Is All Water the Same?

Subject Area: Earth Science Grade Levels: 9 Date: 8/7/14

Abstract Lesson Overview

In this lesson, students will understand the basic principles of the water cycle. The lesson will focus on the human use of water but mostly on the treatment of the wastewater. Students will learn basic water chemistry and perform rudimentary water quality tests. The ultimate goal is to show students that water is water-whether it is discharged from a sewer system or falls from the sky. Once contaminants are removed from water, sewer water is simply water, with all the expected chemical and physical properties.

Instructional Materials Needed

- Worksheets
  "A drop in the Bucket"
  "Water pre-post assessment"
  "California State Water Project"
  video and video notes
  "Wastewater wise"
  "clean it up"
  "Wastewater through the ages" video and questions
  "How much is That?"
  "Water Quality Research"
  "Water Quality Lab"
  "Water Quality Study Guide"
  "Water Pamphlets"
- Lab equipment and materials (graduated cyclinders, filters with coffee filters, ring stands, test tubes) and required reagent tests
- Waters for testing
- Wastewater Video and California State Water Project video

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- Worksheets
  "A drop in the Bucket"
  "Water pre-post assessment"
  "California State Water Project"
  video and video notes
  "Wastewater wise"
  "clean it up"
  "Wastewater through the ages" video and questions
  "How much is That?"
  "Water Quality Research"
  "Water Quality Lab"
  "Water Quality Study Guide"
  "Water Pamphlets"

Cost-$30 (approximately) Instructional Days-10

Expected Student Outcomes-

- Students will understand the extremely small values representing wastewater components such as ppm and ppb.
- Students will design and use a simple treatment plan to physically separate

components of simulated wastewater
- Student will conduct basic water quality tests to compare physical and chemical properties of 5 different water samples.
- Students will understand domestic water sources, uses and wastewater treatment procedures.

Description of Activities

Activity Day One

Students will create a bar graph that shows the total amount of water on earth compared to usable water on earth. Worksheet: "A drop in the Bucket."
They will finish the day by completing the water pre-assessment.

will create serial dilutions of water using food coloring. They will see that the food coloring becomes less obvious with each dilution to the point where it is essentially invisible. Values such as parts per million and parts per billion will be used to describe the concentrations of these solutions.

Activity Day Two

Students will begin study of California water sources by watching and answering questions about the California water project.

Students will complete the water usage chart for homework.

Activity Day Three

We will discuss the household uses of water and how much water we discharge from our homes. As a class we will create a bucket full of typical wastewater that could be created in the kitchen. Coffee grounds, oil, food scraps, dirt, and vinegar are some of the components of this wastewater.

Students will work in lab groups to design a plan that would separate out these components. Worksheet: "Clean it up."

Activity Day Four

Once plans are approved by the teacher, students will begin separating their wastewater. They will work in lab groups of 3 to try to produce the "clean" water from this wastewater.

Activity Day Five

Students will see how water is actually cleaned up by watching the "Wastewater through the Ages" video. They will answer the questions as they watch the video.

Activity Day Six

Students will create serial dilutions of water using food coloring. They will see that the food coloring becomes less obvious with each dilution to the point where it is essentially invisible. Values such as parts per million and parts per billion will be used to describe the concentrations of these solutions. This will introduce them to the terminology needed in "Water quality research."

Activity Day Seven

Students will research major water quality parameters in the computer lab.

Activity Day Eight

As a class, we will discuss the water quality parameters and their importance in wastewater treatment.

Activity Day Nine

Students will compare the 6 water samples by performing basic water quality tests. The water samples include: Sacramento River water, American River water, tap water, reclaimed water, commercial Spring water and wastewater (from their earlier activity.) They will test for pH, nitrate and nitrite concentrations, turbidity (using a spectrophotometer), and water hardness.

Activity Day Ten

Groups summarize their findings. The class discusses the similarities and differences between these samples. We discuss the uses of each type. For example, could reclaimed water be used for irrigating lawns? Could wastewater from your sink be used for drinking?

Culminating Activity and/or Assessment

Students will create water pamphlets that explain water importance and the need for water treatment.

Enrichment Suggestions

Students will debate merits of desalination as a way to provide fresh drinking water.

Students will research the history of drought conditions in California and compare it to the present.

Students will inventory their own home water use and create a water-wise plan for their homes and yards.

