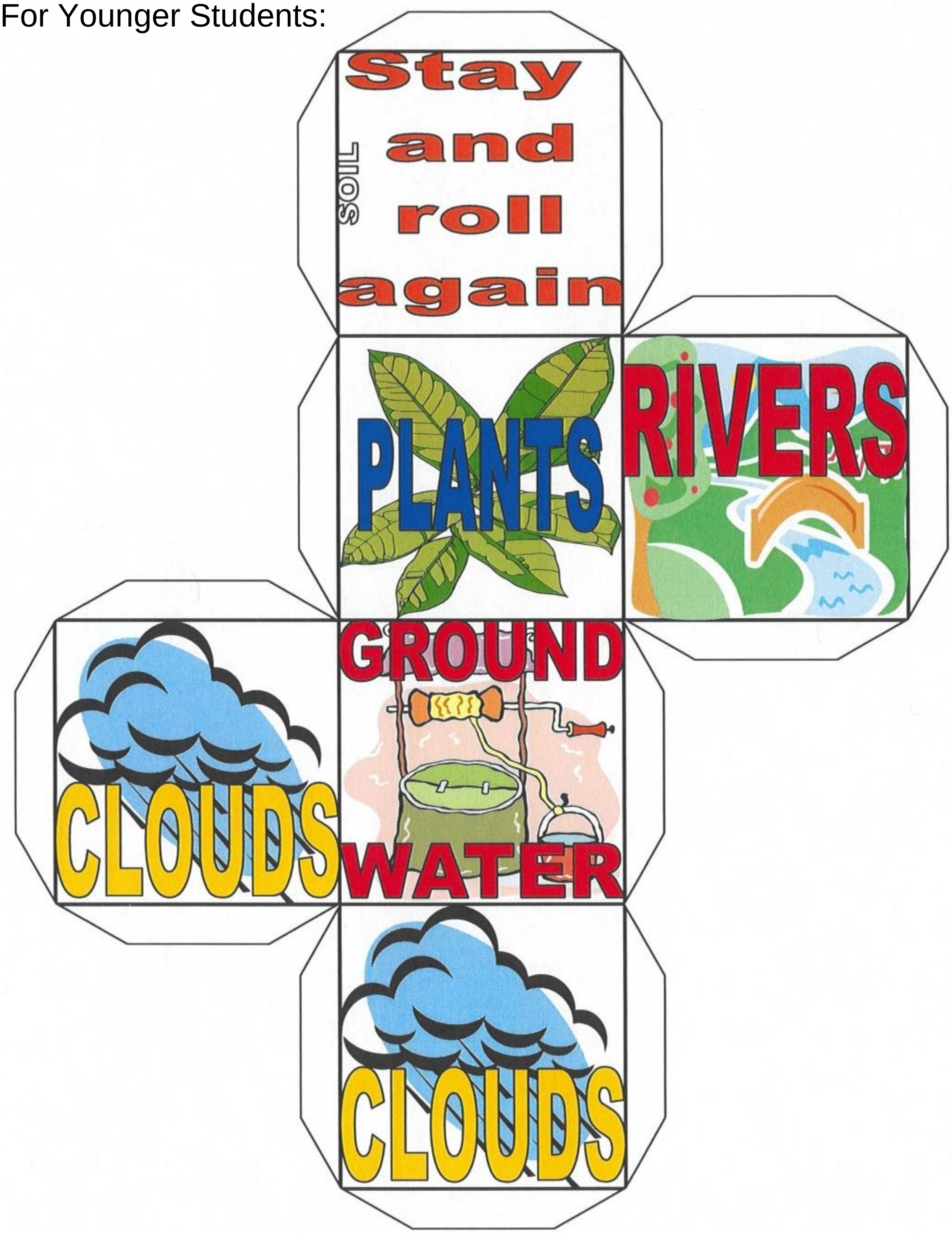
Discussion: The path a water molecule takes isn't in a perfect circle like shown on the water cycle poster but can vary tremendously. The time a water molecule spends in any given part of the water cycle varies too. How long would you guess that a water molecule spends in an ocean? Scientists have estimated 3,200 years! How about up in the atmosphere? Only 9 days. Deep underground? 10,000 years! **How much time does a water molecule spend in parts of the water cycle?**

Water Type	Average Time
Antarctica	20,000 years
Oceans	3,200 years
Glaciers	20 – 100 years
Snow	2 – 6 months
Soil moisture	1 – 2 months
Groundwater – Shallow	100 – 200 years
Groundwater – Deep	10,000 years
Lakes	50 – 100 years
Rivers	2 – 6 months
Atmosphere	9 days

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

Source: adapted by Colorado Springs Utilities from Project Wet, NOAA, and Sky Ranch School

For Younger Students:

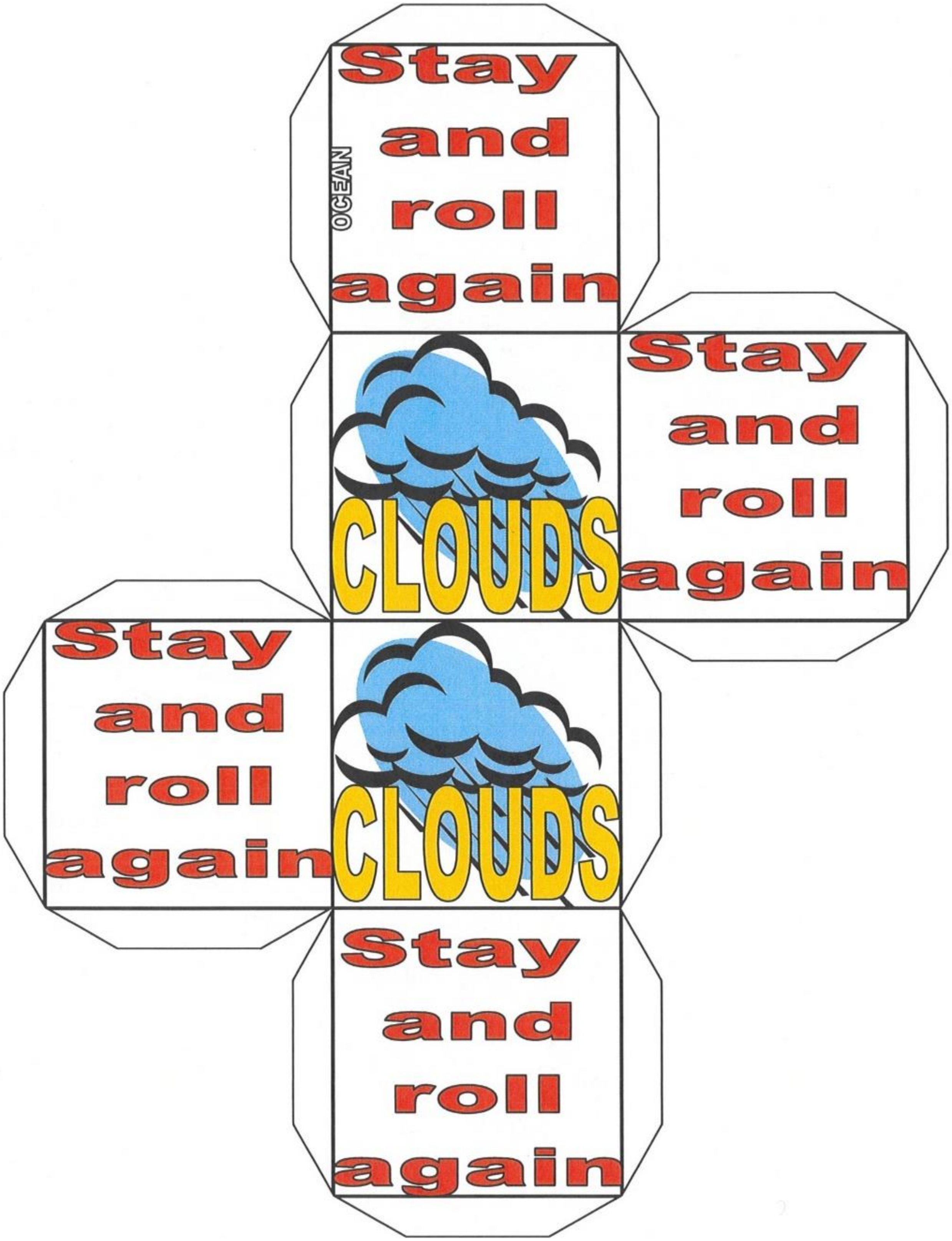


Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Soil Station.

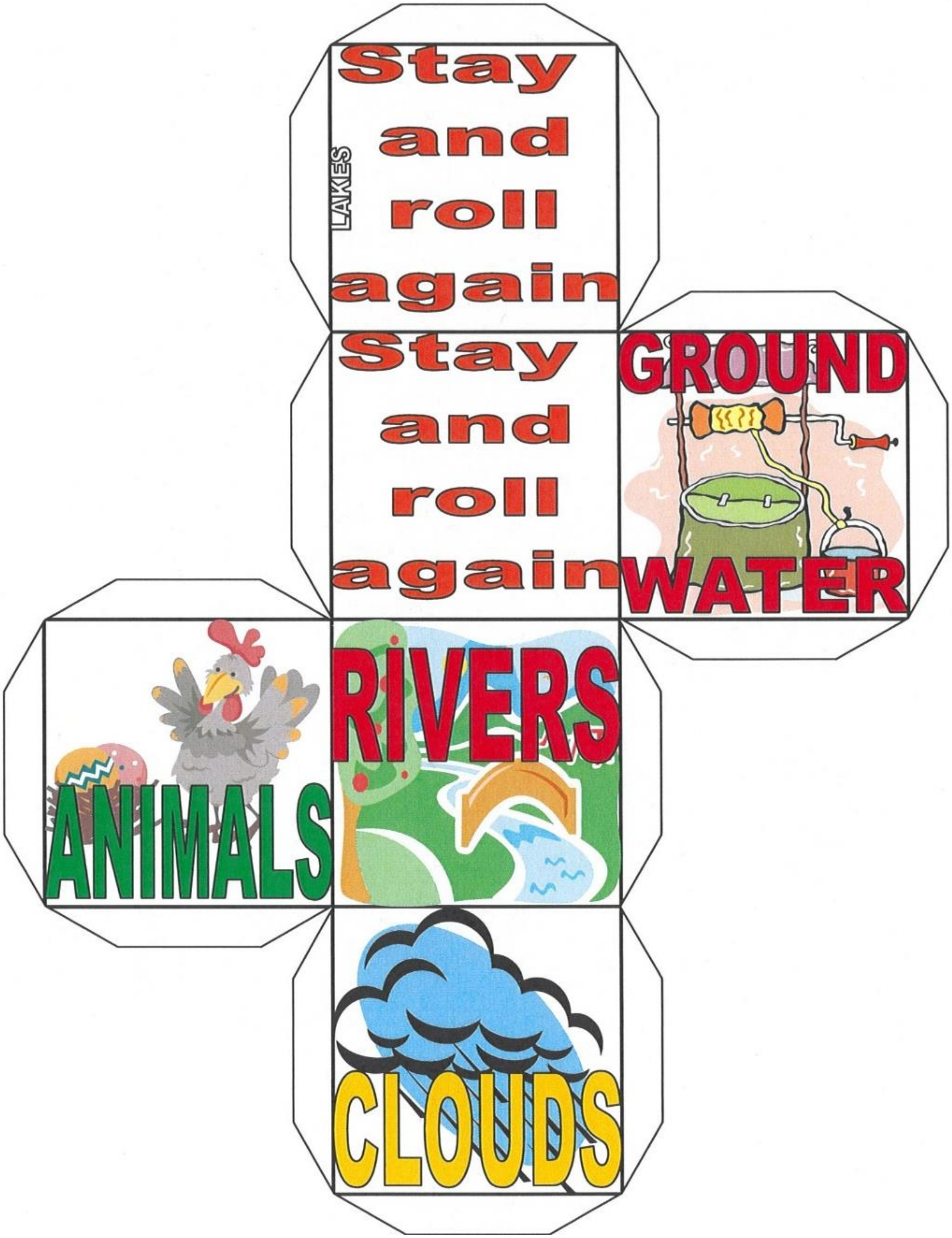
Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Plant Station.

Cut out pattern, laminate, and tape around a wooden block.
Place this die at the River Station.

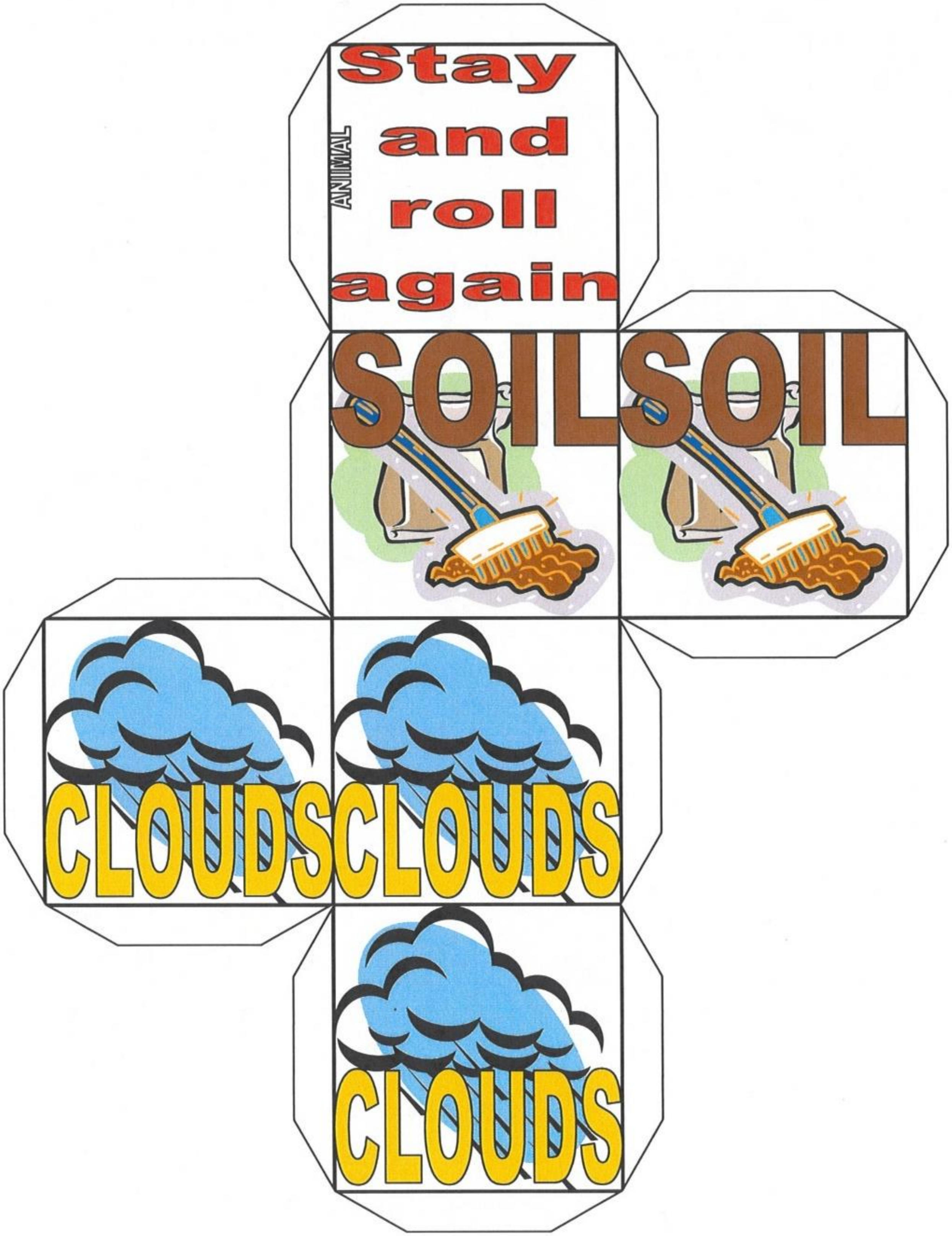
Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Cloud Station.



Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Ocean Station.

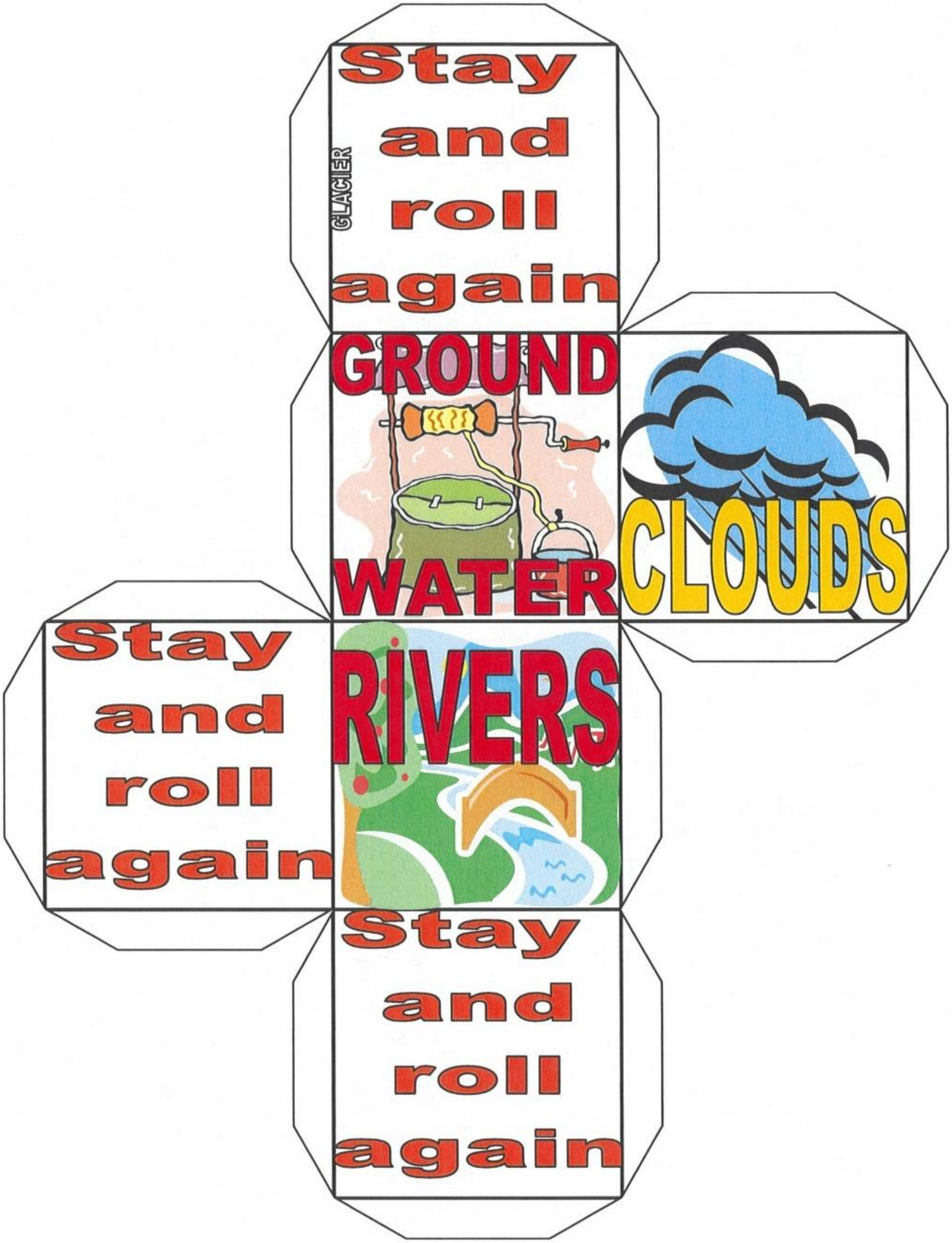


Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Lakes Station.

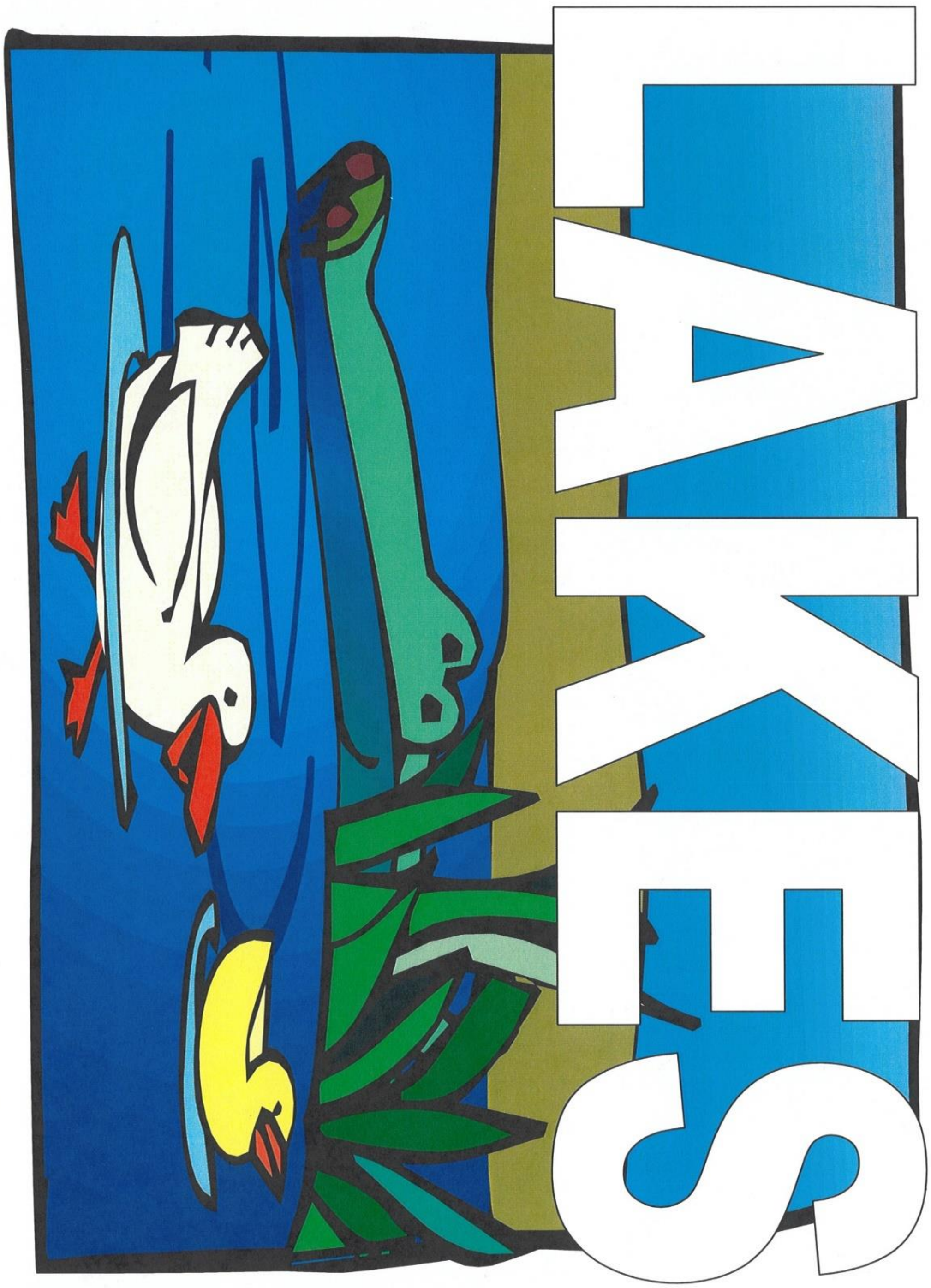


Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Animal Station.

Cut out pattern, laminate, and tape around a wooden block.
Place this die at the Ground Water Station.

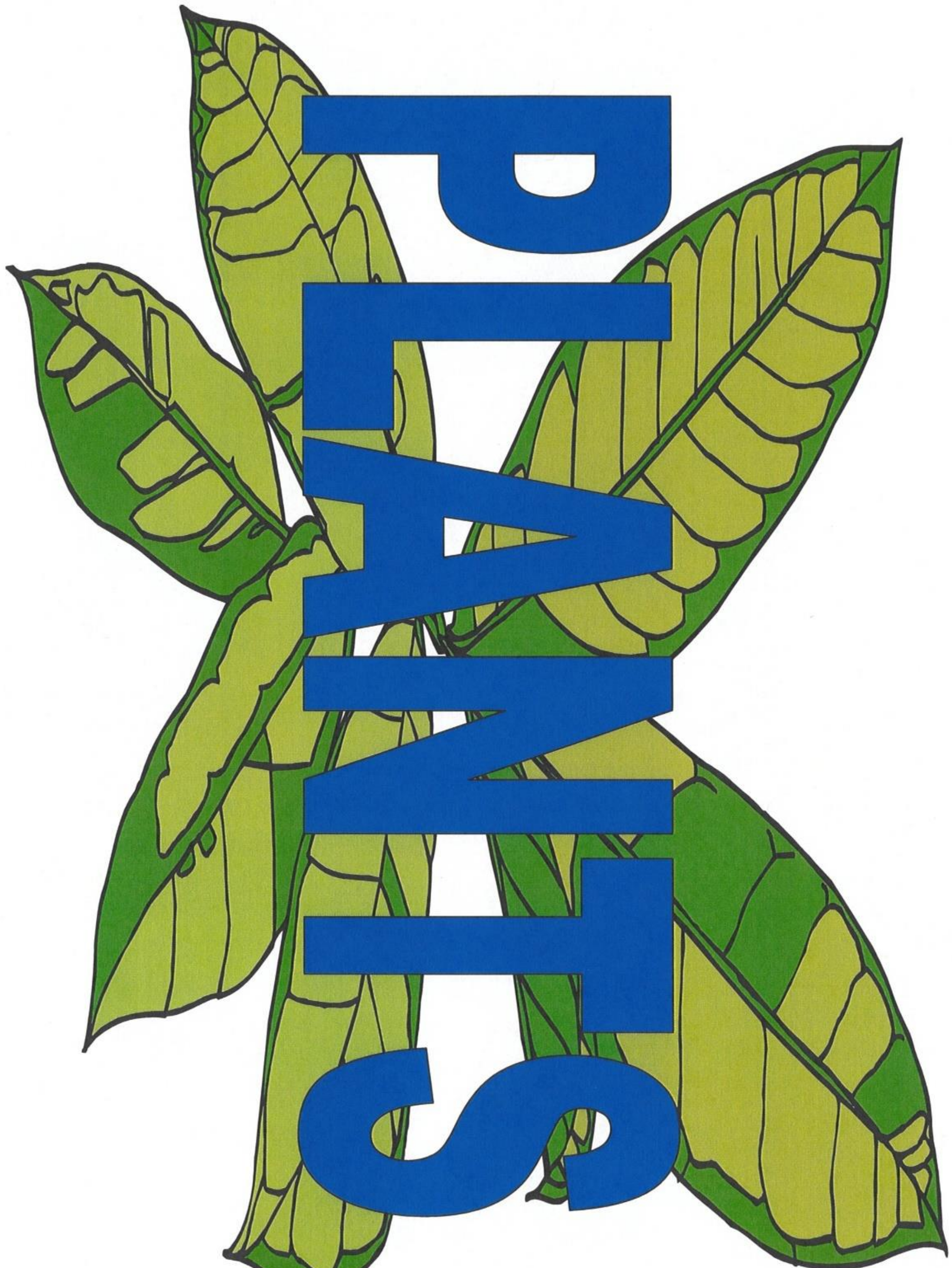


Cut out pattern, laminate, and tape around a wooden block
Place this die at the Glacier Station.


