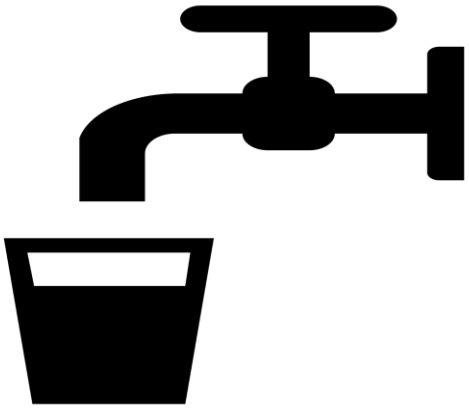

HYDRO P.A.L.

Portable - Aquatic - Learning
Middle School
Water Treatment
Classroom Experiment

This material is based upon work supported
by the National Science Foundation under grant number IIA-1301726.

Overview

In this 3-week middle school unit, designed for periods of approximately 50 minutes, students will review the water cycle, investigate the difference between potable and non-potable water, and explain why different types of potable water taste differently. Students will be able to explain how humans cause water pollution. Students will then begin hands-on experiments to be able to explain porosity that will lead them to the main project of the water treatment experiment. Teachers will be given all the necessary materials to create a water treatment experiment. Students will use 5 different types of media to filter water. They will then test the results and create a filtration system with the provided supplies to see if they can take non-potable water and make it potable. To see all the related NGSS, see Unit Outline. Link to resource folder

Acknowledgments:
Lessons were created by Marianne Roe, Chris Sivels, and Joyce Zakem, with support from Dr. Erica Marti and UNLV students Milady Ramirez, Francisco Chavarria, and Elizabeth Heider. Thank you to Southern Nevada Water Authority for providing resources that were used to develop the lessons.

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Unit Scope and Sequence

Anchoring Phenomenon: If you had a water shortage, how can non-potable water be changed to potable water?

Connection to student identity/culture: Nevada has water issues throughout the state, specifically providing fresh water to all organisms that live within its borders.

Driving Question (Big Question): How can humans purify water so that it is potable?

What question will students generate? (Lesson Questions)	Sub Phenomenon	What are students figuring out? (Central Construction)	What are students doing? 3D Connections	Evidence of Learning/ Student Artifact
What are the misconceptions of the water cycle? Lesson 1 MS-ESS2-4	Water Cycle Review	Where does water exist on Earth and in what form? DCI -- ESS3.A	Webquest CC -- Patterns, Cause and Effect, Stability and Change SEP -- Asking questions, Analyzing and interpreting Data	Webquest Worksheet
What is potable water? Lesson 2 MS-ESS3-3 and MS-ESS3-4	What is the effect of potable and non-potable water concerning humans?	Difference between potable and non-potable water DCI -- ESS3.A and ESS3.C	Research and Data Collection CC-Cause and effect, and Science address questions about natural and material world. SEP -- Engage in argument from evidence	T-Chart Worksheet

Note: The table contains abbreviations used within NGSS. DCI = Disciplinary Core Idea, CC = Crosscutting Concept, SEP = Science and Engineering Principle.

What question will students generate? (Lesson Questions)	Sub Phenomenon	What are students figuring out? (Central Construction)	What are students doing? 3D Connections	Evidence of Learning/ Student Artifact
What makes water potable? Lesson 3 MS-ESS3-3 and MS-ESS3-4	Are there different levels of potable water?	Chemical makeup of different potable waters DCI -- ESS3.A, ESS3.C and ESS3.D	Taste Activity-match chemical makeup with samples. CC -- Patterns, Cause and Effect, influence of society, engineering, and technology on Society and the natural world.	Activity Worksheet with data table and conclusions
How are humans causing non-potable water? Lesson 4 MS-ESS3-3 and MS-ESS3-4	How are humans causing non-potable water?	What actions are humans doing that cause non-potable water? DCI-- ESS3.A, ESS3.C and ESS3.D	Analysis article and video jigsaw (choice A) Or Water Pollution Gizmo (choice B) through explorelearning.com -- All information provided at website -- No lesson plan provided here (same standards apply) CC -- Influence of science, engineering, and technology on society and natural resources SEP -- Asking questions and defining problems, Engaging in argument from evidence.	Mini-Poster of small group ways of human pollution Or Gizmo Explore Sheet

What question will students generate? (Lesson Questions)	Sub Phenomenon	What are students figuring out? (Central Construction)	What are students doing? 3D Connections	Evidence of Learning/ Student Artifact
How can humans convert non-potable water into potable water? Lesson 5 MS-ESS3-1, MS-ESS3-4	Water Purification	What materials can be used to purify water? DCI -- ESS3.A, ESS3.C and ESS3.D	Porosity Lab (Choice A) Or Porosity Gizmo (choice B) through explorelearning.com -- All information provided at website -- No lesson plan provided here (same standards apply) CC- Patterns, Questions about the natural and material world SEP-Constructing explanations and designing solutions	Porosity Lab Sheet Or Gizmo Explore Sheet
What is the most effective way to make water potable? Kit lesson plan 1-4 and optional presentation MS-ESS3-1, MS-ESS3-3, MS-ESS3-4	What is the most effective order of purifying media?	The order to put the kit media to create the most potable water. DCI – ESS3.A, ESS3.C and ESS3.D	Using Hydro P.A.L CC -- Patterns, Cause and Effect, and Stability and Change SEP -- Asking questions and defining problems, Analyzing and interpreting data, Constructing explanations and designing solutions, Engaging in argument from evidence.	Activity worksheets and charts and possible final presentation product

Lesson #1 (one class period)

Date:

Subject / grade level:

Materials:

- Computers (1:1) or small group
- Copies of Webquest worksheets (Water Webquest - Middle School Water Discovery)
- Optional: Water Cycle Posters

Essential Standards and Clarifying Objectives:

- Weather and Climate: MS-ESS2-4 -- Create a model of the water cycle

Lesson objective(s):

- To review the actions and locations of water in the water cycle

Differentiation strategies to meet diverse learner needs:

- Have vocabulary list of water cycle words
- Have lower students paired with higher students
- Have EL and/or SPED students complete extra credit of entrance card only

ENGAGEMENT

- When students enter the room have Mr. Parr Water Cycle Song playing
- Water Cycle Entrance Card Activity

EXPLORATION

- Water Cycle Webquest -- scroll down to bottom of the page and click on: Water Webquest - Middle School Water Discovery (MS Word file)

EXPLANATION

- As students finish the Webquest put into small groups and have them discuss and review what they learned during the Webquest. At the end have groups share out.

ELABORATION

- Ticket out the door: How do humans affect the water cycle?