Students will test the effects of nitrogen pellets (products of water treatment) on plant growth.

Additional Resources

www.watereducation.org
www.aquafornia.com

*Please be sure to send any additional resource files (worksheets, powerpoints, etc.) along with your lesson plan in one of the following formats: Word, PDF, PowerPoint, or Excel.

Foundation Academic Standards

- HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

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

- WHST.9-12.7 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. (HS-PS1-3)

CTE Pathway Standards

- 6.0 Health and Safety
- Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Health Science and Medical Technology sector workplace environment. (Direct alignment with RSTS 9-10, 11-12.4).

- 6.7 Identify and follow ecological practices applicable to the health care setting (i.e., recycling, energy efficiency, environmentally preferable chemical use, waste disposal, and water conservation).

- A6.0 Implement use of the metric system, orders of magnitude, and the pH scale in preparation of reagents, analysis of data, and graphing.

- A8.0 Follow sustainable and safe practices with high regard for quality control.

- A8.1 Follow written protocols and oral directions to perform a variety of laboratory and technical tasks.

- A8.5 Practice laboratory and personal safety including the location and use of emergency equipment (personal protective equipment, no food or drink, no open-toe shoes).

- A8.6 Properly and safely use and monitor a variety of scientific equipment, including pH meters, microscopes, spectrophotometers, pipets, micropipets, and balances.

- A8.7 Determine which equipment is appropriate to use for a given task and the units of

Lesson Plan Relevance To Externship

The lesson plan simulates part of the water treatment processes I learned about on the Externship. Students study properties of water and similarities among different types of water. These different types or samples are representative of various steps in the water delivery and discharge system. The lessons mirror the externship experience to a great extent.

Rubric for the (type in the title) Project

Student Deliverables	1 Exceeds Expectations	2 Meets Expectations	3 Approaches Expectations	4 Fails to meet Expectations

Physical Science Name……..Date……..Per…….

A Drop in the Bucket

Seventy-one percent of earth's surface is covered with water. But how much of this water is available for human consumption? What do you predict?
_____

A. Observe the teacher demonstration about the earth's water supplies. Record the answers as they are given.

1. How much water represents the earth's total water supply? _____
2. The number of mL's representing salt water in the oceans is: _____
3. The number of mL's representing salt water **not** in oceans is: _____
4. The number of mL's representing fresh water in glaciers is: _____
5. The number of mL's representing fresh water in the ground is: _____
6. The number of mL's representing fresh water on the earth's surface is: _____

B. Convert the above numbers to percentages.

mL's/1000 mL x 100 = _____

% of salt water in the oceans is: _____
% of salt water **not** in oceans is: _____
% of fresh water in glaciers is: _____
% of fresh water in the ground is: _____
% of fresh water on the earth's surface is: _____

C. Graph these percentages onto a bar graph. Staple the graph to this sheet.

D. Conclusion:
1. What is the total percent of water on the earth that is available for human consumption?

2. How close was your prediction to the above question?

3. What is the total percent of water unfit for human consumption (salt water)?

4. Why is freshwater more plentiful on some places on earth and not on others?

Water Pre-Assessment

Answer these questions to the best of your ability.

1. Where does our water come from?

2. What do we use our water for?

3. What happens to this water once it leaves our homes?

Water Post-Assessment

Answer these questions based on the lesson from our water unit.

1. Where does our water come from?

2. What do we use our water for?

3. What happens to this water once it leaves our homes?

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Physical Science
Unit: Water
Mrs. Tait

Name: _____
Date:_____ Period: _____

California's State Water Project:

Meeting the Challenge
(Video Questions)

As you watch the video, answer the following questions.

1. _____ touches every aspect of our lives.

