Lesson 2: Water Clarity
Water Quality Sampling

Time Frame: Two 45-50 minute classes
Grade Level: 8th – 12th

Overview:

Water clarity is affected by turbidity and watercolor. Turbidity is a measure of water clarity, specifically, of how much the solid matter suspended in water decreases the passage of light through the water. Materials that become mixed and suspended in water will reduce its clarity and make the water turbid. Many materials contribute to turbidity. In the summer, plankton plays an important role. These microscopic plants and animals are growing and multiplying at a rapid pace in the warm, sunlit, nutrient-rich water. During periods of heavy runoff, silt-laden surface water can be seen running into the river, lakes, streams, bays and bayous. In shallow areas or near the shore, wind-generated waves and boat wakes interact with the bottom to stir up sediments. In some cases fish and other aquatic life, like turtles and carp that feed on the bottom, can stir up sediments. Turbidity impacts aquatic life in the following ways:

- Turbidity interferes with the penetration of sunlight needed for the growth of large plants (macro phytes).
- Suspended particles can transport heavy metals and other toxic substances into the aquatic habit.
- Fish cannot see very well in turbid water and may have difficulty finding food. (On the other hand, high turbidity may make it easier for small fish to hide from larger fish or other predators.)

Sources of turbidity are primarily sediment from disturbed or eroded soil. But microscopic plankton also contribute to high turbidity when their numbers are increased due to excess nutrients and sunlight. In addition to blocking out the light needed by submerged aquatic vegetation, suspended sediment can carry nutrients and pesticides throughout the water system. Suspended particles near the water surface absorb additional heat from sunlight, raising surface water temperature. Settling sediment can bury benthic (bottom dwelling) creatures and fish eggs.

Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem in which plankton flourish at a reasonable level to form the foundation of the food web. High turbidity is an indicator of either runoff from disturbed or eroded soil or blooms of microscopic organisms due to high nutrient inputs. Very clear water is typical of the open ocean and lakes or reservoirs supporting only sparse plant and animal life.

Water clarity is also influenced by water color. In much of East Texas decaying plant materials, including dissolved organic acids like tannins and lignins, give the water a brown tea-like color. Dark water color can interfere with light penetration and visibility.

The Secchi disk is usually a 20-centimeter diameter disk, with black and white quadrants. The Secchi disk provides an easy, convenient method for measuring how far light penetrates below the water surface, determining the limit of visibility of the water. Secchi disk transparency is the deepest point at which you can still see the Secchi disk. The less algae and silt in the water, the deeper the Secchi disk will be visible. More algae and silt limits how far down the Secchi disk can be seen.

Academic Questions:

What is the importance of water clarity?

Objectives:

- To understand how turbidity interferes with light transmission.
- To learn how to measure transparency with a Secchi disk.
- To relate turbidity and watercolor to impacts on aquatic ecosystems.

Key Terms:

Suspended solids, silt, silt deposits, clarity, organic, Secchi Disk, turbidity

Process/Activities:

Activity 1: Introduction – Seeing is Believing

1. Gather the following materials for each group:
    a. Blue, red, yellow, and or green food coloring
    b. 6 equal sized cups or cans with nontransparent sides
    c. 6 small black beads, 6 white beads
    d. Syringe or bulb pipette, measuring cups
    e. water
2. Have student complete the following procedure for determining the impact of color on the clarity of water
    a. Fill 6 equal sized cups with the same amount of water.
    b. Place a black bead and a white bead at the bottom of each cup.
    c. Add a single color of food coloring to four of the containers. Count each drop of die. Record how many drops of die were added at the point that each of the beads was no longer visible. (The white bead and black bead will require different amount of die.)
    d. Repeat these steps by adding an equal amount of blue and red die (to create purple) to the fifth container.
    e. Repeat the steps by adding equal amounts of red, blue, green, and yellow (to create a brownish color) to the sixth cup.
    f. Using the syringe or bulb pipette, slowly remove water from each container until each bead is visible. Using the measuring cup, measure the different amounts of water that were removed at the point each bead became visible.
3. Discuss with student what interfered with their ability to see the beads? Would a bright light help? Why is it important that the cups be opaque (unable to transmit light)? What happened when the depth of water changed?

