What Happens When the Stormwater Arrives? (Learning Experience #2)
Lesson Plan

Overview
Students focus on what they have learned about land use in the Chesapeake Bay watershed and suggest which types of land use result in the most turbidity. Students will examine satellite pictures of the Bay taken before and after Hurricane Irene and Tropical Storm Lee over a two week period of time from late August through mid-September 2011, looking for evidence of a link between land use upstream and turbidity levels and algae growth downstream after periods of heavy stormwater runoff. Finally, the students will predict the consequences of high turbidity and nutrient levels in a local body of water and design a model that could be used to test their predictions.

Lesson Essential Question: Why should we be concerned about stormwater?

Objectives
Students will:

- work productively as a part of a project team.
- use a variety of resources to investigate the background information necessary for this project.
- research and summarize information about stormwater in their watershed.
- keep accurate, complete records in a journal.
- design an experiment that will test a hypothesis.
- communicate ideas and results to other team members and classmates.

Materials Needed for *When the Stormwater Arrives*
Each group should receive a packet containing one of each of the following items:

- A copy of *Testing Causes of Dead Zones* (Student Sheet #1)
- A full-color, laminated set of Chesapeake Bay satellite pictures (from website) including true color image, turbidity measurements, chlorophyll measurements for August 20, 2011 and September 10 – 13, 2011.
- A land use map of the region shown in the satellite pictures (on website)

Materials Needed for *When the Stormwater Arrives* (continued)

- Three (3) plastic water bottles with labels removed
- Small amount of garden soil/silt mix
- Tap water
- Water sample from a nearby stream or pond (optional)
- Chart paper and markers

Grade Level: grades 8-12

Subject Areas: Biology, Earth Science, Environmental Science, Geography, Social Studies

Timeline:
Teacher preparation: 60 minutes
Learning experience: 100 minutes

Setting: Classroom or computer lab; wet lab if including optional water quality testing

Skills: Research in print materials and on web sites, organize information, problem solve as part of a team, communicate to team and classmates, design an experiment that tests a hypothesis

Vocabulary:
Aerobic, algae, algal bloom, bacteria, dead zone, limiting factors, mediate, nitrates, pH, `phosphates, sediment, storm water, turbidity

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Procedure

Turbidity

1. Introduce *What Happens When Stormwater Arrives* by showing students three (3) water bottles, each one about 2/3 filled with a different water sample: tap water, tap water with 10 mL of soil/silt mix, and water from a local stream or pond (optional). Shake each one several times and ask students to describe what each sample looks like in their journals. Set them aside while you introduce the term *turbidity*. You will return to the water bottles later in the learning experience.

2. Explain that high turbidity levels (suspended solids) are one measure of poor water quality. Ask the class how high turbidity levels might affect the organisms in aquatic habitats. Post student answers on a T-chart, with one side for plants and the other for animals.

3. Ask students to divide into their groups. Each group will discuss which kind(s) of land use they think make the highest contributions to turbidity levels in the Chesapeake Bay. Students will answer the question in their journals and explain their reasoning, including what they see on the maps and drawing from their own real life experiences. Each team will share their answers with the class.

4. Distribute the copies of satellite pictures and turbidity levels for the following dates in 2011: August 20, September 10, 11, 12 and 13. Ask the students to look at them carefully and decide if they support their answer to question #3 regarding turbidity levels and land use. Students should consider all of the area upstream from where the tributary rivers flow into the Bay.

5. Tell students that Hurricane/Tropical Storm Irene struck Virginia, Maryland, Pennsylvania and southern New York State on August 27 and 28, 2011, bringing high winds and heavy downpours. Tropical Storm Lee arrived nine days later, dropping up to 15 inches of rain in three days in some areas of the Chesapeake Bay watershed. Ask the students what they notice about the images of the watershed's rivers in the satellite pictures taken on September 10 – 13. Ask students to predict what the turbidity maps will show in different parts of the Bay and its tributaries on these dates, and record those predictions in their journals. The students will compare their predictions to the actual data.

6. Facilitate a class discussion: ask students if there is a pattern linking land use in the Chesapeake Bay watershed and high turbidity levels in the waters of the Bay. Students should answer this question and explain their reasoning in their journals.

7. Show students what has happened to the water in the three sample bottles and ask them to predict the consequences of high levels of turbidity to organisms within an aquatic ecosystem near your school. How could they test their predictions?

Algae

1. Inform your students that several species of algae are normally found in the Chesapeake Bay ecosystem. Their cells contain *chlorophyll A*, which allows algae to provide food for themselves and for animals in the food web such as oysters, crabs and fish. The satellite is equipped with a camera that measures levels of chlorophyll on the surface of the Bay, an indicator of the presence of algae. Algae acquire the nutrients that they need to grow and reproduce from the water in which they live. Ask students to suggest some possible sources of nutrients like nitrates and phosphates in waterways, lakes and estuaries.

2. Under normal circumstances, low concentrations of nitrates and phosphates are limiting factors for algae populations. Ask students to suggest what might be the cause of a sudden increase in the population, called an *algal bloom*. Have student teams look at the satellite pictures and predict where the algal blooms are most likely to be in the week after the pictures were taken.

3. An algal bloom is frequently followed by a rapid die-off of the algae. The dead organisms sink to the bottom where they are broken down by aerobic (oxygen-using) bacteria. There are bottom regions in the Chesapeake Bay that are known as "dead zones" because they don't support organisms like fish and crabs. Ask students to suggest reasons why they think these animals can't live there, and record their ideas in their journals.

4. Ask students to imagine they are a part of a team of scientists trying to discover the reason for a dead zone in a waterway, lake or bay. Each team will discuss possible causes of the dead zone and choose two or three hypotheses to present to the class with explanations for their reasoning.

5. Student teams will choose one of their ideas from the previous task (developing a hypothesis for the cause of a dead zone) and design an experiment to test it. Students will complete *Testing Causes of Dead Zones* (Student Sheet #1), and should include the materials they would use, the data they would propose to gather, technology tools that would increase the reliability of the data, and the method which would be used to control any variables. Each group will predict the data expected if their hypothesis was supported by the data collected.

6. Have students visit the web page of Maryland's Department of Natural Resources that represents dissolved oxygen levels by the month. http://mddnr.chesapeakebay.net/eyesonthebay/currentconditions.cfm?dddmon=8&myear=2011&wqparm_sel=1&submit=Submit+Query&GO=Zoom.

   - Have students place themselves in the role of a crab fisherman looking for the best locations to place crab pots on the bottom of the Bay to catch crabs for dinner or to sell to a local restaurant. Which areas would crab fisherman tend to avoid in the summer? Why?

7. Ask the students to hypothesize whether or not dead zones occur in a body of water near their home or school? If so, when do they think they are most likely to appear? Why?

8. Ask the students to hypothesize whether or not there is a pattern between land use in the Chesapeake Bay watershed and dead zones? Students should answer this question in their journals and provide justification for the hypothesis given.

9. Optional: The *Water Quality Testing Unit* is designed to be used in several of the learning experiences in this curriculum. The Materials needed may be found in your lab or can be ordered from the sources listed. If time permits and the weather will allow the following to safely occur, ask your students to bring in samples of stormwater during/after a heavy rain from local roads or containment ponds. Samples may be stored in a cool, dark place for 48 hours or longer in a refrigerator. Ask students to design a way of testing the samples to decide if stormwater carries extra amounts of sediments and nutrients when compared to normal rainwater. Students could also compare the stormwater results to tap water, well water and the water that is normally found in local streams and ponds in your area.