Water Chemistry and Hydrology Station
Field Station Study Suggestions

South River at Grand Caverns
Grottoes, Virginia

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MAT Program, Environment Based Learning Project
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Materials needed for station:

Fold-up table for display and material sorting
Rolling crates or wheelbarrow for transport to site
GREEN (Global Rivers Environmental Education Network) Comprehensive Water Quality Monitoring Kit $184.95

Item #TEST-9518 – Acorn Naturalists www.acornnaturalists.com , 1-800-422-8886, FAX 1-800-452-2802
This kit comes with supplies for 100 tests for each test,
so materials need to be broken down into individual test sections for buckets

***Ecolog* Field thermometers (optional, but the use of hand-held technology is in the SOLs; most middle schools have these)**
10 1-gallon buckets printed/identified for each test (7 tests, with 3 extras)
1 3-5 gallon bucket for rinsing test tubes between sessions
1 red or differently colored 1-gallon bucket for chemical dumping of test tubes after testing
7 clipboards with laminated test cards and color charts (background info and test instructions on pages 5-12, color charts pages 13-15)
Pencils
Data collection sheet (follows on page 4 of this document)
White dry erase board and markers for recording data
Goggles
Disposable Gloves
Waders/life jackets if velocity and volume station is investigated
Disposable wipes for clean-up
Trash container for used gloves

Station details to consider:

1. **Easy and safe access to water essential**
2. **One teacher and station assistant needed for each session**
3. **At least 30 minutes should be allowed for this station**
4. **No more than about 15 students with at least 2 adults/teachers per session**
5. **Waders and life jackets necessary for volume/velocity test**
6. **Goggles, gloves and clean-up wipes essential**
7. **7 tests/measurements could be conducted per session**
8. **If students arrive at the site with familiarity these testing methods, (and/or more time is available per station), teachers might consider having a student pair group do more than one test**

On Site Station Specifics and Methods
Here's what I do…..

- **Intro discussion = Water "health" is usually unseen, but discernable**
  1. **we'll observe the river, and analyze the riverbank environment for vegetation cover/shade/buffer protection**
  2. **we'll learn about the individual tests and predict test results**
  3. **then we'll test, by using chemical indicators (DO, pH, phosphates, nitrates)**
  4. **then we'll test by measuring (temperature, velocity, volume of flow, turbidity)**

- **Each student pair (for each test) is given background info card to study for 3 or so minutes**
- **Every group studies their info card for 3 minutes or so**
- **Each student pair = shares info with group**
- **Each student pair predicts result of their test in the prediction section of their journal page**
- **Each student pair gets bucket with test**
- **Gloves? Goggles? Ecologs?**
- **Each group does test**
- **Gloves/goggles/handi-wipes/garbage info dispensed**
- **Each group records their test results in journal**
- **Each group records on summary white board**
- **Summary discussion of water quality - maybe give the river "a score" – compare to prediction**
- **Summary discussion of environmental factors that could affect the overall health of river**
- **Stewardship discussion ~ what can each student do to improve water quality?**

Tests:

Dissolved Oxygen

pH

Temperature

C and F – thermometers and Ecologs

Nitrate

Phosphate

Turbidity

Volume/Velocity

Water Chemistry of South River

Names______________________
Date__________________________
Weather___________________________

- **What does your chemical test measure?**
- **What natural things impact the results?**
- **What do humans do to impact the results?**

Indicator	Prediction?	Test Results	Happy Fish Like…
Overall health and appearance of South River			On a scale of 1-10, they like a 10!
Streamside vegetation			Riparian buffers!
Dissolved Oxygen (“D.O.”)			At least 5 ppm
Water Temperature C			Varies, but DO saturation depends on it!
Water Temperature F			Varies, but DO saturation depends on it!
Turbidity			< 10 JTU (Jackson Turbidity Units)
pH			6.5 – 8.5
Nitrates			0 ppm
Phosphates			0 ppm
Velocity & Volume of water/ second?			What difference would this make?

Fecal Coliform Bacteria Test Results

Fecal coliform bacteria are naturally present in the human digestive tract but are rare or absent in unpolluted waters.

- **Coliform bacteria should not be found in well water or other sources of drinking water.**
- **Their presence in water serves as a reliable indication of sewage of fecal contaminations.**
- **Although coliform bacteria themselves are not pathogenic, they occur with intestinal pathogens that are dangerous to human health.**
- **This presence/absence total coliform test detects all coliform bacteria strains and may indicate fecal contamination.**

The coliform test in this kit will indicate if you have above or below 20 coliform colonies per 100 mL of water.