EVALUATION

- Grade the Entrance Card and Webquest Activity

Name_____ Date_____ Period_____

Water Cycle Entrance Card

Pretend you are a drop of water. Describe a trip through the water cycle. Begin your journey in the ocean. For each phase of your journey, explain what phase you are in and why, how the heat and gravity is affecting you and your movements as you travel, and detail each location along your journey from beginning to end. This vocabulary should be included: precipitation, runoff, infiltration, groundwater, evaporation, transpiration, condensation, solar radiation, and gravity.

_____

_____

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_____

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_____

Extra Credit: Draw a picture of your water drop going through the water cycle on the back of this page. Include arrows.

Lesson #2 (one class period)

Date:

Subject / grade level:

Materials:
T-Chart Worksheet -- Computers for research

Essential Standards and Clarifying Objectives:

- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- To understand and give examples and effects of potable and non-potable water.

Differentiation strategies to meet diverse learner needs:

- Group students appropriately to do internet research

ENGAGEMENT

- Question of the day: What are all the ways humans use water? -- Have students complete on paper independently during warm-up.
- Recap water cycle and clarify misconceptions -- Opening whole class discussion.

EXPLORATION

- Explain how to complete the T-Chart research worksheet provided. (See Materials Above) Links provided for students but higher level students could be given permission to search on own.
- Suggestions: students can work in small group or independently. Students can complete worksheet with paper and pencil or electronically (i.e., Google classroom).

EXPLANATION

- Have students share information in small groups or as a whole group depending on how you completed the exploration. Collect data or take care of any misconceptions or questions students need answered.

ELABORATION

- Ticket out the door: Name examples of non-potable water in your neighborhood.

EVALUATION

- Monitor students' completion of T-Chart Activity
- Formative Grading of the T-Chart Worksheet

Name _____ Date _____ Period_____

Use the following links to complete the T-Chart below:

1. https://water.usgs.gov/edu/propertyyou.html
2. https://www.linkedin.com/pulse/what-difference-between-potable-non-potable-water-services
3. http://www.halton.ca/living_in_halton/water_and_wastewater/water_quality_protection/well_water/possible_effects_drinking_contaminated_well_water/
4. https://goneoutdoors.com/potable-vs-nonpotable-water-10027676.html

	Potable Water	Non-potable Water
Definition		
Examples: (at least 3 of each)		
Effects on the Human Body		

Teacher Answer Key

	Potable Water	Non-Potable Water
Definition	Water that is able to be consumed (drank, cooking, and bathing) by humans without causing illness or death. Questions to Consider: Are there levels of potable water? (i.e., Can Americans drink water in Mexico?)	Water that is not able to be consumed by humans. If consumed, it could cause illness or death. Can be used for watering plants, flushing toilets, washing cars, etc. Questions to Consider: Can other living things drink non-potable water?
Examples: (at least 3 of each)	● Tap Water in America ● Boiled Water ● Bottle Water ● Shower Water This is not a complete list	● Car Washes ● Stagnant Water ● Toxic Dumps ● Toilet Water ● Lake, Ocean ● For Americans: Water from other countries This not a complete list
Effects on the Human Body	● A vital nutrient to the life of every cell, acts first as a building material ● It regulates our internal body temperature by sweating and respiration ● The carbohydrates and proteins that our bodies use as food are metabolized and transported by water in the bloodstream ● It assists in flushing waste mainly through urination. ● Acts as a shock absorber for brain, spinal cord, and fetus ● Forms saliva ● Lubricates joints	Include gastrointestinal and stomach illnesses like nausea, vomiting, cramps, and diarrhea.

Lesson #3 (two class periods)

Date:

Subject / grade level:

Materials:
Lab Sheet, cups (enough for each student to have a sample of each type of water), tap water, bottled water (options: spring water and purified water), distilled water, labels from purchased water to discuss differences.
Nevada Water Quality Report, Article: Why do Different Waters Taste Differently?

Essential Standards and Clarifying Objectives

- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- To explore how potable water can taste differently

Differentiation strategies to meet diverse learner needs:

- Review of safety procedures during lab experiments

ENGAGEMENT

- Warm-Up -- Answer the question: Can potable water taste different? Why or Why not? or Venn Diagram of potable and non-potable water
- Review warm-up and differences between potable and non-potable warm up

EXPLORATION

- Taste Test Lab

EXPLANATION

- Students will share their conclusions to the lab activity
- As whole class discuss the actual differences in the different samples (Suggestion: do not tell one class the correct labels until all classes have completed the taste test)

ELABORATION

- Discuss in small groups: What did I learn from this activity? Share out.
- Read and discuss article (Why do different waters taste different) It is an 8 page article you may want to only do parts and highlight what you think is most important.

EVALUATION

- Monitor behaviors during lab activity
- Formatively assess lab activity sheet

Name _____ Date_____ Period _____

Taste Test Lab

Essential Question: Does different potable water taste differently?

Activity:

1. Taste each sample and record your observations in column #1.
2. Look at the water quality report, labels, and article provided to find out information about what is known about the sample waters and fill out column #2.
3. Get instructions from the teacher about how to complete the conclusion below.

Water Samples and observation (How did it taste?) (at least 3 observations)	Information learned from labels (at least 3 pieces of information)
A	
B	
C	
D (optional)	

Conclusion:

My claim about sample A is it is _____ type of water.

My evidence from the article and labels is

_____

_____

_____.

My reasoning from my taste test is

_____

_____

_____

My claim about sample B is it is _____ type of water.

My evidence from the article and labels is _____

_____

_____

_____.

My reasoning from my taste test is _____

_____

_____

_____

My claim about sample C is it is _____ type of water.

My evidence is _____

_____

_____

My reasoning is _____

_____

_____

For teachers:

These are the materials that will be needed: cups 3 or 4 per student (suggestion: the small bathroom Dixie cups work well; plan one gallon per class per type of water); pitchers labeled A, B, C, and/or D (make yourself a key so you know what each one is); in each pitcher add tap water, distilled water and the last one is bottled water. For bottled water, you can compare spring water to purified water which is pitcher D (optional).

Review safety rules and expectations during the tasting. The following procedure is suggested: have the students complete observations silently, have the students pass out cups and come up to you in a line to get some of water A and the whole class tastes at the same time. As the students come up for taste water B, have students throw cup A away and do the same for taste C and/or D. Remind students to record results after each tasting. To save on cups, you could have each student use one cup over and over again. Just make sure the cup is empty before adding the next water.

Prior to completing column 2, have students read the attached article. You could read together as a whole class, jigsaw, or have students read independently (teacher's decision). The teacher should create a fact sheet ahead of time using the information from the labels on your water or facts from the water district website so students can use the information to fill out column #2. Students can work in small groups to fill it out. As they complete column #2, the teacher should tell the students which water types they can choose from (i.e., tap water, bottled water and distilled water).