LAKES


OCEANS

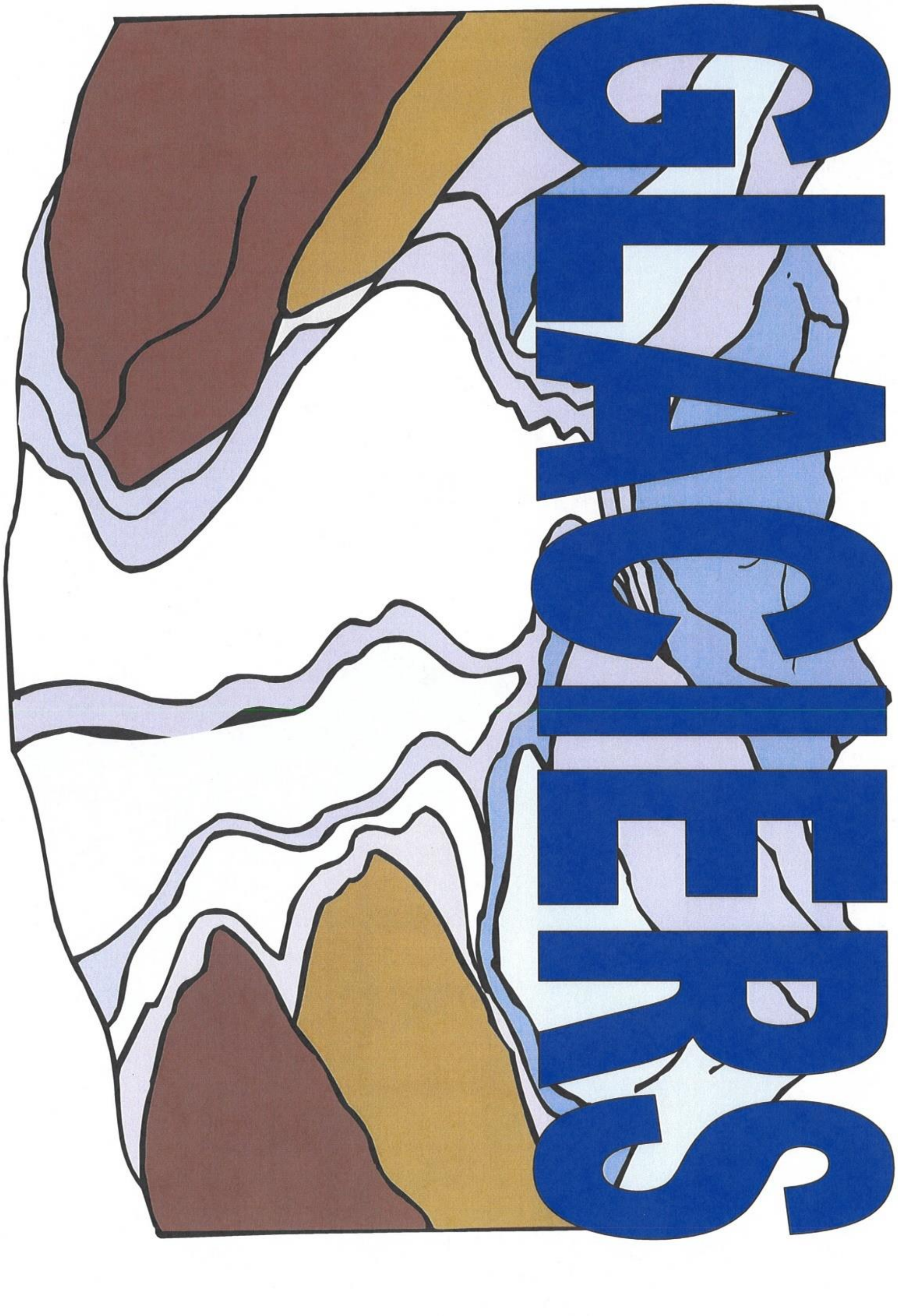

CLOUDS

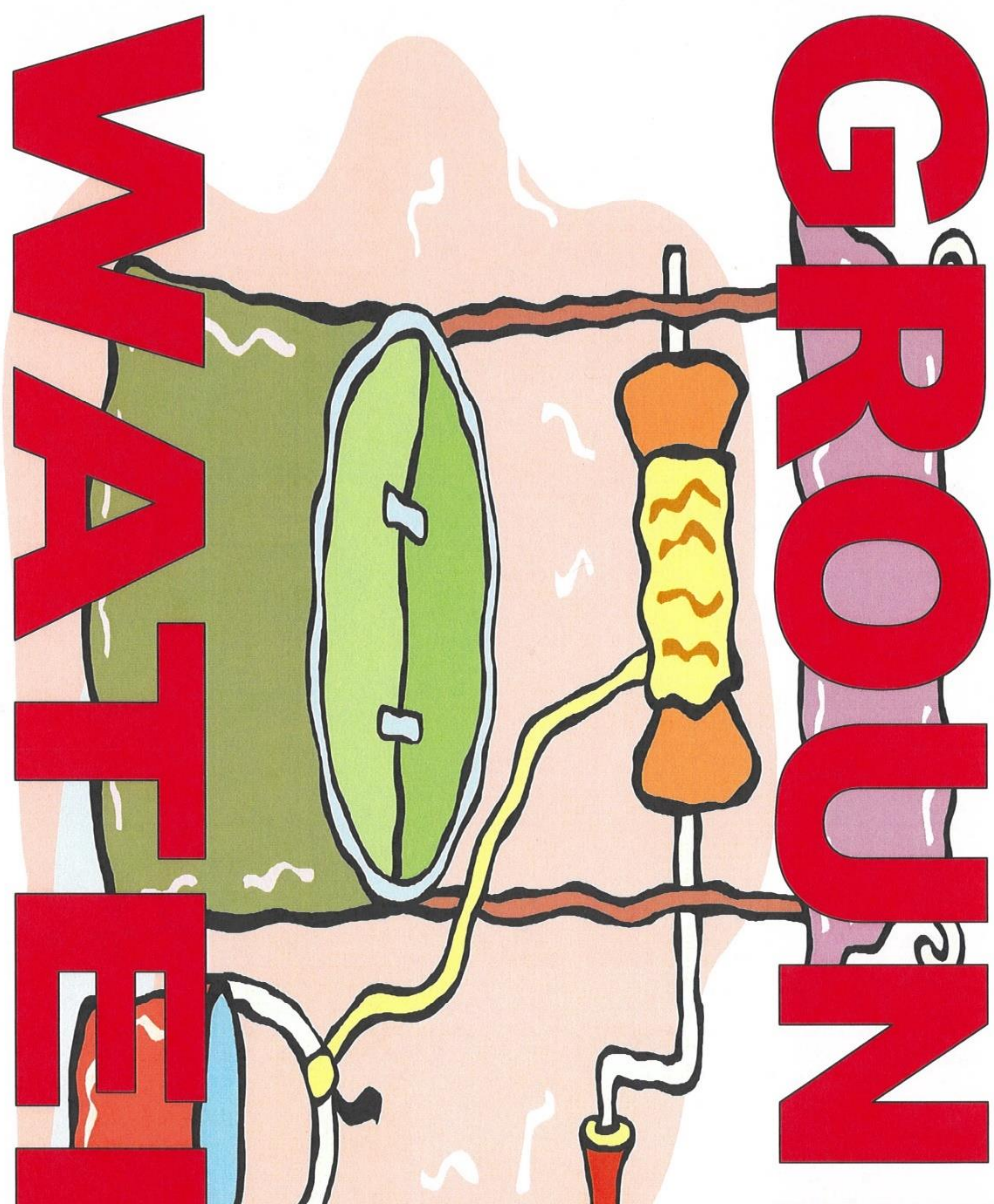

PLANTS


RIVERS

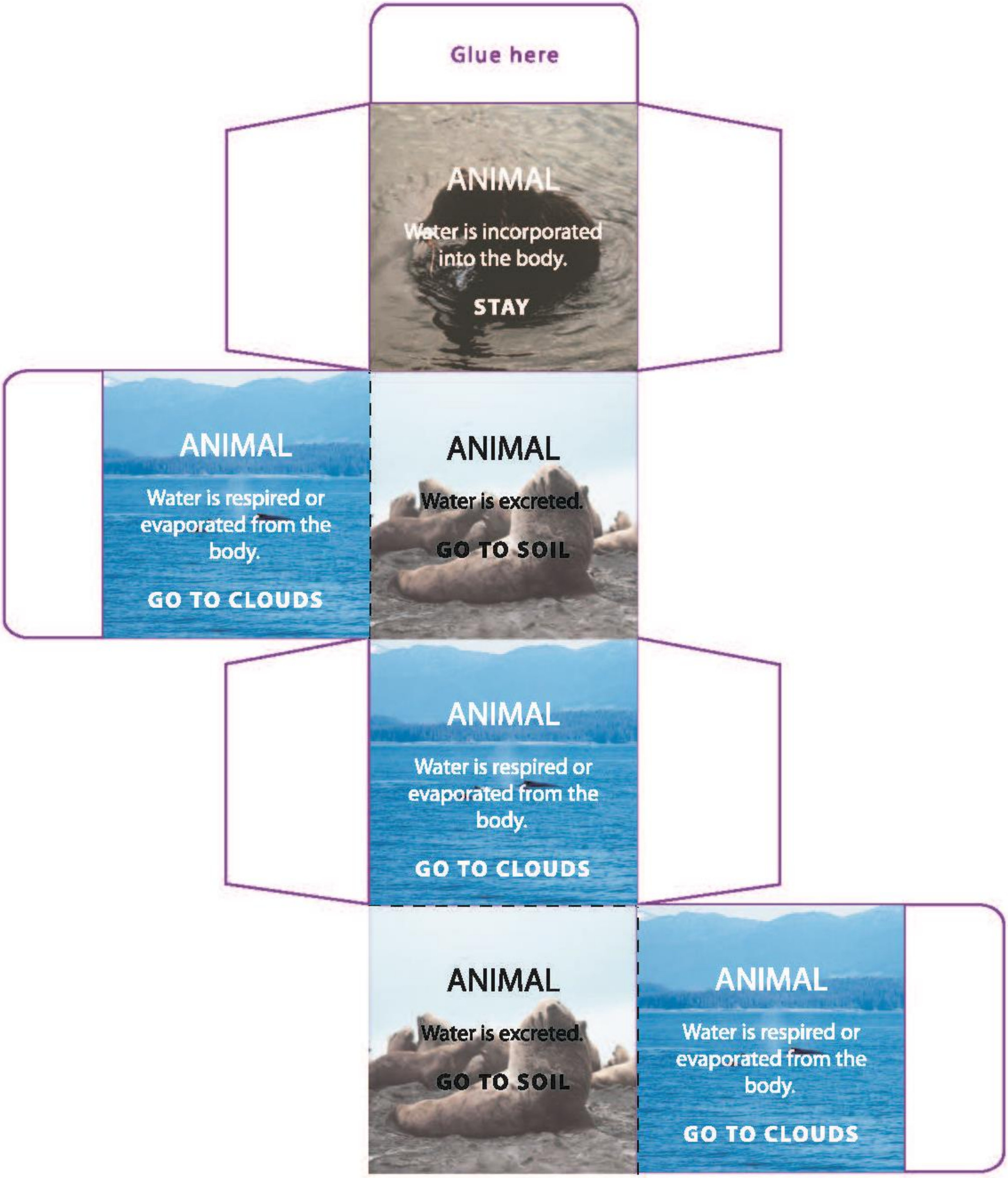

SOIL

ANIMALS

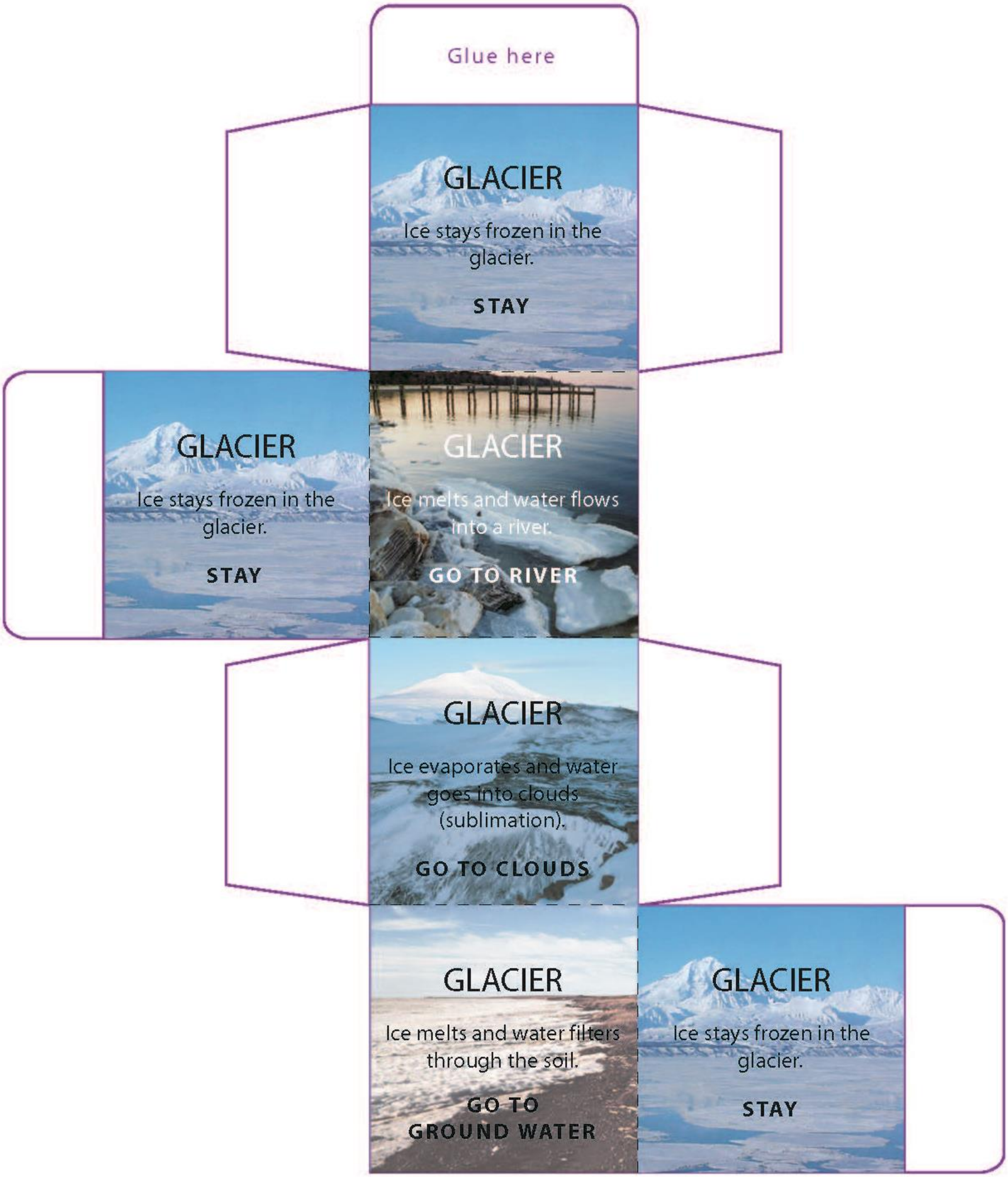

GLACIERS

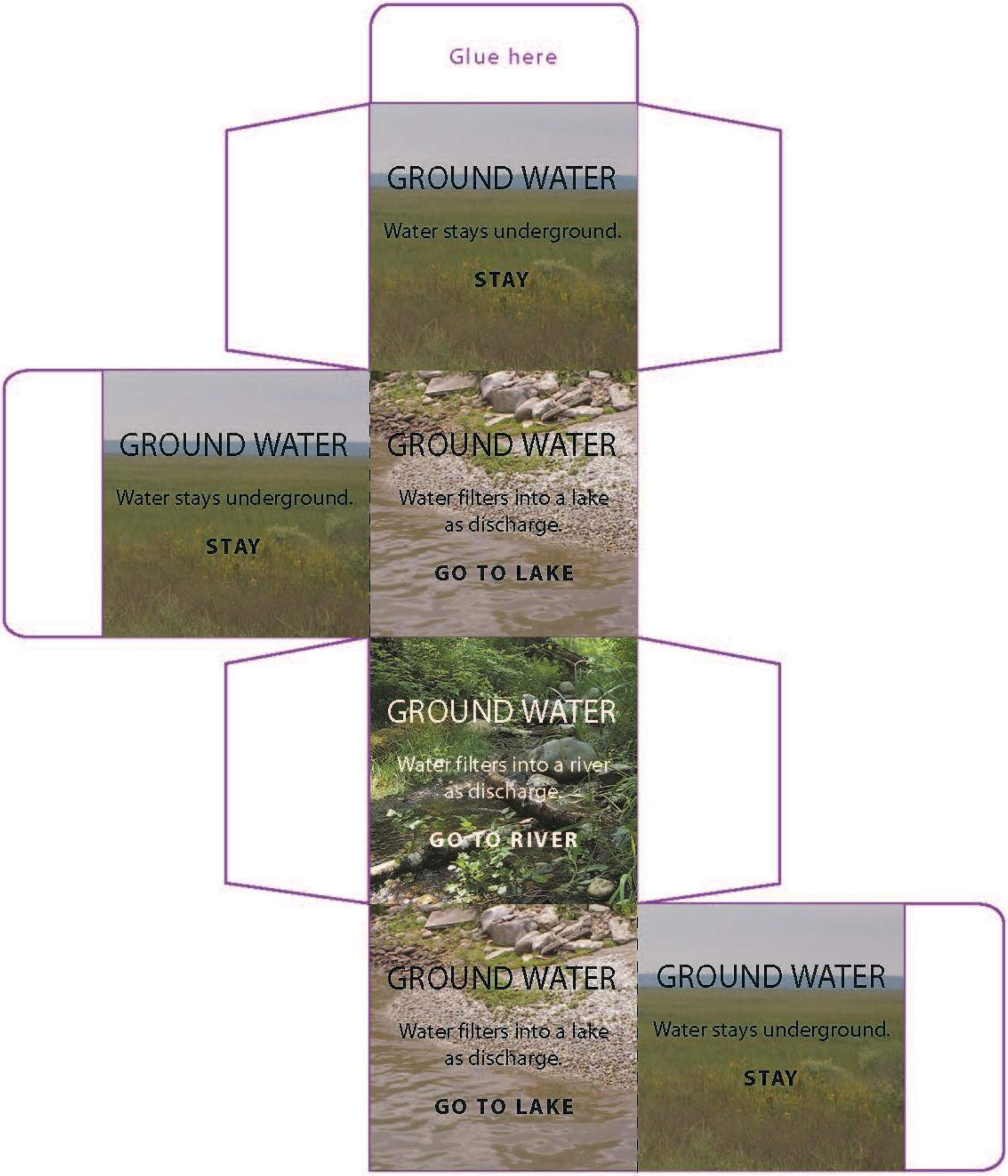

GROUND
WATER

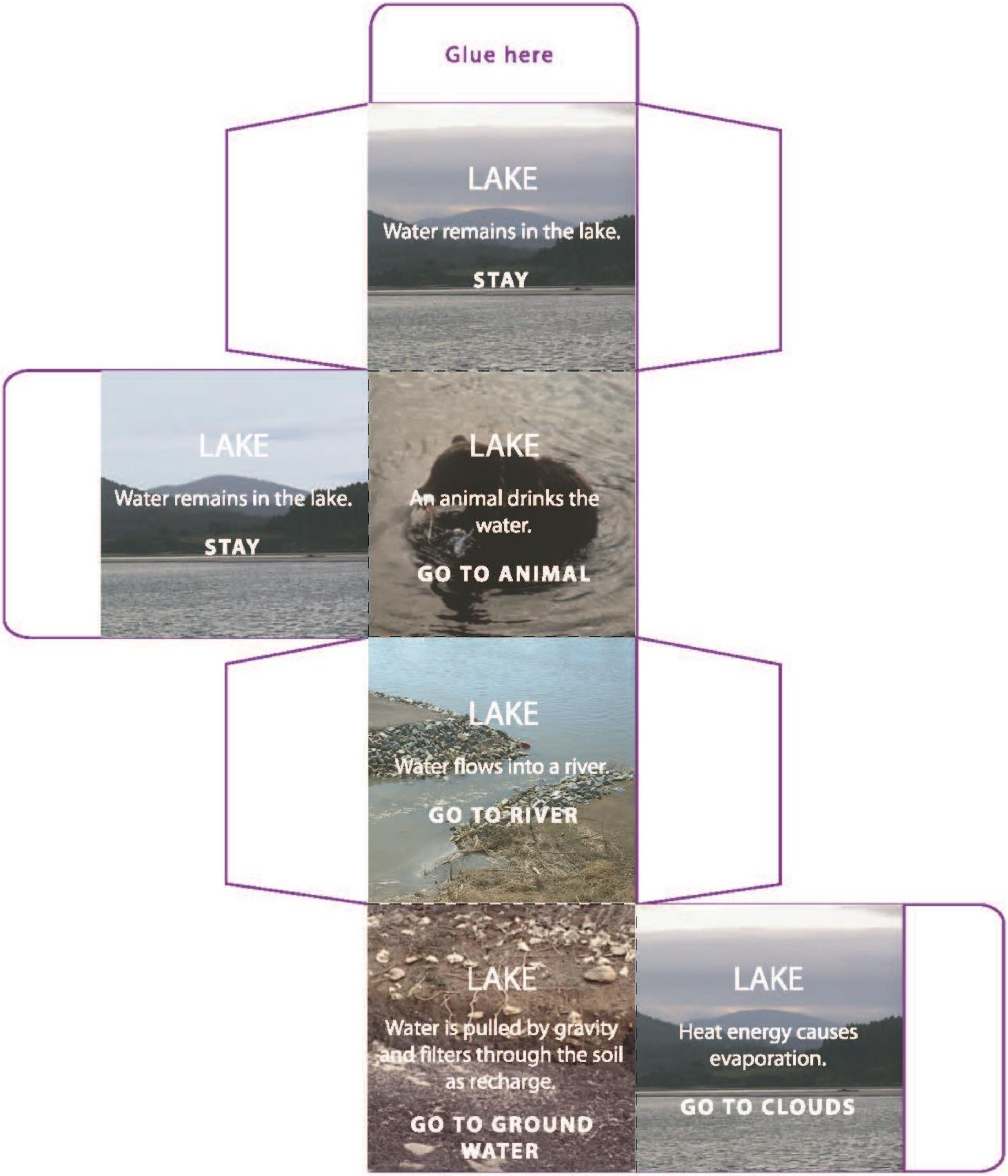
For Older Students:

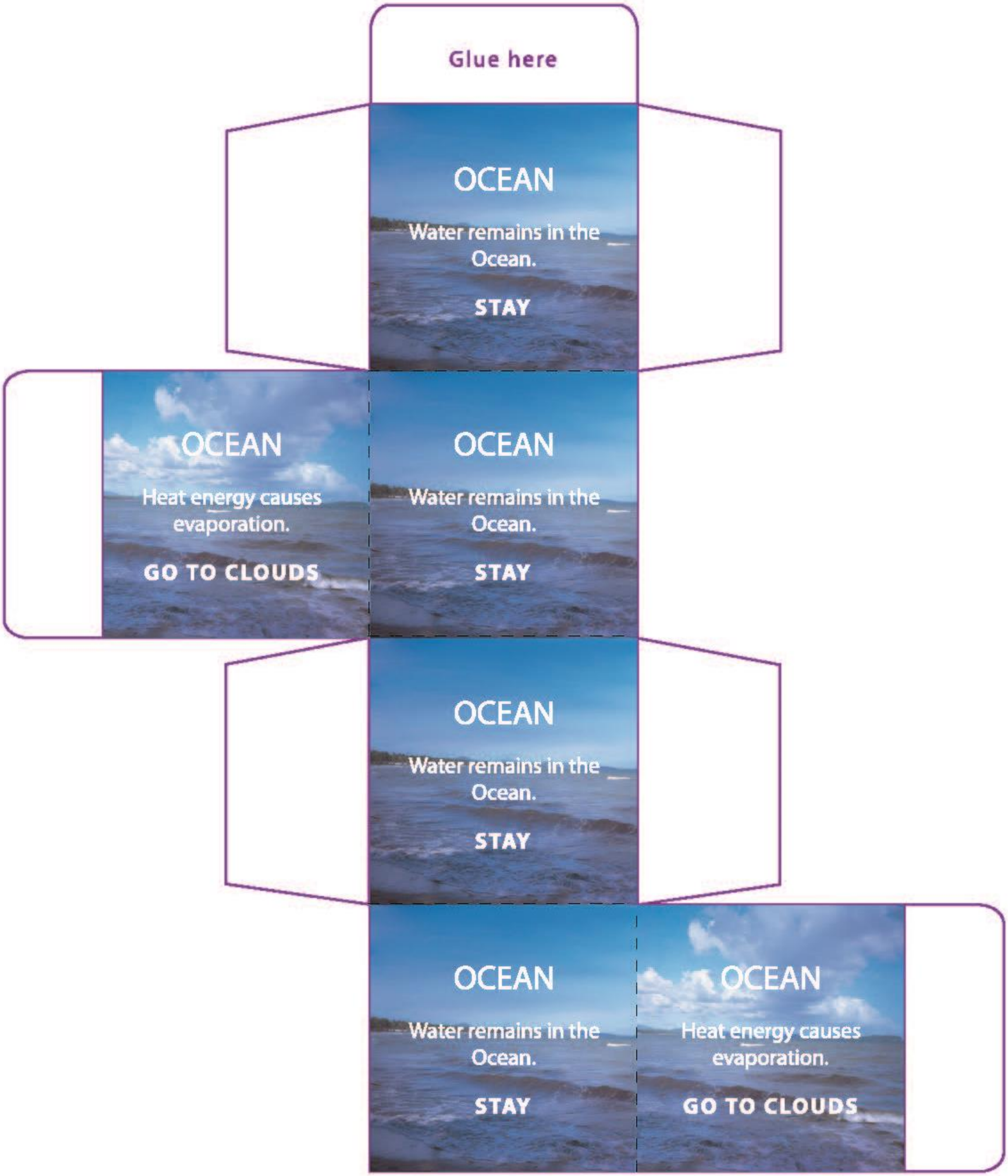


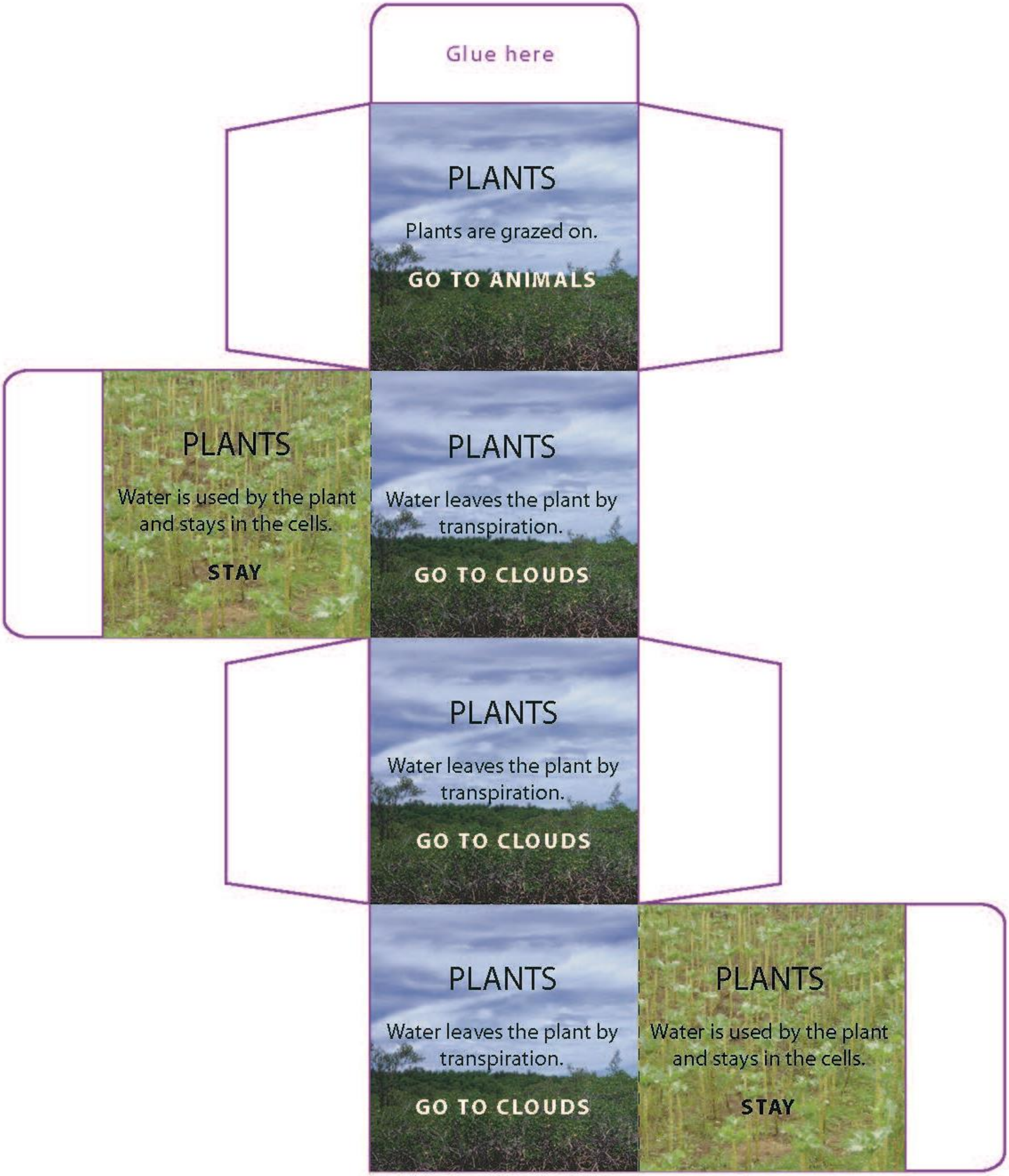

Glue here
CLOUDS
Water condenses and falls onto soil.
GO TO SOIL
CLOUDS
Water remains as a water droplet clinging to a dust particle.
STAY
CLOUDS
Water condenses and falls as snow onto a glacier.
GO TO GLACIER
CLOUDS
Water condenses and falls to the ocean.
GO TO OCEAN
CLOUDS
Water condenses and falls to a lake.
GO TO LAKE
CLOUDS
Water condenses and falls to the ocean.
GO TO OCEAN

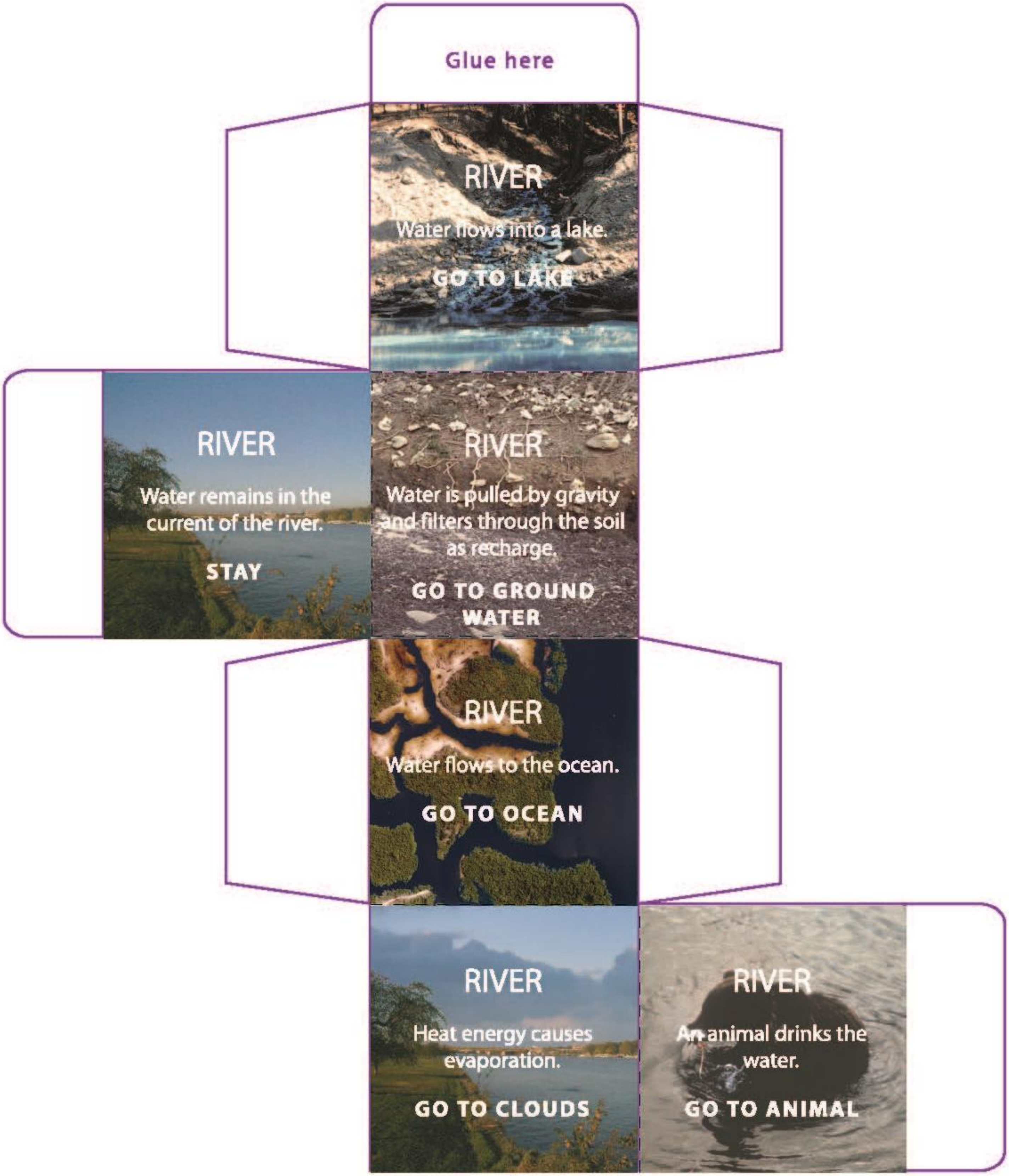

Glue here
GLACIER
Ice stays frozen in the glacier.
STAY
GLACIER
Ice stays frozen in the glacier.
STAY
GLACIER
Ice melts and water flows into a river.
GO TO RIVER
GLACIER
Ice evaporates and water goes into clouds (sublimation).
GO TO CLOUDS
GLACIER
Ice melts and water filters through the soil.
GO TO GROUND WATER
GLACIER
Ice stays frozen in the glacier.
STAY

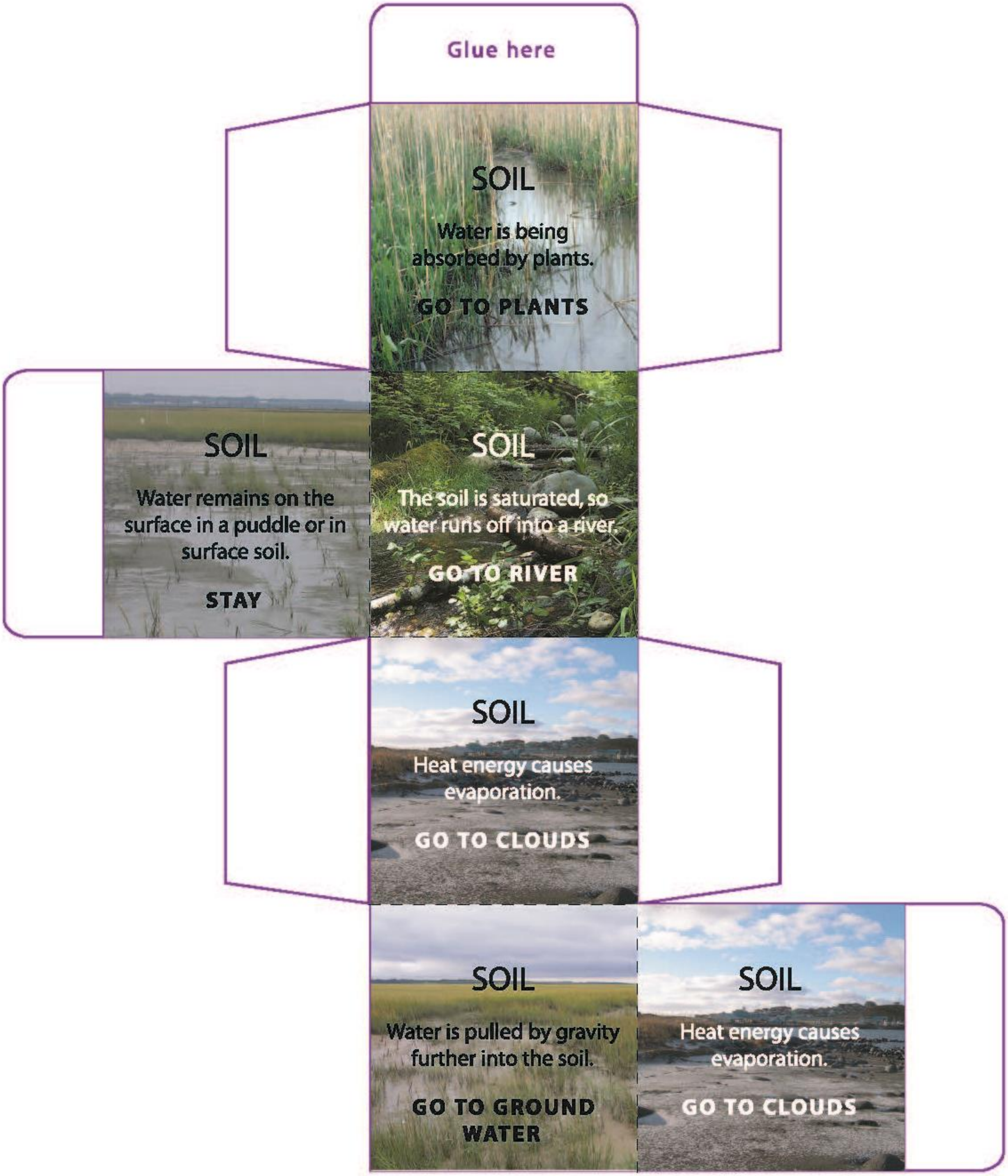

Glue here
GROUND WATER
Water stays underground.
STAY
GROUND WATER
Water stays underground.
STAY
GROUND WATER
Water filters into a lake as discharge.
GO TO LAKE
GROUND WATER
Water filters into a river as discharge.
GO TO RIVER
GROUND WATER
Water filters into a lake as discharge.
GO TO LAKE
GROUND WATER
Water stays underground.
STAY


Glue here
LAKE
Water remains in the lake.
STAY
LAKE
Water remains in the lake.
STAY
LAKE
An animal drinks the water.
GO TO ANIMAL
LAKE
Water flows into a river.
GO TO RIVER
LAKE
Water is pulled by gravity and filters through the soil as recharge.
GO TO GROUND WATER
LAKE
Heat energy causes evaporation.
GO TO CLOUDS


Glue here
OCEAN
Water remains in the Ocean.
STAY
OCEAN
Heat energy causes evaporation.
GO TO CLOUDS
OCEAN
Water remains in the Ocean.
STAY
OCEAN
Water remains in the Ocean.
STAY
OCEAN
Water remains in the Ocean.
STAY
OCEAN
Heat energy causes evaporation.
GO TO CLOUDS


Glue here
PLANTS
Plants are grazed on.
GO TO ANIMALS
PLANTS
Water is used by the plant and stays in the cells.
STAY
PLANTS
Water leaves the plant by transpiration.
GO TO CLOUDS
PLANTS
Water leaves the plant by transpiration.
GO TO CLOUDS
PLANTS
Water leaves the plant by transpiration.
GO TO CLOUDS
PLANTS
Water is used by the plant and stays in the cells.
STAY


Glue here
RIVER
Water flows into a lake.
GO TO LAKE
RIVER
Water remains in the current of the river.
STAY
RIVER
Water is pulled by gravity and filters through the soil as recharge.
GO TO GROUND WATER
RIVER
Water flows to the ocean.
GO TO OCEAN
RIVER
Heat energy causes evaporation.
GO TO CLOUDS
RIVER
An animal drinks the water.
GO TO ANIMAL


Glue here
SOIL
Water is being absorbed by plants.
GO TO PLANTS
SOIL
Water remains on the surface in a puddle or in surface soil.
STAY
SOIL
The soil is saturated, so water runs off into a river.
GO TO RIVER
SOIL
Heat energy causes evaporation.
GO TO CLOUDS
SOIL
Water is pulled by gravity further into the soil.
GO TO GROUND WATER
SOIL
Heat energy causes evaporation.
GO TO CLOUDS


Soil


River


Plants


Ocean


Lake


Ground
Water


Glacier


Clouds


Animal

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Student worksheet

Incredible Journey Water Dice Game

Materials Needed:
- Chenille stem
- Colored Beads

Directions:

- Play the Incredible Journey Water Dice Game as directed by your teacher.
- Answer questions below and fill in station locations on your journey.
- Write a story of your journey using words from the word bank.

Learning Summary

Where does water come from, and where does it go? The earth's water is constantly being used and reused through the water cycle in an endless movement of water around the planet's earth systems.

Questions to Answer

1. What powers the water cycle?

2. The same amount of water exists on Earth today, as when Earth was first created. True or False.

3. Water Journey Map—which station did you visit the most often?

Starting Station:

Stop 1:

Stop 2:

Stop 3:

Stop 4:

Stop 5:

Stop 6:

Stop 7:

Stop 8:

Stop 9:

Stop 10:

Stop 11:

Stop 12:

Stop 13:

Stop 14:

Stop 15:

My Incredible Journey Story

Name: ___________________________

You have just traveled as a water drop through the water cycle, collecting colored beads from where you stayed along the way. Every drop has a different journey. Now you get to tell your story! Use your bracelet to trace your journey explaining how you moved, where you were and what happened to you along the way. Use scientific explanations for your water cycle journey but be creative in your story too!

Bead Color	Location of Water Drop
White	Cloud
Clear	Glacier/ice
Blue	Ocean
Black	Groundwater
Brown	Soil
Green	Plant
Red	Animal
Orange	River
Purple	Lake
Yellow	Sun

Word Bank: Evaporation Runoff
Condensation Precipitation Infiltration
Transpiration Respiration

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Teacher info and answer key

Water Cycle Inside a Balloon*

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.1, SC.4.3.1, SC,5.3.4, SC.MS.3.6
Time commitment: 15 – 20 minutes
Materials Needed:

- Water cycle poster or picture
- 1 clear latex balloon
- Tapered candle in a holder
- Lighter
- Water
- Funnel
- Fireproof surface
- Safety goggles

Educational Messages:

- Explain the water cycle by showing evaporation, condensation, and precipitation.
- Heat water inside a clear balloon and observe steam (evaporation), foggy conditions (condensation) and water droplets (precipitation) forming inside the balloon.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Script:
Water Cycle overview / poster -

The fresh water available on Earth is less than 1% of all water on Earth. Is it possible for us to run out of fresh water?   No. Luckily, nature has a way of cycling the water on the Earth so we don't run out! Does anyone know what that is called? Yes, the water cycle.

The same amount of water exists on Earth today, as it did when Earth was first created. Water is matter and never goes away, rather it changes form between liquid, solid and gas, and cycles from salty ocean water into clouds, into fresh water as rain or snow, which flows back to the oceans.

Think about this: the water some dinosaur drank millions of years ago didn't just go away. It has been traveling through the water cycle and may end up in your water bottle today!