Fecal coliform bacteria standards per 100 mL water:

Desirable	Permissible	Water Use
0	0	Drinking water
NA	< 200	Treated sewage effluent
<200	<1,000	Primary contact (ex. swimming)
<1,000	<5,000	Boating and fishing

Dissolved Oxygen (DO) Test

1. Use goggles and plastic gloves.
2. Record the temperature of the water sample.
3. Submerge the small tube into the water sample. Carefully remove the tube from the water sample, keeping the tube full to the top.
4. Drop two *Dissolved Oxygen TesTabs* into the tube. Water will overflow when tablets are added.
5. Screw the cap on the tube. More water will overflow as the cap is tightened. Make sure no air bubbles are present in the sample.
6. Mix by inverting the tube over and over until the tablets have disintegrated (about 4 minutes).
7. Wait 5 more minutes for the color to develop.
8. Compare the color of the sample to the Dissolved Oxygen color chart. Record the result as ppm DO on your journal page.
9. To find % saturation, locate the temperature of the water sample on the % saturation chart. Locate the DO result of water sample at the top of the chart. The % saturation of the water sample is where the temp row and DO columns intersect.
10. Dispose of your sample as directed
11. Dispose of your gloves as directed.

Dissolved Oxygen (DO) Background Info

Dissolved Oxygen is measured in parts per million (ppm) and % saturation. These are important measurements of water quality.

- Most aquatic life needs between 5 – 12 ppm to survive.
- Cold water can hold more dissolved oxygen than warm water. For example, water at 28 C will be 100 % saturated with 8ppm dissolved oxygen.
- However, water a 8 C can hold up to 12 ppm of oxygen before it is 100% saturated.
- High levels of bacteria from sewage pollution or large amounts of rotting plants can cause the %saturation to decrease.
- This can cause large changes in DO levels throughout the day, which can affect the ability of plants and animals to thrive.

Nitrate Test

1. Use goggles and plastic gloves.
2. Fill the test tube to the 5 mL line with the water sample.
3. Add one *Nitrate Wide Range CTA TesTab*.
4. Cap and mix by inverting until the tablet has disintegrated. Bits of the materials may remain in the sample.
5. Wait 5 minutes for the red color to develop.
6. Note: if the sample does not develop a red color (sample is colorless or yellow), record the result as 0 ppm.
7. Compare the color of the sample to the Nitrate color chart.
8. Record the result in your journal as ppm Nitrate.

1. Dispose of your sample as directed.
2. Discard gloves as directed.

Nitrate Background

Nitrate is a nutrient needed by all aquatic plants and animals to build protein.

- The decomposition of dead plants and animals and the body waste of living animals release nitrate into the aquatic system.
- Excess nutrients like nitrate, increase plant growth and decay, promote bacterial decomposition, and therefore, decrease the amount of oxygen available in the water.
- Sewage is the main source of excess nitrate added to natural waters, while fertilizer and agricultural runoff also contribute to high levels of nitrate.
- Drinking water containing high nitrate levels can affect the ability of our blood to carry oxygen.

pH Test

1. Use goggles and plastic gloves.
2. Fill the test tube to the 10 mL line with the water sample.
3. Add one *pH Wide Range TestTab*.
4. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.
5. Compare the color of the sample to the pH color chart.
6. Record the result as pH in your journal.
7. Dispose of your sample as directed.
8. Discard gloves as directed.

pH Background

pH is a measurement of the acidic or basic quality of water.

- The pH scale ranges from a value of 0 (very acidic) to 14 (very basic), with 7 being neutral.
- The pH of natural water is usually between 6.5 and 8.2.
- Most aquatic organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly.
- pH can be affected by industrial waste, agricultural runoff, or drainage from improperly run mining operations.

Phosphate Test

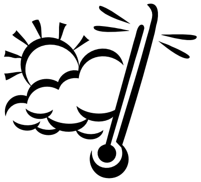
1. Use goggles and plastic gloves.
2. Fill the test tube to the 10 mL line with the water sample.
3. Add one *Phosphorus TesTab*.
4. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.
5. Wait 5 minutes for the blue color to develop.
6. NOTE: If the sample does not develop a blue color (sample is colorless), record the result as 0 ppm.
7. Compare the color of the sample to the Phosphate color chart. Record the result as ppm phosphate in your journal.
8. Dispose of your sample as directed.
9. Discard gloves as directed

Phosphate Background

Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in chemical reactions in all living things.