Have a class discussion about what the students came up with for column #2. After the class discussion, students then complete the conclusion and determine which water was in which pitcher. You may do sample A as a whole class and then let students complete B and C independently. Collect all lab sheets before going over the answers so they cannot change their answers.

Why Do Different Waters Taste Different?

Alexandra Ossola, APRIL 01, 2017

https://www.cooksillustrated.com/science/854-articles/story/why-does-water-from-different-places-taste-different

You might think that water doesn't have much flavor. But to hear Martin Riese tell it, the taste of water can vary almost as much as soda. This is something he's been interested in for a long time. When he would travel with his parents to different cities as a child, Riese would immediately run to the faucet to sample the local flavor. "There are so many varieties of water. When people say, 'oh, it's all the same,' that's not really correct," he says.

After six years of training, Riese received his certification as a Mineral Water Sommelier from the German Mineral Water Trade Association (there are about 100 people in the world that have this credential, according to Pacific Standard, but he's the only one in the U.S.). Today he works as a water sommelier in several restaurants in Los Angeles and even runs a Water 101 class to "educate students on the unique qualities and characteristics of mineral water," according to Riese's website.

Riese is not alone. The Metropolitan Water District of Southern California, which serves 19 million people, employs 25 taste testers to make sure the water coming out of the taps tastes as it should. Every year various organizations hold contests in dozens of states and even on a national scale, to determine the town with the best-tasting water (Bloomington, Minnesota was the winner of the national competition in 2016).

So what determines the flavor of the water coming out of your tap or bottle?

It's all due to minerals and other compounds that the water picks up on its journey. For comparison, water that's been distilled to remove anything dissolved in it—the water you use in your steam iron—tastes "totally boring, like nothing, dry in your mouth," as Riese describes it. But, as it flows through the ground, through rivers and pipes and so forth, water naturally picks up a variety of soluble ingredients that subtly contribute to its flavor.

Water's flavor depends on where the water comes from, says Susan D. Richardson, a chemistry professor at the University of South Carolina. If you get water from a well, it might have a slightly mineral or chalky taste because it's passed through layers of limestone deep underground. Richardson fondly recalls the refreshing, delicious water when she had her own deep well in Georgia.

Water near the beach often has a slight scent of sulfur because of sulfur-producing microbes in groundwater. The stuff purified from some rivers or lakes can have an earthy, organic taste to it that results from leftover bits of decomposing plant matter. If you live in cities like New York or San Francisco, you enjoy pristine, delicious reservoir water piped in from distant mountains. Water bottled from mountain springs, like that from wells, can be packed with minerals that alter its flavor. Calcium makes water taste milky and smooth, magnesium can be bitter, and sodium makes it taste salty.

Riese compares these mineral variations to colors on a painter's palette—the number of minerals might be limited, but ways in which those colors can combine is limitless, he says. Some people, such as food chemistry blogger Martin Lersch, claim to have figured out the right mineral cocktail to recreate the tastes of some of the world's most coveted mineral waters, such as San Pellegrino and Gerolsteiner.

None of these taste-altering minerals are bad for you, Richardson notes—water treatment plants ensure the water is safe to drink. But sometimes the disinfecting chemicals used in treatment, and their byproducts, can affect the water's taste. Chlorine is a pretty common disinfectant; government regulators give a range for how much chlorine is acceptable, so some treatment plants add more than others. "You can tell if there are high chlorine levels in the water: it reeks like swimming pool water," Richardson says.

A highly metallic taste to the water can mean that there are high levels of iron in the water, often leached from old pipes. While that isn't harmful itself, lots of iron can sometimes indicate the presence of another toxic metal: lead. A medicinal taste is also something to be wary of; sometimes,

disinfecting agents react with compounds already in the water to create disinfection byproducts (DBPs). There might not be much in the water, but even a little can greatly affect the water's taste. Because scientists can't identify most of these DBPs there's no telling exactly which DBPs are in medicinal-tasting water, or what their long-term health effects might be; the government limits the quantity of 11 different DBPs, but Richardson's lab has found over 700, she says.

The unique chemical blend of water in particular locations has led to the distinct culinary traditions that come from there. New Yorkers swear it's the water that makes their pizza and bagels taste so good (**we tested and debunked that claim**); Kentucky's **limestone-filtered water** is just right for making bourbon.

Water that has an excess of dissolved calcium and magnesium is known as hard water, and its chemistry presents some unique problems for cooks. When it's used for cooking vegetables or fruits, the minerals can tighten up the plants' natural pectin, giving rise to phenomena like beans failing to soften no matter how long they're soaked and boiled. Adding table salt to the water can minimize that toughening. Water that's too soft, on the other hand, is a headache for bakers, since a certain amount of calcium is needed to help gluten molecules in dough link up.

Other conditions can affect how water tastes as well. In the summertime, more plant matter falls into rivers, giving water more of that earthy taste; seasonal algal blooms can release a stinky (but non-toxic) chemical called geosmin into water that treatment can't get out. Water that's drunk too cold will lack most of its flavor, Riese says—he recommends 59 degrees Fahrenheit for tasting water. Filters might remove some less desirable flavor elements from water, but they also take out the good parts that make water flavorful and distinctive, he adds.

Riese doesn't have a single favorite type of water—he keeps five or six different types of bottled water around the house for different uses, he says. He drinks high-mineral-content water, such as **Gerolsteiner**, when he works out. Still others he and his wife use to make coffee or cook pasta. But

even if you've never noticed the differences in water flavor before, you probably can if you taste different types of water one after another, preferably at room temperature to let the flavor shine through. "Every person can detect differences in water," Riese says. "Everyone can taste the difference. I see it on a daily basis. People are always amazed at how different water can taste.

The following text is from Southern Nevada Water Authority and Las Vegas Valley Water District websites.
https://www.lvvwd.com/water-quality/taste/index.html
https://www.lvvwd.com/water-quality/testing-treatment/index.html
https://www.snwa.com/water-quality/treatment-testing/index.html

Taste: Las Vegas Valley Water District

The taste of Las Vegas' tap water can be affected by two things: the relatively high concentration of minerals in our water, and the presence of trace amounts of chlorine.

It is important to note that our drinking water meets or surpasses all water quality standards. Although some may not care for its taste, the Las Vegas Valley Water District and Southern Nevada Water Authority are committed to meeting the highest standards of water quality.

The Southern Nevada Water Authority has a panel of trained water tasters who meet weekly to evaluate drinking water in the Las Vegas Valley. Learn more about water testing and treatment.

Minerals in our tap water

As is the case in many Western States, Las Vegas' tap water is "hard," meaning it has a higher concentration of dissolved minerals such as calcium and magnesium. Sometimes the minerals found in hard water can be detected in its taste.