Let's take a look at this water cycle poster *(hold up poster, and point out at least evaporation, condensation, and precipitation).* The water cycle has five parts: evaporation, condensation, precipitation, infiltration and surface run-off. The water cycle works because of the energy from the sun. The sun heats the Earth and changes water into a gas called water vapor. This process is called Evaporation. *NOTE: The other ways that liquid water turns into vapor is: Transpiration – plants releasing water vapor through their leaves; and Respiration – animals releasing water vapor into the air through breathing and skin.*

The water vapor rises into the sky where it clings to dust particles. The colder air higher in the atmosphere turns the gas back into liquid water droplets that group together to make clouds. This is called Condensation.

Eventually the clouds gather more water than they can hold, and the water falls back to earth by gravity as rain, snow, sleet or hail. This is called Precipitation.

The precipitation either infiltrates (soaks) into the ground, or runs off the surface into streams, rivers, and lakes. Eventually surface water will flow into an ocean where it gets salty. Through evaporation, the water will turn fresh again. As the salty ocean water gets heated by the sun, only the water molecules rise as vapor, leaving the heavy salt behind in the ocean basin.

Water cycle balloon demonstration –

Let's see if we can create a water cycle inside a balloon. I will need a volunteer to help with observation skills *(call up a volunteer and have them wear safety glasses*).

We'll pour a little water into a balloon so it can represent a lake (*fill balloon with 1 oz. water, and have volunteer feel it and make observations)*.

Who remembers what powers the water cycle? The water cycle is powered by the energy from the sun, so this candle will represent the sun *(light the candle)*.

What do you think will happen when I put the balloon close to the candle? My volunteer will give me a hypothesis, or testable statement *(take a suggestion).* Let's try it, and perhaps you want to cover your ears in case our hypothesis is correct that the balloon will pop *(lower the balloon into the flame)*.

The balloon is not popping! It will not pop because the water "conducts" or transports the heat away from the latex. The water vapor in our atmosphere acts the same way to shield the Earth from getting too hot or cold from the sun.

Notes: The candle flame will heat the water and some of it will start to evaporate, rise, and collect on the top of the balloon. Explain the water cycle while heating the balloon. It will begin to get cloudy inside the balloon, which represents evaporation and condensation. Sometimes the volunteer can see steam rising from the "lake." If your fingers are cool enough, water droplets will form there. These droplets will rain down the inside of the balloon representing precipitation. ***Do not keep the balloon in the flame longer than 3-4 minutes because it may pop.***

Walk around the classroom to show condensation and precipitation. Students can feel the lake has become very warm. Do not let them touch the sooty spot where the candle touched the balloon because it stains.

Source: Colorado Springs Utilities

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Teacher info and answer key

Water Cycle in a Bag

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.1, SC.4.3.1, SC,5.3.4, SC.MS.3.6
Time commitment: 20 minutes to set up, several days to observe
Materials Needed:

- Clear zip-top bag, sandwich sized or bigger
- Water
- Food coloring (optional)
- Strong tape
- Sunny window
- Ice
- Permanent marker
- Handful of dirt (optional)

Educational Messages:

- Students observe the parts of the water cycle inside a clear bag.
- Water moves through the water cycle in three different forms—as a liquid, solid or vapor. See all three forms in this experiment.

Water Cycle Experiment
Directions:

1. Draw the steps of the water cycle onto your bag as pictured in the video and below.
2. Fill the bottom of the bag with water up to about where you drew your ocean. You can add blue food coloring to the water, if desired.
3. Seal the bag and tape it to a window that typically gets a lot of sun.
4. As the water heats up the steps of the water cycle will be visible in the bag!

Watch the video: https://www.youtube.com/watch?v=VZB44_X0pFw

Try This!
Add some water and some ice to a zip-top bag. With the opening of the bag almost closed, blow a few puffs of air into the bag. Can you see the water vapor?

Alternate idea:

- Put a handful of dirt in the zip-top bag.
- Sprinkle a little water on the dirt, just enough to make it moist.
- Close the bag tight and tape it to the sunny window.
- Clean up your mess and watch what happens in the bag.

Sources: Cherry Creek Valley Ecological Park Activity Book, 2006, Parker Jordan Metropolitan District; Fox 21 News, Science Museum Oklahoma

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Teacher info and answer key

Water Cycle Relay

Grade level: 2nd – 6th

Standard/GLE Code: SC.2.3.1, SC.4.3.1, SC,5.3.4, SC.MS.3.6

Time commitment: 30 minutes

Materials Needed:

- Lots of space
- Chalk or masking tape to mark out sites
- Balloons for some other means of representing a drop of water

Educational Messages:

- Students physically demonstrate the path a drop of water must take to complete the water cycle.

Overview/Background:

Discuss the water cycle with the class. Water falls from clouds to the land. Sometimes it falls on mountains, sometimes on plains. Most of Colorado's water falls as snow in the mountains. As it melts, it flows down the mountains into streams where it joins other water drops. These combine to form a river. The river turns and twists until it dumps into the ocean. The sun warms the water on the ocean and it evaporates. The water vapor rises into the sky and forms clouds and the cycle begins again.

Procedure:

Divide the class into groups. For each group, assign one of the paths taken in a water drop's trip through the water cycle to a student: cloud student, mountain student, stream student, river student and ocean student.

Line the students up in the order above – cloud, mountain, stream, river and ocean. Allow plenty of distance between them. You may want the class to design the path to take. It is more fun and challenging if there are things to climb and crawl through along the path. Set up boundaries with cups or pylons so each team knows when to trade off the balloon. Hand each cloud student a balloon and let the relay begin. The cloud student should follow the designated path, then hand off to the mountain student, who then follows a designated path and hands off to the stream student, etc. The cycle is repeated until each student has had a chance to participate or to play each of the roles in the water cycle (round robin).

Extension:

Change the situation. What happens to a rain drop that falls directly into the ocean? Or what happens to the water drop in the winter? How does the relay change if the water is absorbed into the soil and goes into the groundwater or is taken up by a plant? If part of the relay is performed on blacktop, have the students draw a landscape along the path.

Source: Nebraska Groundwater Foundation

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Cloud in a Bottle*

Grade level: 2nd – 6th
Standard/GLE Code: SC.3.3.1, SC.4.3.4, SC.5.1.1, SC.MS.1.1SC.MS.3.6
Time commitment: 20 minutes
Materials Needed:

- One-liter clear plastic bottle with cap
- Isopropyl (rubbing) alcohol
- Foot pump with rubber stopper attachment
- Safety goggles
- 2 water molecule models or pictures.

Educational Messages:

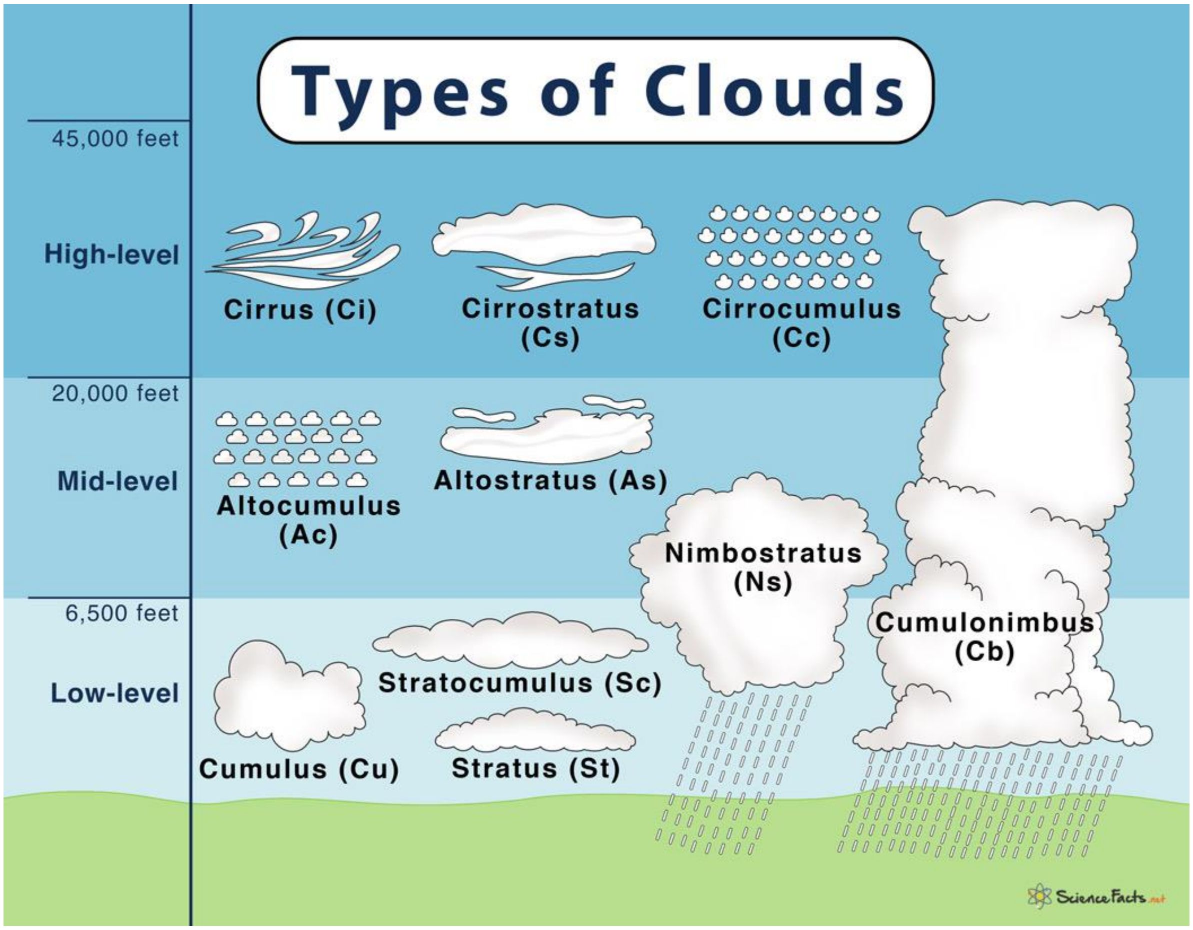
- Create high pressure and low-pressure scenarios inside the bottle to see how water molecules condense to form clouds during low pressure and are forced apart in high pressure.
- Students learn that clouds are made of water vapor and form under certain atmospheric pressure conditions.

NOTE: Entire kit can be purchased on-line at http://www.stevespanglerscience.com/ for approximately $30.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Prep: Fill bottle with about 2 tablespoons of isopropyl alcohol before students arrive.

Script:
Weather is what brings our precipitation—rain, snow, hail, and sleet. This precipitation comes from clouds. Let's take a closer look at clouds.



Raise your hand if you have ever watched the news on TV and heard the meteorologist talk about high or low-pressure systems in our atmosphere. The pressure in our atmosphere is what influences our weather.

Remember that water evaporates into gas (water vapor) that floats around in the air? This water vapor will condense and form clouds when there is low pressure in the atmosphere. But when there is high pressure—the water vapor molecules are forced apart, so there are no clouds *(demonstrate with two Mickey Mouse molecule models).*

To have clouds form we need water vapor and a low-pressure system so the molecules can stick together. With that in mind, let's try to make a cloud inside this bottle. I will need two volunteers to be the pressure system *(call up volunteers and have them put on safety glasses).*

Volunteers, please make observations about the bottle—is there anything inside it? Can you squeeze it? What state is the water inside this bottle—liquid, solid or gas? That's right, this water is in liquid form.

What are clouds made of? Water vapor. Swish around the liquid inside this bottle to convert some of the water from liquid to gas state. Great!

Now let's practice pumping the pressure system together without smashing any fingers. What do you feel coming out of the end of the pump hose? That's right, air. Do you remember what kind of pressure system we need for clouds to develop? We need a low-pressure system. First, we will start with a high-pressure system by pumping air into the bottle.

Then I will remove the stopper and let the air rush out, resulting in a low-pressure system *(attach the rubber stopper to the bottle and have the volunteers pump 10 times while the class counts. You must hold the stopper firmly in place).*

Can you see a cloud yet? *NOTE: Have one of the volunteers try to squeeze the bottle. It will be hard because of high pressure. Explain that the water molecules cannot get together and condense into a cloud because the pressure forces them apart. Then remove the stopper quickly to form a low-pressure system, and instantly a cloud is formed.*

Wow, we made a cloud inside this bottle! As the pressure was released, the water molecules rushed together to make a cloud. This is called condensation.

Stick your finger into the bottle and wiggle it around. What does a cloud feel like?

Let's try that again. What do you think will happen when we add pressure back into the bottle? Watch and observe if your theory is correct.

The cloud disappeared! Are there still water molecules inside the bottle? Yes, but they are forced apart by the pressure, so we have a clear, sunny day. Get ready for a low-pressure system and a cloudy day *(release stopper and the cloud will reappear).*

Let's review – What are clouds made of? Water vapor. Water molecules are always in the air, but clouds will only form under certain conditions. What type of pressure system do we need for clouds to form? Correct, a Low-pressure system.

Sources: Colorado Springs Utilities; Steve Spangler Science

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Colorado Springs Utilities
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Teacher info and answer key

Instant Snow*

Grade level: 2nd – 6th
Standard/GLE Code: SC.3.3.1, SC.4.3.4, SC.5.1.1, SC.MS.1.1
Time commitment: 30 minutes
Materials Needed:

- Insta-Snow powder (sodium polyacrylate) – 1 tsp./student. Insta-Snow powder can be purchased on-line from science providers such as Steve Spangler science: http://www.stevespanglerscience.com/instant-snow-powder.html
- Water – 2 oz. per student
- Tablecloth
- Containers for snow
- Student worksheet

Educational Messages:

- Learn about snow-water content, watch a polymer link with water to form a mixture and observe evaporation.
- Students hydrate a polymer that resembles snow to learn about our water source, mixtures, and evaporation.
- Use math skills to determine average snow pack.

- Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Prep:
Cover tables with tablecloth for easier clean-up or conduct experiment outside. Prior to class, fill a 2 oz cup, container, or baggie with 1 tsp. Insta-Snow powder per student.

Background:
Weather is what brings our precipitation—rain, snow, hail, and sleet. This precipitation is the source of our water supply. The form, or type, of precipitation depends mostly on-air temperature. If it is warm, the precipitation will be rain. If it is cold (generally lower than 32 degrees Fahrenheit), the water vapor in the clouds will crystallize and form snow, sleet or hail. Snow is very important to us because it is the best source of water with the least amount of evaporation loss. Colorado Springs Utilities collects snow-melt water in the spring to fill our reservoirs (reservoirs are human-made lakes used for storing water). Winter snowpack levels are measured so we can estimate how much snow melt water we can expect in the spring when the snow melts.

The snowpack is measured by driving a hollow tube, called a snow sampler, into the snow to obtain a snow core. The sampler is then weighed with a spring scale. Math calculations are made based on the weight to determine how much water content is in the snow. The heavier the snow, the more water it will yield when it melts. On average the snow in Colorado has a 10% moisture content. That means in order to get 1 inch of water, you need 10 inches of snow.

Snow sampler is driven into the snowpack

Snow sampler is being weighed to determine the water content of the snow

Insta-Snow Activity:

Provide each student with a 2 oz. cup that has 1 tsp. Insta-Snow powder in it. Alternatively, you can have students cup their hands and place the powder directly onto their hands. Thereafter add approximately 2 oz. of water. The students will feel the Insta-Snow powder expanding in their hands.

Note: Insta-Snow powder is non-toxic and environmentally safe. However, as with any chemical, students should not ingest Insta-Snow or get it in their eyes. Insta-Snow is not real snow, so students should not eat it.

Use the worksheet to have students make predictions and record their observations.

What is Insta-Snow? Insta-Snow is a polymer known as sodium polyacrylate. Polymers are long chains of molecules. When water is added, it moves from the outside of the polymer to the inside (known as osmosis) and causes the polymer to swell. The polymer chains have elastic qualities, so the Insta-Snow expands as the water is absorbed.

Is the water gone? No, the water molecules have created a mixture with the polymer. Mixtures can be separated. By leaving the Insta-Snow uncovered in a thin layer on a cookie sheet, the water will eventually evaporate into gas form leaving the polymer behind. The polymer can then be rehydrated again.

Extension: Have your students conduct additional experiments to observe the evaporative water loss by weighing and measuring the uncovered Insta-Snow over 7 – 10 days.

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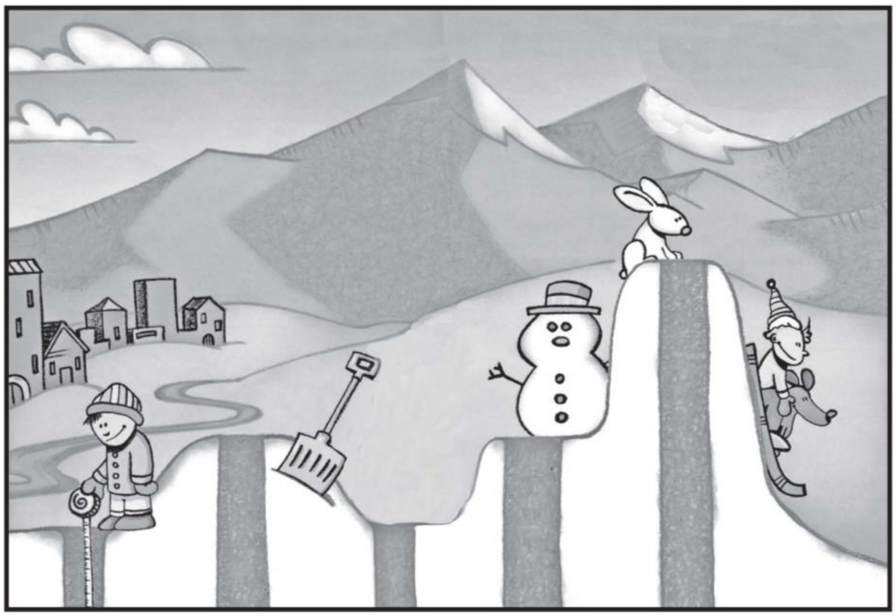
How Much Water is in Snow?

Water Managers measure snow pack to determine how much water will be left after the snow melts.

On average, the snow in Colorado has about a 10% moisture content. That means it would take 10 inches of snow to get 1 inch of liquid water!

*1 inch of liquid water over a 1 mile square area = 17.4 million gallons of water!



Year 1 Year 2 Year 3 Year 4 Year 5

We can find out what the average amount of snowpack is.

Did you know the water you drink most likely started as SNOW in the Rocky Mountains?

Figure it out!

1. Use a ruler to measure the snowpack for each year.
2. Add up the amounts from all 5 years.
3. Divide by the number of years:
4. (½ + 1 + ½ + 1 + 2) ÷ 5 = 1 inches average snowpack.
   (Year 1, Year 2, Year 3, Year 4, Year 5)

Sources: Colorado Springs Utilities; Steve Spangler Science

Student worksheet

Instant Snow

Materials Needed:
- Ruler
- Insta-Snow powder
- Water

Directions:
- Measure snowpack in each year on diagram
  - Add together and divide by 5 to determine average snowpack
- Observe Insta-Snow powder, make predications, and conduct experiment
- Record observations

Describe what the dry powder feels like:

____

____

____

Predict what you think will happen when you add water to the powder:

____

____

____

Conduct the experiment: pour 2 oz. of water onto 1 teaspoon of powder. What happened? Was it different than what you expected?

____

____

____

Describe what the mixture feels like:

Do you think you can separate the mixture? How would you get the water back out?

What do you think will happen if you add more water?

Try it!

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How Much Water is in Snow?

Water Managers measure snow pack to determine how much water will be left after the snow melts.

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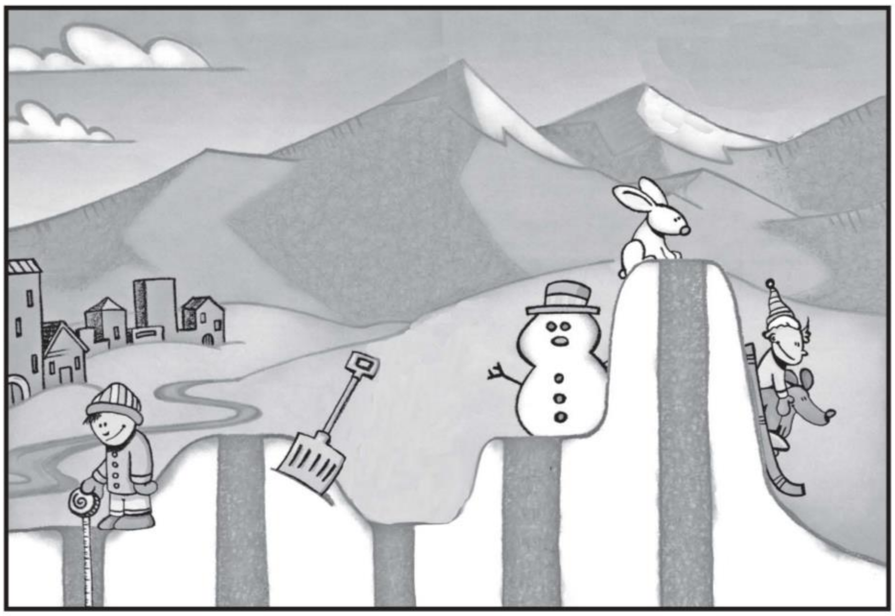

Year 1 Year 2 Year 3 Year 4 Year 5

We can find out what the average amount of snowpack is.

Did you know the water you drink most likely started as SNOW in the Rocky Mountains?

Figure it out!

1. Use a ruler to measure the snowpack for each year.
2. Add up the amounts from all 5 years.
3. Divide by the number of years:
4. (___+___+___+___+___) ÷ 5 = _____ inches average snowpack.
   Year 1 Year 2 Year 3 Year 4 Year 5

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Colorado Springs Utilities
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Teacher info and answer key

Plant Adaptation Activity

Grade level: 2nd – 5th
Standard/GLE Code: SC.2.2.1, SC.3.2.5, SC.4.2.1, SC.5.2.1
Time commitment: 45 minutes
Materials Needed:
- Student worksheet
- Pencil
- Plant adaptation cards (attached)
- Plant samples

Educational Messages:
- Learn about how plants have adapted to survive in our dry climate.
- Do a scavenger hunt to find plant adaptations.
- Brainstorm ways to keep yourself hydrated.

Prep:
Obtain plant samples and set out at stations around the room or you can bring students on the free self-guided water wise garden tour at the Conservation & Environmental Center, 2855 Mesa Road. To reserve a tour email communityrealtions@csu.org

Introduce "Adaptions":
Plants can't walk and move like us, but they have made changes to their shape, leaves and roots to be prepared for the environment in which they live. This is called an adaptation. All living things make adaptations in order to stay alive. For example, a polar bear has thick fur to keep it warm in cold, snowy conditions.

Water Wise Demonstration Garden at Colorado Springs Utilities Conservation Environmental Center, 2855 Mesa Rd.

Plants have adaptations, just like animals. Plants that thrive in Colorado Springs have figured out how to conserve water. These plants have developed clever ways to keep from losing too much water through their leaves. They are water wise plants! Let's take a look at a few water wise plant adaptations.

An adaptation is a characteristic an organism has developed to help it survive in a certain environment.

EXPLAIN WATER WISE PLANT ADAPTATIONS WITH THE CARDS
Some plants have created a way to store water when it's available so that they can have water later when it's dry. At Colorado Springs Utilities, we do that too. We store melted snow (water) in reservoirs (human made lakes) so that we have enough water for our community in the summer when it is hot and dry.

SHOW THE SUCCULENT CARD TO THE STUDENTS
Plants with thick, fleshy, or squishy leaves are called succulents. Succulent plants store water similar to how we would store water in a water bottle. You can tell a plant has succulent leaves because they are much thicker than normal leaves and firm because all of the water inside (just a like a full water balloon.

SHOW THE LIGHT-COLORED LEAVES CARD TO THE STUDENTS
Wearing light-colored clothing reflects the sun's heat and keeps you cooler. Plants have figured out that growing lighter colored leaves helps them save water by not letting their leaves get as hot.

SHOW THE FUZZY LEAVES CARD TO THE STUDENTS
Another way that plants to keep their leaves cooler is with small hairs on the surface. These hairs feel fuzzy to the touch. The hairs act as a type of sunscreen to shield the leaf from intense sunlight.

SHOW THE WAXY LEAVES CARD TO THE STUDENTS
Have you ever used lip balm to keep your lips moist? Some plants have developed a similar type of adaptation to keep the moisture from escaping their leaves: they have a waxy coating on the surface to minimize water loss. Plant leaves that look shiny or feel like they have a hard coating on their leaves use this adaptation – waxy coating.

SHOW THE TINY LEAVES CARD TO THE STUDENTS
Another way for a plant to stay cooler is to expose a smaller surface area to the heat of the sun. Several types of plants have this adaptation and have tiny leaves. When you walk around this area, notice how some plants have larger leaves while others have very tiny leaves.

SHOW THE NEEDLES FOR LEAVES CARD TO THE STUDENTS
Evergreen trees grow very well in Colorado Springs. They have both waxy and tiny leaves. Their leaves are so narrow that we call them "needles." Because needles help evergreen trees conserve water, you'll see many more of them than trees that lose their leaves in the winter (deciduous trees).

SHOW THE NO LEAVES CARD TO THE STUDENTS
Some plants are so water wise that they have no leaves at all. Can you think of a plant that has no leaves? Cacti are a good example. Rather than making their own food in their leaves, they make their food in their stems.

EXPLAIN THAT WATER WISE PLANTS CAN HAVE MORE THAN ONE ADAPTATION
Plants can have more than one adaptation to help them survive. The Yucca plant has light colored and waxy leaves. In addition, its leaves are upright, so they don't get direct sunlight during the hot part of the day. This clever plant also has U-shaped leaves to capture rain drops and direct them to the roots just like a water slide.

1. Explain the scavenger hunt

Now that you've learned about water wise plant adaptations, you're going to get the chance to look for water wise plants adaptations by using your senses with plant samples. Be careful not to damage the plants. Here's how it works:

- You can explore the Water Wise Neighborhood or plant samples provided by the teacher as an individual or with a partner. You do not need to go in any specific order.
- Go through the plant stations and take a close look at the plant. There are seven stops altogether.
- Determine what plant adaptations that plant has. Record your answer on your student worksheet. Remember that a plant may have more than one adaptation. Be careful not to damage the plants.
- When you're done with all the stations, discus your findings with the class.

2. Discover plant adaptations and fill in data sheet

Let the students touch and discover plant samples that exhibit adaptations.

3. Discuss conclusions

After students have had a chance to explore, review what adaptations they discovered.

Plant Adaptation Scavenger Hunt Answer Key

Stop 1- Needles for leaves (N), waxy leaves (W), tiny leaves (T)
Stop 2- Light colored leaves (L), fuzzy leaves (F)
Stop 3- Tiny leaves (T)
Stop 4- Fuzzy leaves (F), light colored leaves (L)
Stop 5- No leaves (0)
Stop 6- Waxy leaves (W)
Stop 7- Succulent leaves (S)

4. Answer inquiry question

What was their favorite adaptation and why? Discuss ways students can "adapt" at home to save water. Ideas might include turning off the water while brushing teeth or washing hands, taking a 5-minute shower, or filling the bathtub only halfway full.

Source: Colorado Springs Utilities, City of Boulder, Department of Public Works

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SUCCULENT LEAVES

STORE WATER

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LIGHT COLORED LEAVES

KEEPS LEAVES COOL

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FUZZY LEAVES

PROTECTS FROM DRYING OUT

WAXY LEAVES
SEAL IN MOISTURE

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TINY LEAVES
LOSE LESS WATER

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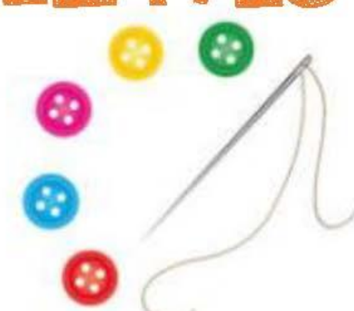
NEEDLES FOR LEAVES

TINY AND WAXY



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DOESN'T HAVE LEAVES

DOESN'T LOSE WATER THROUGH LEAVES

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Student worksheet

Plant Adaptation Scavenger Hunt

Plants have adapted (evolved changes to survive) to save water. Plant adaptations could include:

(S) Succulent – stores water in thick leaves or stem

(L) Light-Colored Leaves – reflects lights and keeps plant cool

(F) Fuzzy Leaves – reflects light and works as a natural sunscreen

(W) Waxy Leaves – holds water in and keeps heat out

(T) Tiny Leaves – less surface area to lose water

(N) Needles – tiny and waxy leaves help evergreen trees save water

(0) No Leaves – does not lose water through leaves

Examine the plant samples provided by your teacher. Write down the letter(s) that correlate to the adaptation(s) the plant is demonstrating to save water.

Note: Some plants may have more than one adaptation!

Stop 1

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Stop 2

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Stop 3

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Stop 4

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Stop 5

____

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Stop 6

____

____

Stop 7

____

____

What was your favorite adaptation and why?

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Teacher info and answer key

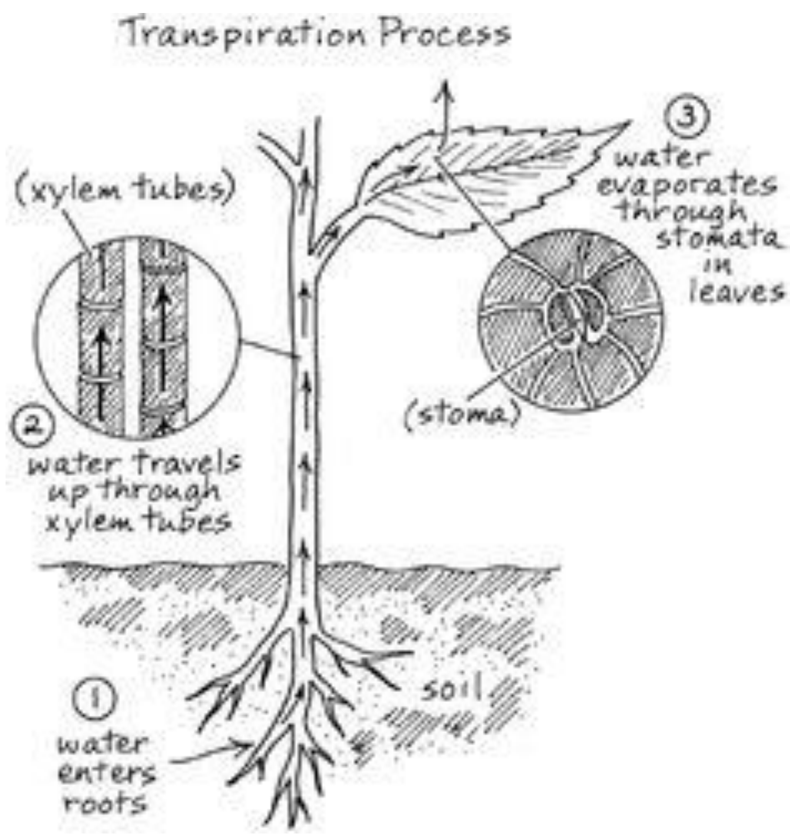
Plant Transpiration Experiment

Grade level: Pre-K – 6th
Standard/GLE Code: SC.P.2.1, SC.K.2.1, SC.2.2.1, SC.3.2.5, SC.S.3.3, SC.MS.3.6
Time commitment: 20 minutes and several days to observe experiment
Materials Needed:
- Clear plastic bag
- Green leafy plant
- Sunny window

Educational Messages:
- Plants depend on water and light to grow.
- Students learn about transpiration and observe moisture that has been released from leaves.

Background:
Transpiration is evaporation of water from plant leaves. It is the process where plants transport moisture from their roots to small pores or holes on the underside of their leaves. These holes (called stomata) take air in and out and let water get out. As water evaporates from the leaves, more water and nutrients are sucked up by the roots. The water evaporates and goes out into the air as part of the water cycle.

Transpiration is important because it allows plants to grow, cool themselves and cool the surrounding environment. The cooler air under a shade tree is due, in part, to transpiration.



Procedure:
You can see transpiration through this fun activity.
1. Place a bag over a plant and seal it with a string.
2. Let the plant in the bag sit in a warm and sunny place for a few days until water droplets form on the inside of the bag.
3. The water that came from the plant's stomata evaporated and then condensed on the inside of the bag. Your plant just created a miniature water cycle!
4. Remove the bag.

Extension:
1. Collect the moisture. Measure the amount.
2. Leave the bag open and observe what happens to the water over the next few days.

For Older Students
Background:
All plants store water within their structure. When the temperature surrounding the plant increases sufficiently, the stored water becomes a vapor (gas). Certain plants transpire more than others. The less transpiration, the less water the plant loses, so in arid climates where water is scarce, conservation in the transpiration process is a typical plant adaptation.

There are subtle distinctions between low water demanding plants and desert plants. Desert plants are plants which grow in desert regions. Low water use plants are plants which require a small amount of water. Native plants are all plants naturally occurring in the region being studied and may or may not be low water plants. Drought resistant plants are plants which can survive long periods without water. Drought resistant plants may be native or non-native plants.

Procedure: Examine several common, leafy, green plants and several desert or drought tolerant plants (look in a local gardening book for examples or call your local nursery person for appropriate plant species). Observe their color, form, and other physical features. Talk about how much water might be stored in each type of plant and how much water each might require based on their observations.

There are many plant adaptations that allow storage of water and/or reduction in the transpiration rate in desert and/or drought resistant plants.

1. Gray or light colors provide a reflective surface.
2. Wilting during the hot part of the day helps plants to reduce water loss by reducing transpiration.
3. Loss of leaves or leaves closing during the summer or dry spells, allows the plant to go into semi-dormancy.
4. A low ratio of surface area of the plant to volume. (For example, succulents will have thick leaves, pads, or main stems.)

The students will compare the amounts of transpiration between plant species with differing water requirements.

Have the students select various desert or drought tolerant and high-water demanding plants. Place a plastic baggie around one or more leaves or each plant. Leave the baggie on the plants for 24 hours. Evaluate the amount of moisture in each plastic bag. Discuss the factors that may influence the amount of water transpired (including leaf and plant structure and color) on evapotranspiration rates. Try the experiment at different times of the year or day vs. night and compare results. The differences in transpiration adaption of desert plants should be apparent.

Extension: Variation of results can be examined by leaving some of the plants in the sun or some in dark closets. Others may be placed in different locations in the classroom. Lead a class discussion; review the differences between riparian plants (plants which grow near water) and drought to tolerant or desert species. Also discuss the distinctions between low water use plants, native plants, drought resistant plants and desert plants.

Discuss how stored water in all living things evaporates into the atmosphere and how humidity is created. Humans keep cool by perspiring or losing water to the air (hydrologic cycle).
Have students figure out the transpiration characteristics of plants in their yards. The transpiration rate of the plants is indicative of water loss to the atmosphere and influences the water requirements of plants.
Source: Colorado Springs Utilities and City of Boulder, Department of Public Works

Teacher info and answer key

How Water Loss Affects Biodiversity

Grade level: 4th – 6th
Standard/ GLE Code: SC.4.3.5, SC.5.2.2, SC.MS.2.7
Time commitment: 40 minutes
Materials Needed:

- Student worksheet

Educational Messages:

- Students learn the impacts of limited water through a reading comprehension assignment provided by ReadWorks.
- Topics include drought, climate change, natural habitats, human impact on plants and animals.
- Students answer reading comprehension questions to assess understanding.
- Students discuss ways to reduce water loss.

In order for humans to live, they need access to fresh water. There are many ways in which humans can affect access to fresh water. Droughts can also have a negative impact on the biodiversity of a region. While droughts are natural, and in many places, a frequent occurrence, there are many things that humans do to increase the severity of these droughts.

Suggested format:

4. Have students read "How Water Loss Affects Biodiversity" either individually, as small groups or as a class.
5. Have students answer the reading comprehension questions.
6. Discuss ways students can help reduce water loss.

