Chemical and Biological Testing Manual

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2025 Edition

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RiverWatchers Volunteer Monitoring

RiverWatchers is a volunteer monitoring program put on by the Foundation for Ohio River Education (FORE). The program was started in 1992 with 5 pilot groups and has grown to include as many as 40 groups. RiverWatchers monitor the Ohio River and selected tributaries. The goals of RiverWatchers are:

- -To monitor and protect water quality
- -To increase public awareness of local water quality issues
- -To promote stewardship of the Ohio River and its tributaries through public education and involvement
- -To enhance science and math education in schools and communities by providing environmental resources

The *RiverWatchers Chemical and Biological Testing Manual* is designed for FORE's RiverWatchers Program, but can be used separately by scout troops, civic organizations, environmental groups, and schools who have an interest in monitoring and protecting the water quality of the Ohio River and its tributaries. Teachers participating in the PA Denny River Education Center program through the Foundation for Ohio River Education (FORE) also use this manual as part of their pre-voyage curriculum.

ORSANCO's first edition of the *RiverWatchers Field Guide* was adapted in 1992 from the *Water Watch Field Guid*e produced by the New Jersey Division of Water Resources, the Izaak Walton League's Save Our Streams Program. It also included information from other guidebooks for volunteer monitoring groups by Jeanne J. Ison, ORSANCO Public Information Programs Manager and Alexandra Stevenson, Communications Coordinator. The publication was revised and renamed in 1994 by ORSANCO's Volunteer Monitoring Coordinator, Karel M. Fraser. It was again revised in 2003 by Elizabeth Thornton, RiverWatchers Coordinator, using materials from the *Hoosier RiverWatch Volunteer Stream Monitoring Training Manual* and the *Field Manual for Global Low-Cost Water Quality Monitoring* (Stapp and Mitchell).

The *Biological and Chemical Testing Manual* (2023) was written and modified from the *RiverWatchers Field Guide 2003* by Melissa Mann, RiverWatchers Coordinator, using materials from the *Hoosier RiverWatch Volunteer Stream Monitoring Manual* and the *ORSANCO River Education Center Curriculum*, written by Erin Overholt and Heather Mayfield.

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Chapter 1: Background

A healthy, natural stream, lake or wetland is a wonderful asset to a community. It enhances the beauty of the surrounding landscape, contributes recreational and drinking water resources, and provides a home for a rich diversity of plant and animal life. The water in such resources comes from precipitation; rainwater overflows over land to the river, or soaks into the soil and moves through hidden underground aquifers, to emerge through the streambed or banks.

Water naturally carries many substances including oxygen, carbon dioxide, nitrates, phosphates, calcium compounds, and sediments. The amount of each substance in unpolluted water depends on the geology, topography, water velocity, water temperature, climate, and vegetation of the surrounding area. Aquatic organisms have adapted over time to live in their specific chemical environment and therefore are adversely affected by uncharacteristic changes.

A healthy water body contains numerous habitats for quality life. Aquatic insects, larval fish, and tadpoles live and feed among the rocks and logs. Schooling fish dwell in the deeper pools. Frogs sit along banks and turtles lurk near the bottom or bask in the sun on logs.

Watersheds

A watershed is the total area of land that contributes runoff to a stream. Major land uses in a watershed determine the quality of surface water in the smaller streams and waterways, which can influence the water quality of larger streams. For example, point source discharges, urban runoff, and runoff from landfills and agricultural areas may contain sediments, organic material, nutrients, toxic substances, bacteria or other contaminants. When these substances are present in significant concentrations, they may interfere with some stream uses.

Factors that effect watersheds

Climate- Water comes to the watershed in seasonal cycles, mainly as rain or snow. Condensation and fog also contribute water to a stream. The seasonal patterns of precipitation and temperature control stream flow and water production.

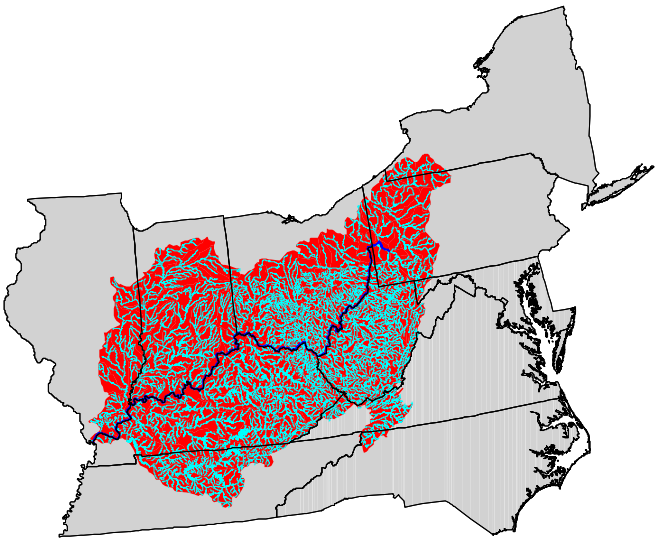
Physical features- The shape and slope of a watershed and the drainage pattern influence surface runoff and seepage in streams that drain the watershed. Steep slopes cause an increase in possible runoff and erosion. Plant cover is also more difficult to establish and the infiltration of surface water is reduced on steep slopes.