Chlorine

The Las Vegas Valley Water District adds small amounts of chlorine during the water-treatment process to protect our drinking water supply. Some people report noticing the taste or smell of chlorine.
Use these tips to help improve the flavor of your tap water.

- **Put a pitcher of tap water in the refrigerator.** This allows the chlorine to dissipate. After just a few hours, you'll notice an improvement in flavor.
- **Add a lemon or orange slice.** You'll add zest and overcome any chlorine taste or smell.
- **Filter your water.** There are hundreds of filter options at varying costs, but an inexpensive activated carbon filter, like those found in carafe systems, can improve

taste and odor perceptions associated with chlorine. These filters do not remove hardness, minerals, sodium or fluoride.

Filtering or softening tap water

If you want to improve aesthetic qualities of your water such as taste and hardness, you may want to purchase a home treatment system.

There are a variety of inexpensive filter systems to remove chlorine from your drinking water. If you do not like the hardness of the valley's water supply, you can invest in a softening system.

Type	Description	Pros	Cons
Activated Carbon Filters	Activated carbon filters attract and hold certain chemicals as water passes through them. They are available in carafe units, faucet-mounted filters and models mounted beneath the sink.	Reduces chlorine odor and taste; many are inexpensive.	Doesn't remove minerals associated with hard water; can require frequent filter changes; does not remove microbes such as bacteria.
Reverse-Osmosis Filters	These systems use both a traditional (usually carbon) filter and a cellophane-like membrane to remove most organic and inorganic compounds. This is the only type of filter that will remove calcium and magnesium, the minerals that cause hard water.	Removes minerals that cause hardness, as well as chemicals such as lead, arsenic and copper. Very effective at removing bacteria and other harmful microbes.	More expensive; may require a plumber; requires more storage space; many units wastewater.
Water Softeners	Devices used to exchange calcium and magnesium for "softer" minerals—usually sodium or potassium.	Reduces water spots; eliminates chalky residue on dishes; may enhance dishwasher and washing machine performance.	Very expensive; higher maintenance. Some add salt to drinking water, which can be harmful to health. Salt in water also can be harmful to houseplants, grass and soil.

Water Testing and Treatment – Southern Nevada Water Authority

We test water all over the valley

To ensure that water meets or surpasses federal drinking water standards, the Water Authority collects and analyzes water samples with more frequency than federal regulations require.

In 2017, Water Authority staff:

- Collected more than **55,250 water samples** at locations all over the valley, from Lake Mead to Mt. Charleston
- Conducted more than **300,100 analyses** of those samples
- Tested for more than **160 regulated and unregulated contaminants**
- Monitored water quality in "real time" **24 hours a day, 365 days a year**

We also conduct extensive quality control sampling of our water distribution system, including reservoirs and pumping stations around the valley. New pipelines also are tested for bacteriological quality before they are accepted as part of the distribution system.

Although this type of sampling is not required by regulation, it's important for identifying the system's potential areas of weakness.

Water sampling stations

We manage **367 sampling stations** where we draw water samples for required testing. Some of these stations are above ground; others are installed in our customers' meter boxes to ensure that water quality is maintained all the way to the tap.

NOTE: Our employees will NEVER ask to enter your home to collect a water sample from your tap. Please see our "How to identify our employees" page for more information.

We treat drinking water to ensure its quality

Nearly 90 percent of our drinking water comes from the Colorado River via Lake Mead. The remainder comes from a deep groundwater aquifer beneath the Las Vegas Valley, which we use primarily during summer months to meet peak demand.

Treating water from Lake Mead

Water drawn from Lake Mead is treated at the Southern Nevada Water Authority's Alfred Merritt Smith Water Treatment Facility or the River Mountains Water Treatment Facility.

The treatment process begins with disinfection. Water is disinfected using ozonation, a treatment process that destroys bacteria and other microorganisms through an infusion of ozone. Ozone is a gas produced by subjecting oxygen molecules to high electrical voltages.

Next, the water is aerated to reduce odors and increase the water's oxygen content. Microscopic particles are then combined through a process called flocculation. These larger, combined particles are removed through the use of a multi-layered filter composed of anthracite coal, silica sand and garnet sand.

As the water leaves the water treatment facilities, chlorine is added to protect it on the way to customers' taps. It also is treated to minimize pipeline corrosion.

Treating groundwater

Because it is naturally filtered, water drawn from the groundwater basin is simply treated with chlorine as it enters the distribution system. For more details about how our water is treated to ensure its quality and safety, visit the Southern Nevada Water Authority website, SNWA.com.

Lesson 4 Choice A (two class periods)

Date:

Subject / grade level:

Materials

- Article for Jigsaw -- it has all the links and video
- Poster Paper and colored markers to create poster
- Notes Page for Presentations/Gallery Walk

Essential Standards and Clarifying Objectives

- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- To investigate ways humans cause water pollution

Differentiation strategies to meet diverse learner needs:

- Pairing weaker readers and writers with strong peer role models. Do lesson in small groups.

ENGAGEMENT

- Have students brainstorm: *What is water pollution and how do humans cause it?*
- Recap and answer any questions from the taste test activity.

EXPLORATION

- According to the article, there are 15 ways that humans pollute water. Read the beginning of the article as a whole class. Then put the students into groups and assign each group one or two ways depending on group sizes. Have each group read about their assigned way and then each group will create a poster to share the information with the rest of the class.

EXPLANATION

- Use small group presentation format or gallery walk for students to complete the Notes page about all the types of water pollution.
- Watch and discuss the Bonus Video found in article link.

ELABORATION

- Reflection Questions at the bottom of the Notes page -- Which type of pollution causes the most harm and why? Which type of pollution do you cause the most and why?
- Share out and collect the data to discuss another day.

EVALUATION

- Posters and Notes pages

Name _____ **Date**_____ **Period**_____

Directions: Use this page to take notes during the group presentation or during the Gallery Walk. In the facts column, include if this type of pollution is direct or indirect.

Type of Pollution	**3 facts about the Type of Water Pollution**
Dumping	
Industrial Runoff	
Agricultural Runoff	
Chemical Runoff	
Landfills	
Plastics	
Construction Runoff	
Batteries	
Domestic City Sewage	

Septic Systems	
Too many nutrients	
Hormones and Antibiotics	
Leaks and Spills	
Fossil Fuels	
Mining	

Reflection Questions: Which type of **pollution** do you think causes the most harm? Why?

_____

_____

_____

Which type of **pollution** do you think you cause the most? Why?