How Water Loss Affects Biodiversity – STUDENT READING PASSAGE

In order for humans to live, they need access to fresh water. While nearly 70% of the earth's surface is water, most of it is salt water, which humans cannot drink. Only a small percentage, about 3%, is fresh water. Of this, about 69% is currently frozen as ice caps and glaciers, while another 3% is held underground in the soil or in rock. This means that only one percent of the world's fresh water-or .03% of the world's total water-is surface water that humans can access to drink. The small amount of potable (suitable for drinking) water makes its conservation incredibly important so that water shortages already occurring in some regions do not spread further. If they do spread, this may lead to conflicts over the right to use this water.

There are many ways in which humans can affect access to fresh water. For example, humans can pollute bodies of water, thereby making them undrinkable. In some cases, they may make physical changes to the land by building over wetlands or damming up rivers. While wealthy countries can afford to make the investments necessary to make sure their residents have access to fresh water, poorer countries often cannot. This means that poorer countries are at greater risk of devastating droughts, which can lead both to dehydration and starvation, as the country is unable to water its crops.

Droughts can also have a negative impact on the biodiversity of a region. Biodiversity refers to an abundance of different types of plants and animal species within a region.

The prefix "bio" means living, while "diversity" refers to different types of things. Around the world, more than 125,000 animal species live entirely in freshwater habitats, including 15,000 species of fish 4,300 species of amphibians, and 5,000 species of mollusks, such as clams and oysters. Millions of other species, including humans, depend on fresh water to drink. When an area loses a large percentage of its fresh water, many animals die off. In some cases, species go entirely extinct. This leads to a decrease in the region's biodiversity.

While droughts are natural, and in many places, a frequent occurrence, there are many things that humans do to increase the severity of these droughts. For one thing, the world's population has doubled in the last 50 years, so humans have been using much more fresh water to drink and grow crops than they did in the past. Humanity's increasing water consumption represents a growing threat to biodiversity.

In Africa, where droughts are common, they have been more prolonged than in the past. This is due in part to climate change, as well as a greater demand for water as the continent's population has increased. During a drought in Kenya that lasted from 2007-2009, over 60 elephants died-some of dehydration, others of starvation due to lack of vegetation to eat, and others of diseases that became fatal due to the elephants' weakened states. Some other endangered animals, such as the white rhinoceros, died too, which brought them closer to extinction.

When the biodiversity of a region declines, the human population suffers as well, in different ways. When a region experiences a significant drought, many animals many die from lack of water and food. If the region is one like Kenya, which depends on its wildlife to draw tourists, the effects of the drought can be devastating. If tourism declines due to high wildlife casualties, then the locals who depend on the income from tourism will lose their livelihood. People may then turn to farming to earn money, but crops will require water to grow. This can place further strain on the water supply and worsen the original problem of the drought. Sometimes, an imbalance in the system, such as a lack of water, can enter into the feedback loop where the situation only gets worse and worse.

Losses in biodiversity can also lead to problems with the availability of food. As we've discussed, a lack of water can prevent farmers from growing crops, which can lead to starvation. However, when a region loses its biodiversity, it disrupts the food chain in many ways. For example, if a species goes extinct, all of the species used to feeding on it must find another source of food. Say a population of freshwater frog dies because its habitat has been depleted in a drought. This means the population of birds that feeds on this frog may decline as well, as it lacks sufficient food. Conversely, the insects that the frogs fed on may increase in number, as the frogs are no longer around to keep their population in check.

One of the many advantages of biodiversity is that there are certain natural processes that plants and animals perform that humans simply cannot. The billions of bees in the world play a critical role in pollinating the world's flowers. If they did not do this, the food supply would dwindle, and the human population would suffer greatly.

Biodiversity can play an important function in the cleaning of water. When water passes through lakes, wetlands, and streams, it often encounters different species of fungi, algae, and bacteria. Many of the microbes actually filter microscopic particles out of the water, making it safe for humans to drink. Even some larger species do similar work. For example, the caddisfly constructs nets underwater that filter out different kinds of particles, which it then eats. Wetlands rich with these underwater organisms act as natural water filtration systems. When the biodiversity of a region declines, many of the organisms critical to this filtering process can disappear. Therefore, pressures on the freshwater supply can cause biodiversity to decrease, which can cut the drinkable water supple even further.

While humans do have some water filtration plants, these plants are expensive and take a lot of energy to maintain. For centuries the water that flowed into New York City was naturally filtered by a northern watershed. As the water flowed south, it was purified. However, as the watershed was polluted and diverted, the water flowing to New York City was no longer filtered. The city faced a choice of spending \$6 billion to \$8 billion to build a water filtration plant, or just \$1 billion to restore the natural watershed. The city wisely chose the latter option.

Comprehension questions answer key on next page.

How Loss of Water Affects Biodiversity Comprehension Questions ANSWER KEY

1. What is biodiversity? *An abundance of different types of plant and animal species within a particular region.*

2. The cause of humanity's increased water consumption is an increased population. What is the effect?
   - *A. Less potable water, a growing threat to biodiversity*
   - B. More potable water, a growing threat to biodiversity
   - C. Less potable water, a decreased threat to biodiversity
   - D. More potable water, a decreased threat to biodiversity

3. What is this passage mostly about?
   - *A. The effects of water loss on biodiversity*
   - B. The drought in Kenya from 2007-2009
   - C. The distribution of the world's fresh water
   - D. The effects of population growth on the water supply

4. Read the following sentences: "Say a particular species of freshwater frog dies because its habitat has been depleted in a drought. This means the population of birds that feeds on this frog may decline as well, as it lacks sufficient food. Conversely, the insects that the frogs fed on may increase in number, as the frogs are no longer around to keep their population in check."

   What does the word "conversely" mean?
   - A. In the same vein
   - B. For this reason
   - C. As an example
   - *D. On the other hand*

5. Choose the answer that best completes this sentence: Humans can affect access to fresh water in many ways, __________ polluting bodies of water and building dams.
   - A. Finally
   - *B. Such as*
   - C. Initially
   - D. Although

6. What makes the conservation of fresh drinking water so important? *The small amount of drinking water makes its conservation important so that water shortages occurring in some regions do not spread further.*

7. Describe a problem caused by losses in biodiversity. *i.e. If tourism in Kenya declines due to high wildlife casualties, then the locals who depend on income from tourism will lose their livelihood.*

8. How might humans help prevent losses in biodiversity? Use information from the passage to support your answer. *Humans can keep bodies of water clean, reduce impacts from dams and build wetlands.*

Source: ReadWorks

Colorado Springs Utilities
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Student worksheet

How Water Loss Affects Biodiversity

Materials Needed:
- Pencil

Directions:

- Read the article about how water loss affects biodiversity.
- Answer reading comprehension questions.
- Check your answers with your teacher.
- Think about ways you can help prevent water loss and impacts to biodiversity.

Read the passage to learn how the lack of water affects plants, animals and people, then answer comprehension questions to test your understanding.

In order for humans to live, they need access to fresh water. Only .03% of the world's total water is accessible for humans to use for drinking. The small amount of potable (suitable for drinking) water makes its conservation incredibly important so that water shortages already occurring in some regions do not spread further. If they do spread, this may lead to conflicts over the right to use this water.

There are many ways in which humans can affect access to fresh water. For example, humans can pollute bodies of water, thereby making them undrinkable. In some cases, they may make physical changes to the land by building over wetlands or damming up rivers. While wealthy countries can afford to make the investments necessary to make sure their residents have access to fresh water, poorer countries often cannot. This means that poorer countries are at greater risk of devastating droughts, which can lead both to dehydration and starvation, as the country is unable to water its crops.

Droughts can also have a negative impact on the biodiversity of a region. Biodiversity refers to an abundance of different types of plants and animal species within a region. The prefix "bio" means living, while "diversity" refers to different types of things. Around the world, more than 125,000 animal species live entirely in freshwater habitats, including 15,000 species of fish 4,300 species of amphibians, and 5,000 species of mollusks, such as clams and oysters. Millions of other species, including humans, depend on fresh water to drink. When an area loses a large percentage of its fresh water, many animals die off. In some cases, species go entirely extinct. This leads to a decrease in the region's biodiversity.

In Africa, where droughts are common, they have been more prolonged than in the past. This is due in part to climate change, as well as a greater demand for water as the continent's population has increased. During a drought in Kenya that lasted from 2007-2009, over 60 elephants died-some of dehydration, others of starvation due to lack of vegetation to eat, and others of diseases that became fatal due to the elephants' weakened states. Some other endangered animals, such as the white rhinoceros, died too, which brought them closer to extinction.

When the biodiversity of a region declines, the human population suffers as well, in different ways. When a region experiences a significant drought, many animals many die from lack of water and food. If the region is one like Kenya, which depends on its wildlife to draw tourists, the effects of the drought can be devastating. If tourism declines due to high wildlife casualties, then the locals who depend on the income from tourism will lose their livelihood. People may then turn to farming to earn money, but crops will require water to grow. This can place further strain on the water supply and worsen the original problem of the drought.

Sometimes, an imbalance in the system, such as a lack of water, can enter into the feedback loop where the situation only gets worse and worse.

Losses in biodiversity can also lead to problems with the availability of food. As we've discussed, a lack of water can prevent farmers from growing crops, which can lead to starvation. However, when a region loses its biodiversity, it disrupts the food chain in many ways. For example, if a species goes extinct, all of the species used to feeding on it must find another source of food. Say a population of freshwater frog dies because its habitat has been depleted in a drought. This means the population of birds that feeds on this frog may decline as well, as it lacks sufficient food. Conversely, the insects that the frogs fed on may increase in number, as the frogs are no longer around to keep their population in check.

One of the many advantages of biodiversity is that there are certain natural processes that plants and animals perform that humans simply cannot. The billions of bees in the world play a critical role in pollinating the world's flowers. If they did not do this, the food supply would dwindle, and the human population would suffer greatly.

Biodiversity can play an important function in the cleaning of water. When water passes through lakes, wetlands, and streams, it often encounters different species of fungi, algae, and bacteria. Many of the microbes actually filter microscopic particles out of the water, making it safe for humans to drink. Even some larger species do similar work. For example, the caddisfly constructs nets underwater that filter out different kinds of particles, which it then eats. Wetlands rich with these underwater organisms act as natural water filtration systems. When the biodiversity of a region declines, many of the organisms critical to this filtering process can disappear. Therefore, pressures on the freshwater supply can cause biodiversity to decrease, which can cut the drinkable water supple even further.

While humans do have some water filtration plants, these plants are expensive and take a lot of energy to maintain. For centuries the water that flowed into New York City was naturally filtered by a northern watershed. As the water flowed south, it was purified. However, as the watershed was polluted and diverted, the water flowing to New York City was no longer filtered. The city faced a choice of spending $6 billion to $8 billion to build a water filtration plant, or just $1 billion to restore the natural watershed. The city wisely chose the latter option.

Comprehension questions on next page.

How Water Loss Affects Biodiversity – Comprehension Questions

1. What is biodiversity?

2. The cause of humanity's increased water consumption is an increased population. What is the effect?
   A. Less potable water, a growing threat to biodiversity
   B. More potable water, a growing threat to biodiversity
   C. Less potable water, a decreased threat to biodiversity
   D. More potable water, a decreased threat to biodiversity

3. What is this passage mostly about?
   A. The effects of water loss on biodiversity
   B. The drought in Kenya from 2007-2009
   C. The distribution of the world's fresh water
   D. The effects of population growth on the water supply

4. Read the following sentences: "Say a particular species of freshwater frog dies because its habitat has been depleted in a drought. This means the population of birds that feeds on this frog may decline as well, as it lacks sufficient food. Conversely, the insects that the frogs fed on may increase in number, as the frogs are no longer around to keep their population in check."

   What does the word "conversely" mean?
   A. In the same vein
   B. For this reason
   C. As an example
   D. On the other hand

5. Choose the answer that best completes this sentence: Humans can affect access to fresh water in many ways, __________ polluting bodies of water and building dams.
   A. Finally
   B. Such as
   C. Initially
   D. Although

6. What makes the conservation of fresh drinking water so important?

7. Describe a problem caused by losses in biodiversity.

8. How might humans help prevent losses in biodiversity? Use information from the passage to support your answer.

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WATERSHEDS, STORMWATER and WATER QUALITY

(Red Colored Section)

- Fire and Flooding*
- Hard Water, Soft Water
- Stormwater Soup*
- Pollution Patrol
- Clean Up the Water!

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Teacher info and answer key

Fire & Flooding*

Grade level: 2nd – 8th
Standard/GLE Code: SC.2.3.2, SC.5.3.3, SC.MS.3.6
Time commitment: 40 minutes
Materials Needed:

- Six 9 oz. clear plastic cups
- One cookie sheet or tray
- Two clear liter bottles
- Two 2X2 inch squares of screen material
- Two rubber bands
- Paper towels
- Access to water
- Two cups of pea gravel
- One cup forest duff/soil
- One cup ash
- Optional: pH paper; total dissolved solids (TDS) meter; data sheet.

Educational Messages:

- Students will learn about the Colorado Springs water collection system, how a fire can impact the watershed, and conduct an experiment to observe run-off and water quality impacts from burned and unburned areas.
- Simulate a rainstorm to observe the difference in the volume of run-off from an unburned area versus a high intensity burn area associated with the Waldo Canyon fire; measure pH and Total Dissolved Solids (TDS) to determine water quality impact to the watershed from the burn area.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Colorado Springs Utilities collects water from streams and reservoirs the mountains to use as our drinking water supply. If a fire burns in the forest, does that impact our water system?

Prep:
Cut off bottoms of clear 1-liter bottles, attach screen with rubber band onto the mouth of the bottles. Fill 1 cup gravel into each inverted bottle. Top with forest soil in one bottle, and ash in the other. Mark 300 ml water level on clear plastic 9 oz. cups; fill two of those cups with 300 ml of water. Set out tray lined with paper towels, and place soil samples and cups on tray.

Problem: After the Waldo Canyon Fire, the Pikes Peak region, including the Fountain Creek Watershed, experienced seven times the erosion rate, which significantly impacted neighborhoods, the environment and urban infrastructure.

Research/Background Information:

The human-caused Waldo Canyon fire started on June 23, 2012, and burned 18,247 acres west of Colorado Springs. The fire burned primarily Ponderosa Pine and mixed conifer stands. The burn area covers multiple tributaries to the Fountain Creek and Monument Creek watersheds that are tributaries to the Arkansas River drainage. According to the initial Burned Area Emergency Response report, areas of low soil burn severity (41% of burn area) still have intact ground cover and are not expected to have an increased watershed response. Moderate soil burn severity areas (40% of burn area) have reduced ground cover and some loss of organics in the soil. These areas are expected to respond similarly to areas of high soil burn severity (19% of burn area). Students can access this report at http://inciweb.nwcg.gov/photos/COPSF/2012-06-23-16:51-waldo-canyon-fire/related_files/ftp-20120720-174350.pdf

Colorado Springs Utilities operates several key water utility features in the burn area, such as pipelines and drinking water reservoirs. Three drinking water reservoirs were directly impacted by the fire, or flood run-off after the fire (Nichols, Rampart and Northfield reservoirs). Due in part to sediment erosion and debris, Nichols and Northfield reservoirs were de-commissioned. Rampart Reservoir holds transmountain diversion water that has been piped from up to 100 miles away and supplies up to 80% of the water supply for Colorado Springs. This reservoir is located within the Waldo Canyon burn area, but fortunately does not receive significant run-off from high intensity burn areas.

Inquiry Questions

Is a wildfire always bad?

Fire is a natural part of the ecosystem and can have beneficial consequences such as increasing nutrients in the soil, releasing seeds for new growth, and reducing plant density and competition for resources (remaining trees can grow stronger). Land management professionals and firefighters sometimes purposely start fires, known as “controlled burns” or “prescribed burns” to reduce the amount of forest litter fuel and thin the forest. If a forest fire burns along the ground, the heat intensity is lower and the root network is not damaged. However, if the fire moves into the tops of the trees, the heat intensifies and becomes extremely damaging.

What is a hydrophobic soil?

Hydro is a Greek word meaning water. Phobic means to have a fear of something. Hydrophobic soils are “afraid of water” and repel rain. Hydrophobic soils are created when hydrocarbon residue is created after organic material is burnt at high temperatures (349 – 550 degrees Fahrenheit) and soaks into empty pore spaces in the soils, making it impervious to water. After a high-intensity heat wildfire, a hard, waxy or glass-like layer can be found a few inches below the ash surface. Hydrophobic soils cannot absorb water, have collapsed or filled pore spaces, and cannot support plant growth because the naturally occurring microbes and organic material have been incinerated.

Will hydrophobic soils recover naturally over time?

The waxy coating will eventually thin and break down over time (usually within 6 years), however, the pore spaces have collapsed, so air and water does not penetrate the soil. In addition, the microbes, micro risers and nutrients needed to support living things have been killed by the high temperatures. Over long periods of time (decades), nature can rebuild itself. Humans can restore a high intensity burn area in a shorter amount of time by scourging the soil to break up the hard layer, aerating the soil to allow air in, and tilling in organic material with microbes and nutrients. Typically, native grass seeds are distributed first because the soil will need a few years to rebuild itself before it can support tree growth.

Fire Run-Off Experiment Instructions:

Materials at each experiment station –

- 1 box of pH paper
- 1 Total Dissolved Solids (TDS) meter
- 1 tray
- Paper towels
- 6 clear 9 oz. cups
- 1 unburned soil sample
- 1 burned soil sample
- Data sheet

Set-up -

1. Place a sheet of paper towel on the tray
2. Set soil samples on top of the 2 clear cups that have binder clips (the clips provide an air break) and place them on the tray.
3. Fill 2 clear cups with water to the 300 mL mark
4. Place the remaining 2 empty clear cups so they are positioned below the spout of the soil sample.
5. Set the pH paper and TDS meter nearby, but not on the tray (to avoid the pH paper from getting wet) if spills occur, which are highly likely.

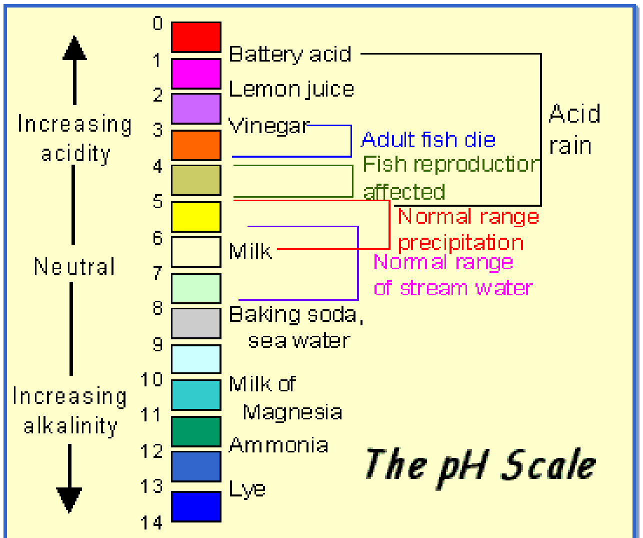
Experiment Procedure – Run-Off

- Students should make predictions on their data sheets of how much water will soak into the ground (flow through the sample into the cup below), and how much will run-off the surface (flow off the spout into the empty cup).
- Instruct students to keep cups and soil samples on the tray (they tip over easily and leak)
- Students should designate who will be the pourers (2). Pourers need to pour the water onto the top of the soil sample in a slow and steady stream that lasts roughly 10 seconds. They may want to practice pouring first. Pour entire contents onto the soil sample and don't stop if run-off occurs.
- Other students will need to assist will holding the spout slightly downward to point to the cup (otherwise the water will dribble down the sides of the soil sample container and miss the cup intended to capture run-off).
- Write down actual observed results on data sheets.

Experiment Procedure – Water Quality Measurements

Each experiment station has a packet of pH paper and a total dissolved solids (TDS) meter for students to measure basic water quality parameters. They will measure run-off water captured from both soil types. If there isn't enough run-off from the un-burned soil sample, then students can gently lift the sample off the cup and test the water that infiltrated the ground instead.

- Explain that pH measures the acidity or alkalinity of a liquid. Ideal pH for stream health is 7.



Courtesy of Environment Canada (http://www.ns.ec.gc.ca/)

- Have students guess on their worksheets if the pH of the run-off water from the burned area will be different from the water draining from the un-burned soil.

- For measuring the pH, remove 2 strips from the pH box, then replace the lid. Hold one strip on the blank side in the right hand and dip the colored tabs into the water for 10 seconds; then remove it and compare it to the key on the box. The line where all three-color tabs

  match the best will be the pH. Repeat for the other run-off water sample and record data on worksheet.

- Total dissolved soilds is a measure of anything attached to the water molecule, such as minerals and salts. Generally, water considered drinkable has less than 500 mL TDS, ideally less than 100 mL. Have students estimate if the TDS will be different between the two run-off water samples.

- To measure the total dissolved solids, first remove the cap on the meter and turn the unit on. Submerge the probe completely in the water and wait a few seconds for the reading to stabilize. Write down the result, which will be in parts per million. Note: There may be a flashing x10 – if so, then multiply the number on the display by 10.

  NOTE: Add a scoop of fresh ash before running the experiment again so that TDS levels are accurate.

Experiment Clean-up:

- Relatively clear water can be poured down the sink.
- Burn area runoff water is best collected in a tub or pitcher and poured onto the soil near a pine tree, if possible, to help neutralize the pH of this water.
- Used pH strips can be disposed of in the trash.
- TDS meters should be rinsed with clean water, recapped and turned off.
- Cups should be rinsed and dried. DO NOT stack wet cups.

- Soil samples should be placed upright in the drying racks overnight before returned to the cardboard box container.
- Trays should be rinsed and dried.
- Don’t forget to return the flash drive to the Teacher Guide binder.

Source: Colorado Springs Utilities

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Student worksheet

Fire and Flooding

Materials Needed:

- Run off kit provided by teacher
- pH paper
- TDS meter

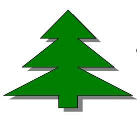
Directions:

- Simulate a rainstorm in an unburned area and a burned area
- Observe and record runoff
- Measure PH of run-off water
- Measure total dissolved solids of runoff water

Name:

____

Step 1: Predict what will happen when you pour 300 mL of water into the soil samples from an unburned area and a burned area. Write your predictions in the boxes below.



Unburned Soil Sample

Prediction: _______ mL will runoff and

_______ mL will soak into ground

Actual Results*:* _______ mL ran off

_______mL soaked into ground

Burned Soil Sample

Prediction: _______ mL will runoff and

_______ mL will soak into ground

Actual Results*:* _______ mL ran off

_______mL soaked into ground

Step 2: Pour 300 mL of water over each soil sample simulating a rain event. Record results in boxes under “actual results”.

Step 3: Predict and then perform pH water quality measures to understand how the pH of runoff water is affected by high intensity fire.

Ph of Runoff

Prediction: pH of burned soil runoff will be **higher/lower/the same** (circle one) as the pH of unburned soil.
***Actual Results**:* _______ pH of burned soil
_______ pH of unburned soil
pH scale is 0 - 14 <7 = acidic 7 = neutral >7 = basic

Total Dissolved Solids (TDS) of Runoff

Prediction: TDS of burned soil runoff will be **higher/lower/the same** (circle one) as the TDS of unburned soil.
***Actual Results**:* _______ TDS of burned soil
_______ TDS of unburned soil
Expected TDS for good quality water is < 100 Secondary, aesthetic Drinking Water Standard for TDS ≤ 500 mg/L

Step 4: Predict and then measure the total dissolved solids (TDS) of the runoff water from the burned and unburned areas to evaluate impacts of fire on water quality.

Step 5: Write conclusions of your data:

Word bank		
Environment	Hydrophobic	Runoff
Erosion	Reservoir	Watershed
High intensity	Restoration	

Were your hypotheses correct? Describe your results.

____
____
____
____

Explain how fire and flooding are related.

____
____
____
____
____

How can water quality and water supply be impacted by a fire?

____
____
____
____

Think of a solution to the flooding problem.

____
____
____
____
____
____

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Teacher info and answer key

Hard Water, Soft Water

Grade level: 2^{nd} – 6^{th}
Standard/GLE Code: SC.2.1.1, SC.4.1.5, SC.5.1.1, SC.MS.1.5
Time commitment: 30 minutes
Materials Needed:

- Distilled water
- Tap water
- Bottled mineral water
- Salt water
- Food coloring
- Liquid soap
- Four empty, clean baby food jars per group (complete with lids)
- One eye dropper per group
- Paper and pen to record results

Educational Messages:

- Students will observe, classify, and order water samples according to their degree of hardness or softness.

Background: When water is considered pure, it is made up of two hydrogen atoms and one oxygen atom-H_20. But water mixes with many things. A raindrop mixes with minerals in the soil and carries those minerals with it to the groundwater or toward a stream or river. When water has high concentrations of calcium and magnesium (types of minerals), it is known as hard water. When water has low concentrations of calcium and magnesium, it is generally called soft water. Distilled water is soft water because it has very low or no mineral content through the distillation process.

Hard water can cause problems in plumbing because it deposits minerals in the pipes, causing a buildup which restricts water flow. You can tell if you have hard water at home because it is hard to get a lather when shampooing and bubble sculpting while you are washing dishes by hand isn't possible. Soft water produces more suds and therefore, is better for cleaning. Many people put water softeners in their homes for that reason. This equipment uses salts to remove most of the calcium and magnesium from the tap water.

Procedure:

- Divide the students into small groups.
- Mix a saltwater solution using one tablespoon of salt per liter of tap water.
- Color the tap water red, the distilled water blue, the salt water yellow and the bottled mineral water green.
- Pour ¼ cup of each water sample into the baby food jars.
- Add two drops of liquid soap into each sample.
  - Have the students predict which of the samples will suds up more.
  - Have students determine what might affect the amount of suds.
  - Have one student per group record the predictions and results on a sheet of paper.
- With lids secured, shake each jar for one minute.

- Encourage the students to use equal force while shaking.
- Gather the results for further discussion.

- Explain hard and soft water to the class.
  - Calcium and magnesium cause the soap to separate from the water resulting in little or no suds.
  - In distilled water, these minerals have been removed and it should create suds like crazy.

Extensions: Make a survey and graph the results. Test rainwater, melted snow, and lake, creek or pond water and add those to the results. Have the students bring in samples from home and test their own water. Which is cheaper, tap water or softened water? Make a graph of the costs. Have the students run a survey on who uses bottled water and why. Write a letter to a water softener company or have a representative visit the classroom. Try using some water softening salts to soften a hard water sample.

Evaluation: How did the prediction compare to the results? Students should be able to describe the difference between hard and soft water, which is better for cleaning and other benefits of soft water over hard water.

Source: Nebraska Groundwater Foundation

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Teacher info and answer key

Stormwater Soup*

Grade level: 2nd – 5th
Standard/GLE Code: SC.2.3.2, SS.3.2.1, SC.4.3.5, SC.5.3.5
Time commitment: 30 minutes
Materials Needed:

- Clear container, about 16 oz. size
- Water
- Salt
- Kool-aid packet, blue color is best
- Molasses, corn syrup or oil
- Litter, candy wrappers
- Grass clippings
- Dirt
- Milk Duds or Whoopers
- Dish soap
- Stir stick
- Labels for containers (included below)
- Student scripts (included below)

Educational Messages:

- Students learn how everyday behaviors impact water quality by participating in a demonstration and reading scripts.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Problem: Stormwater runoff picks up pollutants that degrade water quality of our creeks and streams.

Background Information: Stormwater runoff is rainfall that flows over the ground surface. It is created when rain falls on roads, driveways, parking lots, rooftops and other paved surfaces that do not allow water to soak into the ground. Stormwater runoff is the number one cause of stream impairment in urban areas.

Procedure: Fill the clear container about halfway full of clear water. Discuss why clean water is important, define pollution and ask students how water can get polluted. The demonstration shows how everyday behaviors could affect stormwater quality. Have students take turns reading the scripts and add ingredients to the clean water.

Script:
I have perfected a tasty new Stormwater Soup that I want to make for you today. We're going to meet the Smith Family and see how their everyday behaviors impact water quality. Then we'll talk about ways we can prevent pollution.

- *Water – in a clear container*
  Water is the key ingredient of this recipe and a necessary ingredient for all life…. more on available fresh water, where our water comes from, etc.

- *Fertilizer/pesticides - packet of Kool-Aid*
  Mr. Smith wants to have the greenest lawn on the block, so he bought a brand of fertilizer with lots of phosphorus and added LOTS of it to his lawn. He forgot to check the forecast, because that night it rained and rained…where did the fertilizer go?

- *Vehicle Oil and fluids – use molasses, corn syrup or oil*
  Mr. Smith is a do-it-yourself guy and he likes to tinker with his car. He thought he would change his oil, and some of it ended up dripping on his driveway. No big deal – until that thunderstorm rolled in.

- *Litter – candy wrappers*
  Teenager Susie Smith loves candy and keeps it in her car so her parents won't yell at her for eating it. So on her way home from school, she'll toss the "evidence" out her car window.

- *Dog Poop – Milk Duds or Whoppers*
  The Smiths have a dog and enjoy taking Buddy for a walk to the neighborhood park so the dog will "do his doody" there instead of on their lawn. They often forget to bring a plastic bag to pick up after him.

- *Grass Clippings and Leaves – in a container*
  Mrs. Smith loves tending her yard. But she hates raking up clippings and leaves, so she gets out her leaf blower and sends them into the storm drain by her curb – out of sight, out of mind!

- *Dirt – in a container*
  Mrs. Smith is adding a new garden plot in her yard. She had a load of compost delivered to her driveway, but only spread half of it on her garden before the rain came in. She quickly ducked inside the house, leaving her exposed compost pile to wash into the street.

- *Soap – dish soap*
  Johnny Smith loves keeping his shiny big red truck sparkling clean and washes it in his driveway every chance he gets. Where does that soap go when he hoses it off his car?

- *Salt*
  It is nice to flavor a soup with some salt, which makes me think about how much the Smith's worry about someone falling on their property and suing them. So, they apply lots and lots of salt to their driveway, sidewalks, and front porch anytime the snow flies.

Let's mix this soup. Mmmm! How much would you pay for this bowl of soup?
We ALL pay the price for polluted stormwater runoff.

Solutions:

You can help keep our water clean by simply changing your behavior just a little bit! Follow these good housekeeping tips at home and at work. (*Discuss each item while putting the ingredients away*.)

- Fertilizer/pesticides
  You only need to use fertilizer with phosphorus on a lawn in its 1st year or if soil tests show a phosphorus deficiency. Otherwise, use phosphorus FREE fertilizer, follow label directions for when and how much to apply, gently water the lawn after application to soak the fertilizer into the soil and never apply before a big rainstorm. This will help decrease runoff from your yard containing fertilizer that could cause algae blooms in creek water.

- Oil
  Keep your car in good condition – fix leaks! Place cardboard under your oil pan when changing oil to catch drips. Dispose of oils and other hazards properly –NEVER dump oil or any material down the storm drain. Keep kitty litter or rags nearby to absorb spills.

- Litter
  Easy – don't litter! Place your garbage in bags and tie them off before putting them in your garbage bin. Cover your truck beds when hauling materials. Pick litter up when you see it and tell others not to litter.

- Dog Poop
  Be a responsible pet owner…clean up after your pups and dispose of their poop in your trash. Scoop the Poop!

- Grass Clippings and Leaves
  Clean streets mean clean streams. Keep grass clippings and leaves off hard surfaces and out of the street. Mulch them, compost them, or take them to Rocky Top Resources.

- Dirt
  Ever notice how creeks are brown after a heavy rain? If soil leaves your lawn, it will find the river. Keep a vegetated area around your garden, cover dirt piles with a tarp or mulch, seed bare areas right away.

- Soap
  Use a commercial car wash where the soapy water goes into the sanitary sewer and to the wastewater treatment plant for processing. Otherwise, wash your car on the lawn using a phosphorus-free, biodegradable soap.

- Salt
  Salt your meals, not our rivers and lakes. Shovel first and, if you still need traction, apply some sand that can be swept up in the spring and reused. If you need salt to melt ice, choose the right product for the conditions and apply it evenly using a drop spreader. Even in the worst conditions, 3 pounds (about 3 cups) is the right amount for a 1,000 square-foot area.

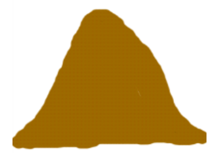
Pet Waste

Vehicle Fluids

Litter

Fertilizer/Pesticides

Grass Clippings



Soil

Salt

Soap

Source: Colorado Springs Utilities

STUDENT SCRIPTS

Mr. Smith wants to have the greenest lawn on the block, so he bought a brand of fertilizer with lots of phosphorus and added LOTS of it to his lawn. He forgot to check the forecast, because that night it rained and rained…where did the fertilizer go?

Mr. Smith is a do-it-yourself guy and he likes to tinker with his car. He thought he would change his oil, and some of it ended up dripping on his driveway. No big deal – until that thunderstorm rolled in.

Teenager Susie Smith loves candy and keeps it in her car so her parents won't yell at her for eating it. So on her way home from school, she'll toss the "evidence" out her car window.

The Smiths have a dog and enjoy taking Buddy for a walk to the neighborhood park so the dog will "do his doody" there instead of on their lawn. They often forget to bring a plastic bag to pick up after him.

Mrs. Smith loves tending her yard. But she hates raking up clippings and leaves, so she gets out her leaf blower and sends them into the storm drain by her curb – out of sight, out of mind!

Mrs. Smith is adding a new garden plot in her yard. She had a load of compost delivered to her driveway, but only spread half of it on her garden before the rain came in. She quickly ducked inside the house, leaving her exposed compost pile to wash into the street.

Johnny Smith loves keeping his shiny big red truck sparkling clean and washes it in his driveway every chance he gets. Where does that soap go when he hoses it off his car?

It is nice to flavor a soup with some salt, which makes me think about how much the Smith's worry about someone falling on their property and suing them. So, they apply lots and lots of salt to their driveway, sidewalks, and front porch anytime the snow flies.

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Teacher info and answer key

Pollution Patrol

Grade level: 2^{nd} – 5^{th}
Standard/ GLE Code: SC.2.3.2, SS.3.2.1, SC.4.3.5, SC.5.3.5
Time commitment: 40 minutes
Materials Needed:

- Student workbook
- Access to internet to play video

Educational Messages:

- Students learn about stormwater runoff by watching the H2O Jo video.
- Students read a water pollution passage and answer questions about storm drains and protecting water quality.
- Students fill in the blanks for a "mad-libs" type watershed story and share the hilarious results.

We all live in a watershed. A watershed is an area of land that drains into a body of water such as a stream, river, lake or ocean. Small watersheds are part of larger watersheds. Colorado Springs lies within the Fountain Creek watershed, which flows to the Arkansas River. The Arkansas River flows to the Mississippi River and eventually to the Gulf of Mexico. Your water supply comes from the Arkansas, Colorado and South Platte River watersheds.

There are many ways water can get polluted. Pollution is anything that can make the water unsafe or unhealthy such as trash, dirt and oil. Water does not only get dirty from people dumping directly into it. Things that happen in our everyday lives, far away from creeks, end up polluting our water. Stormwater runoff is rainwater that flows into creeks. This water can collect debris, trash, chemicals, dog waste and other pollutants which degrade our water quality.

Suggested format:

1. Introduce your students to stormwater pollution by having them watch the eight-minute video on YouTube titled "H2O Jo Takes a Ride through the Storm Drain".
2. Brainstorm ways that students can keep water clean.
3. Have students work on the Pollution Patrol student page in small groups.
4. Student groups can read their Watershed-libs story to the rest of the class.