- Low levels of phosphate are acceptable since they are by-products of normal biochemical reactions occur in all environments.
- Increased levels of this nutrient come from several sources including human and animal waste, industrial pollution and agricultural runoff.
- High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity, and decreased dissolved oxygen levels .

Temperature



1. Use plastic gloves.
2. The temperature is indicated by a liquid crystal number on the Low Range thermometer and a green display on the High Range thermometer.
3. Place the thermometers four inches below the water surface for one minute.
4. Remove the thermometers from the water, read the temperature and record the temperature in degrees Celsius.
5. If using the Ecolog probe, take the temperature again.
6. Discard gloves as directed.

Temperature Background

Temperature is very important to water quality. Temperature affects

- the amount of dissolved oxygen in the water,
- the rate of photosynthesis by aquatic plants, and
- the sensitivity of organisms to toxic wastes, parasites and disease.

- Thermal pollution, the discharge of heated water from industrial operations, for example, can cause temperature changes that threaten the balance of aquatic systems.

Turbidity Test
Using Secchi disc in plastic sample jar

1. Use plastic gloves.
2. Fill sample jar to the turbidity fill line located on the outside kit label.
3. Hold the Turbidity Chart on the top edge of the jar.
4. Looking down into the jar, compare the appearance of the Secchi disk (black and white pattern sticker on bottom of jar) to the Turbidity Chart.
5. Record the result in JTU Turbidity units.
6. Discard gloves as directed.

Turbidity Background

Turbidity is the measure of the relative clarity of water.

- **Turbid water is caused by suspended matter such as clay, silt, organic and inorganic matter, and microscopic organisms.**
- **Turbidity is measured with a Secchi disc and JTU (Jackson Turbidity Units (also as %) are the units.**
- **Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid.**
- **Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances which can be caused by boat traffic and abundant bottom feeders.**

Volume and Velocity - Determining River Volume and Velocity

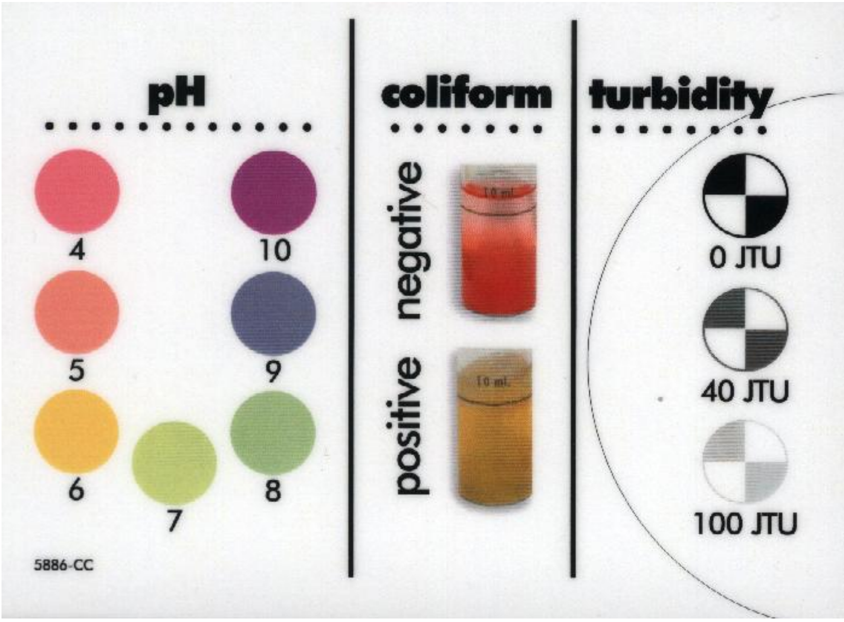
Safety issues to consider:

- **Shallow, and not too swift section of river suggested**
- **Waders and life jackets recommended**
- **Adult supervision/spotters/assistants essential**

1. **This station requires that one student will be in the middle of the river with a meter stick to determine depth and width of the river.**
2. **Another student will be on the bank to assist in the river width measurement and do the recording of data.**
3. **Another student will be on the bank using a second hand on watch or a stopwatch, to measure how far a leaf travels in 5 sec in the middle of the river when the river depth student drops the leaf in the middle of the river**