_____

_____

_____

Lesson 5 Choice A (two class periods)
Date:
Subject / grade level:
Materials: • **Porosity Lab Sheet** • YouTube Video on Porosity -- Use 0-7:22 for engagement activity
Essential Standards and Clarifying Objectives • MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the results of past and current geoscience processes. • MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
Lesson objectives: • After completing this activity students will have a better understanding of pore space and a simple way to measure the relative pore space of 2 different particle samples.
Differentiation strategies to meet diverse learner needs: • Do reading as a small group or possibly whole group depending on reading level. • Pre-vocabulary development of words like permeable, porosity, and porous. • Review lab procedures and safety
ENGAGEMENT • Watch the YouTube video (it is 11:44 long but you can stop the video at 7:22) • See porosity lab activity -- Answer questions on Lab activity sheet
EXPLORATION • Mini Lab activity -- Steps 1-6
EXPLANATION • Article and CER on Lab Activity Sheet -- Steps 7-8
ELABORATION • Ticket out the door: Name at least 2 other materials you think could be used in this activity. Why?
EVALUATION • Formative Grading lab sheet and ticket out the door • Monitor lab procedures

The article on porosity is from the National Park Service teacher resource: Porosity Mini-Lab
https://www.nature.nps.gov/views/Teacher%20resources/Knowledge%20centers/Caves%20and%20Karst/Lesson%20plans/All%20Lesson%20Plans/12%20PML_T.pdf

Additional resource: Porosity and Permeability Lab by Mrs. Keadle
http://www.gwisd.esc2.net/vimages/shared/vnews/stories/4ebbddc12d3a0/Porosity%20and%20Permeability%20Lab%20and%20Aquifer%20Lab2012.pdf

Name _____ Date _____ Period_____

Porosity Lab Activity

Engage: Video Questions:

According to the video: What is porosity?

Fill-in-the-blank(s): As porosity increases, infiltration _____ and runoff _____.

What three factors affect porosity?

Explore: Mini-Lab Procedure:

1. Put 100 ml of sand in one beaker and 100 ml of gravel in another beaker.
2. Fill a graduated cylinder with 100 ml of water.
3. Pour the water slowly into the gravel and stop when the water just covers the top of the gravel.
4. Record the amount of water used in the table below.
5. Repeat step 3 with the sand.
6. Record the amount of water used in the table below.
7. Read the article about porosity and answer the questions.
7. Complete the CER.

Particle Type	Volume of Water Used (ml)
Sand	
Gravel	

Explain: Article: How can you measure pore space?

What we perceive as solid rock is often not so solid. Rock formations made from sedimentary rocks, like sandstone, have spaces between the sediments. These spaces, or pores, are the result of irregular shaped particles not fitting together. (The picture on the left illustrates 3 classifications of soil textures and their relative pore spaces.) Spaces may be formed between soil particles due to the movement of roots, worms, and insects; expanding gases trapped within these spaces by groundwater; and/or the dissolution of the rock. Sandstone caves can form through weathering processes where sandstone and shale meet. Water readily percolates down through sandstone but is trapped and cannot pass through shale beds because their pore

spaces are so small. The groundwater is forced to move laterally along the contact between the two rock units until it seeps out on the face of the canyon wall or at the back of an alcove, creating a spring or seep. The prolonged flow of water along these spring and seep zones ultimately dissolves the calcium carbonate cement and loosens individual sand particles and blocks of sandstone, thus forming a void that enlarges with time. These voids can develop into caves similar to the ones early people used at Mesa Verde National Park (see photo on the right).

Why is this important? Aquifer: a porous rock formation that transports underground water resources. There are many reasons why it is important to study and understand pore spaces and how they affect their soil environment. The first reason is that underground aquifers hold the groundwater we drink within the pore spaces of rock formations. Approximately 40% of the U.S. population relies upon aquifers for drinking water. It is very important to protect these underground water resources. You see this by looking at the flow through the Mammoth Cave aquifer. Approximately 1000 to 10,000 cubic feet of water per day flow through this aquifer. Contaminants entering the aquifer can thus be rapidly transported and spread. Another important aspect of soil concerns our transportation: 50% of U.S. citizens obtain part or all of the oil and gas found within pore spaces.

Crude oil is the “raw” source from which we manufacture gasoline, and there have been many conflicts, even wars, waged over this natural resource. A final reason to study the porosity of soils is because of the oxygen found within these pore spaces. All plants need oxygen for respiration, so a well-aerated soil is desired by the farmers that produce the crops we eat.

IN SUMMARY...SOMETHING AS SIMPLE AS THE SPACES BETWEEN PARTICLES OF SOIL CAN AFFECT THE WATER WE DRINK, THE FOOD WE EAT, AND THE WAY WE GET FROM PLACE TO PLACE!

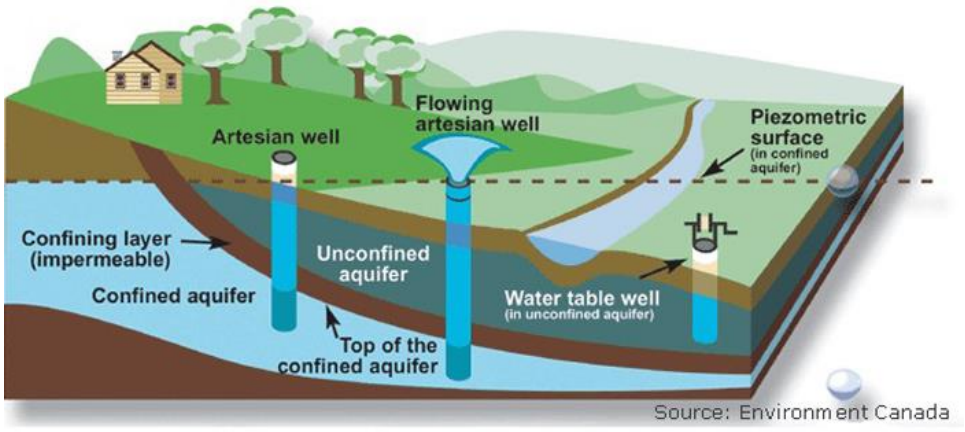

Photo Credit: Environment Canada / USGS

1. What are 3 factors that may result in the formation of pore spaces between soil particles?

2. Explain the difference between the movement of water through sandstone and through shale.

3. What is an aquifer?

4. List 3 ways pore spaces can affect the human population:

CER:

Teacher Suggestions for Lab:

For the YouTube video you only need to show 7:22 minutes and not the full 11:44.

Here are the answers to the questions:

According to the video what is porosity?
Porosity is the amount of pore space in rocks or soil.

Fill-in-the-blank(s): As porosity increases, infiltration _____increases_____ and runoff ____decreases_____.

What three factors affect porosity?

