1. Personal Water Inventory
Snow Science and Water Quantity Unit

INSTRUCTION PLAN

Learning Objectives: Students will:

- Quantify their direct water usage for an entire week.
- Extrapolate their weekly water usage over an entire year.
- Compare and contrast their water usage to other people in the U.S. and the rest of the world.
- Evaluate the influence of different water conservation efforts on the local, national, and global scales.

Time Requirement:

- 25 minutes of class time for introduction and review of dimensional analysis.
- 7 complete days of data collection by student.
- 25 minutes of class time for closure and discussion of analysis/evaluation questions.

Materials Needed:

- Student handout
- Access to the Internet for USGS water usage data

Procedures: This lesson is designed to be an introductory "hook" lesson for freshwater resource use and water budgets.

1. Ask students to get into groups of three or four. Each group only needs a scrap piece of paper and a pencil. If available, a small whiteboard with marker will work.
2. Ask students to answer the following questions as a group. They have 5 minutes to come up with their answer:
    a. How many gallons of water do you think you use per day?
    b. How many gallons of water do you think you use per year?
    c. How do you think your water use compares to others in the nation?
    d. How do you think your water use compares to others in the world?
    e. What percentage of all of Earth's water is available for use by human society?
3. Once all groups have answered, go through the questions in a group discussion using the Socratic method. Scaffold the group responses into the objectives of this activity and how quantifying our water use for one week might help us make better estimates for these five questions.
4. Ask students to return to their desks.
5. Distribute one of the Water Inventory handouts to each student.
6. Read through the directions and answer any student questions that may arise regarding the assignment's requirements and expectations.
7. Discuss possible ideas for how to make measurements easier over the course of the week. Simple dimensional analysis and multiplication can help significantly:
    a. Measuring the volume of water for one minute of each category and then multiplying that by the amount of time each category requires.
    b. Multiplying the previous answer by the number of times each category is used each day.
    c. Use of printed or stated gal/min or gal/use on appliances or faucets.

8. Allow for a few minutes of general student questions or needs for clarification regarding the assignment.
9. After the seven days of data collection, use 25 minutes of class time to discuss how the inventory went. Questions to consider asking the class:
    a. How did this activity make you feel during the week?
    b. How did your family members respond to your data collection?
    c. What was the most challenging aspect of this assignment?
    d. What was the most eye-opening or inspiring aspect of this assignment?
    e. Any/all of the other analysis/evaluation questions on the handout.
10. Ask students to turn in their handouts. Use this opportunity to transition into the value of water budgets TCP activity or Idaho water law TCP activity.

Modifications/Recommendations: Some students may have a difficult time using the Internet for obtaining quality sources for Analysis/Evaluation questions that require web-based research. It could be helpful to spend a few minutes reminding students of examples of quality resources for this: USGS, USDA, EPA, UN, etc.

Alignment with Standards:

NEXT GENERATION SCIENCE STANDARDS

HS-ESS3-4 – Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

Science & Engineering Practices:

- Using Mathematical and Computational Thinking
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Obtaining, Evaluating, and Communicating Information

COMMON CORE STATE STANDARDS

CCSS.ELA-LITERACY.RST.9-10.1 – Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-LITERACY.RST.11-12.1 – Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CCSS.ELA-LITERACY.RST.9-10.7 – Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-LITERACY.RST.11-12.7 – Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-LITERACY.WHST.9-10.7 – Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.WHST.11-12.7 – Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.WHST.9-10.9 – Draw evidence from informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.WHST.11-12.9 – Draw evidence from informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.SL.9-10.1.A – Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

CCSS.ELA-LITERACY.SL.11-12.1.A – Come to discussions prepared having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

CCSS.ELA-LITERACY.SL.9-10.2 – Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.

CCSS.ELA-LITERACY.SL.11-12.2 – Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

CCSS.ELA-LITERACY.SL.9-10.6 – Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

CCSS.ELA-LITERACY.SL.11-12.6 – Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

IDAHO CONTENT STANDARDS

ISSS.9-10.B.1.3.3 – Measure and calculate using the metric system.

ISSS.9-10.B.1.6.2 – Utilize the components of scientific problem solving to design, conduct, and communicate results of investigations.

ISSS.9-10.B.5.1.1 – Analyze environmental issues such as water and air quality, hazardous waste, forest health, and agricultural production.