   Volume Formula: Width x Depth x Distance traveled
   = Cubic meters
   Velocity Formula: Cubic meters x time = cubic meters/sec
   Conversion to gallons/sec = divide by
   Conversion factor of 264.2
   Example: (example data in red)
   If measuring the volume in the middle of the river
   ½ width of river = middle (Ideally volume/velocity should be
   Done at three locations – near bank, ¼ way across, in middle)
   Example: if doing the volume and velocity in the *middle* of river,
   and measures 10 meters from middle to bank,
   10 meters x Distance leaf traveled (in meters)
   in 5 sec that was measured from riverbank as timed
   (10 meters) x depth of river in middle (1 m) = cubic meters of water
   Volume = (100 cubic meters of water – doubled since data
   was for ½ river = 200 cubic meters of water)

4. **Divide cubic meters by 5 seconds to get velocity in cubic meters/sec (200 cubic meters divided by 5 = 40 cubic meters/sec)**
5. **To get velocity measurement in gallons per second, multiply cubic meters/sec by 264.2 (conversion factor) (264.2 x 40 = 10,568 gallons/sec pass that point each second)**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coliform
negative
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40 JTU
100 JTU
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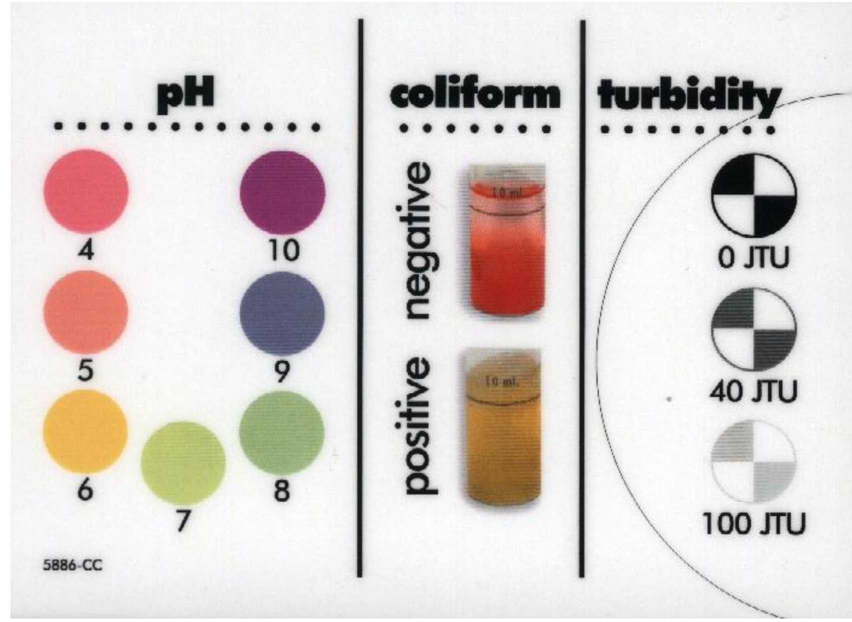
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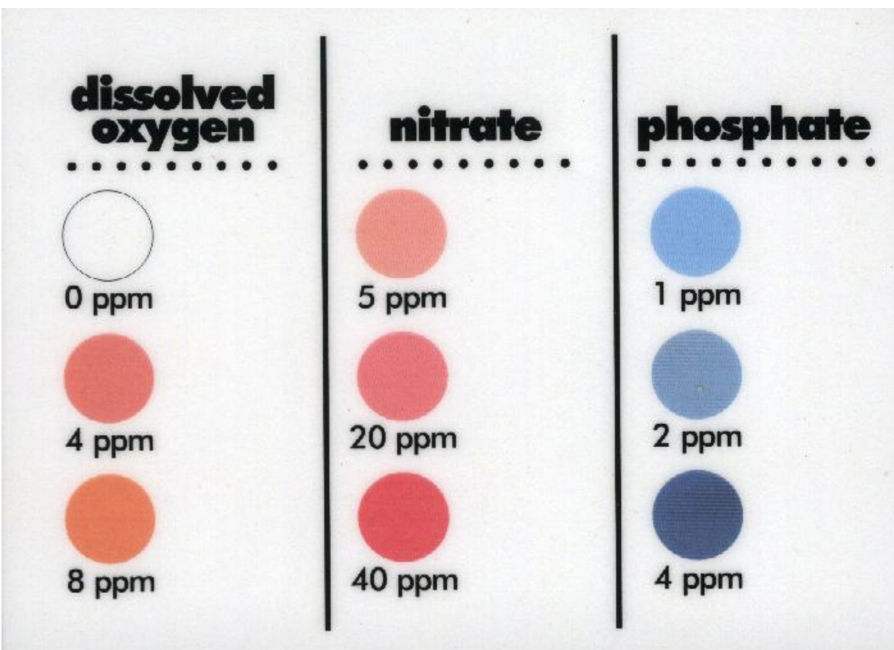