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Pollution Patrol Student Page ANSWER KEY

There are many ways water can get polluted. Pollution is anything that can make the water unsafe or unhealthy such as trash, dirt and oil. Water does not only get dirty from people dumping directly into it. Things that happen in our everyday lives, far away from creeks, end up polluting our water. Stormwater runoff is rainwater that flows into creeks. This water can collect debris, trash, chemicals, dog waste and other pollutants which degrade our water quality.

The storm drains you see under the curbs on the street lead directly to creeks and streams. Each time the sidewalk and street get wet, pollutants such as litter, motor oil, pet waste, leaves, grass clipping, fertilizer and spilled chemicals wash down the storm drain. These pollutants make their way to our creeks and streams. You can help prevent pollution from getting into our creeks and streams.

1. Where do storm drains lead?

 ___Storm drains lead directly to creeks and streams. ___

2. Who is responsible for reducing water pollution? ___ YOU. It is everyone's responsibility to protect their waterways.__

3. Think of three things you can do to reduce water pollution:

   a. Pick up trash.

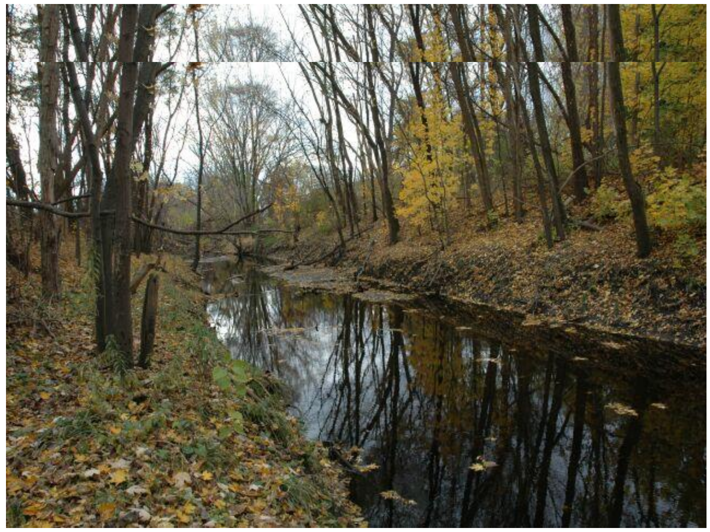
   b. Pick up pet waste.

   c. Rake leaves into piles and place in the compost or dispose in the garbage.

Watershed-Libs

Complete the following for hilarious results.

Complete the following for hilarious results.



Enjoy trails at the Bear Creek Nature Center which follow the creek where you can observe wildlife and enjoy water!

Last week, my friends and I took a hike to the

__________ Creek near our city of
adjective

_____________. The creek ran through an
place

open field and some __________ trees. It
adjective

really was a __________ place to see! After
adverb

we hiked along the creek, we decided to go

______________ down the creek to learn
verb ending in -ing

more about the watershed. Some of the creek's flow is diverted into a reservoir that stores

Colorado Springs drinking water. Some of those reservoirs offer a chance to ___________! In
verb

the creek water we saw sediment that eroded from nearby hills. We also saw a __________
noun

floating in the water. We have to keep this water clean! There were small trout in the Creek and

a __________ _______________ on the shore. Suddenly we saw _____________ had
adjective animal proper name

______________ into the water. My friend discovered a ____________. We shouted:
verb ending in -ed natural object

____________! We took it back to school to study under a microscope. Creeks are always so
funny expression

much __________________
adjective

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Student worksheet

Pollution Patrol

Materials Needed:
- Pencil

What you'll do:

- Read about water pollution.
- Answer questions about storm drains and protecting water quality.
- Fill in the blanks for a "mad-libs" type story and share the hilarious results.

There are many ways water can get polluted. Pollution is anything that can make the water unsafe or unhealthy such as trash, dirt and oil. Water does not only get dirty from people dumping directly into it. Things that happen in our everyday lives, far away from creeks, end up polluting our water. Stormwater runoff is rainwater that flows into creeks. This water can collect debris, trash, chemicals, dog waste and other pollutants which degrade our water quality.

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1. Where do storm drains lead?

   ____

   ____

2. Who is responsible for reducing water pollution?

   ____

   ____

3. Think of three things you can do to reduce water pollution:

   a. ____

   b. ____

   c. ____

Watershed-Libs

Complete the following for hilarious results.

Last week, my friends and I took a hike to the

__________ Creek near our city of
adjective

_____________. The creek ran through an
place

open field and some __________ trees. It
adjective

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Enjoy trails at the Bear Creek Nature Center which follow the creek where you can observe wildlife and enjoy water!

______________ down the creek to learn
verb ending in -ing

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verb ending in -ed natural object

____________! We took it back to school to study under a microscope. Creeks are always so
funny expression

much __________________.
adjective

Clean Up the Water!

Grade level: 2nd – 6th
Standard/GLE Code: SC.2.3.2, SS.3.2.1, SC.4.3.5, SC.5.3.5
Time commitment: 45 minutes
Materials Needed:
Each group of students should have:
- Clear plastic cup filled halfway full of water (represents a lake)
- Vegetable oil (represents car oil)
- Chocolate sprinkles (represents solid animal waste)
- Green sprinkles (represents fertilizer)

Educational Messages:

- Students determine the effect of various types of pollutants on water, and ways to clean it up.

Pollution clean-up supplies:
- Small paper plate or bowl
- 1 cotton ball
- Spoon
- Toothpick

Problem: Once water has been polluted, how can it be cleaned up?

Procedure:
1. Observe how your lake looks at the beginning. Write a sentence in the data collection chart describing how your lake looks.
2. Pour the "car oil" into your lake. Observe how this affects your lake. Write a sentence about it.
3. Add the "solid animal waste" to your lake. Observe how this affects your lake and write a sentence about it.
4. Add the "fertilizer" to your lake. Observe how this affects your lake. Write a sentence about it.
5. Discuss ideas of how you might go about cleaning up your lake with the materials provided.
6. Now, when the teacher indicates it is time work together with materials provided to clean up your lake. You have 3 minutes! You may not use your hands to remove pollution (just the materials provided)!
7. After you clean up your lake, answer these questions:
   - Which waste(s) were you able to clean up completely?
     a. Car oil b. Solid animal waste c. Fertilizer d. None
   - Which waste(s) were you able to partially clean up?
     a. Car oil b. Solid animal waste c. Fertilizer d. None
   - Which waste(s) were you not able to clean up at all?
     a. Car oil b. Solid animal waste c. Fertilizer d. None

- Is the car oil, solid animal waste and fertilizer point source or non-point source pollutants? (Pollution originating from a single, identifiable source, such as a discharge pipe from a factory or sewage plant, is called point-source pollution. Pollution that does not originate from a single source, or point, is called nonpoint source pollution).

- Why?____
____
____
____

Clean Up the Water! Data Collection/Observations:

Clean Lake	
Car Oil	
Solid Animal Waste	
Fertilizer	

Source: Adapted from materials written by Laurel Laumann, 6th grade Teacher, Mrachek Middle School. Used with permission.

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Student worksheet

Clean Up the Water!

Materials Needed:
Each group of students should have:
- Clear plastic cup filled halfway full of water (represents a lake)
- Vegetable oil (represents car oil)
- Chocolate sprinkles (represents solid animal waste)
- Green sprinkles (represents fertilizer)

Pollution clean-up supplies:
- Small paper plate or bowl
- 1 cotton ball
- Spoon
- Toothpick

Directions:

- Once water has been polluted, how can it be cleaned up? In this exercise you will determine the effect of various types of pollutants on water, and ways to clean it up.

Procedure:
Observe how your lake looks at the beginning. Write a sentence in the data collection chart describing how your lake looks.

Pour the "car oil" into your lake. Observe how this affects your lake. Write a sentence about it.

Add the "solid animal waste" to your lake. Observe how this affects your lake and write a sentence about it.

Add the "fertilizer" to your lake. Observe how this affects your lake. Write a sentence about it.

Discuss ideas of how you might go about cleaning up your lake with the materials provided.

Now, when the teacher indicates it is time work together with materials provided to clean up your lake. You have 3 minutes! You may not use your hands to remove pollution (just the materials provided)!

After you clean up your lake, answer these questions:

- Which waste(s) were you able to clean up completely?
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- Which waste(s) were you not able to clean up at all?
  a. Car oil b. Solid animal waste c. Fertilizer d. None

- Is the car oil, solid animal waste and fertilizer point source or non-point source pollutants? (Pollution originating from a single, identifiable source, such as a discharge pipe from a factory or sewage plant, is called point-source pollution. Pollution that does not originate from a single source, or point, is called nonpoint-source pollution).

- Why?____
____
____
____

Clean Lake	____________________ ____________________ ____________________
Car Oil	____________________ ____________________ ____________________
Solid Animal Waste	____________________ ____________________ ____________________
Fertilizer	____________________ ____________________ ____________________

Clean Up the Water! Data Collection/Observations:

WATER SUPPLY and TREATMENT (Purple Colored Section)

- Engineering a Water System*
- Water Filtration Experiment – Make Drinking Water
- Cathodic Protection*

Teacher info and answer key

Engineering a Water System*

Grade level: 3rd – 8th
Standard/GLE Code: SS.3.2.1, SC.4.3.4, SC.5.3.3, SC.MS.3.6
Time commitment: 25 minutes
Materials Needed:

- Labeled photos of the major components of a raw water system (attached)
- Descriptions of those components
- Ways for students to arrange and label photographed components to lay out their own system

Water Pipeline Game pieces:

- 40 white ping pong balls
- 40 blue ping pong balls
- 14 pieces of 2" PVC pipe cut in half
- 6 mixing bowls
- 2 buckets

Educational Messages:

- Demonstrate the components of a raw water system and how it works.
- Intro/explain water system components and functions.
- Break out small groups to assemble pictures in flow order.
- Groups compare and explain their picture order to others.
- Split into two groups – teams receive set of pipeline game components and decide how they want to assemble themselves – run a few whiffles balls and then challenge.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Prep: Have a way for students to label the photographs (dry erasers or sticky notes) as they work and learn about each component.

Script:

Water in Colorado is hard to come by. With just 16 inches of precipitation a year, Colorado Springs faces a challenge to meet the water demands of the city. Most of Colorado's water falls

in the form of snow on the western slopes of the Continental Divide. However, most of the people in Colorado live on the eastern side of the Continental Divide. To keep all those people supplied with water—that's you and me—we have to figure out how to bring A LOT of water from the western slope to town.

Over time, engineers have figured out the best way to move melted snow—your drinking water—from long distances to our city. Here's how it works. First you need a diversion. **A diversion** is the removal of water from its natural course or location—a creek, stream, river—to your water system. Usually that's a canal, pipe or other outlet.

Because Colorado Springs typically gathers water from the western side of the Continental Divide for our own use here on the eastern side of the Continental Divide, the easiest way to get water across those mountains is through a tunnel. **A tunnel** is a below-ground channel used to move water from other areas. Our tunnels move water through the Rocky Mountains.

Snow melts during a short period of the year, but we need water all year round. We need a place to store all that snow melt so we have water when we need it. **A reservoir** is a human-made lake created by a dam to store water. **A dam** is used to create a reservoir. It is a barrier designed to hold water in a designated area like a reservoir. It can be made out of natural materials (boulders and soil) or a combination of natural and man-made materials (asphalt, cement).

When we need water held in a reservoir, we bring the water to town through a series of pipes or natural waterways. **A pipeline** carries or moves water, sometimes over large distances. Our water comes as far as 100 miles away. Sometimes, when water has to move uphill to get from the place where we divert it to our city, we use a pump station. **A pump station** is an electric-driven system that moves water uphill or over higher elevations. We use energy to give water a push, so it flows uphill or up and over a higher elevation to get it to town.

Before we drink all that melted snow, we need to clean our water to assure it's healthy and of good quality. **Water treatment** cleans water to national drinking standards before it is delivered to your home or school. Our drinking water is mostly "first use" water—we are the first people to use it once it has been cleaned up by the water cycle.

Now it is your turn. We will break into small groups, and you'll have 5 minutes to look at the photos I have for you. You must label each photo as a component of your water system (use your worksheet as a reference (see below)). Then place the system components in logical order, showing how each component is found in a water system as it moves water from the mountains to our city.

When students have completed their exercise, ask each group to compare their set of labeled system components with your set. Talk about why they placed system components in the order they did. Is there only one way to build this system?

Now students will have a chance to design their own water system and race water (whiffle balls) to town using the Water Pipeline Game. Break into two teams, explain the pipeline game, and conduct a practice run. Give students a chance to adjust their system design to maximize efficiency. Then conduct the final pipeline official timed race (30 sec) to see who engineered the best water system.

Source: Colorado Springs Utilities

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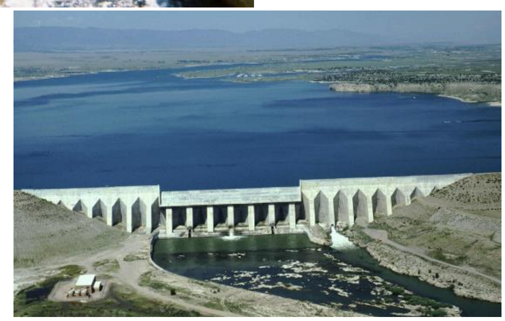
Most major water systems include the following components—all components are of vital importance to assure a healthy water supply for our large community.

Diversion: Removal of water from its natural course or location by canal, pipe, or other conduit.

Tunnel: A below-ground channel used to transport water from other areas. Our tunnels move water through the Rocky Mountains.

Reservoir: A human-made artificial lake, storage pond or impoundment created by using a dam to store water.



Dam: Used to create a reservoir which stores water.

Pump Station: An electric-driven system that moves water uphill or over higher elevations.

Pipeline: Carries or moves water, sometimes over large distances.

Water Treatment: Cleans water to national drinking standards before it is delivered to your home, business or school. Our drinking water is primarily "first source" water—straight from the Rocky Mountains.

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clouds


snow

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reservoir


pipe

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treatment plant


distribution pipe

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home

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Teacher info and answer key

Water Filtration Experiment - Making Drinking Water

Grade level: 2nd – 6th
Standard/GLE Code: SC.7.3.2, SC.4.3.2, SC.5.1.1, SC.MS.1.5
Time commitment: 30 minutes
Materials Needed:
Per group or classroom)

- 1 cup of water with approximately ½ teaspoon dirt (You can substitute with river or creek water.)
- 2 clear plastic cups holding approximately 10 oz. each
- 2 pieces of cheesecloth
- 1 teaspoon powdered alum from the grocery or drug store

Educational Messages:

- Students will be able to describe the methods of purifying water as used by the pioneers, as well as those being used today by water treatment facilities.
- Students add alum to dirty water to observe coagulation, and filter water to clean it up.

Background: The pioneers learned to drink from flowing waters and not from still waters. And while water in lakes, rivers and streams often contain impurities that make them look and smell bad, the water could be "cleaned" to make it safer to drink. The pioneers would use citric acid or alum which took suspended particles and allowed them to sink to the bottom of the bucket. Sedimentation or allowing the water to sit for several hours also took out some impurities. Finally, the pioneers would strain the water through material to take out additional nasties. To further purify the water, especially if diseases were suspected, they boiled the water before drinking. Several of these methods are currently used by water companies to treat our drinking water today. The water that is processed comes from lakes, rivers, streams or groundwater and has usually been transferred and stored before processing. The following steps are typical in a water treatment plant:

Coagulation: To remove dirt suspended in water, powdered alum is dissolved in the water and it forms tiny, sticky particles called "floc" which attach to the dirt particles. The combined weight of the dirt and alum particles becomes heavy enough to sink to the bottom during the next process of sedimentation.

Sedimentation: The heavy particles sink to the bottom and the clear water above the particles pours on to the filtration beds.

Filtration: The clear water passes through layers of charcoal, sand and gravel to remove smaller particles.

Chlorination: The final process where a small amount of chlorine gas is added to kill any bacteria or microorganisms that may be in the water. The pioneers generally boiled their water to kill bacteria and microorganisms.

Procedure:

1. Pass out 1 clear plastic cup that has ½ teaspoon of dirt mixed in the water (or use water from your local river or creek), 2 clear, clean plastic cups and 2 pieces of cheesecloth.
2. Have the students add ½ teaspoon of alum and watch the floc form (flocculation). Allow the cup to sit undisturbed for several minutes (sedimentation).
3. Have the students hold a piece of cheesecloth (representing the charcoal, sand and gravel filter) over the empty cup. Gently pour the top layer of water from the sedimentation cup into one of the empty cups. Pour the water into the second clean, clear plastic cup using the second, clean piece of cheesecloth to cover the top of the cup. Compare the two pieces of cheesecloth (filtration).
4. Discuss with the students the final step necessary to make the water safe to drink (disinfection). How did the pioneers disinfect their water? How do we disinfect our water today?

Extensions:

- Try constructing a water filter using coal, sand, and gravel like the materials in Colorado Springs Utilities water treatment plants (see last page).
- Go on a field trip to your local water treatment plant or invite someone from Colorado Springs Utilities to visit your class.
- Read settler journal entries taking note of references to water quality, quantity and water borne diseases.

Colorado Springs Water System information:

Snowmelt, streams, and rivers are the source of Colorado Springs drinking water. The water is captured in the mountains, stored in reservoirs (human-made lakes) and transported up to 100 miles to town through pipelines. Three river basins supply water to Colorado Springs: 65% from the Colorado River basin, 30% from the Arkansas River basin (this includes water captured from Pikes Peak drainage basins), and 5% from the South Platte River basin. This water is known as "first-use," meaning it comes directly from nature's water cycle process and has not been previously cleaned by humans or used in households or industry. Although this raw water is fairly clean, it is not clean enough for human consumption and must be treated. Raw water is a mixture; the goal of water treatment is to separate the water from other particles, such as bacteria or chemicals, to make it potable. Utilities operates five water treatment plants to clean the water to drinking water standards before they distribute it to customers. Colorado Springs Utilities provides an average of 68 million gallons of water a day.

Also, see Student worksheet

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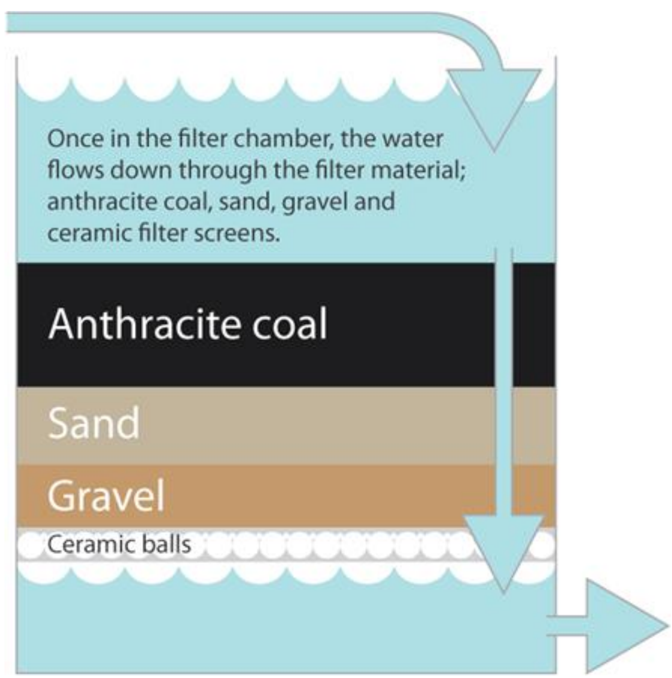
Inquiry Questions

How does the alum make suspended particles stick together?
Alum is the name used for aluminum sulfate, or $Al2(SO4)_3$. Alum's main function is to clarify or floc the water. When alum is rapidly mixed into the water with a pH near 7.0, it forms a gel-like precipitate that bridges or sticks together (coagulation). The precipitate is aluminum hydroxide, chemical formula $Al(OH)_3$. The alum precipitate then forms small bundles (called flocs) that trap suspended particles as they fall through the water. This bridging process is known as flocculation. The water is now mixed slowly so all the particles can collide with each other. Particles are charged, and when those with opposite charges come in contact, they stick together and form larger floc. Imagine two magnets – if you face the two positive ends together or the two negative ends together, they push apart. However, if a positive end meets a negative end, they attract each other.

Why is coal used in the filter? Wouldn't the coal make the water black and dirty?
Not just any coal will do. Colorado Springs Utilities uses anthracite coal because it is very hard (doesn't release coal powder) and can be ground to similar-sized pieces with large surface areas. In the sedimentation step, gravity is not sufficient to remove all of the suspended impurities from water. About 5 percent of the suspended solids may still remain as non-settleable floc particles. These remaining floc particles can cause noticeable cloudiness in the water and may shield microorganisms from the disinfection process. In order to produce a crystal-clear potable (drinkable) water, an additional treatment step, called filtration, is needed. Filtration involves the removal of suspended particles from the water by passing it through a layer or bed of porous, granular material such as sand and coal. As the water flows through the filter bed, the suspended particles become trapped within the pore spaces of the filter material. The pore spaces of anthracite coal are larger than the pore spaces of the sand layer and traps the larger particles and remaining floc. In addition, coal can absorb organics, so bacteria and chemical impurities are trapped in the coal layer.

Is chlorine bad for people? Can the water be disinfected a different way?
Colorado Springs Utilities follows National Drinking Water regulations set by the Environmental Protection Agency (EPA) that require chlorine for disinfection of drinking water supplies. The maximum concentration of chlorine allowed in drinking water is 4 mg/L (EPA standard, the level deemed safe for human health), however, the chlorine levels leaving the water treatment plant are much lower (between 0.6 – 0.7 mg/L). Chlorine at this level meets regulatory requirements and serve the purpose of killing bacteria, without causing health or aesthetic (smell and taste) concerns. There are other ways to disinfect water, such a boiling or using ultra-violet light, however these methods do not meet regulatory requirements.

Colorado Springs Utilities uses anthracite coal, sand, and gravel in our water filter:



Source - Nebraska Groundwater Foundation; Colorado Springs Utilities

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Student worksheet

Water Filtration Experiment – Making Drinking Water

Directions:

- Learn the methods of purifying water used by the pioneers and the process of water purification used in town.
- Read about the Colorado Springs Utilities water system.
- Build a water filter and clean dirty water.
- Take a field trip to the water treatment plant (optional).

Materials Needed:
- 1 cup of water in a clear plastic cup with approximately ½ teaspoon dirt (you can substitute with river or creek water)
- 2 clear plastic cups holding approximately 10 oz. each
- 2 pieces of cheesecloth
- 1 teaspoon powdered alum from the grocery or drug store

The pioneers learned to drink from flowing waters and not from still waters. And while water in lakes, rivers and streams often contain impurities that make them look and smell bad, the water could be "cleaned" to make it safer to drink. The pioneers would use citric acid or alum which took suspended particles and allowed them to sink to the bottom of the bucket. Sedimentation or allowing the water to sit for several hours also took out some impurities. Finally, the pioneers would strain the water through material to take out additional nasties. To further purify the water, especially if diseases were suspected, they boiled the water before drinking. Several of these methods are currently used by water companies to treat our drinking water today.

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Snowmelt, streams, and rivers are the source of Colorado Springs drinking water. The water is captured in the mountains, stored in reservoirs (human-made lakes) and transported up to 100 miles to town through pipelines. Three river basins supply water to Colorado Springs: 65% from the Colorado River basin, 30% from the Arkansas River basin (this includes water captured from Pikes Peak drainage basins), and 5% from the South Platte River basin. This water is known as "first-use," meaning it comes directly from nature's water cycle process and has not been previously cleaned by humans or used in households or industry. Although this raw water is fairly clean, it is not clean enough for human consumption and must be treated. Raw water is a mixture; the goal of water treatment is to separate the water from other particles, such as bacteria or chemicals, to make it potable (safe for drinking). Springs Utilities operates six water treatment plants to clean the water to drinking water standards before they distribute it to customers. Colorado Springs Utilities treats an average of 68 million gallons of water a day.

Water Treatment Process:
Colorado Springs Utilities is fortunate to obtain high quality "raw" (untreated) water from snowmelt off the Rocky Mountains. This water looks clean but can contain sediment and potential pathogens that could cause illness. To meet the Federal and State Drinking Water Standards, we use a traditional, four step water treatment process, similar to the process used by the Egyptians thousands of years ago or the pioneers of more recent time. The four steps of water purification include:

Coagulation: To remove dirt suspended in water, powdered alum is dissolved in the water and it forms tiny, sticky particles called "floc" which attach to the dirt particles. The combined weight of the dirt and alum particles becomes heavy enough to sink to the bottom during the next process of sedimentation.

Sedimentation: The heavy particles sink to the bottom and the clear water above the particles pours on to the filtration beds.

Filtration: The clear water passes through layers of coal, sand, and gravel to remove smaller particles. See last page for pictures of our filter material. The coal layer on top is about 8 feet thick, followed by about 4 feet of sand and 2 feet of gravel on the bottom.

Chlorination: In the final process, a small amount of chlorine gas is added to kill any bacteria or microorganisms that may be in the water. The pioneers generally boiled their water to kill bacteria and microorganisms.

Inquiry Questions

How does the alum make suspended particles stick together?
Alum is the name used for aluminum sulfate, or $Al_2(SO4)_3$. Alum's main function is to clarify or floc the water. When alum is rapidly mixed into the water with a pH near 7.0, it forms a gel-like precipitate that bridges or sticks together (coagulation). The precipitate is aluminum hydroxide, chemical formula $Al(OH)_3$. The alum precipitate then forms small bundles (called flocs) that trap suspended particles as they fall through the water. This bridging process is known as flocculation. The water is now mixed slowly so all the particles can collide with each other. Particles are charged, and when those with opposite charges come in contact, they stick together and form larger floc. Imagine two magnets – if you face the two positive ends together or the two negative ends together, they push apart. However, if a positive end meets a negative end, they attract each other.

Why is coal used in the filter? Wouldn't the coal make the water black and dirty?
Not just any coal will do. Colorado Springs Utilities uses anthracite coal because it is very hard (doesn't release coal powder) and can be ground to similar-sized pieces with large surface areas. In the sedimentation step, gravity is not sufficient to remove all of the suspended impurities from water. About 5 percent of the suspended solids may still remain as non-settleable floc particles. These remaining floc particles can cause noticeable cloudiness in the water and may shield microorganisms from the disinfection process. In order to produce a crystal-clear potable (drinkable) water, an additional treatment step, called filtration, is needed. Filtration involves the removal of suspended particles from the water by passing it through a layer or bed of porous, granular material such as sand and coal. As the water flows through the filter bed, the suspended particles become trapped within the pore spaces of the filter material. The pore spaces of anthracite coal are larger than the pore spaces of the sand layer and traps the larger particles and remaining floc. In addition, coal can absorb organics, so bacteria and chemical impurities are trapped in the coal layer.

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Colorado Springs Utilities follows National Drinking Water regulations set by the Environmental Protection Agency (EPA) that require chlorine for disinfection of drinking water supplies. The maximum concentration of chlorine allowed in drinking water is 4 mg/L (EPA standard, the level deemed safe for human health), however, Springs Utilities uses the lowest concentration of

chlorine allowed by the regulations and the chlorine levels leaving the water treatment plant are much lower (less than 2 mg/L). Chlorine at this level meets regulatory requirements and serve the purpose of killing bacteria, without causing health or aesthetic (smell and taste) concerns. There are other ways to disinfect water, such a boiling or using ultra-violet light, however these methods do not meet regulatory requirements at this time.

Making Drinking Water Experiment Procedure:

1. Get 1 clear plastic cup that has ½ teaspoon of dirt mixed in the water (or use water from your local river or creek), 2 clear, clean plastic cups and 2 pieces of cheesecloth.
2. Add ½ teaspoon of alum and watch the floc form (flocculation). Allow the cup to sit undisturbed for several minutes (sedimentation).
3. Hold a piece of cheesecloth (representing the charcoal, sand, and gravel filter) over an empty cup. Gently pour the top layer of water from the sedimentation cup into the empty cup covered with cheesecloth.
4. Pour the water into the remaining clean, clear plastic cup using the second, clean piece of cheesecloth to cover the top of the cup. Compare the two pieces of cheesecloth (filtration).
5. Read about the final step necessary to make the water safe to drink (disinfection). How did the pioneers disinfect their water? How do we disinfect our water today?

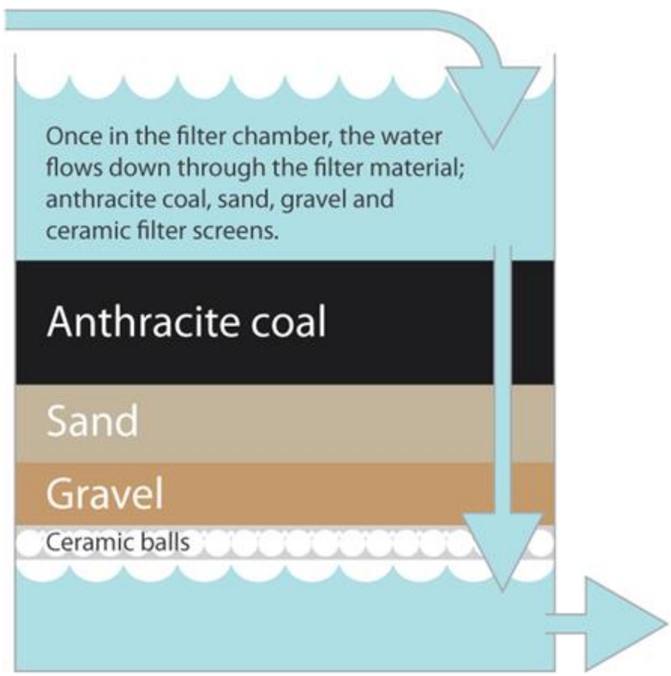
*Although your experiment water may look clean, do not be tempted to drink it because you don't know if it's fully disinfected, even if you boil it for 10 minutes. Colorado Springs Utilities conducts laboratory tests on the treated water to verify it meets drinking water standards before we serve it to you. Enjoy professionally cleaned water from your faucet.

Extensions:

- Try constructing a water filter using coal, sand, and gravel like the materials in Colorado Springs Utilities water treatment plants (see last page).
- Go on a field trip to your local water treatment plant or invite someone from Colorado Springs Utilities to visit your class.
- Read settler journal entries taking note of references to water quality, quantity and water borne diseases.

Source - Colorado Springs Utilities, Nebraska Groundwater Foundation

Colorado Springs Utilities uses anthracite coal, sand, and gravel in our water filter:



Colorado Springs Utilities
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Teacher info and answer key

Cathodic Protection*

Grade level: 4^{th} – 8^{th}
Standard/GLE Code: SC.4.3.4, SC.5.3.3, SC.MS.3.6, SC.HS.3.6
Time commitment: 30 minutes
Materials Needed:
Per Experiment:

- 1 volt meter with clips
- 1 set of metal anodes (zinc, magnesium, aluminum and carbon)
- 1 towel
- 1 tub
- Salt
- Water
- Steel wool
- Paper towels

Educational Messages:

- Students will learn how Colorado Springs Utilities protects metal pipes from excess corrosion by using a sacrificial anode.
- Students will test 3 types of metal to determine which has the highest negative potential and thus would serve as the best sacrificial anode for cathodic protection.

Activities with an asterisk (*) indicate all supplies are available for a free 2-week check-out to schools within our Colorado Springs service territory. Reserve your kit by contacting communityrealtions@csu.org

Problem: Metal pipes used within our water service territory can corrode and burst, which costs a lot of money to fix and causes customer water outages. How can we protect the metals pipes from rusting and subsequently leaking?

Cathodic Protection Prevents Corrosion

We can protect metal pipe from corrosion by using cathodic protection. We bury a positively charged element that attracts negative ions (anode) and send protective current to the cathode and the sacrificial anode corrodes instead of the structure.

A sacrificial anode has a higher energy level (is more reactive) than the metal to be protected.

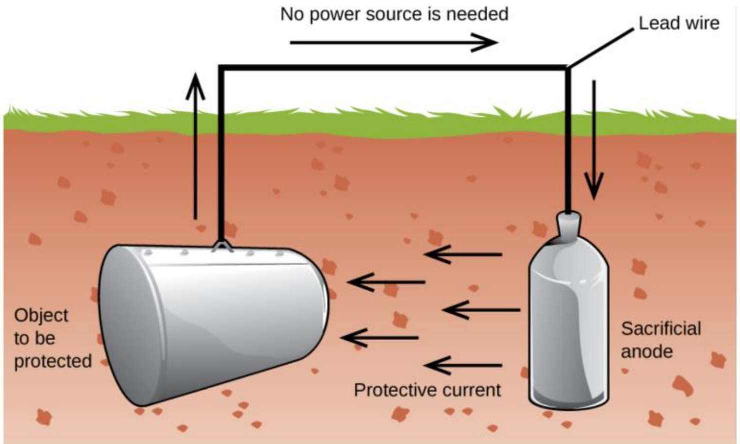
The water pipes we protect are ductile iron, cast iron and steel.

Research/Background Information:
Our system has about 2/3 metal pipes, 1/3 PVC pipes
About 1,400 miles = metal pipes

- Cast iron = <1970s, some as old as late 1800s
- Ductile iron = post 1970s (thinner, lower cost)
- Steel = used for long stretches i.e. SDS, Lower Homestake, and Blue River where joints can be welded

Cathodic Protection can dramatically decrease the number of customers impacted by water "outages" from pipe breaks.

Started cathodic protection in 2014
Only 175 miles of pipe protected so far (SDS, Lower Homestake, parts of Blue, 2C replacements in town)



Two types of cathodic protection systems:

- **<u>Passive/ Galvanic System</u> –** Uses a sacrificial anode (magnesium or zinc) attached and buried next to pipe at different intervals depending on soil chemistry.

- **<u>Active/ Impressed System</u>** – lower anodes into deep well (250 – 300' deep) and cover a radius of influence 5 - 10 miles; i.e. Lower Homestake only needed 3 deep wells to cover 25 miles of pipe.

Anodes – depleted in 25+ years – depends on soil chemistry

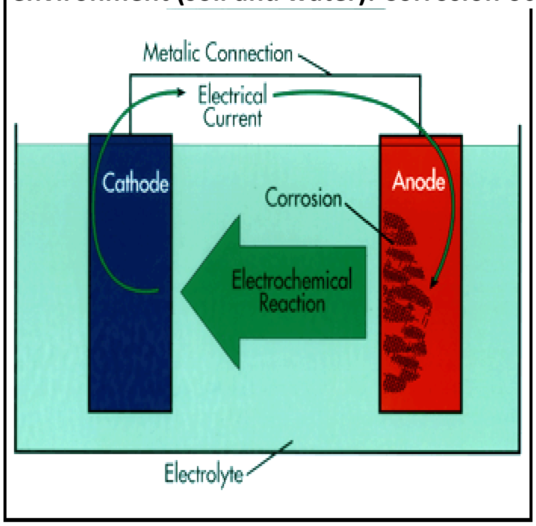
- Clay = corrosive (conductive soils)
- Sand = less corrosive (air insulates)

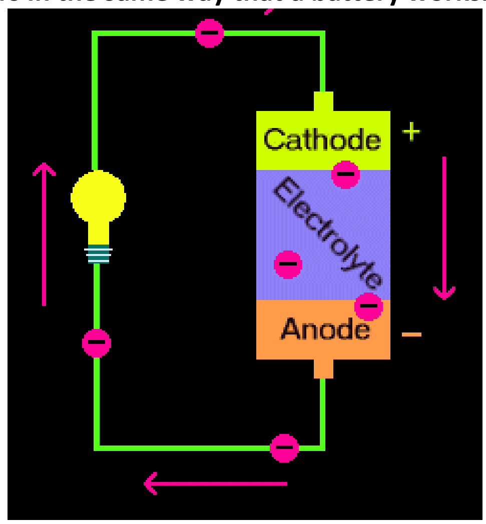
CSU uses high potential magnesium anodes, not zinc (don't tell the students this until after they have done their experiment)

Cathodic protection saves money! It is 10% of the cost of replacing or installing a pipe.