Name: ______________________________ Date: ________________ Period:______

Water Inventory: Your DIRECT Personal Annual Water Budget

Your task is to quantify your water on a few different time scales. Let's be honest right off the bat: ***this will not be easy.*** You will need to keep a daily inventory of your water use and you will need to determine the amount of water used for each "typical" activity below that pertains to you. Most of the uses will pertain to your life, even though, for example, you may not be the person actually washing the clothes or dishes. Since you are directly dependent on the water used for these activities, you need to include the values (your fraction of the total). While each student's inventory may differ from one another, most of the uses below are fairly standard from person to person. Get creative about how to determine how many gallons are used for each particular activity. You can check the mechanical specifications of most appliances in your home, or actually measure/convert the units yourself! ☺

USE	Wed. 11/12	Thurs. 11/13	Fri. 11/14	Sat. 11/15	Sun. 11/16	Mon. 11/17	Tues. 11/18	Wed. 11/19
Drinking water								
Showers/bathing								
Flushing toilet								
Washing clothes								
Washing hands								
Cooking								
Washing dishes								
Washing clothes								
Brushing teeth								
Shaving								
Lawn/landscaping								
Car washing								
Pool or Jacuzzi								
Other:								
Other:								
Other:								
DAILY TOTAL								

Weekly Average Water Use (show work!):

Annual Average Water Use (show work!):

Analysis/Evaluation: Answer the following questions on the back of this page.

1.) Do some research online and compare your annual water usage to the average values for the rest of the United States. How do you compare? Cite the source of comparison you used.
2.) Do some research online and compare your annual water usage to the averages for the rest of the world. How do you compare? Cite the source of comparison you used.
3.) How do you think your values could possibly change throughout the entire year? Or do they? Explain.
4.) Has this activity made you consider how you might be able to use less water? Explain.
5.) Describe at least two ways that you could be more efficient with your water use. Do you think you could use these changes to design solutions to water consumption issues throughout the whole community? Why or why not?
6.) Do some research online about efforts to promote and implement water conservation efforts. This can be for homes, businesses, cities or governments. Please describe efforts on the local scale, the national scale in the United States, and on the global scale for the rest of the world. Cite all sources used.

2. Drop in the Bucket/Freshwater Use and Availability

Snow Science and Water Quantity Unit

INSTRUCTION PLAN

***Adapted from Project WET Curriculum*

Learning Objectives: Students will understand that freshwater is a limited resource and is directly related to winter snowpack.

Time Requirement: 10 – 30 minutes depending on instructional method (demonstration by teacher or exploration by students)

Materials Needed:

- 2.5 gallon bucket
- Measuring cup or beaker
- Salt
- Snow Science PowerPoint slides 1-15

Procedures: This lesson is designed to be an introductory "hook" lesson for freshwater resource use, water budgets and snow science.

1. State the objectives for this lesson.
2. Introduce the Water Cycle by referencing a diagram picture on the projector screen. Be sure to include precipitation, evaporation, condensation and sublimation. (Slide 3)
3. Ask the students, *"What percentage of the Earth's water is freshwater?"* (Slide 4)
4. Assign students to their lab stations and introduce the 2.5 gallons of fresh water in the buckets at the lab stations. Mention that this water represents all of the water on earth. This can also be done as a demonstration by the teacher.
5. Have students share with their lab groups or the class what they came up with and write them on the white board. Make sure that as a class the following are listed:
    a. Polar ice caps and glaciers
    b. Surface water
    c. Groundwater
    d. Ocean water
    e. Water vapor in atmosphere
    f. Water in soil and permafrost
    g. Water in living organisms
6. Ask students how much of the earth's water is salt water? (Answer: 97%)
7. Have volunteer pour 1 cup of water from 2.5 gallons of water. Have them set aside. Tell the group this 1 cup represents all of the fresh water on Earth (the other 3%).
8. Set aside the remaining amount of water in the 2.5 gallon bucket; salt water. This water is not available for us to use as fresh water resource.
9. Tell the group that in the remaining amount (1 cup) of freshwater, most of it is contained in the polar ice caps (76%).
10. Then remove ¾ of the 1 cup (6 oz.) to demonstrate the previously mentioned. The remaining cup (2 oz.) represents the fresh water currently available for us to use as a natural resource. Share that this amount is what is moving through the Water Cycle as groundwater, surface water, and water vapor (see above). Review the Water Cycle as needed.