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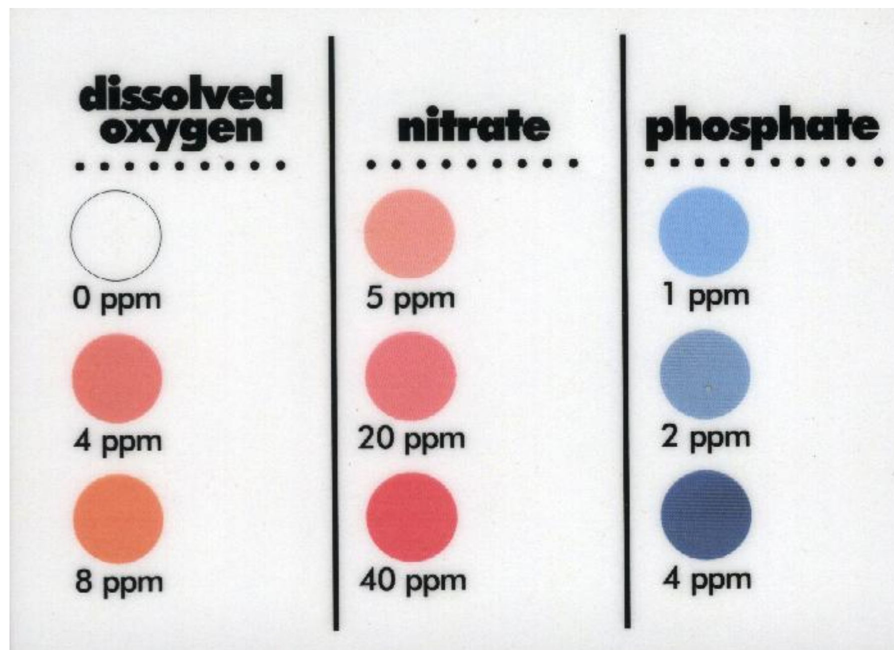
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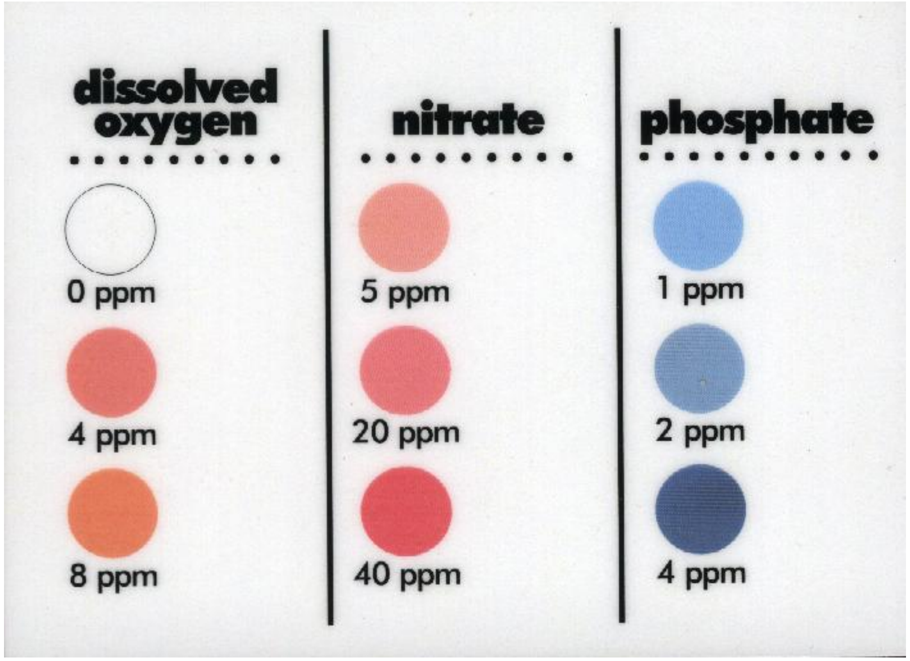
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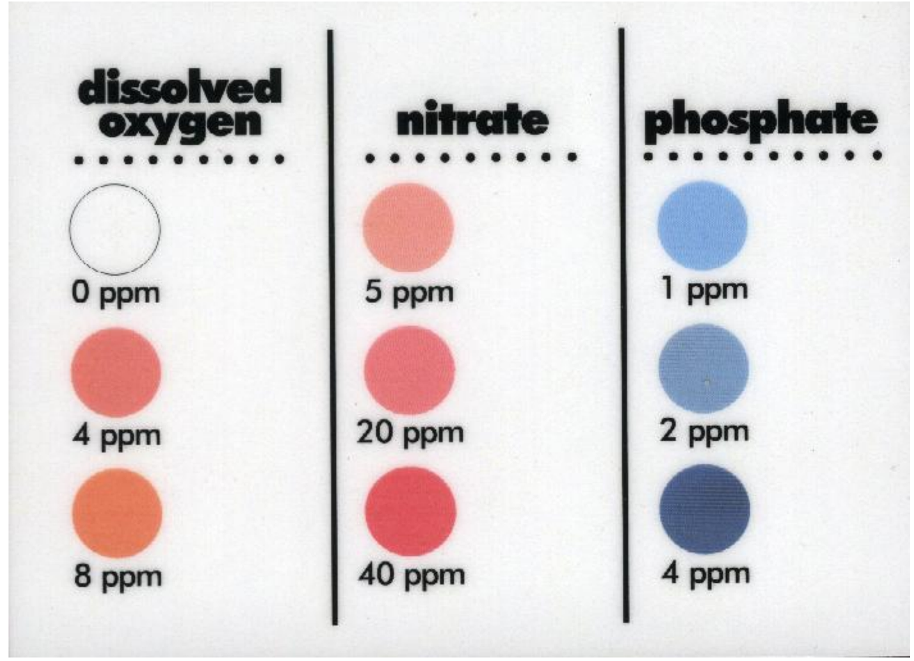
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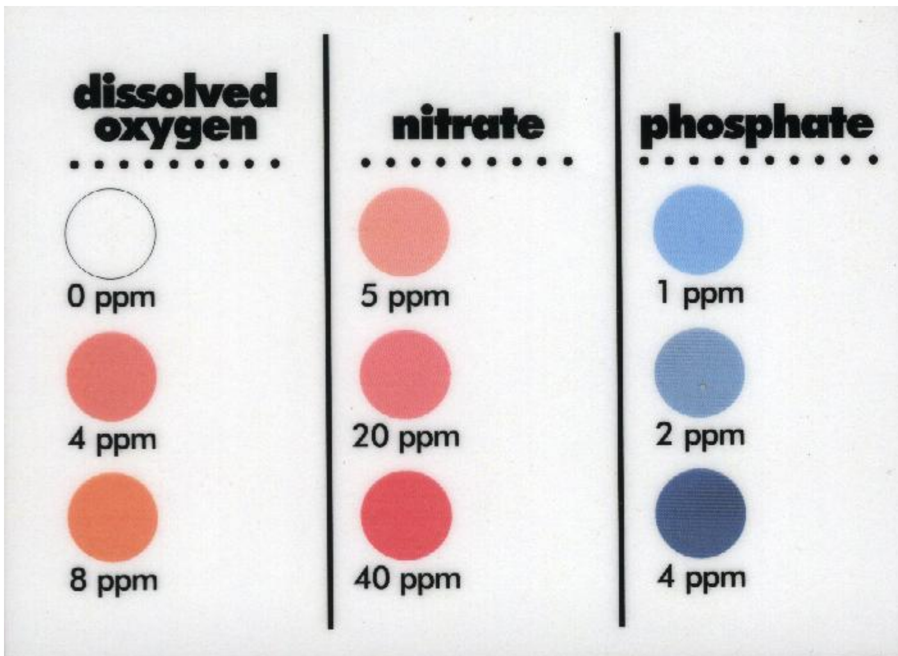
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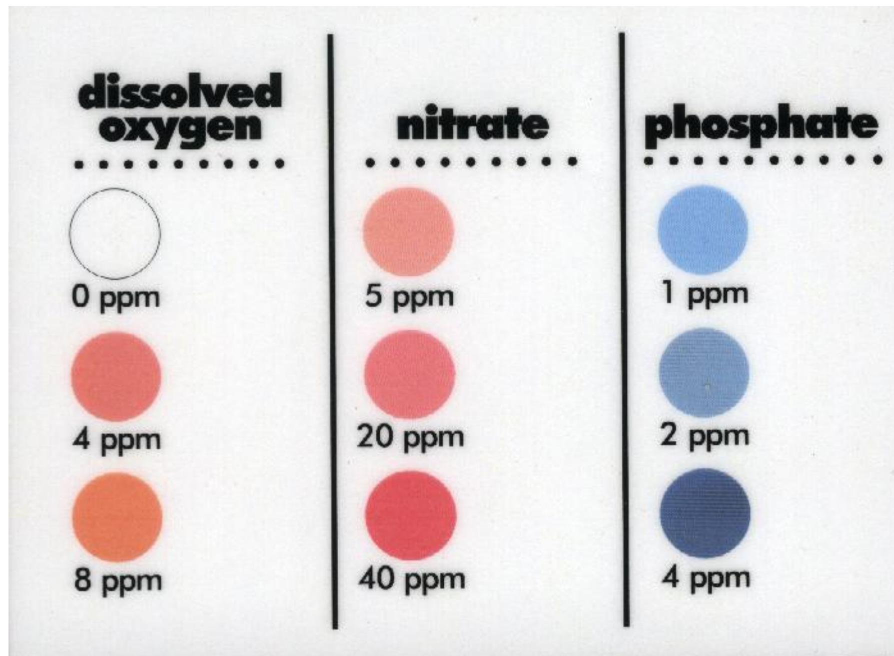
