SAVE OUR STREAMS IZAAK WALTON LEAGUE OF AMERICA

Chemical Monitoring Instructions for Stream Monitors

As you explore your stream's water chemistry, it is important to understand that water chemistry is very complex. While some chemicals are absolutely necessary for life (such as nutrients) others can be harmful (such as pesticides) or harmful in large amounts (back to nutrients). Some chemicals may not directly affect human health, while others (such as nitrate) can have harmful effects in our drinking water.

Following are a few examples of how environmental conditions can influence water chemistry:

- **Time of day:** Dissolved oxygen levels rise during sunlight hours due to increased photosynthesis in aquatic plants and algae. Levels decrease overnight when photosynthesis is not occurring and plants and animals are using up dissolved oxygen.
- **Weather:** Runoff from heavy rains can transport pollutants into streams (which is called nonpoint source pollution). Very dry conditions over a long period of time (drought) lower stream flow, raising the concentration of chemicals in the stream.
- **Physical influences:** Decreased canopy cover causes sunlight to warm the water, which can decrease dissolved oxygen levels.
- **Land use:** What we do on the land greatly affects the volume of stream water flow and quality of our streams' water, including:
  - Development (filling in of wetlands; runoff from paved areas, roofs, and lawns with their many applied chemicals)Agriculture (runoff containing crop chemicals and animal waste, tilling of the land, and filling in of wetlands
  - Recreation (clearing of land, chemical applications, introduction of invasive species)

Monitoring should be conducted at the same station (location) each time. Carefully record the location of your monitoring station on your Chemical Monitoring Data Form. Include roads, bridges, and significant landmarks. Use your smart phone's GPS functionality to determine your longitude and latitude.

If you have attended a Save Our Streams training, you will know how to prepare a *transect* (straight line of rope) across the stream for flow monitoring. You can set one up as a reference point for taking samples for chemical tests or simply wade straight out into the stream to the spot with the greatest flow of water as required for multiple chemical tests.

USE AND STORAGE OF TESTING MATERIALS

Chemicals in test kits, though not dangerous, can cause mild skin and eye irritation and should be handled with care. Ampules are made of glass and can be very sharp. Test strips along with waste materials can be disposed of as you would any household item.

Store all chemical testing materials at room temperature. Dissolved oxygen and phosphate testing kits must be stored in the dark. Check expiration dates and avoid using expired test kits (which could provide inaccurate results).

You can find links to purchase stream monitoring test kits and equipment on the League website at *iwla.org/sos-equipment.*

DISSOLVED OXYGEN

Dissolved oxygen (DO) is necessary for nearly all aquatic life to survive. Certain processes add oxygen to a stream, while others remove or consume oxygen. Oxygen is added to a stream from the atmosphere through mixing in turbulent areas. Plants also contribute oxygen through photosynthesis. DO in streams can be affected by:

- **Water Temperature:** Cold water holds more oxygen than warm water.
- **Time of Day:** On a sunny day, DO levels rise from morning through the afternoon as a result of photosynthesis, reach a maximum in late afternoon, and steadily fall during the night, reaching their lowest point before dawn.
- **Stream Flow:** DO will vary with the volume and velocity of water in a stream. Faster moving water mixes readily with atmospheric oxygen, thus increasing DO.
- **Aquatic Plants:** Plant and algae growth in a stream will affect the oxygen contributed by photosynthesis during the day and depleted by plant respiration at night.
- **Dissolved or Suspended Solids:** Oxygen dissolves more readily in water that does not contain high amounts of salts, minerals, or other solids.
- **Human Impacts:** Lower DO levels may result from human impacts including organic enrichment, urban stormwater runoff, riparian corridor removal, stream channelization, and dams.