2. What moves to the rhythm of the seasons?

3. What two seasons are plentiful in water?

4. What is one way to meet the water challenge?

5. A _____ mile long network of rivers, _____, _____, &

   _____ that provides water to _____ of California people.

6. What are the 2 problems of the struggle?

7. Why do California's want a state-wide system?

8. Who did the California's ask to build the central valley project?

9. What's agriculture in your own words? (Look in dictionary)

10. What happen in 1960?

11. How many public agencies are there?

12. What is the major storage facility?

13. Lake Oroville can store _____ million acre feet of water.

14. How many hydroelectric power generated plants are there in CA?

15. What do they produce?

16. Who measures the depth of the moisture content of the amount of snow?

17. What is a flood in your own words?

18. What is mitigation?

19. Summarize what you have learned from this video. Use at least 5 sentences.

Personal Water Use Survey

DOMESTIC WATER USE	TIME SPENT USING WATER	ESTIMATED GALLONS OF WATER USED	WATER CONSERVING METHOD
Keeping Clean			
Washing hands and face		Tap running 2-5 Gallons per minute	Half-full bowl ½ gallon
Showering		Water running 5 gallons per minute	Five minutes with low-flow head 12 gallons total
Taking a bath		Full tub 30-40 gallons total	Low level tub 15 gallons
Taking a sponge bath		5 gallons per minute	
Brushing teeth		Tap running 5 gallons per minute	Wet brush, rinse ½ gallon
Preparing Food			
Washing food		Water running 5 gallons per minute	Rinsing only About 1 gallon
Cooking		Approximate your use	Approximate your use
Drinking			
Tap water		Running water ¼ gallon	Pitcher in fridge 1/16 gallon
Tea, coffee, cocoa		Running water ¼ gallon	Pitcher in fridge 1/16 gallon
Flushing the Toilet		Regular flow 7 gallons	Low flow 2 – 4.5 gallons
Washing Clothes by Hand		20-30 gallons	
Washing Clothes by Machine			
Low setting		20 gallons	
High setting		30 gallons	
Washing Dishes			
By hand		Running water 30 gallons	Sponge wash and dishpan rinse--5 gallons
In the dishwasher		Full cycle--15 gallons	Short cycle7-- gallons
Cleaning the House		8 gallons	
Washing the Car		Water running 10 gallons per minute	Bucket, sponge, choke nozzle-5 gallons total
Watering the Lawn		In middle of day 10 gallons per minute, 30 minutes	In morning hours 10 gallons per minute, 10 minutes
Watering Plants		5-10 gallons	
Other Uses		You estimate	

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Wastewater Wise

How much water do you use in a day? Estimate the amount of time you spend using water for each activity described on the other side of this sheet. If the estimated gallons are given as a rate (such as gallons per minute), list that rate. Multiply the time and the rate to get the total water used. If the estimated gallons are not listed as a rate, simply list the total water used.

Activity	Time	Water usage rate (/min)	Total water used
Total gallons of wastewater you create.			

Conclusion: How could you reduce the amount of wastewater you create?

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Clean it up!'

How can you clean the wastewater that your class created? Your task is to try to clean as much of the water as possible. You may use any of the pieces of equipment you see on the lab table. You can also request additional materials from your teacher. Your only required step is to determine the beginning mass of your wastewater and the mass of your final "clean" water. All steps should be clearly written so that anyone could follow them.

Procedure for finding mass of wastewater:

_____

_____

_____

- Mass of beginning wastewater: _____ grams

Procedure for cleaning water: (Attach another sheet if necessary)

_____

_____

_____

_____

_____

_____

_____

_____

- Mass of "clean" wastewater: _____ grams

Conclusion: (Write on a separate sheet of binder paper)

1. What was the beginning mass of your wastewater? What was the ending mass?
2. What "waste" did you create along the way? What will happen to that waste?
3. Compare your waste water to tap water. How does it compare? Do you think you truly "cleaned" it?

Key

1. On average, how many gallons of water do Americans use per day?

80

2. What are 2 diseases associated with untreated wastewater?

Cholera and bubonic plague

3. How many people died of Cholera in Sacramento in the 1800's?

1000

4. What happened to the Cuyahoga River in 1952?

Caught on fire

5. When was the Clean Water Act passed?

1972

6. What are 3 ways that wastewater is cleaned at the Sacramento Regional Sanitation plant?

Screens bacteria, chlorine

7. Why is sulfur dioxide added to the wastewater?

To neutralize the chlorine

8. True or False: All of the water treated from the Sacramento Regional Sanitation plant is immediately pumped back to homes to be recycled.

9. What is produced in the biodigesters?

10. About 30% of the biosolids at the water treatment plant are turned into: _____.

11. What are the "Buffer Lands?"

Physical Science Name…….Date……Per……..