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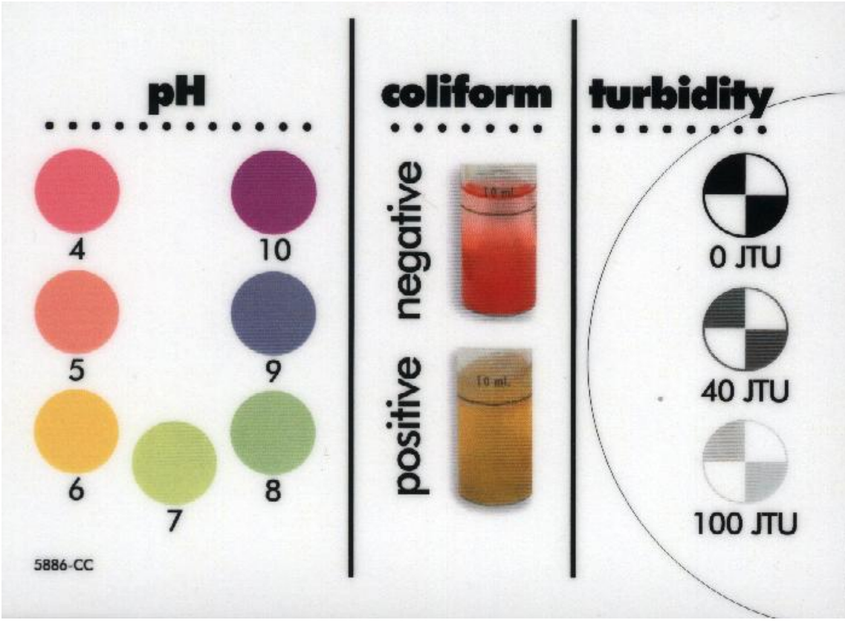
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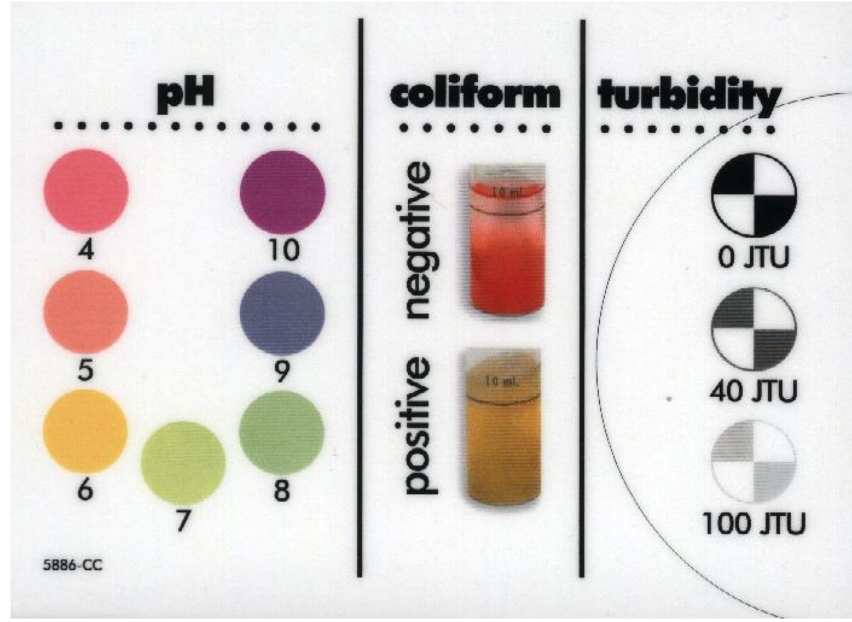
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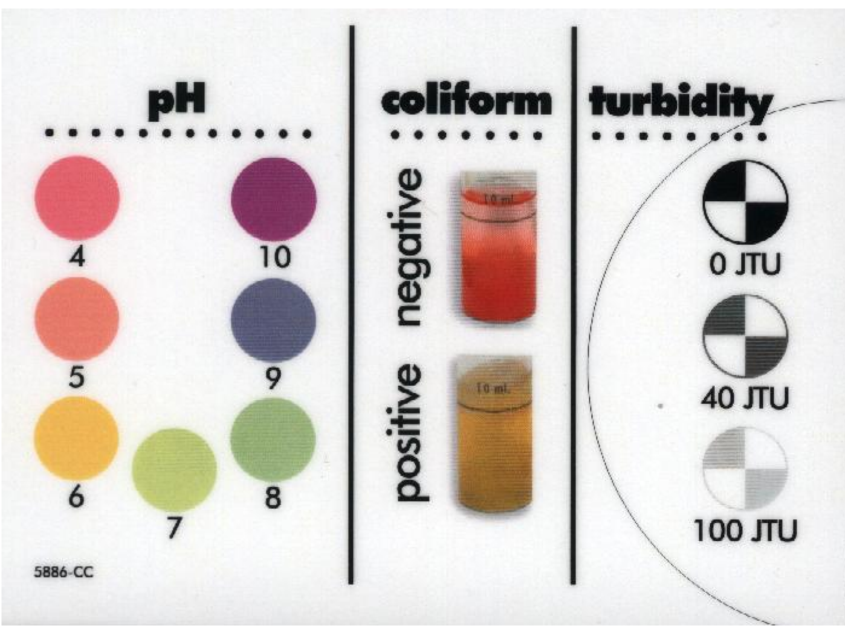
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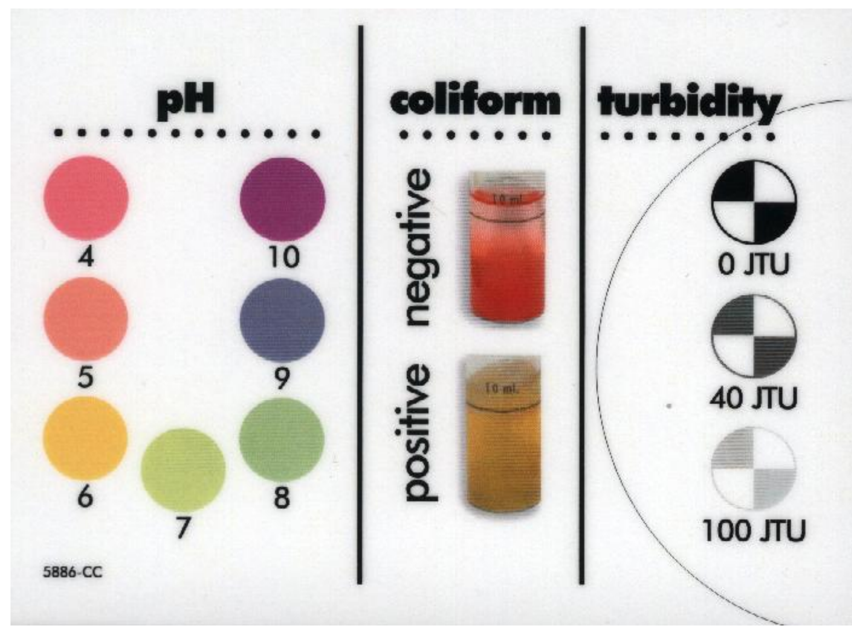
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