Activity 2: Secchi Disk in the Classroom

1. Gather materials –
    a. Three 5-gallon buckets
    b. 1 secchi disk
    c. **Teacher's note:** Before starting, make sure that your Secchi disk line is marked every 10 centimeters. You can mark your Secchi disk line using good quality, waterproof markers and a meter stick. Holding the line attached to the middle of the middle of the disk, pull the line straight and hold the meter stick against the line and place a black mark on the line every 10 centimeters from the top of the disk, place a blue mark at each half meter, and place a red mark on the line at every meter. The marks should go all the way around the line and be wide enough to be clearly visible from a distance of 10 feet.

✓ **Check line measurements yearly for inaccuracy due to stretching.**

2. Prepare turbid or tea colored water in each bucket. Make sure the secchi disk can be seen in only in the bottom of one bucket. Diatomaceous earth, found in pool supply stores can be used to make a stabile turbid solution. It is very messy. Do this activity outside.
3. Laminate 3 secchi disk directions to place next to each bucket. Ask students to form three lines, one behind each bucket.
4. Show them the disk and with a meter stick explain: Measuring clarity (transparency) with a secchi disk using Secchi Disk Test Procedures.
5. Have students practice with the secchi disk.
6. Ask students to list some of the causes of turbidity. Point out there are organic and nonorganic causes.

Activity 3: Secchi disk on a waterway

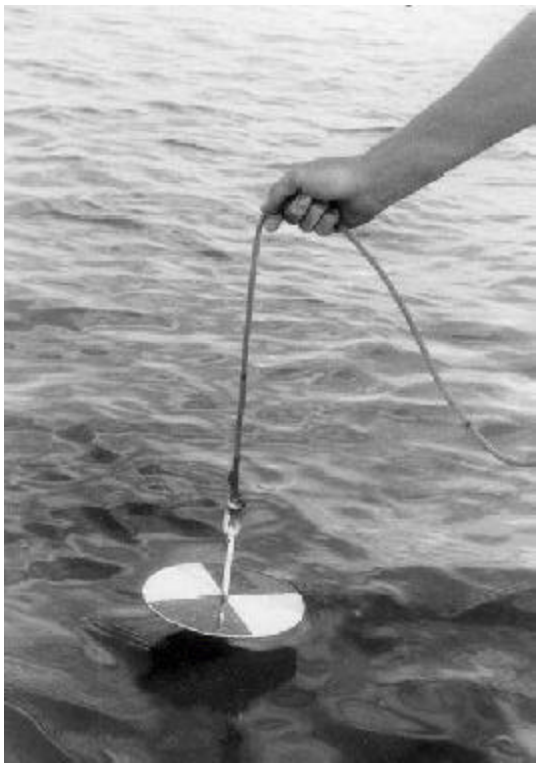
1. If possible, take students to a pedestrian bridge or pier to practice using the secchi disk.
2. Refer to Step 5 of Secchi Disk Test Procedures.
3. Have students fill out Turbidity Worksheet (2.1)

Assessment/Evaluation:

1. In a class discussion, have students explain how turbidity may be influenced by light transmission. The students may refer back to their answers from Activity 1 for assistance.
2. Ask the students to list organic and nonorganic causes for turbidity in a waterway and its affect on the aquatic ecosystem.
3. The student's Turbidity Worksheet (2.1) may be used to assess the student's overall knowledge of turbidity and some of its causes.

Resources:

Texas Watch Monitoring Manual



Secchi Disk Test Procedures

Step 1. Take the reading in the shade without sunglasses while standing with the sun to your back.

Step 2. Lower the disk into the water until the disk just disappears from sight.