Soil- Soil is a thin layer of the earth's crust. It is composed of mineral particles of all sizes and varying amounts of organic materials. It is formed from breakdown of parent rocks to fine mineral particles.

Vegetative cover- Grasses, shrubs, and trees make up the major plant cover types. Presence of these vegetation types results in build-up of organic litter and affects soil development. A forest includes trees in various stages of growth and an understory of shrubs and groundcover. Tree litter protects the soil's surface. Tree roots grow deep into the soil and help to bind it. Plant cover intercepts rain and reduces the force with which raindrops strike the ground. Plants also reduce wind velocity. Fallen leaves and twigs produce litter that decompose and incorporate into the soil. Stems and roots lead water into the ground.

The Ohio River: Then and Now

The Ohio River is 981 miles long. It is formed by the confluence of the Monongahela and Allegheny Rivers in Pittsburgh, PA and empties into the Mississippi River at Cairo, IL. Water from parts of nine states forms the **drainage basin** for the Ohio River: Illinois, Indiana, Ohio, Pennsylvania, New York, West Virginia, Virginia, Kentucky, and Tennessee.



The Ohio River that is seen today resulted from systems of glaciers that advanced through Ohio, Indiana, and Northern Kentucky over a million years ago. These glaciers ultimately buried an ancient river system, known as the Teays. As the glaciers retreated, they created new headwaters for the Ohio River in Western Pennsylvania, and carved the channel for the Ohio River to flow toward Illinois.

Among the first human inhabitants to depend on the river were the Mound Building Paleoindians. Other Native American tribes, such as the Deleware, Wyandot, Shawnee, Miami, Cherokee, Chickasaw, and Iroquois followed. The Iroquois called the river "OYO", meaning "great river", while Frenchmen Rene Robert Cavelier Sieur de La Salle, the first European to see the river in 1669, referred to it as "la belle riviere", meaning the beautiful river.

After LaSalle's discovery, the Ohio River was home to many settlements, where it evolved into a primary transportation route during the westward expansion of the early United States.

In the 1800's the Ohio River played an important role in the Civil War, separating free states from slave states and fostering 23 escape routes that were part of the Underground Railroad.

The river was also used in the 1800's as a shipping route for coal and agricultural goods destined for major cities on its mainstem and along the Mississippi River. At the time, the river was so shallow in places that it could be crossed with horse and buggy. Thus, goods could only be shipped during high water in the spring and the fall.

In response to this problem, the Army Corps of Engineers began a series of projects on the Ohio River that removed sandbars and other obstructions to navigation. This removal process was followed by the construction of locks and dams that pooled the water to a minimum depth of nine feet, providing safe navigation on the river year-round. However, these dams, which relied on wooden wickets being raised and lowered from the river bottom, quickly became dangerous to operate as barges began carrying bigger loads. Therefore, in the 1950's, Corps began replacing wicket dams with modern concrete structures that provided quicker and more efficient navigation along the river. Today, there are 18 of these "high lift" dams and two wicket dams on the Ohio River.

The growth of cities, along with navigation and industrial activities in the late 19th and early 20th centuries, took a heavy toll on water quality in the Ohio River. This resulted in high levels of sewage and industrial discharges that rendered the river unsafe for human contact and unable to support fish and other wildlife.

In 1948, the Ohio River Valley Water Sanitation Commission (ORSANCO) formed a Compact that stated "*sewage or industrial waters originating within a signatory State shall not injuriously affect the various uses of the interstate waters as hereinbefore defined."*

The formation of this compact marked the beginning of a coordinated effort among states bordering the Ohio River to control discharges going into the river. Thus, one major outcome of the Compact was the treatment and regulation of industrial and municipal (sewage) discharges. These regulations, along with regulations enforced by the Clean Water Act in 1972, led to significant water quality improvements that now allow the river to support diverse populations of fish and wildlife, to be used for recreational activities, and to serve as a source of drinking water.