2. Drop in the Bucket/Freshwater Use and Availability

Snow Science and Water Quantity Unit

11. Share that of the remaining 2 ounces only 1 drop represents all of the surface water, including our watershed and snowpack. (Slide 5)
12. Have students work with their group to come up with a list of the "Top 5" uses of fresh water as a resource to human societies. Once they have their list, have them send a student to the white board to write down their list. Take 5 minutes to discuss each group's list and make a Top 5 for the entire class. (Slide 6)
13. Now, to transition to snow, have students draw a snowflake on a scratch piece of paper. It's likely that most students will draw dendrites. Pose the question: are snowflakes always the same? Always perfectly shaped? Why do they sometimes form with six arms?
14. Show video of snowflake formation/chemistry (link in PowerPoint) and then go into the PowerPoint with more information. (Slide 7)
15. Introduce that measurements of the snowpack can help scientists and businesses (hydropower!) predict the volume of water that will be available to access as a natural resource on an annual basis. The amount of water held in the snowpack is called snow water equivalent. Use as much of Slides 8-15 as are relevant to your discussion.)

Modifications/Recommendations: The Drop in the Bucket activity can be done as an exploration in small groups (as described, if time permits), or as a demonstration for the whole class if time is limited. This lesson can flow into lessons 3 and 4 if desired.

Alignment with Standards:

NEXT GENERATION SCIENCE STANDARDS

HS-ESS3-1 – Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

Science & Engineering Practices:

- Developing and Using Models

IDAHO CONTENT STANDARDS

ISSS.9-10.B.5.1.1 – Analyze environmental issues such as water and air quality, hazardous waste, forest health, and agricultural production.

ISSS.9-10.B.5.3.1 – Describe the difference between renewable and nonrenewable resources.

Hold that raindrop

Activity Education Standards: *Note alignment with Oregon Academic Content Standards beginning on p. 483.*

Objectives

The student will (1) measure the rate and volume of drainage from inorganic and organic soils and (2) describe the affect of organic material on the capture, storage, and safe release of rainwater.

Method

Students will demonstrate and collect data on capture, store, and safe release. They will investigate the role organic matter plays in capturing and storing rainfall to slow its release into streams.

For younger students

1. Consult extension activities at the end of each chapter to address the needs of younger students.
2. Read activity background information aloud to younger students or modify for your students' reading level.
3. The modeling portion of this activity may also be done as a demonstration. Depending on the age and abilities of students they may then do the graphing portion on their own, or it may be done as a group.
4. Depending on level of students, some initial set up is required. Adults can punch holes in cans, assist with accurate measurements of water, sand, and peat moss. Students may need some background for measuring fractional parts when comparing water run-off. Rephrase some questions (possibly number 4) or answer as part of a group discussion.

Materials

- large vegetable juice or fruit cans (two per team)
- 1 nail
- 1 hammer
- screen ("noseeum" tent netting works well)
- sand
- peat moss
- pan (one per team)
- stopwatch (one per team)
- water
- copies of student sheets (pp. 121-122)

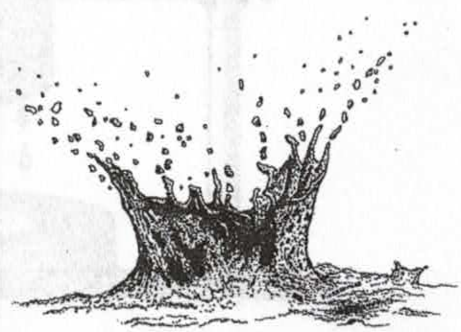
Notes to the teacher

Select two cans of the same size and diameter for each team. With the nail and hammer punch the same number of holes in the bottom of each can. This activity will work best if the holes are punched from the inside of the can. However be aware that the metal edges of the holes on the outside of the can will be sharp.

Once students have completed this activity they may want to repeat the experiment with soils from local uplands and other areas. Compare and discuss the results from these various tests.

Vocabulary

baseflow
groundwater storage
infiltrate
organic material
porous
stormflow
subsurface flow
surface runoff



Background

Do you know . . .

A healthy watershed captures a raindrop where it falls, stores it in the ground, and releases it safely to the stream over time. To capture a raindrop, the surface it falls on must allow it to soak, or **infiltrate**, into the soil. Think of the difference between a raindrop falling on a pane of glass and a raindrop falling on a sponge. The **porous** structure of the sponge lets the water pass into it. Ideally the surface of the soil should be like that sponge—rough with plenty of open spaces for water to move into. When infiltration rates cannot keep up with rainfall rates, water begins to flow over the top of the soil. This is called **surface runoff**. Surface runoff is rainfall that does not infiltrate into the soil, but flows over the surface until it reaches the stream.