Inquiry Question - What is Corrosion?

Corrosion (or rust) is an electro-chemical reaction between a metal and its surrounding environment (soil and water). Corrosion occurs in the same way that a battery works.





Inquiry Question - Why is Cathodic Protection Important to Utilities?

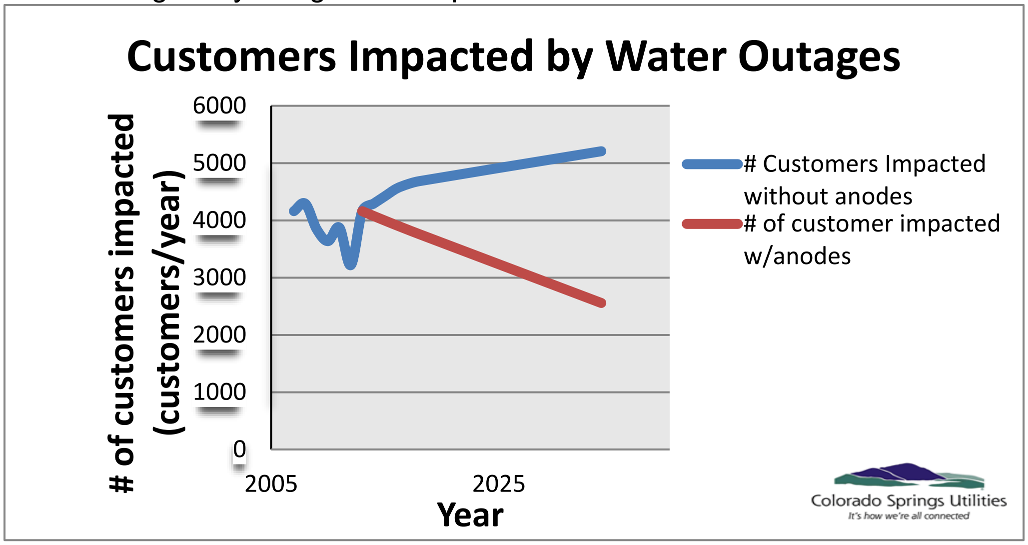
We protect *a lot* of metal infrastructure within our Water/Wastewater Systems:

- 2,039 miles of Potable Water Pipe (1,494 is metallic)
- 212 miles of Raw Water Pipe
- 27 miles of Non-Potable Water Pipe
- 1,646 miles of Wastewater Pipe
- 5 Water Treatment Plants
- 3 Wastewater Treatment Plants
- 26 raw Water Storage Reservoirs
- 35 Above/Underground Water Storage Tanks
- 40 water Pump Stations
- 20 Wastewater Lift Stations

Say No To Rust! We don't want our pipes to corrode.

Cathodic protection saves money! It is 10% of the cost of replacing or installing a pipe.

Colorado Springs Utilities can dramatically decrease the number of customers impacted by water "outages" by using cathodic protection.



Cathodic Protection Experiment Instructions:

Materials –

- Four tables
- Table cloths, plastic
- Jug of water
- 4 galvanic series sets
- 4 plastic containers for experimenting
- 4 towels for the activity stations
- Salt
- 3 cathodic protection posters
- 3 easels
- Printed worksheets for participants
- Pencils for worksheets
- Paper towels
- Steel wool

Set-up -

Fill containers half full with water and add 1 tbsp. salt. Set out the galvanized metal samples and test the volt meters to make sure they have enough battery. Set a small piece of steel wool at each of the 4 activity stations.

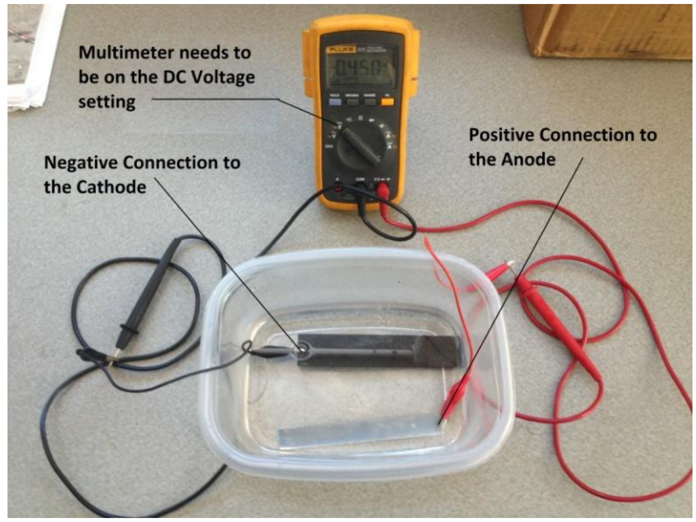
Experiment Procedure –

Create a Cathodic Protection System:

It's up to you to determine the best sacrificial anode to prevent corrosion on an iron pipe.

Instructions:

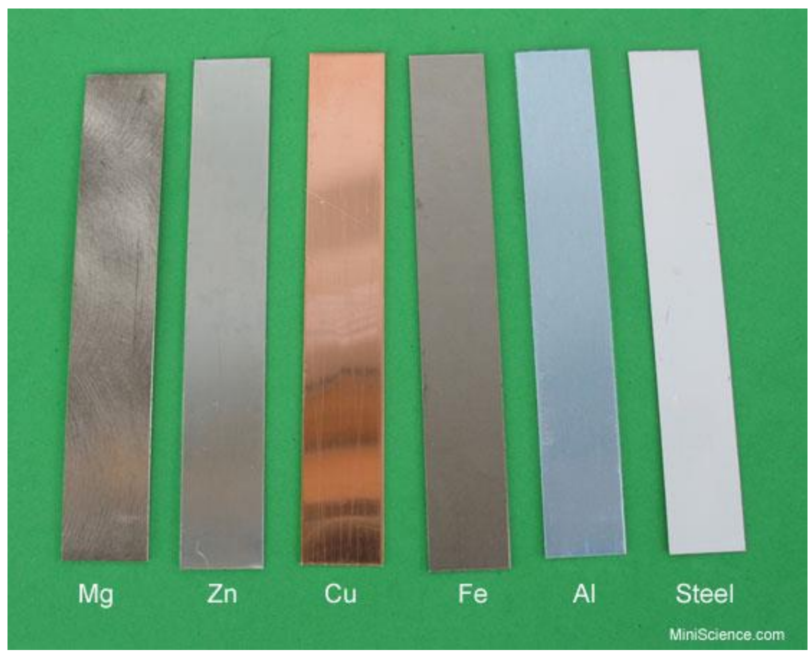
1. Use the voltage meter to test which metal element is the most active in relation to the iron element.
2. You're looking for the highest voltage metal for your sacrificial anode. The more electrically negative a metal is, the better it serves as an anode to protect the iron.
3. Your goal is to attain a structure-to-electrolyte potential between -0.85 and -1.20 volts.



Galvanic Series

Magnesium	Active (Anode)
Zinc	↑
Galvanized Steel	
Aluminum	
Mild Steel	
Cast Iron	
Lead	
Brass	
Copper	
Bronze	
Monel	
Nickel (passive)	
Stainless Steel 304 (passive)	
Stainless Steel 316 (passive)	
Silver	
Titanium	
Gold	
Graphite	
Platinum	Noble (Cathode)

Table 1 The similarity of metals is indicated by their relative position in the galvanic series. The more dissimilar the metals, the greater the corrosion potential in a galvanic circuit.



You'll use these metals from the **galvanic series.** The galvanic series (or **electro potential series**) determines the nobility of metals and semi-metals. When two metals are submerged in an electrolyte, while also electrically connected by some external conductor, the less noble (base) will experience **galvanic** corrosion.

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Careers in Water
Cathodic Protection Engineer

David Thresher, Cathodic Protection Program Manager for Colorado Springs Utilities.

WHAT I DO

Protecting water pipes and other water infrastructure is really important. I can assure that people have safe water to drink and that we keep our environment clean. At Colorado Springs Utilities I help protect 2,039 miles of potable water pipe, 212 miles of raw water pipe, 27 miles of non-potable water pipe and 1,646 miles of wastewater pipe. All that math you are studying now—I use it every day on the job!

HOW I GOT HERE

I knew I wanted to be an engineer when I was a kid. I was really good at math and science and knew that in order to be an engineer those were the subjects in which I had to excel, so I took advantage of my strengths.

I started out in the corrosion field by accident. I was a reliability engineer on the Air Force Academy and the person running the corrosion program quit without notice. The company needed someone to take over the program, so I stepped in. I knew nothing about corrosion prior to taking it over. I soon got my Cathodic Protection 1 Certification and here I am today!

SIMILAR CAREERS

Water is one field where cathodic protection is important. The same expertise is needed in the oil & gas industry. Cathodic protection also is important for all types of sea vessels.[1] This profession may take you to places across the world. Imagine going to Australia to help protect city infrastructure that resides in the ocean, or to India to assure that oil and gas pipes do not contaminate drinking water? The sky's the limit.

Cathodic protection installed on a 20' water pipe.

Source: Colorado Springs Utilities

[1] Cathodic protection is the most widely applied anti-corrosion control technique in corrosive environments such as seawater and soils containing water. It was invented in 1824 by British scientist Sir Humphrey Davy (1778-1829) to protect copper-cladded wooden ships from seawater corrosion.

What pH Tells You and Why it Matters

What does pH tell us?

We are proud to deliver some of the highest quality drinking water in the nation to your home.

Our water operators and chemists continuously monitor water quality to ensure your water meets drinking water standards, tastes good and is safe.

- pH levels tell us if the water is safe and if the pipes are in good shape.

pH stands for the “power of hydrogen”. The pH scale ranges from 0 – 14, with 7 being neutral.

pH measures how acidic or basic (alkaline) a water-based solution is

Although the pH of pure water is 7.0, drinking water and natural water exhibit a pH range because they contain dissolved minerals and gases.

- Water with a pH of less than 7.0 is in the acidic range.
- Water with a pH higher than 7.0 is in the basic or alkaline range.

Why pH Matters - Having a pH in the neutral range means the water is balanced and will not leach minerals from the water or the pipes.

- When pH is high, more scaling appears (minerals precipitate and build up inside the pipes).
- When pH is low, the pipes corrode faster (rust and begin to get holes).

Neutral pH is our standard for your water.

- We add sodium carbonate to raise the pH level if it’s below 7.0.
- We add sodium hydroxide to reduce the pH level when it’s above 7.0.

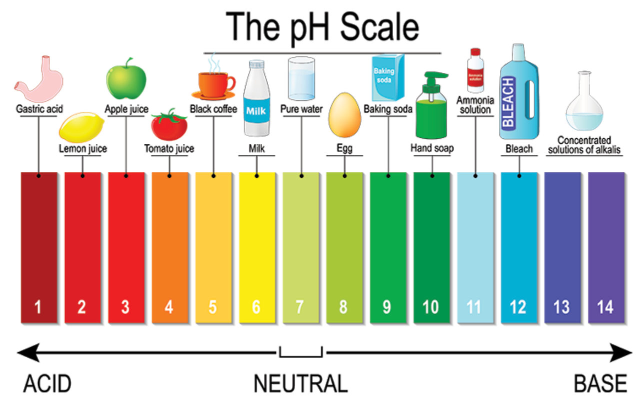

Image source: Sciencenewsforstudents.org

If you have questions about your water quality, please refer to our Water Quality report, and frequently asked questions guide at csu.org.

Annual Water Quality Report: https://www.csu.org/Pages/waterqualityreports-r.aspx

Water Quality FAQs: https://www.csu.org/CSUDocuments/waterqualityfaqs.pdf

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Student worksheet

Cathodic Protection

Materials Needed:
Per Experiment:

- 1 volt meter with clips
- 1 set of metal anodes (zinc, magnesium, aluminum and carbon)
- 1 towel
- 1 tub
- Salt
- Water
- Steel wool
- Paper towels

Directions:

- Use the voltage meter to test which metal element is the most active in relation to the iron element.
- You're looking for the highest voltage metal for your sacrificial anode. The more electrically negative a metal is, the better it serves as an anode to protect the iron.
- Your goal is to attain a structure-to-electrolyte potential between -0.85 and -1.20 volts.

Say No to Rust!

Select the best sacrificial anode to protect your pipe.

1. *My prediction of which metal will work the best (circle your answer):*

   Zinc Aluminum Magnesium

2. *Now test each metal using the volt meter—record your findings:*

Metal Element	Corrosion Potential (volts)
Zinc (Zn)	
Aluminum (Al)	
Magnesium (Mg)	

3. *Based on my test, the best Sacrificial Anode for my Iron Cathode is:*

Remember— You're looking for the highest negative voltage metal for your sacrificial anode.

Congratulations! You're a pipeline engineer.

Colorado Springs Utilities
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Why is Cathodic Protection Important to Colorado Springs Utilities?

We protect *a lot* of metal infrastructure within our Water/Wastewater Systems:

- 2,039 miles of Potable Water Pipe (1,494 is metallic)
- 212 miles of Raw Water Pipe
- 27 miles of Non-Potable Water Pipe
- 1,646 miles of Wastewater Pipe

Cathodic protection saves money! It is 10% of the cost of replacing or installing a pipe.

Say No To Rust! We don't want our pipes to corrode.

Utilities can dramatically decrease the number of customers impacted by water "outages" from pipe breaks by using cathodic protection.

WATER USE and CONSERVATION

(Yellow Colored Section)

- Water Watchers
- Leaky Faucet Lab Worksheet
- Water Uses Worksheet
- Cost of Water
- Water Conservation Wizard

Teacher info and answer key

Water Watchers

Grade level: 3rd – 5th
Standard/ GLE Code: SC.3.2.5, SC.4.3.4, SC.5.3.5
Time commitment: 40 minutes
Materials Needed:

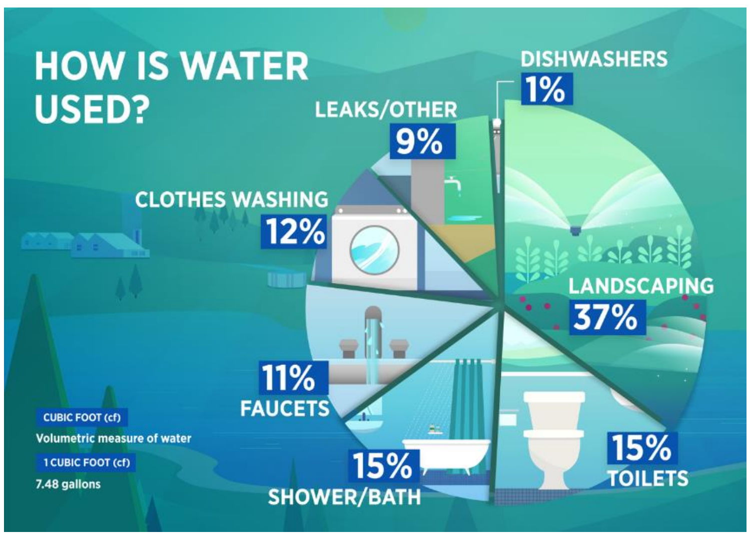
- Food coloring
- Student workbook

Educational Messages:

- Learn about water use in Colorado Springs.
- Discover what a water footprint is and calculate their own.
- Determine best ways to conserve water.
- Take action by testing toilets for leaks.

Our water resources are limited so using water wisely is essential to ensuring supply.

The average residential water use in Colorado Springs is 78 gallons per person per day. 37% of the water used in a residential home is applied outdoors for landscaping. Showers and toilets use the most water inside a home.



Suggested format:

1. Review the Colorado Springs Residential water use pie chart with the students and determine where the most water is used overall. Ask students what "conservation" means. Have them brainstorm ways they can use water wisely.
2. Have students complete the Water Watchers student workbook by taking the WaterSense quiz and see how they score.
3. Explain how to test their toilets at home for silent leaks and assign this task as homework. Tally the class results and watch the YouTube video "Stella Fixes a leaky Flapper".

4. Discuss what a water footprint is. Review free materials on the Water Calculator website, have students complete their own water footprint calculator and consider watching the Aqua water conservation video. Have students complete the "How Much Water is in Your Food?" student page and review answers.

Water Watchers STUDENT WORKSHEET ANSWER KEY

Hey Kids, It's Time to Test Your WaterSense! Think you know everything there is to know about water? You can't be sure until you test your WaterSense. *Circle your answers below. Use the teacher answer key to see how many questions you answer correctly!*

1. When is the best time of day to water your lawn?

A. Early morning or late evening
B. In the afternoon
C. All day long

1. Answer: A

Although it is fun to run through the sprinklers at the hottest time of day, your lawn should only be watered before 10 am or after 6 pm when it's cooler. Watering the yard when it's really hot outside causes the water to evaporate before the plants have time to drink it.

2. How much water could you save by washing your bike with a bucket and sponge rather than letting the hose run?

A. 1 gallon a minute
B. 3 gallons a minute
C. 4 gallons a minute
D. 6 gallons a minute

2. Answer: D

Washing your bike with a bucket and sponge will not only get your bike extra clean, it will also save water. Hoses can waste more than 6 gallons a minute while a bucket only uses a few gallons for a whole wash. Use a bucket and sponge when you help your parents wash the car, too!

3. True or False: It isn't important to save water because there is so much of it on Earth.

A. True
B. False

3. Answer: B

Although there is a lot of water on earth (70 percent of the earth's surface!), most of it is salt water so you can't drink it. It is very important to save the water we use every day because less than 1 percent of the earth's water can be used by people!

4. Which of these ways to wash the car saves the most water?

A. Wash it in the driveway with the garden hose
B. Drive it into the lake
C. Take it through a car wash that recycles water

4. Answer: C

Many car washes save more water than if you wash your car at home. They do this by recycling the water that they use instead of letting it run down the sewer drains. Tell your parents to search online to find a "water-efficient" car wash near your house.

5. How much water does a family of four (mom, dad, brother, and sister) use everyday?

A. 50
B. 116
C. 250
D. 312

5. Answer: D

How can a small family use so much water? It may seem hard to believe, but the average person in Colorado Springs uses about 78 gallons of water each day—that's enough to fill 1,600 drinking glasses! There are many things you can do to save water.

6. Stuck helping mom or dad wash the dishes? Which may use less water?

A. Washing dishes by hand
B. Washing dishes in a dishwasher

6. Answer: B

To waste the least amount of water in the kitchen, use your dishwasher only when it's filled all of the way with dirty dishes. You could also fill the sink with water instead of running the tap.

7. True or False: Keeping the water running when you brush your teeth wastes a lot of water.

A. True
B. False

7. Answer: A

You can save up to 8 gallons of water by turning off the faucet when you brush your teeth in the morning and before bedtime. That adds up to more than 100 gallons of water each month!

8. Which of the following uses less water?

A. Taking a 5-minute shower
B. Taking a bath

8. Answer: A

While it might be more fun to splash in a warm bath, it takes 50 gallons of water to fill a tub but only 10 to 15 gallons for a 5-minute shower. If you do take a bath, put the stopper in the drain right away and change the temperature as you fill the tub. Consider filling it only half full.

9. Which of these everyday objects is a water-saving tool?

A. A bucket
B. A clock
C. A broom
D. All of the above

9. Answer: D

Put a bucket under the tap while you make the water the right temperature. The water you collect can be used to water plants or fill up a squirt gun. Use a clock to keep your showers under 5 minutes. Use a broom instead of the hose to clean your driveway or sidewalk.

10. Which of these activities wastes the MOST water per day in the average home?

A. Running the tap while washing dishes
B. Using a garbage disposal
C. A leaky toilet
D. Long showers

10. Answer: C

A leaky toilet can waste about 20- 200 gallons of water every day! Ask to help your parents test your toilets for leaks. Place 10 drops of food coloring in the tank and if the color shows in the bowl after 15 minutes, you have a leak.

11. True or False: It's okay to flush some trash down the toilet like cotton balls and tissue.

A. True
B. False

11. Answer: B

Flushing the toilet for silly reasons wastes a lot of water. Cutting out 1 flush per day saves enough water to wash 32 loads of laundry each year.

12. What should you do if you see or hear a leaky faucet in your house?

A. Ignore it—drips are no big deal
B. Do nothing—there is no way to fix a drippy faucet
C. Tell your parents

12. Answer: C

Leaky faucets are big water wasters. If you see or hear a leaky faucet, tell your parents about it so they can get it fixed. If you don't, those drips and drops can add up to 2,700 gallons of wasted water in one year!

SCORING:

9 or more questions correct: Congratulations, you're a WaterSense Hero! You understand that water is a precious resource that must be used more efficiently.

6-8 questions correct: You're a WaterSense Whiz Kid!

Less than 6 questions correct: You're a WaterSense Wonder! But that means there's room for improvement!

To learn more about why water efficiency is important and how you can become water-efficient, visit www.epa.gov/watersense.

Toilet Testing Data Collection:

1. Have your students test their toilets at home for silent leaks.

Toilet Leak Testing Instructions:

a. Add 10 drops of food coloring into the water in the tank.

b. Do not flush.

c. After 15 minutes, look in the bowl and see if colored water appears.

d. You have a leak if colored water from the tank seeps into the bowl. Silent leaking toilets can waste 20 gallons of water a day!

2. Tally your class data:

   ________ Number of toilets tested

   ________ Number of toilets leaking

3. Determine the amount of water lost to "silent" leaks by multiplying the number of leaking toilets by 20 gallons per day: _________ Amount of water lost per day (gallons).
4. Figure out how much water is lost in a year by multiplying by 365: _________ Amount of water lost per year (gallons).
5. Have the class watch the 2.5-minute YouTube video on how a 4th grader can replace a toilet flapper: "Stella Fixes a leaky Flapper"
6. Fix toilet flappers or replace leaking toilets.
7. Calculate how much water your class is saving by fixing or replacing leaking toilets:

   ________ Number of leaking toilets fixed

   ________ Multiply by 20 gallons per day

   ________ Multiply by 365 days = number gallons your class has saved per year

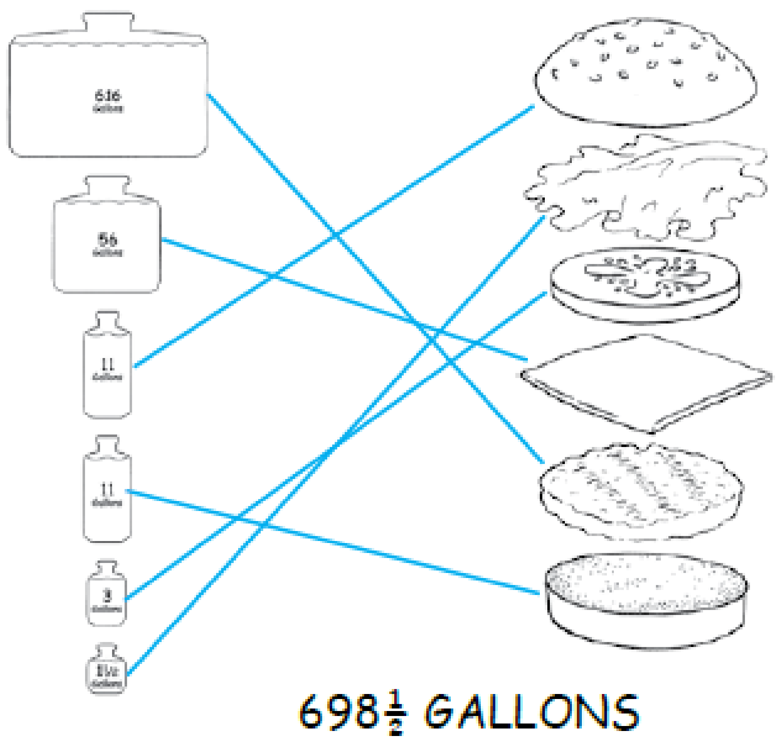
Please share your class results by emailing communityrelations@csu.org

What is a Water Footprint?

Your water footprint is the amount of water you consume in your daily life, including the water used to grow the food you eat, to produce the energy you use and for all of the products in your daily life – your books, music, house, car, furniture and the clothes you wear.

Ask students to guess how much water they use every day – not just for drinking, brushing teeth, washing hands, cooking and cleaning, but for the products they use. Students can calculate their own water footprint and see if they estimated correctly. Other useful water footprint information and water conservation educational materials can be found on the water calculator website: https://www.watercalculator.org/education/teaching-conservation-with-water-footprint-calculator/

How Much Water is in Your Food? Student Page ANSWER KEY:



Source: Colorado Springs Utilities and California Department of Water Resources

Student worksheet

Water Watchers

Materials Needed:

- Food coloring

Water is precious. Here in Colorado Springs, we live in a semi-arid climate that only gets an average of 16 inches of precipitation per year. We don't have enough water in town for all the people that live here, so Colorado Springs Utilities brings in water from the Rocky Mountains 100 miles away. To make sure we have enough water, everyone needs to use it wisely.

What you'll do:

- Take a Water Sense quiz.
- Use food coloring to test your toilets for leaks.
- Watch a video on how to replace a leaky toilet flapper.
- Learn about a water footprint and calculate yours.
- Complete a match game and add up the gallons of water needed to make a cheeseburger.

Water Watchers Quiz

It's Time to Test Your Water Sense! Think you know everything there is to know about water? You can't be sure until you test your Water Sense. *Circle your answers below. Use your teacher's answer key to see how many questions you answer correctly!*

1. When is the best time of day to water your lawn?

   A. Early morning or late evening
   B. In the afternoon
   C. All day long

2. How much water could you save by washing your bike with a bucket and sponge rather than letting the hose run?

   A. 1 gallon a minute
   B. 3 gallons a minute
   C. 4 gallons a minute
   D. 6 gallons a minute

3. True or False: It isn't important to save water because there is so much of it on Earth.

   A. True
   B. False

4. Which of these ways to wash the car saves the most water?

   A. Wash it in the driveway with the garden hose
   B. Drive it into the lake
   C. Take it through a car wash that recycles water

5. How much water does a family of four (mom, dad, brother, and sister) use every day?

   A. 50
   B. 116
   C. 250
   D. 312

6. Stuck helping mom or dad wash the dishes? Which may use less water?

   A. Washing dishes by hand
   B. Washing dishes in a dishwasher

7. True or False: Keeping the water running when you brush your teeth wastes a lot of water.

A. True
B. False

8. Which of the following uses less water?

A. Taking a 5-minute shower
B. Taking a bath

9. Which of these everyday objects is a water-saving tool?

A. A bucket
B. A clock
C. A broom
D. All of the above

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11. True or False: It's okay to flush some trash down the toilet like cotton balls and tissue.

A. True
B. False

12. What should you do if you see or hear a leaky faucet in your house?

A. Ignore it—drips are no big deal
B. Do nothing—there is no way to fix a drippy faucet
C. Tell your parents

Check your answers with the teacher's answer key and see how you scored!

WaterSense SCORING:

9 or more questions correct: Congratulations, you're a WaterSense Hero! You understand that water is a precious resource that must be used more efficiently.

6-8 questions correct: You're a WaterSense Whiz Kid!

Less than 6 questions correct: You're a WaterSense Wonder! But that means there's room for improvement!

To learn more about why water efficiency is important and how you can become water-efficient, visit www.epa.gov/watersense.

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Is Your Toilet a "Silent" Leaker?

Did you know that toilets are the source of most water leaks? According to the Environmental Protection Agency, one out of every four toilets can be a "silent" leaker, losing about 20 gallons of water a day without you noticing. If you can hear your toilet running, you may be losing up to 200 gallons a day!

Ask your parents' permission to test your toilets at home for silent leaks.

Toilet Leak Testing Instructions:

a. Add 10 drops of food coloring into the water in the tank.

b. Do not flush.

c. After 15 minutes, look in the bowl and see if colored water appears.

d. You have a leak if colored water from the tank seeps into the bowl. Silent leaking toilets can waste 20 gallons of water or more a day!

1. Tally your toilet testing data:

   ________ Number of toilets tested

   ________ Number of toilets leaking

2. Determine the amount of water lost to "silent" leaks by multiplying the number of leaking toilets by 20 gallons per day:

   _________ Amount of water lost per day (gallons).

3. Figure out how much water is lost in a year by multiplying by 365:

   _________ Amount of water lost per year (gallons).

4. Watch the 2.5-minute YouTube video on how a 4th grader can replace a toilet flapper: "Stella Fixes a leaky Flapper"

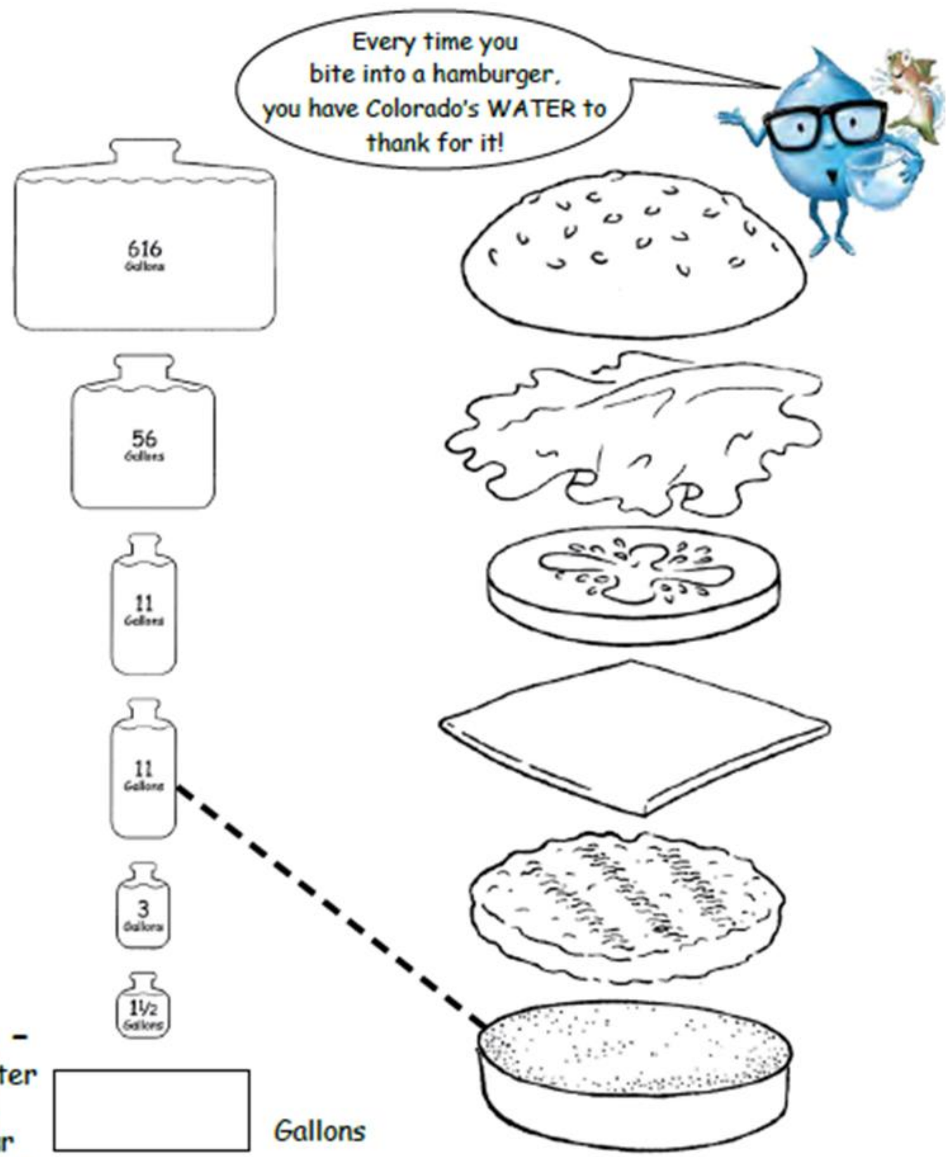
5. Fix toilet flappers or replace leaking toilets. Congratulate yourself for saving water!

6. Share your results with your teacher to determine how much water your class is saving by fixing or replacing leaking toilets.

What is a Water Footprint? Your water footprint is the amount of water you consume in your daily life, including the water used to grow the food you eat, to produce the energy you use and for all of the products in your daily life – your books, music, house, car, furniture and the clothes you wear. Find out your water footprint using this calculator: https://www.watercalculator.org/

How Much Water is in Your Food?

Match up the ingredients on the right to the correct number of gallons it takes to grow or produce each. Then color your own burger!



Add it up –
How much water did it take to make your cheeseburger?

	Gallons

Source: California Department of Water Resources

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Lab Worksheet

Leaky Faucet Lab Worksheet

Grade level: 4th – 8th
Standard/GLE Code: SS.4.3.1, SS.4.4.1, SC.5.3.4, SC.MS.3.8, Math
Time commitment: 30 – 45 minutes
Materials Needed:

- Measuring cup
- Data sheet (attached)
- Dripping faucet

Educational Messages:

- Students use math skills to measure a dripping faucet and determine the amount of water lost.

Leaky Faucet Lab Sheet

Hypothesis:
How many gallons of water do you think are wasted from one leaky faucet in **one year**?
I think about ___________gallons of water will be wasted in one year.

Data for leak:

How many mL did you collect in **one minute?**
Trial 1 ________________mL Trial 2 ________________mL Trial 3 ________________mL
To find the average: (trial 1 mL + trial 2 mL + trial 3 mL) ÷ **3** = average
Average amount of water collected in one minute: ____________________mL

Leak Calculations:

1. To find out how many mL it would leak in one hour, multiply the amount leaked in one minute by 60 (minutes in one hour).

   ______________mL leaked in one minute **x** **60** = ______________mL in an hour

2. To find out how many mL it would leak in one day, multiply the amount leaked in one hour by 24 (hours in one day).

   ___________mL leaked in one hour **x** **24** = ___________mL in a day

3. A unit you might be more familiar with is *Liters* (think of a 2L bottle of soda pop). Divide the number of mL by 1000 (mL in one liter).

   ______________mL leaked in a day ÷ **1000** = ______________mL in a day

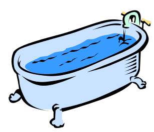
4. To find out how many gallons that would be, divide the mL leaked in one day by 3,785 (mL in one gallon).

_____________L in a day ÷ **3,785** = __________gallons in a day

5. Now multiply the number of gallons in a day by 365 (days in a year).

gallons in a day **x 365** = ___________________________ gallons in a year

How close was your hypothesis? Were you surprised?



Challenge Questions

1. The average bathtub holds 50 gallons of water. How many bathtubs would the water from your leak in our experiment fill up?

gallons in a year ÷ **50** = _____________________________ bathtubs

2. Cubic feet are another way to measure how big something is. If there are about 7.48 gallons of water in one cubic foot, how many cubic feet would your leak fill up?

gallons in a year ÷ **7.48** ______________________________ cubic feet in a year

3. If your kitchen measured 10 ft x 10 ft and if the ceiling was 8 ft high, there would be 800 cubic feet of space in your kitchen. Would the water from your leak in our experiment fill up your kitchen if it didn't go down the drain?

4. Do you have any leaks at your house?
   If you can find a clear measuring cup that shows mL, you can measure how much water drips out in one minute. Write the number here.

5. Next, do the calculations from the front of this page again using your *real* leak! How much water is being wasted?
   Source: Environmental Protection Agency

Worksheet

Water Uses Worksheet

Grade level: 2nd – 6th
Standard/GLE Code: SS.2.2.2, SS.4.4.1, SC.5.3.4, SC.MS.3.8
Time commitment: 15 minutes class time plus homework tracking use at home
Materials Needed:

- Water Uses Worksheet

Educational Messages:

- Students keep track of their daily water use and discuss ways to conserve water.