Typical range for dissolved oxygen = 8.7 to 12.9 mg/L (rivers); 7.4 to 10.4 mg/L (lakes)

Reporting Technique: For use with the CHEMetrics dissolved oxygen test kit

1. Remove the 25 ml sample cup from the kit and rinse it three times with stream water.
2. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, fill the sample cup to the 25 ml mark, mixing the water and air as little as possible.
3. Lower the sample cup down to wrist depth while holding it upside down. Turn the opening downstream so that the cup backfills with water, then turn the cup upstream and carefully remove cup and water sample from stream.
4. Gently tip the sample cup to pour off excess water.
5. Place the ampoule in the sample cup, tilting it so the tip is wedged in one of the spaces along the side of the sample cup.
6. Snap off the tip of the ampoule by pressing it against the side of the cup, allowing it to fill with water.
7. Remove the ampoule from the cup and mix the water by inverting the ampoule several times. Be careful not to touch the broken end, as it will be sharp.
8. Two minutes after you break off the ampoule tip, compare the ampoule to the color standards provided in the kit. Remove sunglasses before making a color determination. NOTE: It's important to read the ampoule exactly at two minutes – it will continue to change color.
9. Hold the comparator nearly flat while standing directly beneath a bright source of light. Place your ampoule between the color standards moving it from left to right until the best color match is found. Record your result on the Chemical Data Form.

Avoid breaking the ampoule open, as the contents may be mild skin and/or eye irritants.

pH

pH is a measure of a water's acid/base content and is measured in pH units on a scale of 0 to 14. A pH of seven (7) is neutral (distilled water), while a pH greater than seven is basic/alkaline and a pH less than seven is acidic.

The pH level of stream water is influenced by the concentration of acids in rain and the types of soils and bedrock in the state. The typical pH of rainfall in the United States is slightly acidic, ranging from 5.0 to 5.6.

Rainwater pH is determined by natural atmospheric processes and human activities (e.g., industry emissions causing acid rain). Low pH levels (acidic) can have a harmful impact on the health of aquatic communities

Most aquatic organisms require habitats with a pH of 6.5 to 9.0.

Reporting Technique: For use with Hach® pH test strips

1. Check the expiration date on the bottom of the bottle. If the test strips have expired, DO NOT USE them.
2. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, dip the test strip in the water and remove it immediately.
3. Hold the test strip level for 15 seconds. DO NOT SHAKE excess water from the test strip.
4. Estimate pH by comparing the test strip to the color chart on the test strip bottle. Remove sunglasses before reading the strip. The strip will continue to change color, so it is important to make a color determination immediately after 15 seconds.
5. Record results on the Chemical Data Form.

CHLORIDE

Chloride is a chemical found in salts, which tend to dissolve easily in water. Elevated levels of chloride in a stream may indicate inputs of human/animal waste or from fertilizers, many of which contain salts. During winter months, elevated chloride levels may occur as a result of road salt runoff into nearby streams. Chloride can be used as a conservative measure of water contamination since other natural processes, such as breakdown by bacteria, do not affect it.

Typical range for chloride = 16 to 29 mg/L (rivers)

Reporting Technique: For use with Hach Chloride QuanTab® titration strips and a sample cup from one of the CHEMetrics test kits.

1. Rinse the 25 ml CHEMetrics test kit sample cup three times with stream water.
2. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, fill the sample cup to the 25 ml mark, mixing the water and air as little as possible.
3. Remove a test strip from bottle and replace the cap immediately.

4. Insert the lower end of the test strip into the sample cup filled with water. Do not submerge past the yellow line at the top of the titrator.
5. Allow the sample water to completely saturate the wick of the titrator. There is no time limit for this test – the reaction is complete when yellow string turns dark (this will take a few minutes).
6. Note where the tip of the white chloride peak falls on the numbered QuanTab scale. This represents the QuanTab unit value.
7. Refer to the table on the QuanTab test strip bottle to convert the QuanTab units into a chloride concentration and record the results on the Chemical Data Form.
8. If the QuanTab unit is below 1.0, report the chloride concentration as < (less than) the lowest concentration listed on the test strip vial (which for data submission purposes is 25 mg/L).

PHOSPHATE

Phosphorus is an essential nutrient for plants and animals and is usually present in natural waters as dissolved orthophosphate. Plant growth in surface waters is generally limited by the amount of orthophosphate present. It is the simplest form of phosphorus found in natural waters and is most available for plants to use. In most waters, orthophosphate is present in very low concentrations. For our purposes, we will refer to orthophosphate as simply "phosphate."