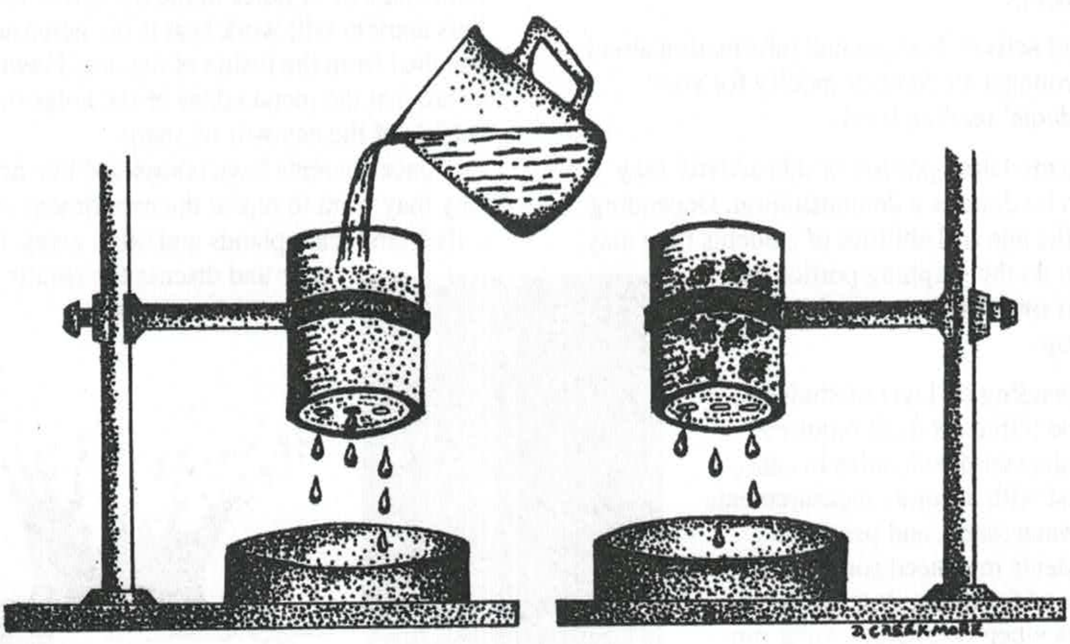
Organic material in soils can act like a sponge to hold onto water, increasing the ability of soil to store it. When the soil has taken in as much water as it can store, the rest of the infiltrated water begins to percolate (drain) through the soil to be stored in the ground (**groundwater storage**) or on its way to the stream. It can take a long time for water to move from the top of a watershed to the stream at its base. This increases the period of time any one storm contributes water to the stream. The water that percolates through the soil to the stream is called **subsurface flow**. Subsurface flow is much slower than overland flow.

Procedure

Now it's your turn . . .

How do the soils and plants of a healthy watershed capture and store rainwater, and then release it to a stream over time? In this investigation you will model a rainstorm and then calculate the difference in time between **stormflow** and **baseflow**, and the amount of water retained by soils.

1. Select two cans of the same size and diameter for each team. With the hammer and nail punch the same number of holes in the bottom of each can. Try to place the holes in approximately the same position in each can.
2. Line the bottom of each can with screen.
3. Place 4 cups of sand in the bottom of one can.



4. Mix 2 cups of sand and 2 cups of peat moss together and place in the bottom of the second can.
5. Place the first can—the one with only sand—over a pan to catch the drainage. Pour one measured quart of water into the first can all at once, and begin timing. Record how long it takes for the water to quit dripping from the bottom of the can.
6. Measure the amount of water that drained from the can. Record the information on the data sheet
7. Place the second can—the one with the mixture of sand and peat moss—over a pan to catch the drainage. Pour one measured quart of water into the second can all at once, and begin timing. Record how long it takes for the water to quit dripping from the bottom of the can.
8. Measure the amount of water that drained from the can. Record the information on the data sheet.
9. Answer the questions provided.