There is little danger of North America running out of water. But there is a danger that we will run short of high-quality water. You can help by using only as much water as you need. If you study how you use water now, you will be able to find ways to conserve.

Study the chart below. Then keep this sheet with you for one day. Mark the paper each time you use water. Remember this is an estimate, not an exact measure of how much water you use. Use the average amount given in the second column to do your calculating. For example, if you get six drinks of water a day, you would estimate 6 x ¼ = 1 ½ gallons. You would not drink ¼ gallon of water each time you get a drink, but that much could run from the faucet if you let it run to get cold.

Water Uses Worksheet

How You Use Water	Average Amount	**Put a Tick Mark for Each Use**	Total Gallons Used
Taking a bath	30 gallons x		=
Taking a shower	20 gallons x		=
Flushing a toilet	2.5 gallons x		=
Washing hands or face	2 gallons x		=
Brushing teeth	¼ gallon x		=
Drinking water	¼ gallon x		=
Other (you estimate)	x		=

Total inside water used by you in one day__________________ gallons

Compare and graph each student's inside use. Determine the similarities and differences.

Discuss ways to conserve indoor water. Have the students bring in a utility bill from one of the winter months (January or February works best) and another utility bill from a summer month (July or August). Compare inside and outside water use. Which is greater and why? How can water be saved outdoors?

Extension:

- Contact your local water conservation specialist at Colorado Springs Utilities communityrealtions@csu.org to arrange a classroom presentation on water saving devices.
- Have the students plant a garden with a variety of plants that require differing amounts of water to grow. Measure the water applied to each plant. Take notes on their physical appearances.
- Research water usage in developing countries. Compare amounts with the student's usage. Have the students carry jugs of water for a day (simulating what many people in developing countries have to do). Discuss changes in attitudes toward water use before and after carrying the jugs.

Source: Nebraska Groundwater Foundation

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Teacher info and answer key

Cost of Water

Grade level: 4th – 8th
Standard/GLE Code: SS.4.4.1, SC.5.3.4, SC.MS.3.8
Time commitment: 30 minutes
Materials Needed:

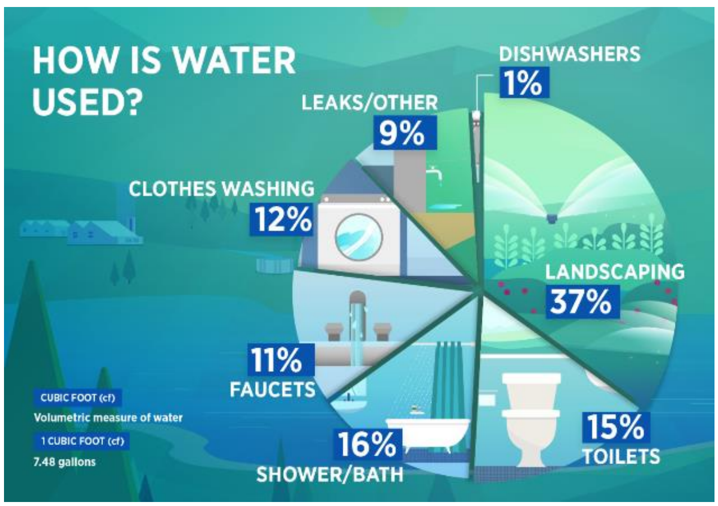
- Student Worksheet

Read the information below to calculate water costs on the student worksheet attached:

Educational Messages:

- Students learn the amount of residential water use in Colorado Springs and calculate the cost for various water needs.

Each citizen of Colorado Springs uses an average of **78 gallons of water each day** for all uses (bathing, washing dishes, food preparation, outdoor use etc.)



The cost for residential water in Colorado Springs is about **1¢ per gallon**.

Source: Colorado Springs Utilities

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The Cost of Water – ANSWER KEY

1. If the average person uses 2,340 gallons of water per month and water costs 1 cent per gallon, how much would the average person pay for one month's water use?
   2,340 gallons X $0.01 = $23.40

2. The Smith family has four people. How much water did they use in one month? How much would their water cost?
   2,340 gallons X 4 = 9,360 gallons
   9,360 gallons X $0.01 = $93.60

3. The average price for a gallon of soda pop is about $2.50. How much does 1,000 gallons of soda pop cost? If a gallon of bottled water costs about $.90, how much would 1,000 gallons of bottled water cost? Compare that to the cost of 1,000 gallons of tap water.
   Soda = $2.50 X 1,000 gallons = $2,500
   Bottled Water = $0.90 X 1,000 gallons = $900
   Tap Water = $0.01 X 1,000 gallons = $10

4. The Smiths have a faucet that is leaking at the rate of 80 drops per minute. If 1,000 drips equal one eight ounce cup, how long will it take for the faucet to leak one gallon of water? How many cups are leaked in one 24-hour day?
   1,000 drips / 80 drips per minute = 12.5 minutes for 1 cup of water
   16 cups in 1 gallon; 16 X 12.5 minutes = 200 minutes for 1 gallon
   24 hours X 60 minutes = 1440 minutes in a day X 80 drips per minute = 115,200 drips in a day
   115,200 drips / 1,000 drips in a cup = 115.2 cups of water lost in a day (or 7.2 gallons)

5. The Smith's water their lawn three times a week using three hoses. Hose A runs 1 hour, Hose B runs 45 minutes, and Hose C runs for 30 minutes. If each hose delivers 650 gallons of water per hour, how much water do the Smith's use each week for watering? (please note, time is exaggerated and is not accurate for actual watering)
   Hose A = 650 gallons
   Hose B = 488 gallons (650 X .75 hour)
   Hose C = 325 gallons (650 X .5 hour)
   Total of 1,463 gallons per day X 3 days a week = 4,389 gallons used in a week

6. How much does it cost per week for the Smith's to water their lawn?
   4,389 gallons X $0.01 = $43.89

7. The Smith family learned that they could save water and money by watering their lawn in the evening or early morning hours when the evapotranspiration rate (water lost to the air) was lower. They reduced their weekly water by 1/3! How many gallons of water did they save? How much money did they save?
   4,389 / 3 = 1,463 gallons saved per week
   1,463 X $0.01 = $14.63 saved per week

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Student worksheet

Cost of Water

Directions:

- Use your math skills to calculate how much water is used, and how much it costs.

1. If the average person uses 2,340 gallons of water per month and water costs 1 cent per gallon, how much would the average person pay for one month's water use?

2. The Smith family has four people. How much water did they use in one month? How much would their water cost?

3. The average price for a gallon of soda pop is about $2.50. How much does 1,000 gallons of soda pop cost? If a gallon of bottled water costs about $.90, how much would 1,000 gallons of bottled water cost? Compare that to the cost of 1,000 gallons of tap water.

4. The Smiths have a faucet that is leaking at the rate of 80 drops per minute. If 1,000 drips equal one eight ounce cup, how long will it take for the faucet to leak one gallon of water? How many cups are leaked in one 24-hour day?

5. The Smith's water their lawn three times a week using three hoses. Hose A runs 1 hour, Hose B runs 45 minutes, and Hose C runs for 30 minutes. If each hose delivers 650 gallons of water per hour, how much water do the Smith's use each week for watering? (please note, time is exaggerated and is not accurate for actual watering)

6. How much does it cost per week for the Smith's to water their lawn?

7. The Smith family learned that they could save water and money by watering their lawn in the evening or early morning hours when the evapotranspiration rate (water lost to the air) was lower. They reduced their weekly water by 1/3! How many gallons of water did they save? How much money did they save?

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Teacher info and answer key

Water Conservation Wizard

Grade level: 5th – 8th
Standard/GLE Code: SC.5.3.4, SC.5.3.5, SC.MS.2.5, SC.MS.3.8
Time commitment: 45 minutes plus home testing
Materials Needed:

- Contact us at communityrealtions@csu.org for free students' workbooks, shower timers and toilet testing tablets

Educational Messages:

- Use the student worksheet to have students learn about Colorado Springs Water System, answer questions to test reading comprehension, determine Smith Family water use, and calculate water savings with conservation measures.

Answer Key

Water IQ Quiz

1. How much precipitation does Colorado Springs get in a year? ____16____ inches
2. Which precipitation type supplies the majority of our water source?
   Circle one: ***Snow*** *Hail Rain Sleet*
3. How many acre feet of water flow off the western slope of the Rocky Mountains and travel to the Pacific Ocean?____8.7 million_____ acre feet

   Bonus question: What side of the Continental Divide do you live on? Circle one: ***East*** *West*
4. Which river basin supplies the most water for Colorado Springs? __Colorado River____
5. How far has some of your water traveled to get to town? _______100_________ miles
6. Colorado Springs Utilities cleans your water so it's safe to drink at how many water treatment plants?_______6_______
7. How many gallons does a typical Colorado Springs resident use per day?
   ___78_______gallons
8. What is most residential water used for? _____Landscaping_________
9. Which room in the house uses the most water? Circle one: **Bathroom** Kitchen Laundry Room
10. Where does the water go after it's been used inside the home? __The wastewater goes to the Water Resource Recovery Facility_______
11. How many other communities downstream does our reclaimed water flow past before it reaches the Gulf of Mexico? _____200 communities______________
12. What percentage of reclaimed water is reused in town for non-drinking purposes? __10___%

Smith Family Water Record (use amounts and assumptions above X 4 people X 7 days)			
Activity	***Typical Inefficient Use – WEEK 1***	***Water-wise Use - WEEK 2***	***Water Savings: WEEK 1 – WEEK 2 (gallons)***
Showering	20 gallons x 4 people x 7 days = 560 gallons	7.5 gallons x 4 people x 7 days = 210 gallons	560 – 210 = 350 gallons saved
Washing Hands and Face	2.5 gallons x 4 times a day x 4 people x 7 days = 280 gallons	1 gallon x 4 times a day x 4 people x 7 days = 112 gallons	280 – 112 = 168 gallons saved
Brushing Teeth	2.5 gallons x 2 times a day x 4 people x 7 days = 140 gallons	1 gallon x 2 times a day x 4 people x 7 days = 56 gallons	140 – 56 gallons = 84 gallons saved
Flushing Toilet	3.5 gallons x 5 flushes a day x 4 people x 7 days = 490 gallons	1.3 gallons x 5 flushes x 4 people x 7 days = 182 gallons	490 – 182 = 308 gallons saved
Total:			910 gallons saved every week

Smith Family Yearly Water Savings (gallons) = 910 gallons a week x 52 weeks in a year = 47,320 gallons a year saved

Convert Yearly Water Savings from Gallons to Cubic Feet (cf) = 47,320 gallons divided by 7.48 gallons = 6,326.20 cubic feet

Colorado Springs Utilities' Cost Chart					
Utility Type	*Cost per cubic foot (cf)*		*Smith Family Yearly Water Savings (cf)*		*Cost Savings per Year ($)*
Water	$0.05	X	6,326.20	=	$316.31
Wastewater	$0.02	X	6,326.20	=	$126.52
Natural Gas	Only about half the bathroom water is heated. Divide the amount of water saved per year by 2 = 6,326.20 / 2 = 3,163.10				
	$0.05	X	Answer from line above 3,163.10	=	$158.16
			Total Cost Savings:	=	**$600.99 saved a year**

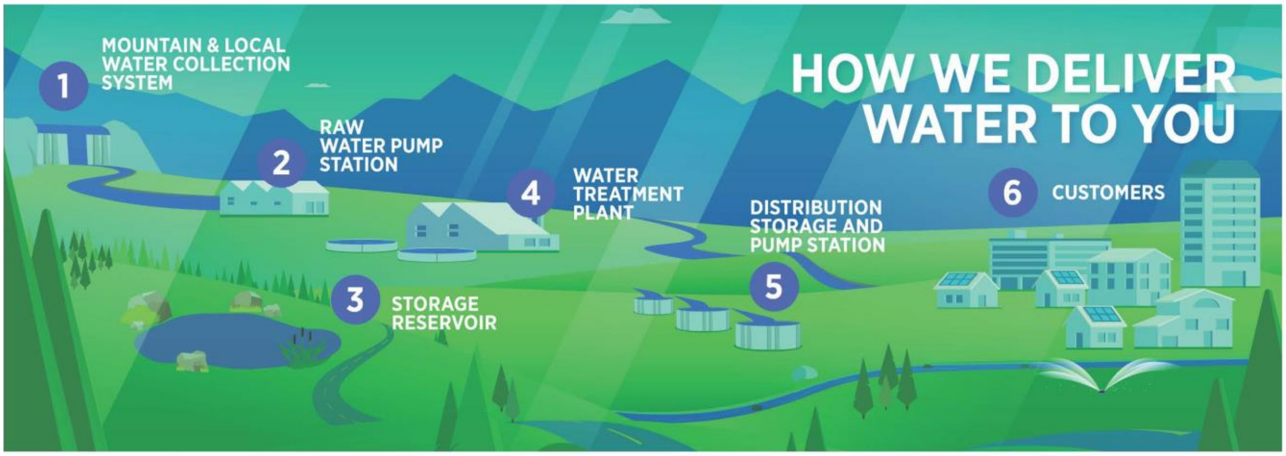
Total cost to upgrade bathroom using high-efficiency fixtures = $120

Water Conservation Wizard

Student Workbook

Name: ______________________________

Section 1 – Colorado Springs Water Supply



Colorado Springs gets its water from streams, lakes and reservoirs that are supplied by snowmelt. We live in a semi-arid (dry) climate and receive an average of 16 inches of precipitation a year. That is not enough water for the size of our city, so we must import water from further away. In fact, most of our water comes from snow that fell in the Rocky Mountains. Unlike other cities, we are not located near a river or major waterway, so we have built an extensive water system to bring water to us. 65% of our drinking water comes from the Colorado River Basin 100 miles away.

Colorado Springs diverts water from the western side of the Rocky Mountains through the Continental Divide via four tunnels, nearly 300 miles of raw (untreated) water pipeline and five pump stations. This water is stored in 25 reservoirs before it is treated at one of our six water treatment plants and then delivered to you through more than 2,000 miles of distribution pipe buried under the streets.

A reservoir is a man-made lake used to store water.

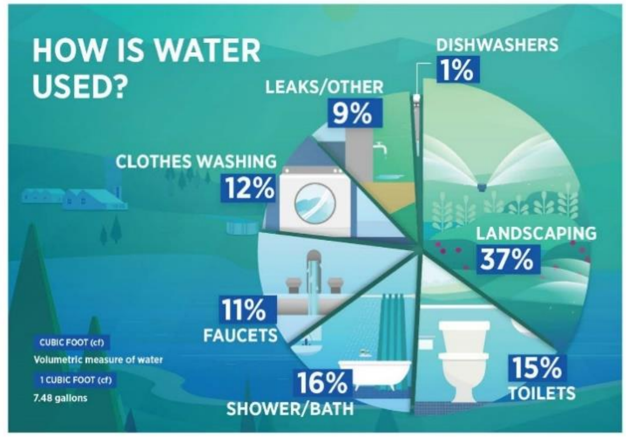
You are the **"first user"** of most of the water you drink, which means the water has not been used in other homes and businesses. Our water is some of the best in the nation and consistently meets or exceeds state and federal drinking water standards.

Colorado Annual Stream Flows

Colorado Springs residents use an average of 78 gallons of water a day.

Once you are done using it, the wastewater inside your house travels through sanitary sewer pipes to the Water Resource Recovery Facility where it is cleaned. Ninty percent of this reclaimed water is released down Fountain Creek to other communities downstream, while 10% is reused in town for non-drinking purposes such as watering city parks and golf courses. Your reclaimed water will flow past more than 200 communities downstream and eventually end up in the Atlantic Ocean via the Gulf of Mexico.

RESIDENTIAL WATER USE



Section 1 Water IQ Quiz

1. How much precipitation does Colorado Springs get in a year? ____________ inches

5. Which precipitation type supplies the majority of our water source?
   Circle one: ***Snow*** ***Hail*** ***Rain*** ***Sleet***

3. How many acre feet of water flow off the western slope of the Rocky Mountains and travel to the Pacific Ocean? ________________________ acre feet
   Bonus question: What side of the Continental Divide do you live on? Circle one: ***East*** ***West***

4. Which river basin supplies the most water for Colorado Springs? _________________________

5. How far has some of your water traveled to get to town?______________________miles

6. Colorado Springs Utilities cleans your water so it's safe to drink at how many water treatment plants? __________

7. How many gallons does a typical Colorado Springs resident use per day? ____________gallons

8. What is most residential water used for? _____________________________

9. Which room in the house uses the most water? Circle one: ***Bathroom*** ***Kitchen*** ***Laundry Room***

10. Where does the water go after it's been used inside the home? ______________________________

11. How many other communities downstream does our reclaimed water flow past before it reaches the Gulf of Mexico? ___________________

12. What percentage of reclaimed water is reused in town for non-drinking purposes? ____________%

How well did you do? Ask your teacher for the answer key and see how you rate:

- 10 - 12 correct = High water IQ - Water Wizard!
- 8 - 10 correct = Moderately high water IQ - Water Smart
- 4 - 7 correct = Medium to low water IQ - Water Wonderer
- 0 - 3 correct = Low water IQ – Study this workbook to improve

Your Water IQ:

____

Section 2 – Calculate the Water Savings

Water is a limited resource. Efficient water use is using water towards the greatest benefit and eliminating waste.

The Smith family has made a commitment to become better water managers. The family studied the Residential Water Use pie chart on page 2 and decided the best place to start saving water was in the bathroom. They tracked their water use for two weeks to see how much water and money they could save. During WEEK 1 they followed their usual habits, which were the same as those listed in the Typical Use column of the Water Use Chart. In WEEK 2, they changed their water use behavior as shown in the Water-wise Use column and installed efficient fixtures in the bathroom including a high-efficiency toilet, showerhead and faucet aerator.

Water Use Chart

Activity	*Typical Inefficient Use – WEEK 1*	*Water-wise Use* - WEEK 2*
Showering	8-minute shower: 20 gallons	5-minute shower with high-efficiency showerhead: 7.5 gallons
Washing Hands and Face	water running: 2.5 gallons	water turned off except to rinse and aerator installed: 1 gallon
Brushing Teeth	water running: 2.5 gallons	water turned off except to rinse and aerator installed: <1 gallon
Flushing Toilet	1 flush: 3.5 gallons	high-efficiency toilet flush: 1.3 gallons

*Water-wise Use includes conservation habits (i.e behaviors such as taking shorter showers and not leaving the faucet running) and using efficient fixtures (high-efficiency toilet, showerhead and faucet aerator).

Water Record – Determine the amount of water used by the four (4) Smith family members if each of them did the following actions ***each day***:

- Took one shower
- Washed face and hands four times
- Brushed teeth two times
- Used the toilet five times

Smith Family Water Record
(use amounts and assumptions above X 4 people X 7 days)

Activity	*Typical Inefficient Use – WEEK 1*	*Water-wise Use - WEEK 2*	*Water Savings: WEEK 1 – WEEK 2 (gallons)*
Showering			
Washing Hands and Face			
Brushing Teeth			
Flushing Toilet			
Total:			

Use the total amount of water the Smith family saved in a week (located in the yellow box) to calculate how much water they could save in a year if they continued their new water management habits.

Smith Family Weekly Water Savings __________ gallons X 52 weeks = ______________ gallons saved per year

Section 2 – Calculate the Water Savings

How Much Money Can the Smith Family Save?

It costs money to purchase water, heat water and dispose of wastewater. Determine how much money the Smith family saved in a year using their new water management habits. Colorado Springs Utilities charges by the cubic foot, so you must convert gallons into cubic feet. There are 7.48 gallons of water in a cubic foot.

Convert Yearly Water Savings from Gallons to Cubic Feet (cf) =

Colorado Springs Utilities' Cost Chart

Utility Type	*Cost per cubic foot (cf)*		*Smith Family Yearly Water Savings (cf)*		*Cost Savings per Year ($)*
Water	$0.05	X		=	
Wastewater	$0.02	X		=	
Natural Gas	Only about half the bathroom water is heated. Divide the amount of water saved per year by 2 =				
	$0.05	X	Answer from line above	=	
			Total Cost Savings:	=	$

The Environmental Protection Agency (EPA) recommends using WaterSense® labeled products to save water. ***What do high-efficiency fixtures cost?***

High-efficiency toilet	$100
High-efficiency showerhead	$15
Faucet aerator	$5

Do the math:

Total cost to upgrade bathroom =

RETURN ON INVESTMENT

Within 1 year you'll have recovered the cost of fixture replacement through water and energy savings!

Family Encounter using a Shower Timer

(recreated with permission of Carla Rae Smith, a D20 science teacher)

Save water while you shower! Use the shower timer provided by Colorado Springs Utilities to change your habit to taking a shower that is under five minutes.

1. For the first three days, track your usual time for each shower in the chart below. For the next four days, use the five-minute timer. If you go over, estimate by how much or set your own timer. Extra lines on the chart are for family members to take on the challenge. If you don't take a shower on a day, leave it blank. If you take more than one shower in a day, add the times together.

Name	Shower Time (minutes)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7

2. Typical showerheads can flow between 2.5 and 5 gallons per minute (gpm). High-efficiency showerheads are closer to 1.5 gpm. Measure your shower's flow rate by placing a bucket under the showerhead to catch the water for one minute. Use a stopwatch to be exact and measure the amount of water in the bucket after one minute. Your actual flow rate is: __________gpm

3. Calculate the amount of water used in the longest shower on your table: _________ gallons

4. Calculate the amount of water used in the shortest shower on your table: ________ gallons

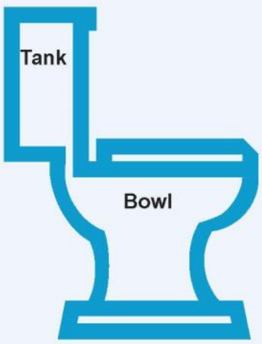
5. Calculate the water use difference between the long and short showers: _________ gallons

6. What was a strategy you used to reduce your shower time?

Is Your Toilet a "Silent" Leaker?

Did you know that toilets are the source of most water leaks? According to the Environmental Protection Agency, one out of every four toilets can be a "silent" leaker, losing about 20 gallons of water a day without you noticing. If you can hear your toilet running, you may be losing up to 200 gallons a day!

Ask your parents' permission to test your toilets at home for silent leaks.



Toilet Leak Testing Instructions:

a. With your parent's permission, add a special dye tablet or 10 drops of food coloring into the water in the tank at the back of the toilet.

b. Do not flush.

c. After 10 minutes, look in the bowl and see if colored water appears.

d. You have a leak if colored water from the tank seeps into the bowl.

Toilet Leak Testing Data Chart	
Number of toilets tested =	
Number of toilets leaking =	
Amount of water lost per day to leaking toilets (estimate 20 gallons of water a day per leaking toilet) =	
Water lost to leaking toilets in one year (gallons) =	

Fix toilet flappers or replace leaking toilets. Watch this YouTube video to see how you can fix the flapper yourself: Go to YouTube.com and search "Stella Fixes a Leaky Flapper."

Congratulations: You now are a Water Conservation Wizard!

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RESOURCES and SUGGESTIONS (Pink Colored Section)

- **Colorado Springs Utilities Suggested On-line Resources**
- **Additional Water Activities and Ideas**
- **Pikes Peak Library District Water Books List**
- **Water Music**

Colorado Springs Utilities Suggested On-line Resources

1. Education resources found on our website

Education Webpage - https://www.csu.org/Pages/Education.aspx
Contact Us: communityrealtions@csu.org

- Classroom Presentations - https://www.csu.org/Pages/ClassroomPresentations.aspx
- Educational Videos - https://www.csu.org/Pages/EducationalVideos.aspx
- Facility Tours and Field Trips - https://www.csu.org/Pages/FacilityTours.aspx
- Remote Learning Resources - https://www.csu.org/Pages/RemoteLearningResources.aspx
- Student Activities and Programs - https://www.csu.org/Pages/StudentActivities.aspx
- Teacher Resources - https://www.csu.org/Pages/TeacherResources.aspx

2. Online Videos and Websites

General Water Information

- The History of Colorado Springs Utilities Water (12-minute video): https://www.youtube.com/watch?v=mMRDhQNO34c&feature=youtu.be
- Live Like You Love It – the value of water in Colorado (2-minute video - appropriate for good readers): https://www.youtube.com/watch?v=zcAhSu_7k5w
- Water: What you Pay for from the Alliance for Water Efficiency (3 minute video): https://www.youtube.com/watch?v=dq9Yg_jlsUc&feature=youtu.be
- Discover Water interactive website from Project Wet that supports education about the water cycle, ecosystems, and water conservation: http://www.discoverwater.org/
- Dewey's Journey: Follow our water mascot, Dewey, on his journey from the mountains to town. Dewey shares his tips on best ways to save water. Ideal for young learners. (Courtesy of the Colorado Springs Conservatory Simple Gifts Series.) https://www.youtube.com/watch?v=SqAbOwo8X0w
- Dewey's Journey Through the Wastewater Process: Follow our water mascot, Dewey, on his journey through a water resource recovery facility where he gets cleaned up to be reused. Ideal for young learners. (Courtesy of the Colorado Springs Conservatory Simple Gifts Series.) https://www.youtube.com/watch?v=vz0t2V4YcvM

Water Cycle Information

- The Ways of Water (2.5-minute video): https://www.youtube.com/watch?v=RwrYFJEJSQ0
- Thirstin's water cycle. Excellent, 2-minute student educational water cycle animation tool provided by the Environmental Protection Agency: http://www.epa.gov/ogwdw/kids/flash/flash_watercycle.html

Stormwater

- H_2O Jo Takes a Ride through a Storm Drain. A kid-friendly 8-minute video following a drop of water through the water cycle and his adventures as rain water runoff, showing how polluted water affects water quality: https://www.youtube.com/watch?v=ytq7DP9ENhU

Water Conservation

- Water Use Calculator. Student-friendly, easy to use water use calculator to determine the average amount of water used daily, and a pledge to reduce water use by 10%:

http://www.swfwmd.state.fl.us/conservation/thepowerof10/

- Conserve Water from National Geographic (3-minute video – water savings tips students can implement): http://video.nationalgeographic.com/video/green-guide-howdini/conserve-water-greenguide

3. **Water Education Kits**

Colorado Springs Utilities supports educators by providing water education kits for check-out. Two education kits options include **Water Education Kit** (reinforce water properties, availability, water cycle and water management concepts) and the **Fire & Flooding Kit** (runoff experiment that reinforces erosion and water quality concepts). The kits include all consumable materials and are available free for a two-week check-out to teachers and schools within the Colorado Springs Utilities service area (D-2, D-8, D-11, D-12, D-20, D-49). Email communityrealtions@csu.org to reserve your kit and pick it up at the Conservation & Environmental Center, 2855 Mesa Rd., Monday – Friday, 8 am – 5 pm.

Water Education Kit contents:

- **Get to Know Your H_2O** – learn about water on Earth and our local water source.
- **Cloud in a Bottle Kit** – Reinforce evaporation and condensation by creating a cloud inside a bottle; includes foot pump, pump adaptor, clear bottle, isopropyl alcohol, safety glasses, and activity guide.
- **Water Cycle Inside a Balloon** – Show evaporation, condensation and precipitation inside a clear balloon; includes candle with holder, lighter, clear balloons, water cycle poster, funnel, activity guide.
- **Incredible Water Drop Journey** – Pretend to be a water drop going through the water cycle and residing in different mediums; includes station ids, cubes/dice, pipe cleaners, colored beads, student journey, activity guide.
- **Around the Water Cycle: Readers Theater** – Students have parts as water drops; includes reader's theater scripts.
- **Fire Runoff experiment** – See the difference between runoff from a natural forest soil verses a burned area; includes 1 soil sample from burned forest, 1 soil sample from unburned forest, 6 cups, extra ash, data sheets, pH paper, 1 total dissolved solids meter, activity guide.
- **Water Properties Experiment Table** – Supplies and instructions to set up six different water property experiments on one table for students to conduct on their own; includes plates, pipettes, blue dye, cups, paperclips, pins, paper towels, index cards, glass jars, pennies.
- **Water Trivia Flash Cards –** Test your student's knowledge about various worldwide and local water facts.
- **Water Rights Trading game –**students buy and sell water rights using poker chips and play money; includes poker chips, play money, user cards, jelly beans.

Fire & Flooding Kit contents:

- Activity Guide with step-by-step procedures for conducting run-off and testing experiments.
- Flash drive with PowerPoint presentation
- Program outline and script
- 6 Run-off experiment sets – includes trays, unburned soil samples, burned soil samples, cups, paper towels, extra ash to refill between experiments.
- 6 pH paper sets
- 6 Total dissolved solids (conductivity) meters
- Extra batteries
- Data sheets

Source: Colorado Springs Utilities

Additional Water Activities and Ideas

- Prepare a bulletin board with some of the students' work during this unit. You may want a board displaying the uses of water, a section with newspaper and magazine clippings of water issues, photos of how water and living things are related or one about the water cycle.
- Have the class put together a shadow box or diorama about water.
- Have them write and perform a water play or puppet show for younger students.
- Take an erosion hike and spot examples of water damage, either natural or human made.
- Study water stories of the Native Americans or of people from other lands.
- Have the class develop their own classroom water laws and penalties, e g., forgetting to turn off water "costs" a recess period; letting the water get cold before drinking "costs" a conservation poem, etc.
- Have the class put together a saving water resolution and have it signed by the principal.
- Set up a display in the school cafeteria showing how water can be conserved by even the youngest students.
- Have a poster contest on saving water.
- Have the students study the source of their water supply. Is it in danger of being polluted? Study any polluted lakes, rivers or streams in your area. What are the effects that can be seen? What about those we don't see?
- Have a PR campaign with the students. Send letters to the editor, design posters and bumper stickers or write and present news stories about a water topic.
- See about volunteering, as a class, at a local lake or recreation area to do cleanup, etc.
- Put together a People's Water Court and stage a mock trial for a major water polluter or waster.
- Study the major rivers in Colorado.

- Write a letter to the city officials in a major metropolitan area that uses surface water as its major supply of water. Colorado Springs, Aurora, Denver and Thornton are a few. Study surface water sources in other parts of the world.

- Put together an aquarium of Colorado fish.

- Study water pollution and the types of pollution - disease carrying agents, inorganic and organic chemicals, plant nutrients, sediment, heat, radioactive substances, oxygen demanding wastes and synthetic organic chemicals.

- Develop an environmental and/or water textbook of clippings from newspapers, magazines, etc. Keep them in a loose-leaf notebook (Don't forget cartoons!). Be sure articles are labeled with the newspaper's name and date. Have the students write a summary or interpretation of the articles.

- Make a sediment dam in a bottle using an empty pop bottle. Pour in a few tablespoons of soil and the rest with tap water. Shake the bottle to show how sediment mixes with water. When left alone for several hours, the sediment will settle to the bottom just like it does in a reservoir.

- Have an engineer visit and discuss how and why dams are built. Ask for a cross section of the dam.

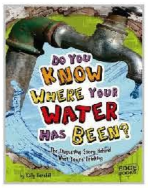
- Set up a learning center using the worksheets in this packet.

Source: City of Aurora; Nebraska Groundwater Foundation

Pikes Peak Library District Water Books List

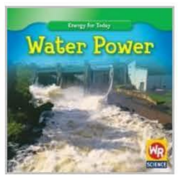
WATER BOOKS

Resources for 4th Graders
and Their Teachers.



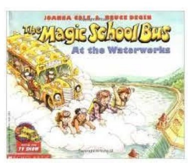
Barnhill, Kelly. <u>Do You Know Where Your Water Has Been?</u> Describes the history of water treatment and current water treatment systems. Book level 4.3.

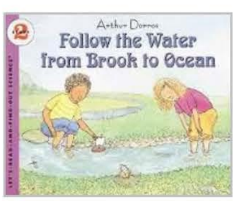
Benduhn, Tea. <u>Water Power.</u> Details water power, how we use it now and how we might in the future. Book level 4.0.



Cassino, Mark with Jon Nelson, Ph.D. <u>The Story of Snow: The Science of Winter's Wonder.</u> Tells the story of snow. Features photos of snow crystals in their beautiful diversity and includes how snow crystals are formed. Book level 4.8.

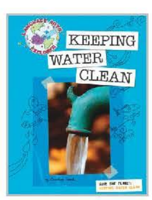
Cole, Joanna. <u>The Magic School Bus at the Waterworks.</u> Join Ms. Frizzle and her class as they follow the trail of water, from its sky-high source to the school bathroom. Book level 3.7.

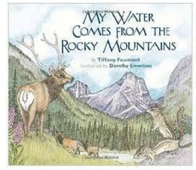




Arthur Dorros. <u>Follow the Water from Brook to Ocean.</u> Follows the flow of water to the ocean. Book level 3.6.

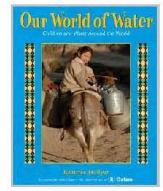
Farrell, Courtney. <u>Keeping Water Clean.</u> Travel around the world and learn how people use water and learn water conservation tips. Book level 3.6.

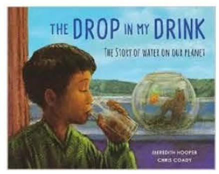




Tiffany Fourment. <u>My Water Comes From the Rocky Mountains.</u> Introduces children to our nation's watershed, the Continental Divide. Also explains the water cycle, using water, and water treatment. Ages 6-10.

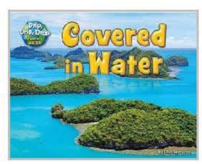
Hollyer, Beatrice. <u>Our World of Water.</u> Details children around the world and what water means to them. Book level 4.9.





Hooper, Meredith. <u>The Drop in my Drink.</u> Tells the story of water on Earth. Book level 4.9.

Kazunas, Ariel and Charnan Simon. <u>Experiment with Water.</u> Learn more about water's properties with these 3 experiments. Ages 7-10.

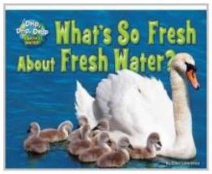


Lawrence, Ellen. <u>Covered in Water.</u> Teaches about the water cycle and where water if found on Earth. Book level 3.9.

Lawrence, Ellen. <u>Say Hello to H2O.</u> Teaches about the properties of water. Book level 4.2.

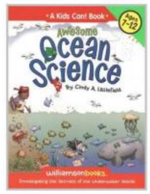
Lawrence, Ellen. <u>The Water Beneath Your Feet.</u> Teaches about groundwater and the water cycle. Book level 4.4.

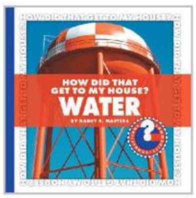
Lawrence, Ellen. <u>Wet, Blue, and Good for You.</u> Learn about the journey water makes through your body. Book level 4.2.



Lawrence, Ellen. <u>What's So Fresh About Fresh Water.</u> Teaches about Earth's fresh water. Book level 3.9.

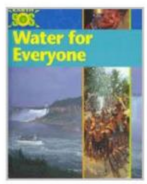
Littlefield, Cindy A. <u>Awesome Ocean Science.</u> Teaches about the ocean and how to protect it. Provides hands-on activities. Ages 7-12.

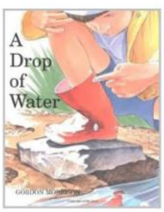




Masters, Nancy R. <u>How Did That Get to my House: Water.</u> Explains water supply and how it is delivered to homes. Book level 3.1.

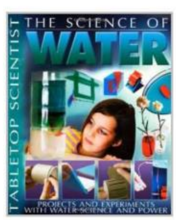
Morgan, Sally. <u>Water For Everyone.</u> Information about the water cycle and water conservation. Ages 8 & up.

