TURBIDITY AND SEDIMENT

Turbidity- an indication of the presence of dirt and other particulate matter in water- is an important variable in the health of a stream. The biggest contributor to turbidity is erosion. High levels of turbidity negatively affect all living things in a stream. For this activity the turbidity of stream water will be measured using a turbidity tube, also known as a transparency tube. This instrument is less expensive than an electronic turbidimeter. The variances that may occur with this instrument are discussed below. Although the pre and post discussions are necessary to provide important information about each topic, it is the activity that is most vital to this unit. Be sure to allow plenty of time to complete the activity.

Equipment needed

- A bucket with a weight on the lip. The weight is important. It will allow the bucket to tip easily and collect water. The bucket should be tied to a rope long enough to reach the water from a bridge or streamside collection site.
- Turbidity tube 120 cm in length and stand
- Funnel (to make it easier to pour water into the turbidity tube)
- Boots or waders (needed to protect against sharp objects)
- Data forms, pencils and clipboard
- Calculator
- Small table (convenient but not essential)
- Display board
- If available, a stepstool (some students are not tall enough to look down into the turbidity tube from the top)

Using the Turbidity Tube

With a turbidity tube one measures the length of a column of water at which one can first definitely see a black and white target at the bottom of the tube. This is a judgment call. It is good practice to set a standard for "definitely seeing the black and white target" to help reduce variances in the readings. This can be done with a practice round or during the first round of sampling by permitting all of the students to look through the same column of water at a target that can be considered definitely visible. Note that some students will need a stepstool to look down into the turbidity tube.

Site Selection

Select a site from which water can be easily collected from the stream without stirring up the stream bottom. The site should be upstream from other activities such as benthic macroinvertebrates and stream speed that could stir up sediment and taint your sample. A bridge or culvert provides an ideal sampling location but be careful about traffic. If sampling from the bank, pick a spot that is not obstructed by bushes and brush. Watch out for poison ivy, nettles, blackberries, etc. If sampling from within the stream, wear boots or waders to protect against sharp objects and face upstream when collecting water to avoid the mud that your feet will stir up.

Turbidity Lesson Narrative

The mission is to make these points:

- Turbidity tests the amount of dirt in the water.
- Dirt, or sediment, hurts the river in many ways.
    - It makes it more expensive to clean the drinking water. It can coat the gills of small organisms.
    - It can keep organisms from attaching to gravel or rocks, which may cause them to get swept away in fast water.
    - Sediments in the water can raise the temperature of the water. This can lower the amount of dissolved oxygen in the water.

Introduction: 5 – 8 minutes.

1. My name is _____ and I'm a volunteer with the Turbidity station.

2. Look at the water in this stream. How would you describe it? Can you see the bottom? Is something affecting the clarity?

3. Do you think it would be OK to drink it straight from the stream? Why do you think that? What are you worried about? *(Students may say it's yucky; there is bacteria or germs, it's dirty, there are chemicals or pollution in it, etc.)*

4. Agree that they should not drink the water straight from the stream. You may want to note that in Ann Arbor, the drinking water comes from the Huron River, but it is cleaned up first.

5. Explain that the biggest source of pollution in the Huron River is dirt.

The Activity: 10 – 15 minutes.

1. Explain the activity, and that it is a way to get a sense of how much dirt is in the stream.

2. Show the students the turbidity tube. Make sure that the tube and the black and white disk at the bottom of the tube are clean and the white clamp on the small hose at the bottom of the tube is closed. Work in a shady area if possible because direct sunlight interferes with the readings.

3. Collect the water sample in the bucket on a rope from the main current, not an eddy or a pool. Make sure the bucket does not drag along the bottom to procure the cleanest sample possible. If throwing the bucket out, reel it in quickly to avoid this.

4. Vigorously shake or swirl the bucket so that the sediment is well mixed with the water. Quickly pour water from the bucket into the turbidity tube using the funnel until it is filled to the top. Assign someone - the drainer- to watch the clamp to make sure there is no water draining.

5. A second team member -the watcher- stands so that his body shades the tube from direct sunlight (if the tube is not in shade) and watches carefully- looking down from the top of the tube. Explain that they need to keep looking down the tube as you let water out, and to say "Stop!" when they can see the white and black disk. Explain to the drainer that they will need to clamp the hose tightly when "stop" is called.