Observations

	Drainage time	Amount of water
Sand only		
Peat moss and sand		

Questions

1. Which took longer to drain, sand alone or the mixture of sand and peat moss?
   The sand and peat moss mixture should take longer to drain.
2. Was there a difference between the amount of water you added to the can and the amount that drained from the can? If so, what happened to the "missing" water?
   There should be a difference. The water was stored in the soil.
3. Which held onto more water, sand alone or the mixture of sand and peat moss?
   The sand and peat moss mixture should retain more water.
4. Which took longer to drain, sand alone or the mixture of sand and peat moss?
   The mixture of sand and peat moss should take longer to drain.
5. What role do plants and organic material—such as peat moss—play in capturing, storing, and releasing rainwater to streams over time?
   Organic material acts as a sponge to capture rainwater and store it in the soil. Soils with organic material both hold onto more water, and release it more slowly.

Going further

1. Redo the experiment with soils from at least six sites in the uplands and other areas in your watershed. Compare the water holding capacity of these samples with the examples you tested in the previous experiment. Predict the results before beginning the second set of tests. What might account for the differences, if any?

Name

Hold that raindrop

Do you know . . .

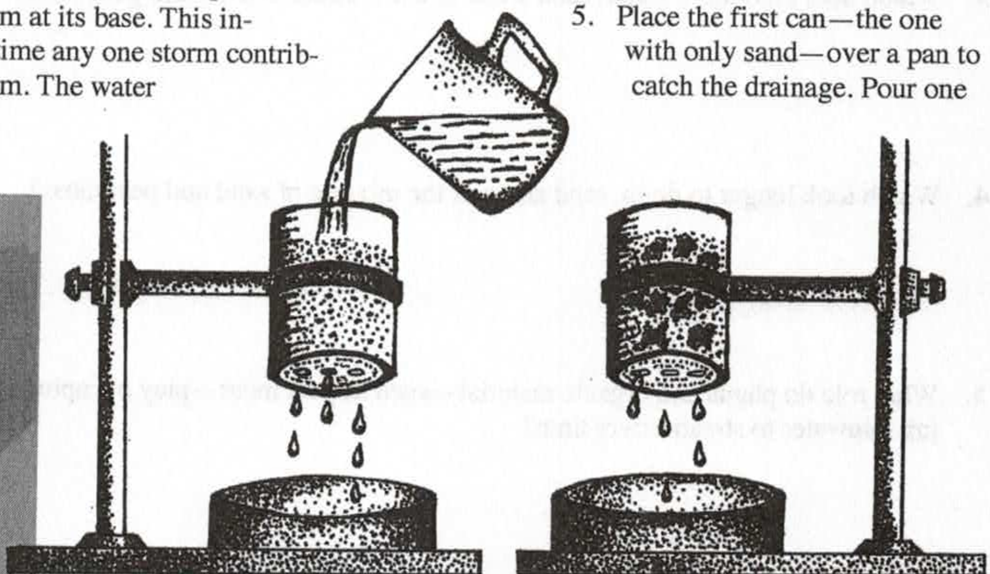
A healthy watershed captures a raindrop where it falls, stores it in the ground, and releases it safely to the stream over time. To capture a raindrop, the surface it falls on must allow it to soak, or **infiltrate**, into the soil. Think of the difference between a raindrop falling on a pane of glass and a raindrop falling on a sponge. The **porous** structure of the sponge lets the water pass into it. Ideally the surface of the soil should be like that sponge—rough with plenty of open spaces for water to move into. When infiltration rates cannot keep up with rainfall rates, water begins to flow over the top of the soil. This is called **surface runoff**. Surface runoff is rainfall that does not infiltrate into the soil, but flows over the surface until it reaches the stream.

Organic material in soils can act like a sponge to hold onto water, increasing the ability of soil to store it. When the soil has taken in as much water as it can store, the rest of the infiltrated water begins to percolate (drain) through the soil to be stored in the ground (**groundwater storage**) or on its way to the stream. It can take a long time for water to move from the top of a watershed to the stream at its base. This increases the period of time any one storm contributes water to the stream. The water that percolates through the soil to the stream is called **subsurface flow**. Subsurface flow is much slower than overland flow.

Now it's your turn . . .

How do the soils and plants of a healthy watershed capture and store rainwater, and then release it to a stream over time? In this investigation you will model a rainstorm and then calculate the difference in time between **stormflow** and **baseflow**, and the amount of water retained by soils.