1. Particle shape
2. How tightly packed are the materials.
3. Degree of sorting

Explore: Materials needed for lab (per lab group) -- water, two beakers, two 100 ml graduated cylinders, and 100 ml of sand and gravel each. Suggestions to save materials or for lower academic classes -- do the sand as a demo and let students do gravel in small groups. Gravel can be dried and used period after period, whereas sand you will need enough for each group for each period because it does not dry quickly. The gravel can be used year after year easily. Sand should be only reused if drying it is feasible. (Note: you can put the sand in an oven at 250 °F to dry it or put it in the sun on newspaper in a thin layer)

Explain: Students can work independently or in lab groups to read the article and complete the questions depending on student reading level. For lower students still struggling with CER, you may give them these sentence starters instead of asking them to write it out themselves.

I claim that _____ has more pores. My evidence from the table above is _____My reasoning from _____is_____
_____

Answers:

1. What are 3 factors that may result in the formation of pore spaces between soil particles?

MOVEMENT OF ROOTS, WORMS, AND INSECTS • EXPANDING GASES TRAPPED WITHIN THESE SPACES BY GROUNDWATER • DISSOLUTION OF THE ROCK (THE ROCK DISSOLVED AND LEFT BEHIND SPACES.

2. Explain the difference between the movement of water through sandstone and through shale.
WATER MOVES EASILY THROUGH THE SANDSTONE; SHALE HAS SMALLER PORE SPACES AND THEREFORE, WATER CANNOT PASS THROUGH.

3. What is an aquifer?
A POROUS ROCK FORMATION THAT TRANSPORTS UNDERGROUND WATER RESOURCES.

4. List 3 ways pore spaces can affect the human population:
THEY HOLD THE WATER WE DRINK IN AQUIFERS • THEY HOLD OIL THAT WE USE FOR TRANSPORTATION • OXYGEN TRAPPED WITHIN THE PORE SPACES IS NEEDED BY PLANTS FOR RESPIRATION

CER: Good Example
I claim that gravel has more pores. My evidence from the table above is gravel used ____ml or less water and the sand used ____ml or more water. My reasoning from the video and article is GRAVEL HAS MORE PORE SPACE BECAUSE THERE ARE LARGER SPACES IN-BETWEEN THE SEDIMENTS. THE LARGER SPACES ARE A RESULT OF THE IRREGULAR SHAPES OF THE GRAVEL PARTICLES. SAND IS SMOOTHER AND ROUNDER, WHICH HELPS IT FIT TOGETHER BETTER AND LEAVE LESS SPACE IN-BETWEEN THE PARTICLES.

Kit Lesson Plan Activity #1 (one to two class periods)

Date:

Subject / grade level:

Materials:

- The water treatment kit and its manual
- Storm Water Sample or Lake Water Sample (see manual for recipes)
- Student Worksheets for Kit lesson #1

Essential Standards and Clarifying Objectives

- Weather and Climate: MS-ESS2-4 -- Create a model of the water cycle.
- MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the results of past and current geoscience processes.
- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- This kit is used to demonstrate how water filtration works. Students will study the water filtration process by taking contaminated water and observing it as it flows through the system, and taking samples throughout the process to compare to the unfiltered water.

Differentiation strategies to meet diverse learner needs:

- Students will be working in small groups guided by teacher demo

ENGAGEMENT

- ½ sheet activity found on Student Worksheets for Kit lesson #1

EXPLORATION

- Teacher needs to put at least 1 kit together if not more. The kit will be needed on day 2 and enough water to do demos of all 6 tubes for each period -- see manual for amounts.
- Teacher will run sample water through tube A and have students complete water tests. Continue this process until all 6 tubes have been tested individually.
- Students should complete Data collection sheet for each tube before teacher demonstrates next tube.
- As the teacher, decide if you need 1 chart per group or per student.
- You need to explain to students to record the color of the test strips immediately because the strips change color over time when exposed to air.

EXPLANATION

- Use Acceptable Levels of minerals and other test factors to complete worksheet.

ELABORATION

- Ticket out the door: Which 2 tubes tested together would make the water sample tests have more acceptable levels? (circles or highlights) Why did you pick these 2 tubes together?

EVALUATION

- Formative -- Highlighted Analysis Chart and Ticket out the door

Name _____ Date _____ Period _____

Directions: Look at each picture and decide whether the material allows for water to flow through it quickly or not. Fill in the sentence below.

A B C

I think sample_____ will let the most water flow through quickly because

_____

_____

_____

I think sample _____ will let the least water flow through quickly because

_____

_____

_____

Other Materials that could have good porosity are

_____

_____

Individual Tube Test Analysis Chart

Directions: After putting the test strip in the water sample, record the number and color the strip turns for each test.
For TDS (total dissolved solids) and turbidity just record the number provided by the teacher.

	Total Alkalinity	pH	Total Hardness	Iron	Copper	Lead	Nitrates	Nitrites	Free Chlorine	TDS Total dissolved solids	Turbidity
1											
2											
3											
4											
5											
6											

Explain: Use the Acceptable Levels of Minerals and Other Test Factors to circle or highlight the boxes that fall within the acceptable levels.

Acceptable Levels of Minerals and Other Test Factors

Class Set -- DO NOT WRITE ON or TAKE OUT of ROOM

Total Alkalinity:	20-200 mg/l
pH:	6.5 to 8.5 but 7 is optimal
Total Hardness:	0-150=soft, 150-200=moderate, 200+=hard
Nitrate:	20-40 mg/l
Nitrite:	2-4 mg/l
Chlorine:	optimal is 10 mg/l or less
Iron:	0.3 mg/l or less
Copper:	1.3 mg/l or less
Lead:	0 mg/l
TDS (Total dissolved solids)	500 mg/l or less
Turbidity level of color:	clear as possible

Kit Lesson #2 (one to two class periods)

Date:

Subject / grade level:

Materials:

- The water treatment kit and its manual
- Storm Water Sample or Lake Water Sample (see manual for recipe)
- Worksheets for Kit Activity #2
- Water Filtration and Media Article

Essential Standards and Clarifying Objectives

- Weather and Climate: MS-ESS2-4 -- Create a model of the water cycle.
- MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the results of past and current geoscience processes.
- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- This kit is used to demonstrate how water filtration works. Students will study the water filtration process by taking contaminated water and observing it as it flows through the system, and taking samples throughout the process to compare to the unfiltered water.

Differentiation strategies to meet diverse learner needs:

- Students will be working in small groups guided by teacher demo

ENGAGEMENT

- Small group discussion of which 2 tubes they want to test together and why
- Share out and have a final decision as a class of three different 2-tube tests to try out.

EXPLORATION

- Teacher needs to put at least 1 kit together if not more. The kit will be needed on day 2 and enough water to do demos of all 6 tubes for each period -- see manual for amounts.
- Teacher will run sample water through each of the 2-tube combos the class decided on in the Engagement activity and have students complete the water tests. Continue this process until all 3 pairs of tubes have been tested individually. This is still a mini-demo lesson where each group gets the same water.
- Students should complete Data collection sheet for each tube before teacher demonstrates next tube.
- As the teacher, decide if you need 1 chart per group or per student.