6. Once the watcher is ready, tell the drainer to open the white clasp and watch as the water level in

the tube falls until the black and white disk at the bottom of the tube becomes definitely visible and the watcher calls out "Stop!" The drainer immediately stops the flow.

7. Use the numbers on the tube to measure the length of the column of water to the nearest 0.2 centimeter (cm) and record on the data sheet. For example, if the water level is at the third mark above 73, the length of the water column is 73.6 cm. **Note**: Students make a lot of mistakes reading this scale. Explain how it is read and **always** check their readings for errors. This length (73.6 cm in our example) is the transparency of the water: the greater the length, the clearer the water.

8. If the water was very clear and you don't let much if any water out, tell the students to take some dirt and put it into the tube, and swirl to mix in. Then continue the test from step 6.

9. Calculate the turbidity of the water using the following formula and record it on the data sheet. Remember, transparency is the length of the column of water in the tube. The units of turbidity are "per meter", indicated as m^{-1}. In our example, the turbidity is equal to 100/73.6 = 1.36 m^{-1}.

$$\textbf{Turbidity} = \frac{\textbf{100 cm/meter}}{\textbf{Transparency (cm)}}$$

Wrap Up: 5 minutes.

1. How would you rate this water in terms of its turbidity? (Check table on data sheet)
    a. *Answers will vary*
2. What do the measurements tell us about the health of this stream today?
    a. *Answers will vary*
3. What conditions could cause the measurements to be different?
    a. *More or less water in the stream, construction upstream, recent storms, etc.*
4. What are some effects of high turbidity?
    a. *It interferes with the survival of fish and other aquatic life by clogging their gills and preventing them from getting oxygen that is essential to life. Predator fish and other aquatic organisms can't see to hunt in highly turbid water.*
    b. *Sediment causes loss of habitat diversity; it fills the open spaces between the rocks and gravel in the stream bottom. These interstices are excellent habitat for small critters; they provide shelter from predators and protection from strong currents that might sweep them away. Gravel provides an excellent place for many fish to spawn. But none of this can happen if the gravel is embedded--choked with mud. Imagine trying to live in your house if it were filled with mud to the ceiling! Fewer types of critters can survive in muddy streams than can survive in clear ones.*
    c. *Deposition of sediment in slow, quiet reaches of a stream raises the level of the streambed, causing increased flooding.*
    d. *High sediment levels interfere with the operation of drinking and industrial water treatment plants, adding greatly to the cost of making the water fit for our use.*
    e. *High sediment levels often indicate stream bank sloughing erosion, resulting in damage to streamside property that is washed away.*
    f. *High sediment levels may indicate the loss of valuable topsoil in the watershed through erosion.*
5. What can people do to reduce stream turbidity?
    a. *Reduce run-off, plant rain gardens, put up construction barriers, don't cut streamside trees and shrubs, minimize bare soil, minimize impervious surfaces.*

Background Information

A stream with high turbidity will have problems with sedimentation since the dirt will eventually settle out of the water and to the stream bottom. Sediment- ordinary mud- is THE biggest single water pollution problem we have in the U.S.

Sediment causes problems in many ways:

1. High sediment levels interfere with the operation of drinking and industrial water treatment plants, adding greatly to the cost of making the water fit for our use. The Huron River supplies approximately 85% of Ann Arbor's drinking water. When turbidity is high, the sand beds used for filtering sediment out of the water must be cleaned much more frequently and the cost of treating the water goes up.
2. High sediment levels interfere with the survival of fish and other aquatic life by clogging their gills and preventing them from getting the oxygen that is essential to life. High sediment levels also damage habitat for flora.
3. Predator fish and other aquatic organisms can't see to hunt in highly turbid water.
4. Sediment causes loss of habitat diversity. It fills the open spaces between the rocks and gravel in the stream bottom. These interstices are excellent habitat for small critters. They provide shelter from predators and protection from strong currents that might sweep them away. Gravel provides an excellent place for many fish to spawn. But these benefits are lost if the gravel is choked with mud. Fewer types of critters can survive in muddy streams than can survive in clear ones. As species disappear due to habitat loss the food web is disrupted.
5. Deposition of sediment in slow, quiet reaches of a stream raises the level of the streambed causing increased flooding.

Sediment levels as an indicator

1. High sediment levels often indicate stream bank sloughing erosion. Streamside property may be lost due to washing away.
2. High sediment levels may indicate the loss of valuable topsoil from farm fields in the watershed through erosion.