1. Select two cans of the same size and diameter for each team. With the hammer and nail punch the same number of holes in the bottom of each can. Try to place the holes in approximately the same position in each can.
2. Line the bottom of each can with screen.
3. Place 4 cups of sand in the bottom of one can.
4. Mix 2 cups of sand and 2 cups of peat moss together and place in the bottom of the second can.
5. Place the first can—the one with only sand—over a pan to catch the drainage. Pour one



Vocabulary

- baseflow
- groundwater storage
- infiltrate
- organic material
- porous
- stormflow
- subsurface flow
- surface runoff

Student sheet

measured quart of water into the first can all at once, and begin timing. Record how long it takes for the water to quit dripping from the bottom of the can.

6. Measure the amount of water that drained from the can. Record the information on the data sheet
7. Place the second can—the one with the mixture of sand and peat moss—over a pan to catch the drainage. Pour one measured quart of water into the second can all at once, and begin timing. Record how long it takes for the water to quit dripping from the bottom of the can.
8. Measure the amount of water that drained from the can. Record the information on the data sheet.
9. Answer the questions provided.

Observations

	Drainage time	Amount of water
Sand only		
Peat moss and sand		

Questions

1. Which took longer to drain, sand alone or the mixture of sand and peat moss?

2. Was there a difference between the amount of water you added to the can and the amount that drained from the can? If so, what happened to the "missing" water?

3. Which held onto more water, sand alone or the mixture of sand and peat moss?

4. Which took longer to drain, sand alone or the mixture of sand and peat moss?

5. What role do plants and organic material—such as peat moss—play in capturing, storing, and releasing rainwater to streams over time?

Student sheet

Water? Right!

Activity Education Standards: Note alignment with Oregon Academic Content Standards beginning on p. 483.

Objectives

Students will (1) describe how water rights allocate water resources and (2) demonstrate a water rights allocations system.

Method

Students will experience limited water resources, generate lists of water uses and allocate resources.

For younger students

1. Consult extension activities at the end of each chapter to address the needs of younger students.
2. Read activity background information aloud to younger students or modify for your students' reading level.
3. You may want to explore how the usage numbers were devised; see extensions for this section. Very young students will need familiarity with a calculator or help to calculate large numbers. Modify some questions and vocabulary, for example: "hydroelectric use" could be explained as "dam usage."

Materials

Introduction

- paper cups (one per student)
- water jug (plastic gallon container)
- 3"×5" cards

Activity

- copies of student pages (pp. 157-160)

Notes to the teacher

The introduction is a demonstration activity. As an introduction to the Riparian Rights Doctrine of water rights, begin by placing a partially full water jug on the floor. Then have students arrange their chairs in a circle around the jug. Distribute paper cups to the students. Whoever is closest to the jug has the first priority and may take all the water they need. Have that student pass the jug to the next closest person. Continue around the circle, moving farther and farther away from the original water source until the jug has gone all the way around the circle, or the jug is empty. If some students did not get water, ask them how they feel about it. If the jug did complete the circle, discuss how some would have felt if the water ran out before it got to them. Discuss this method of water rights. Is it fair? What are its problems? What are its benefits?

To introduce Prior Appropriation Doctrine, have all students write their birth date on a 3"×5" card. Next, have them arrange their chairs in a line from oldest to youngest. Give the water jug to the oldest student. Tell that student to take all they need and then pass it on to the next oldest, and so on down the line. Discuss the problems and benefits of this system of water rights.

Ask the students to compare the two systems. Then ask them to improve on these two systems. Can they come up with a system that solves the problems of either of these systems of water rights? What factors (e.g., fairness, predictability, most important uses, etc.) are the most important in a system of water rights?

Vocabulary

Prior Appropriation Doctrine
Riparian Rights Doctrine
water rights

If students have trouble agreeing about priorities it may be useful to point out that this is also a problem for society. Everyone does not agree on what is the fairest system of water rights.

Background

Do you know . . .

Water rights are a legal system for allocating water. A water right does not give anyone ownership of water. Instead it allocates who has the right to use it. Water rights can be held by a person, group, business, or community. Even fish and wildlife can have legal water rights.

The system of water rights is not the same in all areas of the United States. The water rights system generally used in the eastern United States gives people who own land next to the stream the right to use water from it. This is called the **Riparian Rights Doctrine**.

In most of the western United States a different legal system is used to decide who has the right to use water. This system, sometimes called the **Prior Appropriation Doctrine**, gives the first person to use water a "prior" right to use it. This "first-come, first-served" system of rights, also called "first in time, first in right," means that if all of the water in a stream is already allocated there can be no new users.