Renewable Resources: Wastewater Through the Ages

(video questions)

1. On average, how many gallons of water do Americans use per day?
2. What are 2 diseases associated with untreated wastewater?
3. How many people died of Cholera in Sacramento in the 1800's?
4. What happened to the Cuyahoga River in 1952?
5. When was the Clean Water Act passed?
6. What are 3 ways that wastewater is cleaned at the Sacramento Regional Sanitation plant?
7. Why is sulfur dioxide added to the wastewater?
8. True or False: All of the water treated from the Sacramento Regional Sanitation plant is immediately pumped back to homes to be recycled.
9. What is carried in the "purple pipes?"
10. What is produced in the biodigesters?
11. About 30% of the biosolids at the water treatment plant are turned into: _____.
12. What are the "Buffer Lands?"

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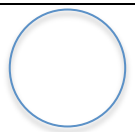
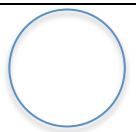
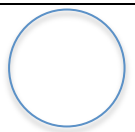
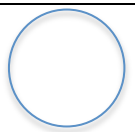
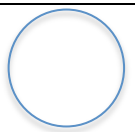
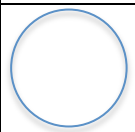
How much is that?

Pure water that looks clean and transparent. However, some water samples may look pure but could actually contain small amounts of contaminants. At what point could water be considered contaminated? To answer this question, you will need to understand some very small types of measurements such as parts per million (ppm), parts per billion (ppb) and even parts per trillion.

Procedure:

1. Place one drop of food coloring in well plate #1.
2. Into well plate #2, place one drop of food coloring and 9 drops of water; mix with a toothpick. This food coloring solution was originally a 1/10 concentration. Now you have changed the solution to a concentration of 1/100. Record the concentration of the solution in well plate #2. Color the circle with the approximate shade of the solution.
3. Add 1 drop of the solution in #2 to well plate #3. Add 9 drops of water. Record the new concentration and color of this solution.
4. Continue this process until you make 12 solutions.

Well plate #	1	2	3	4	5	6
Well plate color						
concentration	1/10					
Concentration using scientific notation	$1/10^1$					
Is food coloring still in the water?						

Adapted from "How Much is That," Clean Water Curriculum, Hampton Roads Sanitation District; modified by Maria Tait, Sept. 29, 2014.

Well plate #	7	8	9	10	11	12
Well plate color						
concentration						
Concentration using scientific notation						
Is food coloring still in the water?						

Conclusion:

1. In which well plate was the concentration:
   1 ppm (1/1,000,000)? _____ 1 ppb (1/1,000,000,000)? _____ 1 ppt (1/1,000,000,000,000)? _____

2. In which well plate do you first observe no visible evidence of food coloring?

3. Is food coloring still present in well plate #12? How could you prove it is present? Or prove it disappeared?

4. The acceptable level for mercury contamination in drinking water is 0.002 ppm. Would you be able to see pieces of mercury in this concentration of water?

Adapted from "How Much is That," Clean Water Curriculum, Hampton Roads Sanitation District; modified by Maria Tait, Sept. 29, 2014.

Physical Science Name……..Date……Per……..

Water Quality Testing

In this lab, you will analyze water quality parameters from these water sources:

American River, Sacramento River, Tap water, Reclaimed water, commercial "spring" water, your "cleaned" water.

You will test all water samples for color, odor and turbidity. You will test your "cleaned water" and another source for pH, nitrites, nitrates, general hardness and carbonate hardness. Results will be shared among the entire class.

Purpose Question: How do you think these water samples will compare to each other? (Refer to the water research parameters from last activity.)

Hypothesis: _____
_____
_____

Procedure:
1. Obtain and label test tubes A, B, C, D, E and F.
2. Describe the color by holding the sample up to the light.
3. Describe the odor by wafting air across the sample towards your nose.
4. Determine the turbidity by using a spectrophotometer. Light with a wavelength of 400 nm will be passed through a small test tube. A test tube with nothing in it (a blank cuvette) should give 100 % transmission and 0% absorption. Fill a cuvette about ½ full with your water sample and place in the holder. Record the % transmission of light.
5. Measure pH, NO_2, NO_3, KH and GH with test strips. Simply dip the test strip into a beaker of your sample water. Compare the color changes to the color chart. Record the levels in your data table.