EXPLANATION

- See kit manual for teacher help and explanation of water filtration and media article reading. Have students work in small groups or individually to complete reading comprehension questions in their science notebooks. The reading only has 5 media because the kit has large and small gravel to make a total of 6 tubes.

ELABORATION

- Ticket out the door: What order would you put all 6 tubes tested together which would make the water sample tests have more acceptable levels? (circles or highlights) Why did you pick this order for the 6 tubes?

EVALUATION

- Formative: Reading/Question page Comprehension

Name _____ Date _____ Period _____

Using your highlighted analysis chart and ticket out the door from your last class, decide as a team which 2 tubes you want to test together in series. (The water sample will go through both tubes before you test it)

We will use tube _____ and tube _____ because

_____

_____

_____

_____

_____

Class Tests of 2 Tubes at a Time

Tubes	Total Alkalinity	pH	Total Hardness	Iron	Copper	Lead	Nitrates	Nitrites	Free Chlorine	TDS Total dissolved solids	Turbidity

Explain: Use the Acceptable Levels of Minerals and Other Test Factors to circle or highlight the boxes that fall within the acceptable levels

Acceptable Levels of Minerals and Other Test Factors

Class Set -- DO NOT WRITE ON or TAKE OUT of ROOM

Total Alkalinity:	20-200 mg/l
pH:	6.5 to 8.5 but 7 is optimal
Total Hardness:	0-150=soft, 150-200=moderate, 200+=hard
Nitrate:	20-40 mg/l
Nitrite:	2-4 mg/l
Chlorine:	optimal is 10 mg/l or less
Iron:	0.3 mg/l or less
Copper:	1.3 mg/l or less
Lead:	0 mg/l
TDS (Total dissolved solids)	500 mg/l or less
Turbidity level of color:	clear as possible

Water Filtration and Media

- Water Filtration is used to remove **suspended solids** (*the particles you can see in the water*) and to remove dissolved substances, like minerals or molecules that give the water color. The water that you get at home through your faucet was treated by filtration. That's one of the reasons the water is clean.
- A number of materials can be used in water filtration. Often, a filter will consist of several layers of material such as sand, anthracite, pebbles, ion exchange resin, and activated carbon. The general term used for these materials is **media**. The different media are used for different purposes, but the general idea is the same: ***To trap suspended particles or attract the dissolved substances.***

- **Gravel or Small rocks**

Large rocks or small rocks are good for catching the large **suspended particles**, while still allowing the water to move quickly through the column. The first filtration column contains large rocks and the second filtration column contains smaller gravel. You can keep the large particles from clogging the finer **media**, like sand. However, small particles can pass through the holes between the gravel and rocks. Gravel and rocks do NOT remove any of the **dissolved substances**, such as minerals or color. As a result, you can expect to see some suspended solids or **turbidity** in the water after it leaves the filtration column. **Note**: *Turbidity is how cloudy or hazy the water is due to the individual particles in the water that are visible to the naked eye*.

- Question 1: What is the main function of the large and small rocks?

- **Anthracite**

Anthracite, often referred to as hard coal, is a hard, compact variety of coal that has a submetallic luster or shine. Imagine grabbing a piece of charcoal and crushing it into pieces. In your hand you would see small, submetallic, hard pieces with uneven edges. Guess what you're holding: **Anthracite**! Compared to gravel and rocks, the space between the pieces of anthracite is smaller. That means you can trap smaller, **suspended particles**. Therefore, you will have *less* **turbidity** in the water after filtering through anthracite as compared to gravel and rocks. HOWEVER, anthracite is NOT effective at attracting dissolved substances, so you might notice that the water still has color and minerals.

- Question 2: Why is there less turbidity in the water after passing through anthracite?

- **Activated Carbon**

Activated carbon resembles anthracite. It's a hard, black material that can trap particles. Like anthracite, it's made of carbon, but this material went through a special heating process, called **pyrolysis**. After being heated, activated carbon is very **porous** and has a lot of **surface area**. There are many places for particles to get stuck. In addition, activated carbon is very good at attracting dissolved substances, like the organic molecules that make up color. It can even absorb gases that might be dissolved in the water.

You might have activated carbon in your home. For example, if you have an aquarium, there's a good chance you have a filter with activated carbon in order to remove color, odors, and organic waste produced by the fish. After a while, you will need to replace the activated carbon in the filter. You MUST replace it because eventually there are no more places on the activated carbon to attract dissolved organics or to trap particles.

- Question 3: Explain how pyrolysis enhances the function of activated carbon.

- **Sand**

Sand is very fine rock, usually **silica**. Since grains of sand are so small, the space between the particles is tiny. This means most suspended particles cannot pass through. So, the **turbidity** will be very low after sand filtration. Only particles invisible to the human eye will pass through, like bacteria. However, some bacteria does get caught in the sand. The negative side of using sand is that the water will move much slower through the filter. So you don't want to use this filter as your first treatment process because it will slow down the flow of water, especially if it gets clogged with large particles.

CAUTION. Even when water looks clean, it could still have bacteria and other harmful organisms, requiring disinfection to make the water safe to drink. Disinfection is a crucial stage in the water treatment process because it kills the bacteria; the disinfection stage is NOT part of the Hydro P.A.L system.

- Question 4: Why is disinfection a crucial part of the water treatment process?

- **Ion Exchange Resin**

Ion exchange resin is a special man-made material that attracts **ions** dissolved in water. Ions are atoms or molecules that have become positive or negatively charged. Some common ions are calcium, magnesium, sodium, chloride, nitrate and sulfate. These come from minerals that are dissolved in water as the water flows through rocks. Water that is underground will typically have a lot more minerals or dissolved ions in it as compared to water flowing on Earth's surface, like rivers and lakes.

Minerals are NOT harmful to your health, but sometimes people want to remove them because they can build up in pipes and on your faucet over time. If you have ever noticed a hard, white buildup on your faucet, then you probably have water with lots of minerals. We call this **hard water**. Ion exchange can remove these minerals. We call this **water softening** because you are reducing the water hardness.

Ion exchange works by switching out the ions that cause hard water with ions that don't cause hard water. Like sand, the ion exchange media is really small and this means water is going to move slowly through it. Use this media to get rid of unwanted minerals, but it's too expensive to use this for trapping particles.

- Question 5: What is the negative effect of minerals in your water?

Kit Lesson Plan #3 and 4 (three to four class periods) ** Students will complete the 6 tube test twice, picking different orders for both tests.