Procedure

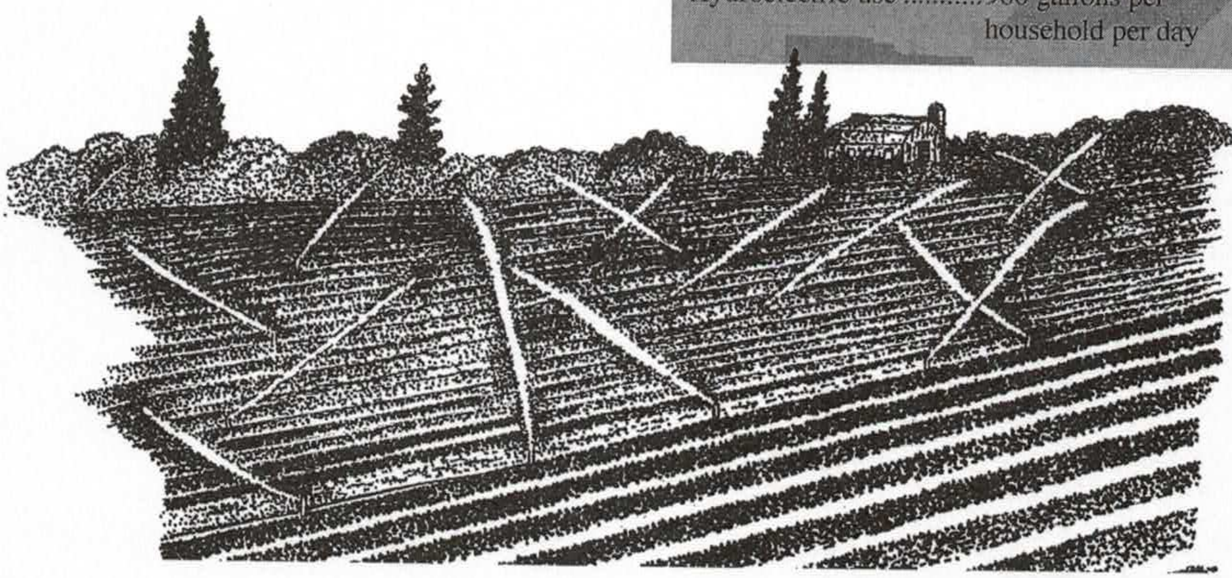
Now it's your turn . . .

Everbody needs water. We use water in our homes, to grow our food, in our industries, for generating power, for recreation, and to support forests, fish and wildlife. But there is not always enough water to go around.

Sometimes there is not enough water when supplies change because of droughts or other natural events. At other times there is not enough water because there are simply too many users. When there is not enough water people must make decisions about who will get the water that is available. What is a fair way to decide who gets the water?

Below is a table listing amounts of water used for different purposes. Use these figures when answering the questions.

Use	Amount
Home use	900 gallons per household per day
Industrial use	450 gallons per household per day
Minimum stream flow	1,000,000 gallons per day
Irrigation	450 gallons per household per day
Hydroelectric use	900 gallons per household per day



Questions

1. Why is it important to maintain minimum streamflows?
   Minimum streamflows protect fish, wildlife, and other aquatic organisms.

2. Including support services and not counting the amount of water needed to maintain minimum stream flows, how many gallons are needed each day to support each household?
   2,700 gallons. Home use + Industrial use + Irrigation + Hydroelectrice use

3. Including the amount needed to maintain minimum streamflows, how many gallons per day are needed to support a town of 1,000 households? 2,000 households? 5,000 households?
   1,000 households = 3,700,000 gallons
   2,700 gals/household × 1,000 households = 2,700,000 gals
   2,700,000 gals + 1,000,000 gals (minimum stream flow) = 3,700,000 gals
   2,000 households = 6,400,000 gallons (2,700,000 × 2 + 1,000,000)
   5,000 households = 14,500,000 gallons (2,700,000 × 5 + 1,000,000)
   Note: the minimum streamflow is always only 1,000,000 gals.

4. If the river this town depends on has an average flow of 34,000,000 gallons per day, how many households can it support? Round to the nearest whole thousand without going over the available water supply.
   12,000 households
   34,000,000 gals/day - 1,000,000 minimum streamflow = 33,000,000
   33,000,000 gals/day ÷ 2,700 gals/day = 12,222, rounded down to 12,000

5. The amount of rainfall can vary from year to year. If a drought caused the average streamflow to drop by half how many households could it support? Round to the nearest whole thousand without going over the available water supply.
   5,000 households.