A	B	C	D	E	F
American River	Sacramento River	Tap water	Reclaimed water from Regional Sanitation District	Commercial “spring” water	Your team’s “cleaned” water from last week

Water Container/source	Water Quality Parameters							
	Color	odor	Turbidity (% transmission)	pH	Nitrite (ppm)	Nitrate (ppm)	General hardness (ppm)	Carbonate hardness (ppm)
A American River								
B Sacramento River								
C Tap Water								

Water source	Water Quality Parameters							
	Color	odor	Turbidity (% absorption)	pH	Nitrite (ppm)	Nitrate (ppm)	General hardness (ppm)	Carbonate hardness (ppm)
D Reclaimed Water								
E Commercial "spring" Water								
F Your "cleaned" water								

Conclusion:

1. Nitrates should not exceed 10 ppm for clean drinking water. Nitrites should not exceed 1 ppm for clean drinking water. Did any of the samples prove to be unhealthy for nitrate or nitrite content?

2. Which water samples was highest for GH? KH? What does this say about the amount of soap you would need to "lather up" using this source?

3. What sample source would you consider to be "cleanest" for drinking? Why?

4. What sample source would you consider to be unfit for drinking? Why? Are there any other uses you can think of for this water?

5. What was the most obvious difference between these sources?

6. Was your original hypothesis supported or not? Explain.

Physical Science Name.....Date.....Per.....

Water: *Vocabulary Review*

Match the word from the word list to the definition that best describes it. Give an alternative definition (hint, picture or example) for each word.

Word list: California Water Project, chlorine, cholera, Clean Water Act, concentration, fertilizer, groundwater, reclaimed water, salinity, turbidity, wastewater, water cycle, water hardness, water treatment

Word	**Definition**	**Alternative definition (Hints/pictures/ or examples)**
1.	the removal of contaminants from untreated **water** to produce drinking **water** that is pure enough for the most critical of its intended uses	
2.	former wastewater (sewage) that is treated to remove solids and impurities	
3.	The amount of a solute in a given amount of solution	
4.	Measure of the amount of magnesium, calcium and other salts in water	
5.	Primary federal law in U.S. governing water pollution	
6.	Process by which water circulates between the earth's oceans, atmosphere and land through precipitation and condensation.	
7.	Water found underground in the cracks and spaces in soil, sand and rock.	
8.	Water that has been used for household, agricultural or industrial purposes; sewage	
9.	Chemical or natural substance that has been added to soil to increase its productivity	
10.	Cloudiness of water caused by large numbers of small particles, including bacteria	
11.	world's largest publicly built and operated water and power development and conveyance system; provides water, flood control, and hydroelectric power to the people of our state.	
12.	A measure of the saltiness of water	

13.	Infectious disease contracted through infected water supplies	
14.	An element used as a disinfectant for cleaning water	

Water *Study Questions*

To prepare for the test questions on the water unit, answer and study the following questions:

1. What do we use water for? Why is it so important for our daily lives? What threatens our water supply?

2. What are the advantages of the California Water Project? How does this help our state?

3. Most of the earth's suface is covered with water. Does that mean we will always have plenty of water for our uses? Explain.

4. Where does our water in Sacramento come from?

5. Where does our water in Sacramento go after we are done using it? What happens to it there?

6. Why is treatment of wastewater important?

Physical Science ***Water Pamphlets***

To summarize our first unit on water, you will create a pamphlet. Think of this as an educational pamphlet you could give any member of the public as a way to teach them about this most important resource.

The pamphlet will be made from a sheet of paper that is folded twice. The outside of the paper will contain the front cover, back cover and inside flap. The inside will answer three main questions about water.

Each panel should be neat and creative. Written information should be accurate and succinct. Bullet points can be used to summarize important ideas. The specific instructions for each panel is as follows:

<u>Outside</u>

- Front Cover: Should grab the viewer's attention and describe the make-up of water.
- About the author(s) page
- Inside flap: your choice

<u>Inside</u>

- Panel 1: Where does our water come from?
- Panel 2: What do we use water for?
- Panel 3: Where does it go after we are done?

outside

Front cover Title page	Back cover About the author(s) page	Inside flap Way to Save water

inside

Panel 1 Where does our water come from?	Panel 2 What do we use our water for?	Panel 3 Where does water go when we are finished with it?

Grading:

1. Accurate information……./20 points
2. Neat……/10 points
3. Creative and colorful……./10 points