Some common sources of sediment:

1. Agricultural and lumbering practices leading to soil erosion from fields and forests
2. Overgrazing of pasturelands, an extremely serious problem in the western U.S
3. Exposure of bare soil to rains during building and road construction
4. Runoff from gravel roads during heavy rains
5. Damage and destruction of streamside vegetation buffer zones (riparian buffer zones). These buffer strips consist of trees, shrubs, grass, and other plants, and serve to filter sediment from surface runoff water before it gets to the stream. The roots, particularly woody roots, tend to armor the stream banks against erosion by the stream current.
6. Stream bank erosion caused by increased flash flooding as a result of a high percentage of impervious surfaces (concrete, asphalt, roofs, streets, parking lots, etc.) in the watershed. This causes a lot of the water from a storm to run directly and quickly into the stream rather than infiltrating into the ground and moving to the stream as groundwater much more slowly.

Reducing Turbidity

To reduce turbidity one must reduce erosion and runoff from surfaces that carry dirt into the waters of a

watershed. Here are some ways to accomplish this:

1. Protect riparian zones: keep them well vegetated, planting trees and shrubs where needed
2. Use retention ponds, diversions and rain barrels to prevent dirty runoff from parking lots, roads, rooftops, etc. from reaching streams and lakes
3. Use farming practices that minimize runoff into streams and lakes
4. Establish and enforce regulations for activities such as mining that cause runoff into lakes and streams.

For this and all other units, advanced level information is available if desired. Contact HRWC and request an electronic version of the unabridged manual.

Turbidity Data Sheet

Turbidity indicates the amount of dirt in the water. Dirt, or sediment, hurts the river in many ways. It makes it more expensive to clean our drinking water. It can coat the gills of small organisms. It can keep organisms from attaching to gravel or rocks, which may cause them to get swept away in fast water.

Transparency Measurement	**Turbidity** **Turbidity = 100 cm/meter / Transparency (cm)**	**Scale**
(Number on the tube) **1 _____cm** **2 _____cm**	(Calculated) **1 _____m^{-1}** **2 _____m^{-1}**	● A turbidity of **1.0 m^{-1} or less** is quite good— very clear water. ● Between **1.0 and 2.0** is pretty good. ● From **2.0 to 5.0** is a bit muddy. ● From **5.0 to 10.0** is quite muddy. ● **Greater than 10** means that the water is really bad.

1. How would you rate this water in terms of its turbidity?

2. What do the measurements tell us about the health of this stream today?

3. What conditions could cause the measurements to be different?

4. What are some results of high turbidity?

5. What can people do to reduce stream turbidity?

KEY Turbidity Data Sheet

1. How would you rate this water in terms of its turbidity?
    a. **Answers may vary**

2. What do the measurements tell us about the health of this stream today?
    a. **Answers may vary**

3. What conditions could cause the measurements to be different?
    a. **More or less water in the stream, construction upstream, recent storms, etc.**

4. What are some results of high turbidity?
    a. **It interferes with the survival of fish and other aquatic life by clogging their gills and preventing them from getting oxygen that is essential to life.**
    b. **Predator fish and other aquatic organisms can't see to hunt in highly turbid water.**
    c. **Sediment causes loss of habitat diversity; it fills the open spaces between the rocks and gravel in the stream bottom. These interstices are excellent habitat for small critters; they provide shelter from predators and protection from strong currents that might sweep them away. Gravel provides an excellent place for many fish to spawn. But none of this can happen if the gravel is embedded--choked with mud. Imagine trying to live in your house if it were filled with mud to the ceiling! Fewer types of critters can survive in muddy streams than can survive in clear ones.**
    d. **Deposition of sediment in slow, quiet reaches of a stream raises the level of the streambed, causing increased flooding.**
    e. **High sediment levels interfere with the operation of drinking and industrial water treatment plants, adding greatly to the cost of making the water fit for our use.**
    f. **High sediment levels often indicate stream bank sloughing erosion, resulting in damage to streamside property that is washed away.**
    g. **High sediment levels may indicate the loss of valuable topsoil in the watershed through erosion.**

5. What can people do to reduce stream turbidity?
    a. **Reduce run-off, put up construction barriers, don't cut streamside trees and shrubs, minimize bare soil, minimize impervious surfaces.**