There are natural sources of phosphorus, such as certain soils and rocks, but most elevated levels of phosphorus are caused by human activities. These include human, animal, and industrial wastes as well as runoff from fertilized lawns and cropland. Excess phosphorus in water speeds up plant growth, causes algal blooms, and can result in low dissolved oxygen ("hypoxic") conditions that can lead to the death of certain fish, invertebrates, and other aquatic animals.

Typical range for total phosphorus = 0.11 to 0.34 mg/L (rivers); 0.05 to 0.13 mg/L (lakes)

Reporting Technique: For use with CHEMetrics phosphate test kit

1. Remove the 25 ml sample cup and black lid from the kit and rinse them three times with stream water.
2. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, fill the sample cup to the 25 ml mark, mixing the water and air as little as possible.
3. Lower the sample cup down to wrist depth while holding it upside down. Turn the opening downstream so that the cup backfills with water, then turn the cup upstream and carefully remove the cup and water sample from the stream.
4. Gently tip the sample cup to pour off excess water.
5. Add 2 drops of A-8500 Activator Solution, place the black cap on the sample cup, and shake to mix the contents.
6. Place the ampoule in the sample cup, tilting it so the tip is wedged in one of the spaces along the side of the sample cup.
7. Snap off the tip of the ampoule by pressing it against the side of the cup, allowing it to fill with water.
8. Remove the ampoule from the cup and mix the water in the ampoule by inverting it slowly several times. Be careful not to touch the broken end, as it will be sharp.
9. Two minutes after you break off the ampoule tip, compare the ampoule to the color standards provided in the kit. Remove your sunglasses before making a color determination. NOTE: It's important to read the ampoule exactly at two minutes – it will continue to change color.
10. Based on the color of your ampoule, use the appropriate color comparator to estimate the orthophosphate concentration.
    a) The low-range circular comparator measures concentrations ranging from 0 to 1 mg/L. To use the circular comparator, place your ampoule, flat end downward, into the center tube. Direct the top of the comparator up toward a good light source while viewing from the bottom. Rotate the comparator to match your ampoule to the standards and record your results on the Chemical Data Form.
    b) The high-range comparator in the lid of the kit measures concentrations ranging from 1 to 10 mg/L. Hold the high range comparator nearly flat while standing directly beneath a bright source of light. Place your ampoule between the color standards moving it from left to right until the best color match is found. Record your result on the Chemical Data Form.

NITRATE-N/NITRITE-N

Nitrogen is an essential plant nutrient, but excess nitrogen can cause water quality problems. Too much nitrogen and phosphorus in surface waters cause nutrient enrichment, increasing aquatic plant growth and changing the types of plants and animals that live in a stream. This process, called eutrophication, can also affect other water quality parameters such as temperature and dissolved oxygen.

Nitrate and nitrite are two forms of nitrogen.

- **Nitrate** is very easily dissolved in water and is more common in streams. Sources of nitrate include soil organic matter, animal waste, decomposing plants, sewage, and fertilizers. Nitrate is more soluble in water than phosphorus and can move more readily into streams.
- **Nitrite** is another form of nitrogen that is rare because it is quickly converted to nitrate or returned back to the atmosphere as nitrogen gas. Due to its instability, detectable levels of nitrite in streams and lakes are uncommon. Detectable nitrite levels in streams may indicate a relatively fresh source of ammonia.

The amount of nitrate or nitrite dissolved in water is reported as nitrate-N (nitrate expressed as the element nitrogen) or nitrite-N in milligrams per liter of water (mg/L). Stream water nitrate rates may vary greatly depending on season and rainfall, fertilizer application rates, tillage methods, land use practices, soil types, and drainage systems. Consistently high nitrate readings (over 10 mg/L) may be cause for concern and warrant further investigation.