Date:

Subject / grade level:

Materials:

- The water treatment kit and its manual.
- Storm Water Sample or Lake Water Sample (see manual for recipe).
- Resource and Worksheets for Activity #3

Essential Standards and Clarifying Objectives

- Weather and Climate: MS-ESS2-4 -- Create a model of the water cycle.
- MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the results of past and current geoscience processes.
- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- This kit is used to demonstrate how water filtration works. Students will study the water filtration process by taking contaminated water and observing it as it flows through the system, and taking samples throughout the process to compare to the unfiltered water.

Differentiation strategies to meet diverse learner needs:

- Students will be working in small groups guided by teacher demo

ENGAGEMENT

- Small group discussion of which order you want to put all 6 tubes together to get best results and why
- When each individual group is ready, get teacher approval

EXPLORATION

- Teacher needs to put all kits together so that each group can manipulate the kit to run the water through all 6 tubes in the order that they planned.
- Suggestions: teacher will run sample water through each of the 6 tube combos that each group decided on in the Engagement activity and have students complete water tests. (The teacher can move the tubes and test or the teacher can allow each group to do this on their own)
- Before groups start testing, review the presentation lesson and have students work on their presentation while they wait for their time at the kit. If you are not doing the presentation lesson, then students can work on vocabulary, reflections, or other water filtration activity. (See resource folder for help)
- Students should complete Data collection sheet for their test.
- As the teacher, decide if you need 1 chart per group or per student.

EXPLANATION

- Highlighting and reflecting about the results of their experiment.

ELABORATION

- Reflection Question: What order would you put all 6 tubes tested together which would make the water sample tests have more acceptable levels? (Circles or highlights) Why did you pick this order for the 6 tubes? What changes would you make for better results?

EVALUATION

- Monitor group projects and interaction

Name _____ Date _____ Period _____

Test # _____

Using your highlighted chart and ticket out the door from your last class (2-tube tests), decide as a team which order you would use all 6 tubes together.

Order:

_____

_____

_____

_____

_____

_____

Tests of 6 Tubes at a Time

# of Tubes	Total Alkalinity	pH	Total Hardness	Iron	Copper	Lead	Nitrates	Nitrites	Free Chlorine	TDS Total dissolved solids	Turbidity
6											

Explain: Use the Acceptable Levels of Minerals and Other Test Factors to circle or highlight the boxes that fall within the acceptable levels

Acceptable Levels of Minerals and Other Test Factors

Class Set -- DO NOT WRITE ON or TAKE OUT of ROOM

Total Alkalinity:	20-200 mg/l
pH:	6.5 to 8.5 but 7 is optimal
Total Hardness:	0-150=soft, 150-200=moderate, 200+=hard
Nitrate:	20-40 mg/l
Nitrite:	2-4 mg/l
Chlorine:	optimal is 10 mg/l or less
Iron:	0.3 mg/l or less
Copper:	1.3 mg/l or less
Lead:	0 mg/l
TDS (Total dissolved solids)	500 mg/l or less
Turbidity level of color:	clear as possible

Reflection Questions for Test #1

Which tests fell within the acceptable range?

_____

_____

_____

Which tests did not meet the acceptable range?

_____

_____

_____

What changes would you like to make and why?

_____

_____

_____

_____

_____

Reflection Questions for Test #2

Which tests fell within the acceptable range?

_____

_____

_____

Which tests did not meet the acceptable range?

_____

_____

_____

Which test made the water more potable and why?

_____

_____

_____

_____

_____

Kit Lesson Plan Presentation Optional (three class periods)

Date:

Subject / grade level:

Materials:

- The water treatment kit and its manual.
- Art supplies for posters and or computers to create electronic presentation.
- Worksheets for Presentation

Essential Standards and Clarifying Objectives

- Weather and Climate: MS-ESS2-4 -- Create a model of the water cycle.
- MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distribution of Earth's mineral, energy, and groundwater resources are the results of past and current geoscience processes.
- MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Lesson objective(s):

- This kit is used to demonstrate how water filtration works. Students will study the water filtration process by taking contaminated water and observing it as it flows through the system, and taking samples throughout the process to compare to the unfiltered water.

Differentiation strategies to meet diverse learner needs:

- Students will be working in small groups guided by teacher demo

ENGAGEMENT

- Whole group discussion reviewing presentation expectations and rubric

EXPLORATION

- Presentation preparation - small groups will decide how they want to present their results to the rest of the class
- Give groups two class periods to work on this project

EXPLANATION

- Day 3 - small groups will present and students will complete the reflection page while being the audience

ELABORATION

- Day 1: Students will each write out what they need to do or bring for day 2 to complete presentation by the end of that period
- Day 2: Be ready to present the following class period
- Day 3: Complete reflection page

EVALUATION

- Monitor group projects and interaction and grade presentations
- If you want students to reflect on their own experience, provide questions to be completed in science notebooks:
    - What went well with your group experiment?
    - What improvements could your team make to get better results?
    - What did I do individually to help my group be successful? (give specific examples)
    - What did you learn about porosity and potable water?

Instructions and Grading for Group Presentation

Presentations can be a poster or PowerPoint. Your group can decide the format.

Your presentation should include:

- Title and group members' names and group name (5 points)
- Which test was best (1 or 2) (5 points)
- The order of the tubes in this test (5 points)
- Why your group decided this was the best test (use data from your charts) (10 points)
- Share your Results (10 points)
- Do you think this water is potable, why or why not? (5 points)
- If you did this test another time, what changes would you make? (5 points)

Your presentation should be complete, neat, and have no spelling and grammar issues (5 points)

Instructions and Grading for Group Presentation

Presentations can be a poster or PowerPoint. Your group can decide the format.

Your presentation should include:

- Title and group members' names and group name (5 points)
- Which test was best (1 or 2) (5 points)
- The order of the tubes in this test (5 points)
- Why your group decided this was the best test (use data from your charts) (10 points)
- Share your Results (10 points)
- Do you think this water is potable, why or why not? (5 points)
- If you did this test another time, what changes would you make? (5 points)

Your presentation should be complete, neat, and have no spelling and grammar issues (5 points)

Instructions and Grading for Group Presentation

Presentations can be a poster or PowerPoint. Your group can decide the format.

Your presentation should include:

- Title and group members' names and group name (5 points)
- Which test was best (1 or 2) (5 points)
- The order of the tubes in this test (5 points)
- Why your group decided this was the best test (use data from your charts) (10 points)
- Share your Results (10 points)
- Do you think this water is potable, why or why not? (5 points)
- If you did this test another time, what changes would you make? (5 points)

Your presentation should be complete, neat, and have no spelling and grammar issues (5 points)

Name _____ Date _____ Period_____

Group Presentations Feedback

Name of Group:	Test 1 or Test 2	Order of the tubes:	What was good about the results:	What could the team do to improve the results of their experiment: