



# CLEAR AS MUD

**SUBJECTS:** Science, Social Studies, Career Education, Mathematics and Health

**GRADES:** 4-5

**KERA GOALS:** Meets KERA goals 1, 2, 3, 4, 5, and 6

**ACADEMIC EXPECTATIONS:** Use reference tools and research tools; make sense of the variety of materials they read; make sense of the various things that they observe; use mathematical ideas and procedures; organize information and use of classification rules and systems; understand scientific ways of thinking and working; identify, analyze, and use patterns; identify and analyze systems; use the concept of scale and scientific models; understand conditions of nature; understand change over time; understand and use number concepts; understand and use various mathematical procedures; understand and use measurement concepts; understand and use statistics and probability; demonstrate the skills to evaluate and use services and resources available in their community; show their abilities to become self-sufficient individuals; show their abilities to become responsible members of a family, work group, or community; use critical thinking skills to solve a variety of problems in a real-life situation; organize information to develop or change their understanding of a concept; use a decision-making process to make informed decisions; connect knowledge and experiences from different subject areas; use what they already know to acquire new knowledge, skills, or interpret experiences; and expand their understanding of existing knowledge.

**DURATION:** One class period of 30-45 minutes or longer

**GROUP SIZE:** One class of 25-30 students (or less)

**SETTING:** Indoors

**KEY VOCABULARY:** Pollution, chemical, organic, ecological, point and non-point source pollution, ground water, runoff, watershed, karst, turbidity and boundaries

**ANTICIPATORY SET:** Have you ever thought about what affects the water we drink? Many things that happen in our community or in surrounding areas may affect our drinking water either directly or indirectly. Maybe some of the things we do around our homes affect our water.

**OBJECTIVES:** The students will be able to: 1) recognize the different kinds of pollution that affects water; 2) define turbidity and non-point source pollution and discuss how they relate to their water samples.

**MATERIALS:**

- ◆ Three different colors of construction paper—blue, gold (or brown), and red. Use two sheets of each to make tokens (Note: we purchased sequins in the various colors to avoid hole punching)
- ◆ Graph paper
- ◆ Crayons/colored pencils
- ◆ Paper punch
- ◆ One teaspoon measure (for paper punch tokens)
- ◆ One tablespoon measure (if 1/2 inch tokens are chosen)
- ◆ Two empty wide mouth peanut butter jars
- ◆ Wax paper and Saran Wrap
- ◆ “Clear As Mud Research Forms”



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## CLEAR AS MUD

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**BACKGROUND:** All of the water that has ever been available is on the earth right now. In some of your studies you may have come across information stating that we are drinking the same water the dinosaurs did millions of years ago. In many ways this is true. The same water is just recycled over and over.

Here is an interesting analogy of the biosphere's hydrologic cycle. If all water in the world were equal to 1,000 gallons, we would find approximately 971 gallons in the oceans and seas, 20 gallons in the ice caps and glaciers, 6 gallons underground, 2 gallons in the atmosphere, 1 quart in fresh water lakes, 1 cup suspended in the soil, and 1 teaspoon in our rivers. With this analogy in mind, it is apparent how fragile this vital resource is. Yet each day we hear about water being damaged by pollution. Sometimes pollution stresses ecosystems beyond their capabilities to support life.

Pollution is a complex topic. These are the three kinds of pollution affecting the Green River and other bodies of water in our area. They are:

**Chemical Pollution:** the introduction of toxic substances into an ecosystem, e.g., contamination of a water supply by pesticides, or toxic spills from railroads and interstates. Hydrologists believe toxic spills to be a greater threat to water quality than pesticides. This is particularly true in the Mammoth Cave area because of the karst terrain (an area characterized by many sinkholes and disappearing streams which quickly carries water plus its pollutants underground). Most of the water in this area comes from groundwater (water that is found underground, in the layers of soil and bedrock.)

**Organic Pollution:** over-supplying an ecosystem with organic material such as bacteria or nutrients, e.g., agricultural fertilizer.

**Ecological Pollution:** stresses ordinarily created by natural processes, e.g., abnormal increase in sediments in runoff producing large quantities of silt. This can be caused by heavy logging, leaving no roots to hold the soil in place, construction, and some farming practices.

For the most part, pollution is invisible; it usually takes a great deal of time to exhibit its impact. Turbidity is the

exception. The definition of turbidity is: the degree of cloudiness due to material suspended in water. "Turbidity is the result of suspended solids in the water. Turbidity is the opposite of clarity. At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as suspended particles absorb heat from sunlight proportionate to the concentration of particles. Remember, warm water holds less oxygen than cooler water. Less light penetrating the water decreases photosynthesis, which in turn reduces oxygen concentrations. Suspended solids may clog fish gills, reduce growth rates and decrease resistance to disease, as well as preventing egg and larval development. Particles of silt, clay, and organic materials may settle to the river bottom, especially in impounded and slow-moving rivers. These settled particles can accumulate and smother eggs of fish and aquatic insects resting on the river bottom" (*Field Manual for Water Quality Monitoring*, Mitchell & Stapp, 1988). Turbidity has the greatest impact on the health of water in the Mammoth Cave area. This is due, almost entirely, to soil erosion.

Groundwater is continually being affected by pollution. Some pollution enters water from a localized source, such as a factory, and is quite easily traced. This is called **point source pollution**. Other pollution enters from a variety of less traceable sources. For example, when rain washes over fields, forest floors, meadows, and rock outcroppings, carrying sediment into a water source. This is called **non-point source pollution**. Non-point pollution is the most common source of pollution in the Mammoth Cave area.

Hydrologists are people who study water. In the Mammoth Cave area hydrologists study the way water travels in the watershed (a region or area that drains into a body of water). In its meandering, water may be contaminated in various ways. In many instances water is altered to the extent that it becomes a hazard to wildlife, wildlife habitats, and humans.

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## PROCEDURE:

1. Before the activity begins, make tokens out of construction paper (using a paper punch) or purchase sequins. For the **first** water sample (Jar #1), make 1,960 blue tokens (representing water), 40 red tokens (representing other pollutants such as chemical or organic pollution), and 400 gold tokens (representing sediment, ecological pollution). For the **second** water sample (Jar #2) make 970 blue, 70 red and 1,360 gold. (If you feel your students would do better with larger tokens, you may want to cut 1/2 inch squares instead of using a paper punch.) Stir them so all the colors are **thoroughly mixed**. Make copies of the Clear As Mud activity sheets for each group (class will be divided into groups of two or three) as well as an extra teacher copy.

2. List the three major categories of pollution (chemical, organic and ecological) on the chalkboard and discuss each. Refer to the information section for a description.

3. Divide the class into groups of two or three. Each group will be acting as a research team and will analyze two samples of water from the Echo River Spring. This spring is one location where water exits Mammoth Cave and flows into the Green River. The teacher distributes the Clear As Mud activity sheets at this time.

4. Distribute the colored paper tokens of sample one, by having one member of each group measure 1 teaspoon of the paper punched tokens or 1 tablespoon of the cut 1/2 inch square tokens from Jar #1.

5. Instruct students to separate the colored tokens into different piles, according to color. Once this is done, they should count the number of each color and use crayons/colored pencils to fill in the bar graphs on their activity sheet. The units per sample (number of each color) should go up the side and the components (three different elements found in the sample; water – blue, sediment – gold, and other pollutants – red) across the bottom. This will make it easier to compare each team's findings. Remind the class that each group has taken a sample from a slightly different location of Echo River Spring and at a slightly different time. Samples will be similar but not identical. All samples are carefully returned to the jar. Remind the students that in a "real" water sampling the sample would not be returned to the jar.

6. After the bar graphs are completed, compare each team's results and record them on the blackboard. Then repeat the same process with sample two. What is different? Why? The teacher reminds the students that they are sampling from the same location. After discussion, students should be able to identify that the second sample was taken on a different day. The teacher asks, "What speculations can you make about this particular day?" The students should make the correlation between rain, and erosion. More sediment has been added to the water because of a change in weather. This additional sediment has increased what is referred to as turbidity or the cloudiness of the water. If the water has higher turbidity levels that means more sediment or dirt is in the water making the water cloudy so less light is able to travel through. Is that good or bad? How? Is it pollution? What kind?

7. The teacher defines turbidity as: the degree of cloudiness due to material suspended (held) in the water. Turbidity is measured by how much light can travel through a water sample. The teacher shows the students a piece of saran wrap and a piece of wax paper. Which of the two would have a higher degree of turbidity? The student's answer should be the waxed paper.

8. Discuss how natural elements are considered to be pollution when the elements' presence are out of balance with the natural order. Discuss how runoff into sinkholes, from forest, field, meadows etc. can travel into the water, thus changing the health of the water. Because water in this region comes from such a vast area (60,000 acres) it is difficult to pinpoint the exact source of pollution. This would be called non-point pollution.

9. The students work in groups to complete their activity sheets. The class can discuss the answers as they finish.

**CLOSURE:** Water is a resource that wildlife and humans must have to survive. In our area of Kentucky, the lack of water has rarely been a problem. The quality of the water rather than the quantity should be our concern.

**EVALUATION:** The teacher is able to evaluate the students by observing their interaction while working in groups and by observing the bar graphs and activity sheets of each group.

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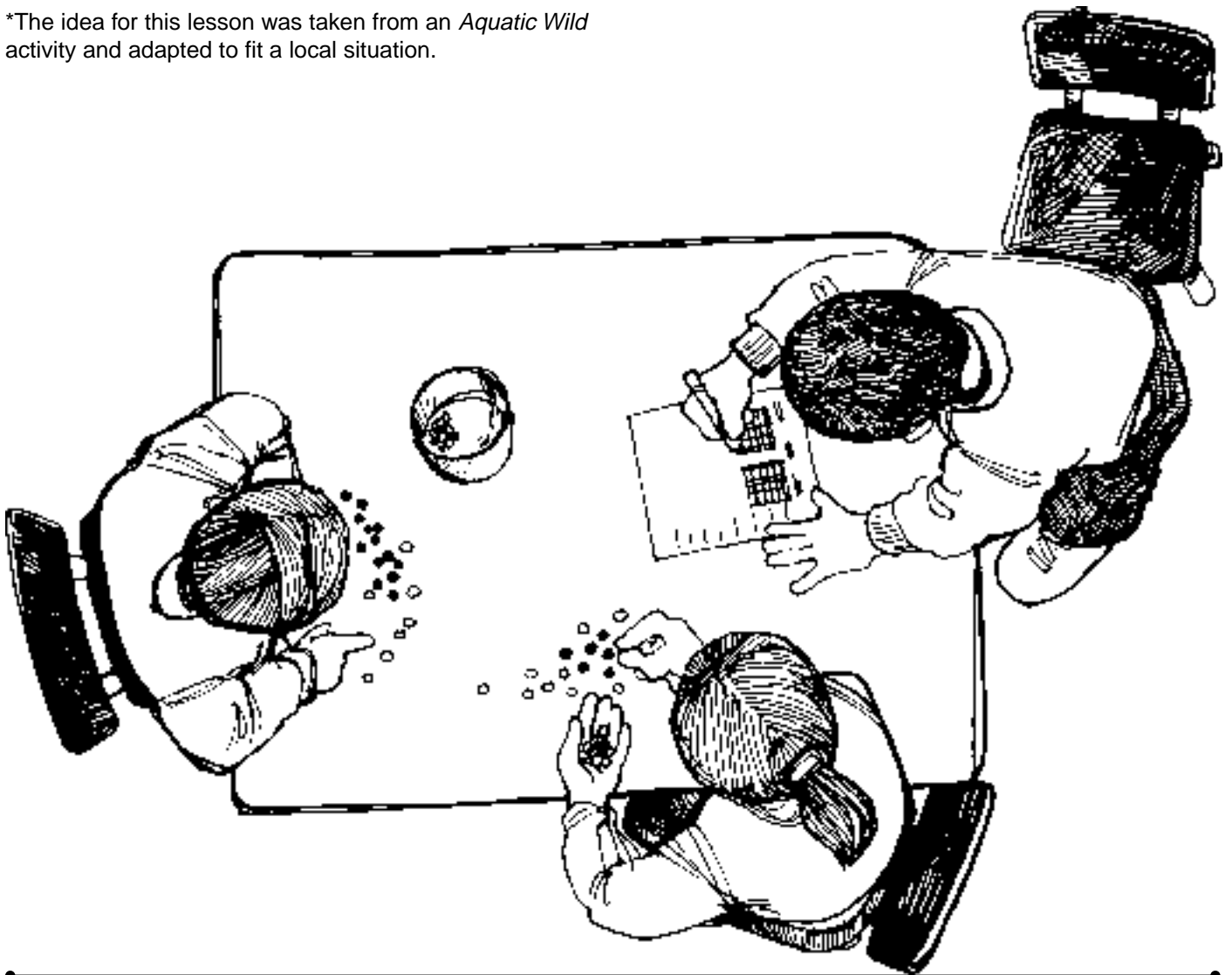
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### EXTENSIONS:

1. The students could research the current national and state laws protecting water quality in Kentucky and the U. S. The students could write a short history of the U. S. Clean Water Act.
2. The students could invite a guest speaker from a local agricultural, conservation or other similar agency to speak about what their organization is doing to protect water.
3. Students could travel to a stream or river to collect water and test it for various elements such as pH or dissolved oxygen.

\*The idea for this lesson was taken from an *Aquatic Wild* activity and adapted to fit a local situation.



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# CLEAR AS MUD RESEARCH FORM

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Research Team: \_\_\_\_\_

Pollution is a complex topic. There are three kinds of pollution affecting the Green River and other bodies of water in our area. They are:

**Ecological Pollution:** stresses ordinarily created by natural processes, e.g., abnormal increase in sediments in runoff producing large quantities of silt.

**Chemical Pollution:** the introduction of toxic substances into an ecosystem, e.g., contamination of a water supply by pesticides, or toxic spills from railroads and interstates. Hydrologists believe toxic spills to be a greater threat to water quality than pesticides. This is particularly true in the Mammoth Cave area because of the karst terrain (an area characterized by many sinkholes and disappearing streams which quickly carries water plus its pollutants underground).

**Organic Pollution:** over-supplying an ecosystem with nutrients, e.g., agricultural fertilizer.

**DIRECTIONS:**

In a few minutes you will be taking a sample of water collected from the Echo River Spring. As a team you will need to measure the components of the sample which include: water (blue dots), ecological pollution= silt and sediment (gold dots), and other pollutants= chemical and organic (red dots). As in all research, it is important to be precise and accurate.

To set up your graph: to the left side of each graph you will put the number of units by 10 (0, 10, 20, 30, etc.) going up. Across the bottom you will list what you found in your sample (water, sediment, other pollutants). After you have counted the parts of your sample and prepared your graph, color in the rows with crayons or colored pencils.

**Sample 1.**

Sample Time: \_\_\_\_\_

Collector: \_\_\_\_\_


**Sample 2.**

Sample Time: \_\_\_\_\_

Collector: \_\_\_\_\_


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# CLEAR AS MUD RESEARCH FORM

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1. Was there a big difference between sample one and sample two?

If so, what was it? and why do you think it occurred?

2. We have talked about turbidity being the amount of sediment in water. The higher the amount of sediment the less light that can pass through the water. If we were to compare saran wrap and wax paper to our samples –

Sample One would be more like \_\_\_\_\_

Sample Two would be more like \_\_\_\_\_

3. Write a definition and give an example for each of the following:

Point source pollution –

Non-point source pollution –

4. Name three problems that high turbidity could cause to a river ecosystem.

1.

2.

3.