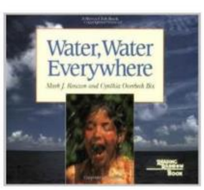




Morrison, Gordon. <u>A Drop of Water.</u> Consider a moment in time with a drop of water on a child's finger. Think about where the drop came from. Book level 3.9.

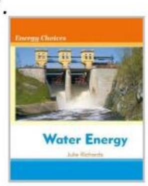
Parker, Steve. <u>The Science of Water.</u> Provides information and experiments about the science of water. Book level 4.2.

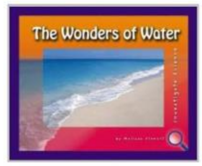




Rauzon, Mark J. and Cynthia Overbeck Bix. <u>Water, Water Everywhere.</u> Introduces the properties of water and the vital role it plays on Earth. Book level 4.7.

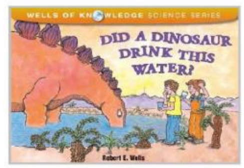
Richards, Julie. <u>Water Energy.</u> Explains water power. Ages 7-9.





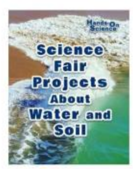
Stewart, Melissa. <u>The Wonders of Water.</u> Uses text, illustrations, and activities to explain the importance of water and its characteristics. Book level 3.7.

Waldman, Neil. <u>The Snowflake: A Water Cycle Story.</u> Follows the journey of a snowflake throughout the year. Ages 5 & up.

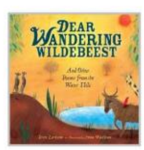


Wells, Robert E. <u>Did a Dinosaur Drink This Water?</u> A basic introduction to water's properties, uses, and conservation. Book level 5.1.

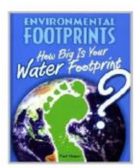
TEACHER RESOURCES



Gardner, Robert. <u>Science Fair Projects about Water and Soil</u>. Using common materials, students can perform simple, hands-on experiments The scientific concepts of each experiment are explained. Ages 8 &up.



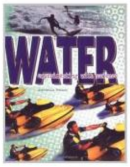
Latham, Irene. <u>Dear Wandering Wildebeest</u>. Poems from an African watering hole as well as facts about the animals and their environment. Book level 5.0.



Mason, Paul. <u>How Big is Your Water Footprint?</u> Explains the water cycle, ways people use water, and ways to reduce your water footprint. Ages 9-12.

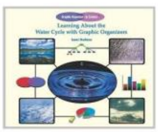
McGill, Jordan. <u>Water Science Fair Projects</u>. Tips on a great science fair project and several experiment possibilities. Ages 9-12.

MORE TEACHER RESOURCES

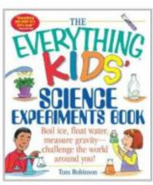


Meiani, Antonella. <u>Water: Experimenting With Science</u>.
Explains the properties of water listing several experiments. Ages 9 and up.

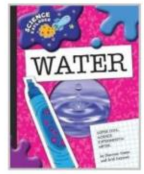
Mulder, Michelle. <u>Every Last Drop</u>.
Celebrates water around the world and shows how to care for it. Ages 9-12.



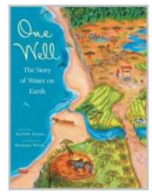
Nadeau, Isaac. <u>Learning About the Water Cycle with Graphic Organizers</u>.
Uses both text and graphs to explain earth's water cycle and how the water cycle affects life.



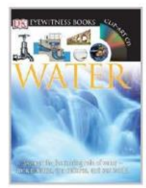
Robinson, Tom. <u>The Everything Kids' Science Experiments Book</u>.
Check out these experiments on boiling water, the density of, dripping and freezing of, floating, and more. Ages 7-12.



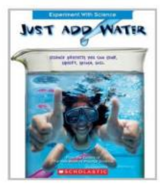
Simon, Charnan and Ariel Kazunas. <u>Super Cool Science Experiments: Water</u>.
Learn more about the properties of water through these 6 experiments. Learn about condensation, density, erosion, molecules, and more. Ages 9-13.



Strauss, Rochelle. <u>One Well: The Story of Water on Earth</u>.
A call to action to show how each of us can protect our water. Book level 6.0.



Woodward, John. <u>Water</u>.
An Eyewitness book explaining the world of water. Ages 8-12.



The New Book of Popular Science Editors. <u>Just Add Water.</u>
Science projects you can sink, squirt, splash, and sail. Book level 5.1.

HELPFUL DATABASES ON PPLD.ORG

Head to ppld.org and click on PPLD Kids and hit the Homework button on the bottom left. Then choose your category! Some databases may require your library card. Here are a few examples:

All Databases:

Explora for Primary Schools
Science Reference Center

Recommended Websites under:

PPLD Kids Science and Nature
National Park Service Kids—search water
Ology @ American Museum of Natural History— search water
Smithsonian Education: Science & Nature—Ocean Portal

PIKES PEAK LIBRARY DISTRICT ppld KIDS seek • engage • transform

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Water Music

Tapes relating to water are readily found in your local library or perhaps your school's music teacher may be of help. You may wish to put on an entire program for the school about water and its importance, using some of this music, original skits, poems, creative writings, etc. done by your class. Enjoy!

Brahms, Johannes ***Rain Sonata***

Cavanaugh, Jarnes and Barris, Harry ***Mississippi Mud***

Cherubini, Luigi ***The Water Carrier***

Chopin, Frederick ***The Raindrop***

Debussy, Claude ***La Mer***

Dresser, Paul ***On the Banks of the Wabash***

Earl, Mary and MacDonald, Ballard ***Beautiful Ohio***-1918

Emmett, Daniel ***Dance, Boatmen, Dance***

Foster, Stephen ***Old Folks at Home***

Guthrie, Woody ***Roll on Columbia***

Handel, George Frideric-***Water Music***

Kern, Jerome ***Old Man River***

Mendelssohn, Felix **Becalmed at Sea**, ***The Rivulet***

Mercer, Johnny and Mancini, Henry ***Moon River***

Newman, Randy ***Burn On***

Nolan, Bob ***Cool Water***

Ravel, Maurice ***Jeux d 'eau***

Rogers, Jimmie ***Miss the Mississippi and You***

Rubinstein, Nicholas ***Ocean Symphony***

Seeger, Pete ***Of Time and Rivers Flowin***

Schubert, Franz ***Water Songs***

Strauss, Johann II ***Blue Danube***

Tait, John ***The Banks of the Dee***-1767 (believed to be the first popular song in U.S.)

Taylor, Tell ***Down by the Old Mill Stream***-1910

Unknown, ***Deep River***-Negro Spiritual, 1850's

Unknown, ***Shennandoah***-1830's

Williams, Vaughn ***Sea Symphony***

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Appendix 1 – Standards Coorelation with SWEAP

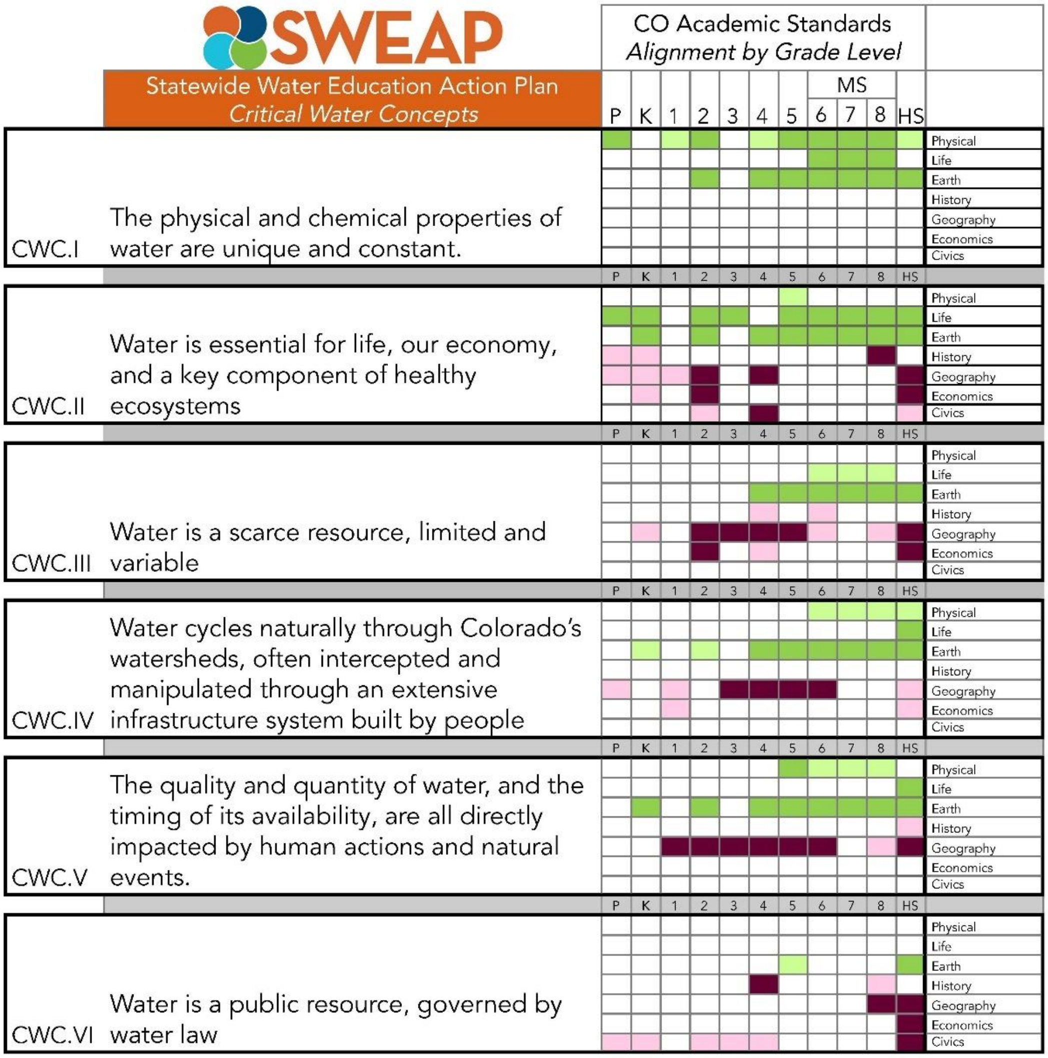
Toolkit for Colorado Educators and Organizations

The Statewide Water Education Action Plan (SWEAP) is a water education framework that organizations and individual educators can use to realize the "Outreach, Education and Public Education" goals set forth in the Colorado Water Plan. In order to assist implementation of SWEAP to help meet the Colorado Water Plan's education goals, Water Education Colorado convened a task force of eight water educators and additional advisors from around the state experienced in standards-based education for PK-12 audiences. The role of this group was to advise on connections between Critical Water Concepts identified in SWEAP and Colorado Academic Standards for Science and Social Studies. The six SWEAP Critical Water Concepts represent foundational understandings for water education throughout Colorado.

Cross-reference Figures 1, 5, 6 and 7 to correlate Colorado Academic Standards with water concepts are included in this Appendix. For full toolkit please visit Water Education Colorado:
SWEAP Task Force Toolkit_Final (watereducationcolorado.org)

https://www.watereducationcolorado.org/wp-content/uploads/2021/11/SWEAP-Task-Force-Toolkit_Final_11_5_2021.pdf

Source: Statewide Water Education Action Plan (SWEAP) Task Force – Critical Water Concepts and Colorado Academic Standards – Toolkit for Colorado Educators and Organizations



KEY - *Alignment to CO Academic Standards*

	Science: Mild Support if emphasized by teacher and/or provides foundation for concept.
	Science: Moderate to Strong Support/alignment of concept within grade-level standards.
	Social Studies: Mild Support if emphasized by teacher and/or provides foundation.
	Social Studies: Moderate to Strong Support/alignment of concept within grade-level standards.

COLORADO
Department of Education

SWEAP
STATEWIDE WATER EDUCATION
ACTION PLAN | 2020-2025

SWEAP Critical Water Concept			Colorado Academic Standards Grade Level Expectations										
										MS			
			P	K	1	2	3	4	5	6	7	8	HS
CWC.I	The physical and chemical properties of water are unique and constant.	Science	**SC.P.1.1;** SC.P.1.2		*SC.1.1.1*	SC.2.1.1; *SC.2.3.1;* **SC.2.3.2**		*SC.4.1.5;* *SC.4.3.1;* SC.4.3.2	**SC.5.1.1;** SC.5.1.2; SC.5.3.4;		SC.MS.1.1; SC.MS.1.5; *SC.MS.1.6;* SC.MS.2.3; **SC.MS.3.6;** *SC.MS.3.7*		*SC.HS.1.1;* *SC.HS.1.7;* *SC.HS.1.9;* *SC.HS.1.10;* *SC.HS.3.4;* **SC.HS.3.6;** *SC.HS.3.7*
		Social Studies											
CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems	Science	**SC.P.2.1;** SC.P.2.2	**SC.K.2.1;** SC.K.3.2		**SC.2.2.1;** SC.2.3.2	SC.3.2.5	SC.4.3.2; SC.4.3.4	*SC.5.1.4;* SC.5.2.1; SC.5.2.2; SC.5.3.3		SC.MS.2.3; SC.MS.2.5; *SC.MS.2.6;* SC.MS.2.7; **SC.MS.3.8**		*SC.HS.2.1;* *SC.HS.2.3;* SC.HS.2.4; SC.HS.2.5; SC.HS.2.6; *SC.HS.2.12;* SC.HS.2.13; **SC.HS.3.6;** *SC.HS.3.7;* **SC.HS.3.9;** *SC.HS.3.10;* *SC.HS.3.11*
		Social Studies	*SS.P.1.1;* *SS.P.2.1*	*SS.K.1.1;* *SS.K.2.2;* *SS.K.3.2*	*SS.1.2.2*	**SS.2.2.2;** SS.2.3.1; *SS.2.4.2*		**SS.4.2.2;** SS.4.4.1				SS.8.1.2	SS.HS.2.3; SS.HS.3.1; *SS.HS.4.1*
CWC.III	Water is a scarce resource, limited and variable	Science						SC.4.3.4	**SC.5.3.4**		*SC.MS.2.5;* *SC.MS.3.7;* **SC.MS.3.8**		SC.HS.3.4; *SC.HS.3.7;* **SC.HS.3.9;** SC.HS.3.10; SC.HS.3.12
		Social Studies		*SS.K.2.2*		**SS.2.2.2;** **SS.2.3.1**	SS.3.2.1; SS.3.2.2	*SS.4.1.1;* SS.4.2.1; SS.4.2.2; *SS.4.3.2*	SS.5.2.1; *SS.5.2.2*	*SS.6.1.2;* *SS.6.2.2*		*SS.8.2.2*	SS.HS.2.2; SS.HS.2.3; SS.HS.3.1; SS.HS.3.2
CWC.IV	Water cycles naturally through Colorado's watersheds, often intercepted and manipulated through an extensive infrastructure system built by people	Science		*SC.K.3.2*		*SC.2.3.1*		SC.4.3.1; SC.4.3.2; SC.4.3.4; SC.4.3.5	**SC.5.3.3;** SC.5.3.5		*SC.MS.1.5;* *SC.MS.1.6;* **SC.MS.3.6;** SC.MS.3.7; SC.MS.3.8		*SC.HS.1.7;* *SC.HS.1.9;* SC.HS.2.6; SC.HS.3.4; **SC.HS.3.6;** SC.HS.3.7; SC.HS.3.9
		Social Studies	*SS.P.2.1*		*SS.1.2.1;* *SS.1.3.1*		SS.3.2.1	SS.4.2.1; SS.4.2.2	SS.5.2.2	SS.6.2.1; SS.6.2.2			*SS.HS.2.1;* *SS.HS.2.2;* *SS.HS.2.3;* *SS.HS.3.1*
CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Science		SC.K.3.1; *SC.K.3.2*		SC.2.3.2		*SC.4.3.4;* SC.4.3.5	SC.5.1.2; SC.5.3.3; SC.5.3.4; SC.5.3.5		*SC.MS.1.1;* **SC.MS.3.6;** SC.MS.3.7; **SC.MS.3.8**		SC.HS.2.6; SC.HS.2.13; **SC.HS.3.4;** **SC.HS.3.6;** **SC.HS.3.7;** **SC.HS.3.9;** SC.HS.3.10; SC.HS.3.11; SC.HS.3.12
		Social Studies			SS.1.2.2	**SS.2.2.2**	SS.3.2.1; SS.3.2.2	*SS.4.2.1;* SS.4.2.2	**SS.5.2.2**	**SS.6.2.1;** **SS.6.2.2**		*SS.8.2.1;* *SS.8.2.2*	*SS.HS.1.2;* **SS.HS.2.2;** SS.HS.2.3; SS.HS.3.1
CWC.VI	Water is a public resource, governed by water law	Science							SC.5.3.5				SC.HS.3.9; SC.HS.3.11
		Social Studies	*SS.P.4.2*	*SS.K.4.1;* *SS.K.4.2*		*SS.2.4.2*	*SS.3.4.2*	*SS.4.1.1;* SS.4.1.2; *SS.4.4.2*				*SS.8.1.1;* *SS.8.1.2;* *SS.8.2.1;* SS.8.2.2	**SS.HS.2.2;** **SS.HS.2.3;** SS.HS.3.2; SS.HS.4.1; *SS.HS.4.2;* SS.HS.4.3

Key:
Text Format: GLEs in **Bold** = strong connections; Normal = moderate connections; *Italics* = mild connections
Coding: Content Area.Grade Level.Standard Category.Grade Level Expectation
Coding Example: *SC.2.3.1* (SC = Science; 2= Second Grade; 3 = Earth & Space Science; 1 = Grade Level Expectation (GLE): "*Some events on Earth occur quickly...*"

CWC.I The physical and chemical properties of water are unique and constant.

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (HS-ESS2-5)
Middle School	Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	Construct an explanation based on evidence for water's role in how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2)
Second Grade	Science	SC.2.3.2	Wind and water can change the shape of the land; models can show the shape and these changes to the land.	1. Obtain information to identify where water is found on Earth and that it can be solid or liquid. (2-ESS2-3) 2. Develop a model to demonstrate how water can change the shape of land (e.g. through flooding or erosion). (2-ESS2-2)
Pre-K	Science	SC.P.1.1	Recognize that physical properties of objects and/or materials help us understand the world.	Use senses to explore the properties of water by investigating changes in liquid water and solid ice when water is heated, cooled, or combined.

CO Academic Standards - Progression by SWEAP Critical Water Concept (Strong*)

CWC.II Water is essential for life, our economy, and a key component of healthy ecosystems.

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	Plan and conduct an investigation of how the properties of water and its effects on Earth materials and surface processes may alter dynamics within an ecosystem. (HS-ESS2-5)
High School	Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity (e.g. types of crops and livestock that can be raised). (HS-ESS3-1)
Middle School	Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	Construct a scientific explanation based on evidence for why water resources are unevenly distributed, limited or not renewable, such as groundwater. (MS-ESS3-1)
Fourth Grade	Social Studies	SS.4.2.2	Connections are developed within and across human and physical systems.	Analyze how people use geographic factors in creating settlements and have adapted to and modified the local physical environment in order to use water resources through the development of irrigation ditches/acequias (to support food production) and hardrock mining.
Fourth Grade	Social Studies	SS.4.4.1	Identify, investigate, and analyze multiple perspectives on civic issues.	Give example of issues faced and multiple perspectives in regards to allocation and availability of water as Colorado's population grows and the state faces uncertainty over future climate and provide possible solutions.
Second Grade	Science	SC.2.2.1	Plants depend on water and light to grow and on animals for pollination or to move their seeds around.	Plan and conduct an investigation to determine if plants need sunlight and water to grow. (2-LS2-1)
Second Grade	Social Studies	SS.2.2.2	People in communities manage, modify, and depend on their environment.	1. Explain that people settle in certain areas because of the need to access freshwater. 2. Explain how access to freshwater affects a community's ability to thrive. 3. Identify examples of how water draws people and wildlife to particular areas.
Kinder garten	Science	SC.K.2.1	To live and grow, animals obtain food they need from plants or other animals, and plants need water and light [and nutrients].	Use observations of patterns among all living things that describes plants and animals (including humans) need water to survive (and humans and other animals need food that we get from plants and animals). (K-LS1-1)
Pre-K	Science	SC.P.2.1	Recognize that living things have unique characteristics and basic needs that can be observed and studied.	Describe how habitats provide for the basic needs of plants and animals, including water, to grow and survive by observing familiar living things (e.g. a classroom pet or a classroom garden that can also produce food).

CWC.III Water is a scarce resource, limited and variable

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (HS-ESS3-1)
Middle School	Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	Construct a scientific explanation based on evidence for how the uneven distribution of Colorado and Earth's groundwater resources are the result of past and current geoscience processes. (MS-ESS3-1)
Fifth Grade	Science	SC.5.3.4	Most of Earth's water is in the ocean and much of Earth's freshwater in glaciers or underground.	Describe and graph the amounts and percentages of saltwater and freshwater in various reservoirs to provide evidence for the statement "water is a scarce resource, limited and variable" by comparing the amount of water available for human use in Colorado (e.g. for a local drinking water supply or food production) from various sources (e.g. surface vs. groundwater). (5-ESS2-2)
Second Grade	Social Studies	SS.2.2.2	People in communities manage, modify, and depend on their environment.	Explain how communities manage and use scarce freshwater resources and certain nonrenewable groundwater sources.
Second Grade	Social Studies	SS.2.3.1	Resources are scarce, so individuals may not have access to the goods and services they want.	1. Explain scarcity by giving examples of behaviors related to water and limited water (i.e., water restrictions). 2. Investigate how different individuals and communities water use varies.

CWC.IV Water cycles naturally through Colorado's watersheds, often intercepted and manipulated through an extensive infrastructure system built by people.

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes by investigating stream transportation and deposition using a stream table. (HS-ESS2-2)
Middle School	Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	1. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity by using a Colorado watershed as an example. (MS-ESS2-4) 2. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions in Colorado. (MS-ESS2-5) 3. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates and precipitation patterns within Colorado. (MS-ESS2-6)
Fifth Grade	Science	SC.5.3.3	Earth's major systems interact in multiple ways to affect Earth's surface materials and processes.	Develop a model using an example to describe why 85% of Colorado's precipitation falls west of the Continental Divide by modeling the influence of the hydrosphere (e.g. gulfs of Mexico and California, Pacific Ocean, Mississippi Valley), atmosphere (prevailing winds), and the geosphere (e.g. the state's mountain ranges) on precipitation patterns in the state. (5-ESS2-1)

CWC.V The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Science	SC.HS.3.4	Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes, and these effects occur on different time scales, from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.	Analyze geoscience data to make the claim that one change to Earth's surface (e.g. loss of ground vegetation from fire, flood, etc.) can create feedbacks that cause changes to other Earth systems (e.g. increase in water runoff and soil erosion or changes in food production). (HS-ESS2-2)
High School	Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes by investigating stream transportation and deposition using a stream table or testing the solubility of different materials as evidence of chemical weathering and recrystallization. (HS-ESS2-2)
High School	Science	SC.HS.3.7	The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors.	1. Analyze geoscience data to make the claim that one change to Earth's surface (e.g. loss of ground vegetation from fire, flood, aridification, etc.) can create feedbacks that cause changes to other Earth systems (e.g. increase in water runoff and soil erosion). (HS-ESS2-2) 2. Analyze geoscience data to make the claim that one change to Earth's surface (increase in water vapor or carbon dioxide in the atmosphere, etc.) can create feedbacks that cause changes to other Earth systems (increase in variability and severity of weather patterns, increasing surface temperatures, etc.) (HS-ESS2-2)
High School	Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (HS-ESS3-1)
High School	Social Studies	SS.HS.2.2	Geographic variables influence interactions of people, places, and environments.	Explain how altering the environment by altering water supplies has brought prosperity to some places and created environmental dilemmas for others by examining differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.).
Middle School	Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	1. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions in Colorado. (MS-ESS2-4) 2. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates within Colorado. (MS-ESS2-6)
Middle School	Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	Construct a scientific explanation based on evidence for how the uneven distribution of Colorado and Earth's groundwater resources are the result of past and current geoscience processes and how their distributions are significantly changing in Colorado and on Earth as a result of removal by humans. (MS-ESS3-1)
Sixth Grade	Social Studies	SS.6.2.1	Use geographic tools and resources to research and make geographic inferences and predictions about the Western Hemisphere.	Identify uses of technology in agriculture for maximum water efficiency such as automated headgates and sprinkler systems.
Sixth Grade	Social Studies	SS.6.2.2	Regional differences and perspectives in the Western Hemisphere impact human and environmental interactions.	1. Classify and analyze how water affects human interactions with the environment. 2. Identify physical water features (e.g. transbasin diversions, irrigation canals and mountain snowpack) and the positive and negative impacts on human systems in different regions.
Fifth Grade	Social Studies	SS.5.2.2	Causes and consequences of movement.	1. Discuss allocation of water resources amongst different user groups. 2. Describe how migration patterns reflect application of technology often involving water quantity for agriculture and manufacturing (e.g. construction of irrigation ditches/acequias allowed for food production in new areas).

CWC.VI Water is a public resource governed by water law

Grade	Subject	GLE Code	Grade Level Expectation (GLE)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
High School	Social Studies	SS.HS.2.2	Geographic variables influence interactions of people, places, and environments.	Research and interpret multiple viewpoints on issues that shape policies and programs for water resource use and explain how the management of water supplies has brought prosperity to some places and created environmental dilemmas for others by examining Colorado examples (e.g differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.).
High School	Social Studies	SS.HS.2.3	3. The interconnected nature of the world, its people and places.	Analyze how cooperation and conflict influence the division and control of Earth by using examples of Colorado's water administration and treaties/interstate compacts over water resources as an example.

HIGH SCHOOL

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.HS.3.4	Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes, and these effects occur on different time scales, from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Analyze geoscience data to make the claim that one change to Earth's surface (e.g. loss of ground vegetation from fire, flood, etc.) can create feedbacks that cause changes to other Earth systems (e.g. increase in water runoff and soil erosion or changes in food production). (HS-ESS2-2)
Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	CWC.I	The physical and chemical properties of water are unique and constant.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. (HS-ESS2-5)
Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Plan and conduct an investigation of how the properties of water and its effects on Earth materials and surface processes may alter dynamics within an ecosystem. (HS-ESS2-2)
Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	CWC.IV	Water cycles naturally through Colorado's watersheds, often intercepted and manipulated through an extensive infrastructure system built by people	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes by investigating stream transportation and deposition using a stream table. (HS-ESS2-2)
Science	SC.HS.3.6	The planet's dynamics are greatly influenced by water's unique chemical and physical properties.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes by investigating stream transportation and deposition using a stream table or testing the solubility of different materials as evidence of chemical weathering and recrystallization. (HS-ESS2-2)
Science	SC.HS.3.7	The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundation for the global climate system. Global climate models are used to predict future changes, including changes influenced by human behavior and natural factors.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	1. Analyze geoscience data to make the claim that one change to Earth's surface (e.g. loss of ground vegetation from fire, flood, aridification, etc.) can create feedbacks that cause changes to other Earth systems (e.g. increase in water runoff and soil erosion). (HS-ESS2-2) 2. Analyze geoscience data to make the claim that one change to Earth's surface (increase in water vapor or carbon dioxide in the atmosphere, etc.) can create feedbacks that cause changes to other Earth systems (increase in variability and severity of weather patterns, increasing surface temperatures, etc.) (HS-ESS2-2)

HIGH SCHOOL

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Construct an explanation based on evidence for how the availability of water (e..g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity (e.g. types of crops and livestock that can be raised). (HS-ESS3-1)
Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	CWC.III	Water is a scarce resource, limited and variable.	Construct an explanation based on evidence for how the availability of water (e..g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (HS-ESS3-1)
Science	SC.HS.3.9	Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Construct an explanation based on evidence for how the availability of water (e.g. access to fresh water in rivers, lakes, and groundwater), occurrence of water-related natural hazards (e.g. floods, droughts), and changes in precipitation related to changes in climate have influenced human activity. (HS-ESS3-1)
Social Studies	SS.HS.2.2	Geographic variables influence interactions of people, places, and environments.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Explain how altering the environment by altering water supplies has brought prosperity to some places and created environmental dilemmas for others by examining differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.).
Social Studies	SS.HS.2.2	Geographic variables influence interactions of people, places, and environments.	CWC.VI	Water is a public resource, governed by water law.	Research and interpret multiple viewpoints on issues that shape policies and programs for water resource use and explain how the management of water supplies has brought prosperity to some places and created environmental dilemmas for others by examining Colorado examples (e.g differences between tribal nations and nontribal communities, consequences of poverty on access to clean drinking water, rural versus urban access to water, immigration/settlement and its impact on access to water resources, etc.).
Social Studies	SS.HS.2.3	3. The interconnected nature of the world, its people and places.	CWC.VI	Water is a public resource, governed by water law.	Analyze how cooperation and conflict influence the division and control of Earth by using examples of Colorado's water administration and treaties/interstate compacts over water resources as an example.

MIDDLE SCHOOL

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	CWC.I	The physical and chemical properties of water are unique and constant.	Construct an explanation based on evidence for water's role in how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2)
Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	CWC.IV	Water cycles naturally through Colorado's watersheds, often intercepted and manipulated through an extensive infrastructure system built by people	1. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity by using a Colorado watershed as an example. (MS-ESS2-4) 2. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions in Colorado. (MS-ESS2-5) 3. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates and precipitation patterns within Colorado. (MS-ESS2-6)
Science	SC.MS.3.6	Water cycles among land, ocean, and atmosphere, and is propelled by sunlight and gravity. Density variations of sea water drive interconnected ocean currents. Water movement causes weathering and erosion, changing landscape features.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	1. Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions in Colorado. (MS-ESS2-4) 2. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates within Colorado. (MS-ESS2-6)
Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Construct a scientific explanation based on evidence for why water resources are unevenly distributed, limited or not renewable, such as groundwater. (MS-ESS3-1)
Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	CWC.III	Water is a scarce resource, limited and variable.	Construct a scientific explanation based on evidence for how the uneven distribution of Colorado and Earth's groundwater resources are the result of past and current geoscience processes. (MS-ESS3-1)
Science	SC.MS.3.8	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. Resources are distributed unevenly around the planet as a result of past geologic processes.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Construct a scientific explanation based on evidence for how the uneven distribution of Colorado and Earth's groundwater resources are the result of past and current geoscience processes and how their distributions are significantly changing in Colorado and on Earth as a result of removal by humans. (MS-ESS3-1)

MIDDLE SCHOOL

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Social Studies	SS.6.2.1	Use geographic tools and resources to research and make geographic inferences and predictions about the Western Hemisphere.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	Identify uses of technology in agriculture for maximum water efficiency such as automated headgates and sprinkler systems.
Social Studies	SS.6.2.2	Regional differences and perspectives in the Western Hemisphere impact human and environmental interactions.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	1. Classify and analyze how water affects human interactions with the environment. 2. Identify physical water features (e.g. transbasin diversions, irrigation canals and mountain snowpack) and the positive and negative impacts on human systems in different regions.

FIFTH GRADE

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.5.3.3	Earth's major systems interact in multiple ways to affect Earth's surface materials and processes.	CWC.IV	Water cycles naturally through Colorado's watersheds, often intercepted and manipulated through an extensive infrastructure system built by people.	Develop a model using an example to describe why 85% of Colorado's precipitation falls west of the Continental Divide by modeling the influence of the hydrosphere (e.g. gulfs of Mexico and California, Pacific Ocean, Mississippi Valley), atmosphere (prevailing winds), and the geosphere (e.g. the state's mountain ranges) on precipitation patterns in the state. (5-ESS2-1)
Science	SC.5.3.4	Most of Earth's water is in the ocean and much of Earth's freshwater in glaciers or underground.	CWC.III	Water is a scarce resource, limited and variable.	Describe and graph the amounts and percentages of saltwater and freshwater in various reservoirs to provide evidence for the statement "water is a scarce resource, limited and variable" by comparing the amount of water available for human use in Colorado (e.g. for a local drinking water supply or food production) from various sources (e.g. surface vs. groundwater). (5-ESS2-2)
Social Studies	SS.5.2.2	Causes and consequences of movement.	CWC.V	The quality and quantity of water, and the timing of its availability, are all directly impacted by human actions and natural events.	1. Discuss allocation of water resources amongst different user groups. 2. Describe how migration patterns reflect application of technology often involving water quantity for agriculture and manufacturing (e.g. construction of irrigation ditches/acequias allowed for food production in new areas).

FOURTH GRADE

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Social Studies	SS.4.2.2	Connections are developed within and across human and physical systems.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Analyze how people use geographic factors in creating settlements and have adapted to and modified the local physical environment in order to use water resources through the development of irrigation ditches/acequias (to support food production) and hardrock mining.
Social Studies	SS.4.4.1	Identify, investigate, and analyze multiple perspectives on civic issues.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Give example of issues faced and multiple perspectives in regards to allocation and availability of water as Colorado's population grows and the state faces uncertainty over future climate and provide possible solutions.

SECOND GRADE

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.2.2.1	Plants depend on water and light to grow and on animals for pollination or to move their seeds around.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Plan and conduct an investigation to determine if plants need sunlight and water to grow. (2-LS2-1)
Science	SC.2.3.2	Wind and water can change the shape of the land; models can show the shape and these changes to the land.	CWC.I	The physical and chemical properties of water are unique and constant.	1. Obtain information to identify where water is found on Earth and that it can be solid or liquid. (2-ESS2-3) 2. Develop a model to demonstrate how water can change the shape of land (e.g. through flooding or erosion). (2-ESS2-2)
Social Studies	SS.2.2.2	People in communities manage, modify, and depend on their environment.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	1. Explain that people settle in certain areas because of the need to access freshwater. 2. Explain how access to freshwater affects a community's ability to thrive. 3. Identify examples of how water draws people and wildlife to particular areas.
Social Studies	SS.2.2.2	People in communities manage, modify, and depend on their environment.	CWC.III	Water is a scarce resource, limited and variable.	Explain how communities manage and use scarce freshwater resources and certain nonrenewable groundwater sources.
Social Studies	SS.2.3.1	Resources are scarce, so individuals may not have access to the goods and services they want.	CWC.III	Water is a scarce resource, limited and variable.	1. Explain scarcity by giving examples of behaviors related to water and limited water (i.e., water restrictions). 2. Investigate how different individuals and communities water use varies.

KINDERGARTEN

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus (Connected NGSS Performance Expectation)
Science	SC.K.2.1	To live and grow, animals obtain food they need from plants or other animals, and plants need water and light [and nutrients].	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Use observations of patterns among all living things that describes plants and animals (including humans) need water to survive (and humans and other animals need food that we get from plants and animals). (K-LS1-1)

PRESCHOOL

Subject	GLE Code	Grade Level Expectation (GLE)	CWC Code	SWEAP Critical Water Concept (CWC)	Evidence Outcome - adapted for water focus
Science	SC.P.1.1	Recognize that physical properties of objects and/or materials help us understand the world.	CWC.I	The physical and chemical properties of water are unique and constant.	Use senses to explore the properties of water by investigating changes in liquid water and solid ice when water is heated, cooled, or combined.
Science	SC.P.2.1	Recognize that living things have unique characteristics and basic needs that can be observed and studied.	CWC.II	Water is essential for life, our economy, and a key component of healthy ecosystems.	Describe how habitats provide for the basic needs of plants and animals, including water, to grow and survive by observing familiar living things (e.g. a classroom pet or a classroom garden that also produces garden or classroom that can also produce food).

NOTES:

Water Activities Teacher Resource Guide

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