Although the regulation of discharges, or "point sources" have decreased, many sources of pollution in the Ohio River, "non-point" pollutants, which are harder to regulate, still account for almost 80% of the pollution problems that exist today. Non-point pollutants include fertilizers, pesticides, and agricultural runoff that are carried directly into the river and its tributaries when it rains.

Another major pollution problem in many cities along the Ohio River today is failing sewage infrastructure that can result in overflows of sanitary and combined sewer systems during heavy rain events. These overflows account for high levels of bacteria and pathogens that render the river unsafe for recreational contact during and after wet-weather events.

Ohio River Facts

- *The Ohio River is a source of drinking water for more than three million people.*
- *More than 25 million people, almost 10 percent of the U.S. population, live in the Ohio River Basin.*
- *Approximately 130 species of fish have been collected from the Ohio River.*
- *The average depth of the Ohio River is 24 feet.*
- *There are 20 dams and 49 power generating facilities on the Ohio River.*
- *Over 230 million tons of cargo are transported on the Ohio River each year. Coal and other energy products make up approximately 70 percent of the commerce traveling by barge.*

About ORSANCO and the Foundation for Ohio River Education

The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate agency established in 1948 by a compact to control and abate interstate water pollution in the Ohio River Valley. ORSANCO represents eight states and the federal government. Member states are Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia and West Virginia. Among ORSANCO programs are water quality monitoring and assessment; spill detection and notification; pollution control standards for discharges into the Ohio River; and public information programs.

Each member state's governor, and the President of the United States, appoints three commissioners to ORSANCO's governing board. ORSANCO's advisory committees also provide guidance for its programs. These volunteer-based committees are made up of private citizens, along with representatives from businesses, industries, municipalities, utilities, state agencies, and federal government agencies. Approximately 30 staff members work at the organization's headquarters in Cincinnati, OH.

The ORSANCO Educational Foundation (OEF) was developed in 2003 as a 501(c)3 non-profit arm of ORSANCO. OEF was renamed the Foundation for Ohio River Education (FORE) in 2009. FORE's mission is to design and manage educational programs that will foster an environmentally responsible public.

Types of Pollution

Water pollution is primarily due to the carelessness of humans, and is reflected by a decline in the diversity of aquatic plants and animals. Water pollution can typically be placed into one of two categories: **point** or **nonpoint source pollution**. Point source pollution is easy to identify because it is discharged from the end of a pipe. Nonpoint source pollution originates from runoff and is more difficult to identify. It is a product of land use, and it makes up about 75% of water pollution.

Water pollution can also be divided into four general categories that may overlap: sediment pollution, organic wastes, nutrient pollution, and toxic substances.

Sediment Pollution

Sediment pollution exists wherever the sediment load (sand, silt and mud) in a water body exceeds that of natural conditions. This occurs where development has stripped away the natural vegetation, creating highly erodible areas. Such areas include construction sites, sand and gravel pits, agricultural lands, urban areas, unpaved roads, and eroding roadsides.

Sediment pollution can have a dramatic impact on water resources. Sediment fills in the cracks between rocks and logs, creating poor habitat and smothering aquatic insect life important for fish. Sedimentation also reduces the channel capacity of streams, resulting in increased flooding.

Organic Wastes

Most aquatic life needs oxygen to survive. Water is capable, however, of dissolving only a small amount of oxygen from the surrounding air. Waste containing organic material requires oxygen to decompose. Large accumulations of organic wastes use large amounts of oxygen, leaving little oxygen for fish and aquatic insects. Less desirable organisms, like some fly larvae and worms, may become too abundant in low oxygen waters. Large, deep, slower moving water tends to have naturally low oxygen levels and is particularly vulnerable to oxygen deficiency.

Nutrient Pollution

Aquatic plants require nutrients such as nitrogen and phosphorus for growth, but too much of these nutrients can result in excessive growth of aquatic vegetation and algae, or *eutrophication*. An explosive growth of algae, termed an algae bloom, is a result of nutrient overloading. Such a bloom blankets the water's surface and can produce odor and taste problems in drinking water. An algal bloom will deplete the oxygen supply in the water as it decomposes.

Toxic substances

Toxic substances may enter water bodies through industrial and municipal wastewater discharges, through agricultural and urban land runoff, or from leaching of waste materials dumped in the area. These substances impair or kill aquatic life, reducing the numbers and diversity of species, and thereby disrupting the natural aquatic community.