- Note the depth at which it disappears.
- (Hint: Grab the Secchi disk line at the water's surface with your thumb and forefinger and hold onto the Secchi disk line as you do Step 3.)

Step 3. Slowly raise the disk and note the depth at which it reappears (barely visible).

- (Hint: Grab the Secchi disk line at the water's surface with your other thumb and forefinger. You should be holding the line at two different places.)

Step 4. Average the two depth readings obtained above.

- The average of the two readings is your Secchi disk transparency and is considered to be the limit of visibility, or index of transparency.
- (Hint: The point on the Secchi disk line that is halfway between the two places you have grabbed the line is the average of the two depth readings. It is your Secchi disk transparency.)

Step 5. Record the Secchi disk transparency measurement on your paper to the nearest 0.01 meter (1 centimeter). If your Secchi disk reaches the bottom and you can still see it, indicate transparency is > greater than the depth.

- ✓ **If you are monitoring from a bridge or pier use a fixed point on the bridge structure as a height reference point.**
  - ❖ Tie a wrist loop in the end of the disk line to prevent loss of the Secchi disk.
  - ❖ Lower the Secchi disk until the surface of the disk is exactly even with the water's surface. Record the distance from the bridge (or pier) height reference point to the water's surface using the Secchi disk line.
  - ❖ Lower the disk into the water until it disappears from view. At that point mark or grab the Secchi disk line at the bridge height reference point.
  - ❖ Slowly raise the disk and grab or mark the line when the disk reappears. This mark should also be made on the line at the bridge height reference point.
  - ❖ Calculate the average of the last two depths marked (when the disk disappeared and when it reappeared).
  - ❖ Subtract the distance from the water's surface to the bridge height reference point.
  - ❖ The remaining value is the Secchi disk transparency value you record on your paper.

Total Depth Test Procedures

To use your Secchi disk to measure depth, lower the disk gently until you see or feel the line go slack. Pull up on the line gently to straighten it out. Read the measured line attached to the disk at the water level. Record the total depth of the water in meters.

In very shallow streams and water bodies, a tape measure, or a yard stick can often be used to measure total depth. Remember to convert measurement to meters before recording the information on the monitoring form.

- ✓ **For conversion purposes, 1 inch = 2.5 centimeters or .025 meters; 6 inches = .15 meters; 12 inches = .30 meters.**

Name: _____

Date: _____

Worksheet 2.1

Turbidity Worksheet

I. Indicate how the following items and actions might affect water clarity

Soil

_____

Sewage

_____

Microorganisms

_____

Industrial waste

_____

Heavy rains

_____

Leaves and debris

_____

Garbage

_____

II. Match water color with potential causes

_____ Green
_____ Orange-Red
_____ Light Brown
_____ Yellow Coating on Stream Bed
_____ Multi-color Sheen
_____ Yellow brown to dark brown
_____ White cottony masses on stream beds
_____ Foaming

A. oil floating in the stream
B. indicates the possibility of acid drainage
C. indicates the possibility of “sewage fungus”
D. acids being released from decaying plants
E. indicates sulfur entering the stream
F. indicates sediment deposition caused by erosion
G. when white and greater than 3 inches – indicates the presence of detergents
H. indicates the possibility that nutrients are being released into the stream and feeding algae

Teachers Guide 2.2

Turbidity Worksheet

I. Indicate how the following items and actions might affect water clarity

– Any reasonable answer may be accepted for the following items.

Soil

_____

Sewage

_____

Microorganisms

_____

Industrial waste

_____

Heavy rains

_____

Leaves and debris

_____

Garbage

_____

II. Match water color with potential causes

___H___	Green
___B___	Orange-Red
___F___	Light Brown
___E___	Yellow Coating on Stream Bed
___A___	Multi-color Sheen
___D___	Yellow brown to dark brown
___C___	White cottony masses on stream beds
___G___	Foaming

A. oil floating in the stream
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