   34,000,000 gals/day ÷ 2 = 17,000,000
   17,000,000 - 1,000,000 (min. stream flow) = 16,000,000
   16,000,000 ÷ 2,700 = 5,925.9259 but rounded down to 5,000

6. Sometimes water may be used, but not used up. For example, part of the water that enters households as domestic water leaves as sewage. Which uses can return water to a river? Why?
   Home use—most water is returned
   Industrial use—most water is returned
   Irrigation—little water is returned
   Hydroelectric use—most water is returned

7. For each of the returns you discussed above, does anything need to be done to the returned water before it is returned to the river?
   Water from household, industrial, and irrigation uses needs to be cleaned before it is returned.

8. If there is not enough water for all users, what are some ways a town could try to get more? If no more is available, how could they distribute the available water? Which uses have the highest priorities? Why?
   Answers will vary.

8. Design your own system of water rights. How should water be distributed? Who has the first priority for water use? Why?

Answers will vary.

Going further

1. See "Water Court," *Project Wet*, pp. 413-419.
2. Design an experiment that would detect if someone was taking more irrigation water from the river than the amount allowed by their water right.
3. Design an experiment to test the efficiency of a common lawn sprinkler.
4. See "Water Works," *Project Wet*, pp. 274-278.
5. Is your local water system supported by wells? If so, investigate the recharge and use capacity of the local water system. Design a hypothetical situation where drought reduces the local water supply by one-half. Hypothesize how the community would solve this water shortage dilemma.
6. Using precipitation, and potential evapotranspiration data obtained from your local hydrologist, graph the precipitation, the actual evapotranspiration, and the potential evapotranspiration. Discuss usage, recharge, and deficit as it relates to the watershed. How might this affect the streamflow over a period of a year?

Water? Right!

Name

Do you know . . .

Water rights are a legal system for allocating water. A water right does not give anyone ownership of water. Instead it allocates who has the right to use it. Water rights can be held by a person, group, business, or community. Even fish and wildlife can have legal water rights.

The system of water rights is not the same in all areas of the United States. The water rights system generally used in the eastern United States gives people who own land next to the stream the right to use water from it. This is called the **Riparian Rights Doctrine**.

In most of the western United States a different legal system is used to decide who has the right to use water. This system, sometimes called the **Prior Appropriation Doctrine**, gives the first person to use water a "prior" right to use it. This "first-come, first-served" system of rights, also called "first in time, first in right," means that if all of the water in a stream is already allocated there can be no new users.

Now it's your turn . . .

Everbody needs water. We use water in our homes, to grow our food, in our industries, for generating power, for recreation, and to support forests, fish and wildlife. But there is not always enough water to go around.

Sometimes there is not enough water when supplies change because of droughts or other natural events. At other times there is not enough water because there are simply too many users. When there is not enough water people must make decisions about who will get the water that is available. What is a fair way to decide who gets the water?

On the next page is a table listing amounts of water used for different purposes. Use these figures when answering the questions.

Vocabulary

Prior Appropriation Doctrine
Riparian Rights Doctrine
water rights

Student sheet

Questions

Use	Amount
Home use	900 gallons per household per day
Industrial use	450 gallons per household per day
Minimum stream flow	1,000,000 gallons per day
Irrigation	450 gallons per household per day
Hydroelectric use	900 gallons per household per day

1. Why is it important to maintain minimum streamflows?

2. Including support services and not counting the amount of water needed to maintain minimum stream flows, how many gallons are needed each day to support each household?

3. Including the amount needed to maintain minimum streamflows, how many gallons are needed each day to support a town of 1,000 households? 2,000 households? 5,000 households?

4. If the river this town depends on has an average flow of 34,000,000 gallons per day, how many households can it support? Round to the nearest whole thousand without going over the available water supply.

Student sheet

5. The amount of rainfall can vary from year to year. If a drought caused the average streamflow to drop by half how many households could it support? Round to the nearest whole thousand without going over the available water supply.

6. Sometimes water may be used, but not used up. For example, part of the water that enters households as domestic water leaves as sewage. Which uses can return water to a river? Why?

7. For each of the returns you discussed above, does anything need to be done to the returned water before it is returned to the river?

8. If there is not enough water for all users, what are some ways a town could try to get more? If no more is available, how could they distribute the available water? Which uses have the highest priorities? Why?

9. Design your own system of water rights. How should water be distributed? Who has the first priority for water use? Why?