Typical range for Nitrate + Nitrite-N = 3 to 8.5 mg/L (rivers); 0.05 to 0.94 mg/L (lakes)

Reporting Technique: For use with Hach nitrate-N/nitrite-N test strips

1. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, dip the test strip into the water for one second and remove. DO NOT SHAKE excess water from the test strip
2. Hold the strip level, with pad side up, for 30 seconds.
3. Compare the NITRITE (lower) test pad to the nitrite-nitrogen color chart on the test strip bottle, estimate the nitrite concentration in mg/L, and record your reading on the Chemical Data Form. (Remove sunglasses before reading the strip.) The pad will continue to change color, so make a determination immediately after 30 seconds.
4. At 60 seconds (meaning 30 additional seconds after estimating the nitrite concentration), compare the NITRATE (upper) test pad to the nitrate-nitrogen color chart on test strip bottle, estimate the nitrate concentration in mg/L, and record your reading on the Chemical Data Form. (Remove sunglasses before reading the strip.) The pad will continue to change color, so make a determination immediately after 60 seconds.

TRANSPARENCY

Transparency is a measure of water clarity and is affected by the amount of material suspended in water. As more material is suspended, less light can pass through, making it less transparent. Suspended materials may include soil, algae, plankton, and microbes. Transparency is measured using a transparency tube and is measured in centimeters. It is important to note that transparency is different from turbidity; transparency is a measure of water clarity measured in centimeters, while turbidity measures how much light is scattered by suspended particles using NTUs (Nephelometric Turbidity Units).

Low transparency (or a high number of suspended particles) is a condition that is rarely toxic to aquatic animals, but it indirectly harms them when solids settle out of the water, which can clog gills, destroy habitat, and reduce the availability of food. Furthermore, suspended materials in streams promote solar heating, which can increase water temperatures (see Water Temperature) and reduce light penetration (which reduces photosynthesis) – both of which contribute to lower dissolved oxygen levels. Sediment also can carry chemicals attached to the particles, which can have harmful environmental effects.

Sources of suspended particles include soil erosion, waste discharge, urban runoff, eroding stream banks, disturbance of bottom sediments by bottom-feeding fish (such as carp), and excess algal growth.

Reporting Technique: We measure transparency with a transparency tube that shows how many centimeters down into the tube you can see the black and white pattern at the bottom.

1. Make sure the finger clamp on the hose is closed.
2. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and, facing upstream, fill the transparency tube
3. Hold the tube upright and in the shade. Use your body to shade the tube if nothing else is available.
4. With your back to the sun, look directly into the tube from the open top and release water through the small hose, regulating the flow with the finger clamp until you are able to distinguish the black and white pattern (Secchi pattern) on the bottom of the tube. Close the finger clamp.
5. Read the number on the outside of the tube that is closest to the water line. Record your reading in centimeters (cm).
6. Rinse the tube after each use so that the bottom Secchi pattern does not become dirty and clouded.

WATER TEMPERATURE

Many of the chemical, physical, and biological characteristics of a stream are directly affected by water temperature. Some species, such as trout, are quite sensitive to temperature changes. Water temperatures can fluctuate seasonally, daily, and even hourly.

Human activities can adversely raise stream temperatures in a variety of ways., including by:

- Releasing warmed water into a stream from industry discharges or runoff from paved surfaces
- Removing riparian corridors, which increases solar heating
- Causing soil erosion, which results in darker water that absorbs more sunlight

Changes in water temperature affect water quality:

- Cool water holds more oxygen than warm water, so the amount of dissolved oxygen decreases when temperatures rise
- The rate of photosynthesis by algae and aquatic plants increases with higher temperatures
- The metabolic rates of aquatic animals increase with higher temperatures
- The sensitivity of organisms to diseases, parasites, and toxic wastes increases with rising water temperatures

Human impacts are most critical during the summer, when low flows and higher temperatures can cause greater stress on aquatic life. It is important to note that the temperature of some streams is normally higher than others, depending on groundwater flow into the stream, weather, and other factors.

Reporting Technique: Use a non-mercury thermometer or meter probe to measure stream temperature. From your monitoring station, wade straight out to the spot with the greatest flow of water (along the *transect* if you have one) and place the thermometer or probe directly into the stream, holding it underwater for at least two minutes so the reading can stabilize. Record the temperature on your Chemical Data Form.