The effects of toxic substances on living organisms can be divided into four categories:

Acute toxicity- cause immediate danger or death

Chronic toxicity- has long term non-lethal effects which may alter appetite, growth, metabolism, or reproduction

Bioaccumulation- becomes toxic as it concentrates in animal tissues either from direct consumption or through the food chain

Behavioral modification- causes an organism to leave the area or otherwise alter its normal behavior

Diagnosis

(*Adapted from North Carolina's Stream Watch Program*)
In order to determine the factors affecting the health of your water resource, it is necessary to familiarize yourself with some warning signs of pollution. Given below are point and nonpoint pollution sources and symptoms associated with each. These will help you investigate and define the origins of water quality degradation.

Type of land use surrounding stream

Forests: Look for signs of sedimentation such as cloudy or muddy water. Logging, road building, or clear cutting of trees for development may cause erosion.

Agricultural: Check for algal blooms associated with misuse of fertilizers on croplands and orchards and runoff from manure-laden pastures, feedlots, and compost heaps. Erosion of cropland and over-grazed pastures may lead to sediment pollution. A low macroinvertebrate count will help determine whether pesticide management is a factor.

Urban: Urban runoff may contain many kinds of pollutants including metals, salts, chemicals, and oils. Check for surface color sheen, low pH levels, excessive algae growth, or deposition of unnatural materials. Check for absence of pollution-intolerant macroinvertebrates.

Industries: Watch for discoloration, odors, low pH levels, excessive algae growth, or deposition of unnatural materials. Check for absence of pollution intolerant macroinvertebrate and fish species.

Sewage treatment plants and septic systems: Watch for organic pollution such as excessive algae growth associated with release of organic matter. Also, very few or no macroinvertebrates may indicate the presence of too much chlorine in the water.

Sanitary landfills: Look for signs of runoff from landfills or inflow of contaminated groundwater, such as rusty streaks in the stream bank. Excessive nutrients or toxic substances may be present. Check for algal blooms and the absence of pollution-intolerant species of benthic macroinvertebrates.

Construction: Erosion and sediment pollution may occur if appropriate control structures are not in place. Look for cloudy or muddy water and sediment deposition on the streambed.

Residential: Poor fertilizing practices, defective septic systems, and dumping of grass clippings may lead to organic enrichment with a resultant algal bloom. Misuse of pesticides and herbicides may cause toxic pollution; check for an absence of aquatic life. If a color sheen is noticed on the water's surface it may be from automobile oil dumped nearby. Sudsy, white foam on the water surface may indicate the presence of detergents used to wash cars or clothes.

Physical indicators of water pollution

Color of Water

- ***Green or blue-green*:** If the water is excessively green, this could be an indication of nutrients being released into the water feeding algae and causing an algal bloom.
    - **What to do:** Check watershed for possible fertilizer or manure runoff areas, sewage discharge, landfill runoff, or septic system failure.

- ***Orange-red*:** Orange to red deposits could be caused by acid drainage or the presence of synthetic dyes.
    - **What to do:** Check watershed for industrial waste or landfill seepage draining into the water body.

- ***Light brown (muddy or cloudy)*:** Indication of sediment deposition caused by erosion.
    - **What to do:** Search upstream for disturbed ground left open to rainfall.

- ***Yellow brown to dark brown*:** This is probably due to acids released from decaying plants.
    - **What to do:** Nothing. This coloration occurs naturally each fall when dead leaves collect in the water; also common in streams draining into marsh or swampland.

Surface or Bottom Coatings

- ***Yellow coating on bottom of water body*:** Indication of sulfur entering the water body.
    - **What to do:** Check upstream for industrial waste operation.

- ***Multi-color reflection*:** Indicates oil floating on the surface.
    - **What to do:** Check closely upstream for source, waste oil may have been dumped nearby.

- ***White cottony masses on streambed*:** Indication of "sewage fungus".
    - **What to do:** Check for sewage or other organic pollution.

- ***White foam on surface*:** A small amount of foam may occur naturally. If the foam is more than three inches high, it may be from detergents.
    - **What to do:** Check upstream for industrial or residential waste being discharged.

Stream Odor

***Rotten Egg*:** May indicate sewage pollution. Odor may also occur naturally in marshy or swampy land.

***Musky*:** May indicate presence of untreated sewage, livestock waste, algae, or other conditions.

***Chlorine*:** May indicate that a sewage treatment plant is over-chlorinating their effluent.

***Fishy*:** May indicate the presence of excessive algal growth or dead fish.

Chapter 2: Safety

All volunteers should read the following safety precautions prior to beginning any monitoring activities. Safety is the critical first step in any volunteer monitoring program. All volunteers should be trained in safety procedures and should at all times carry safety instructions, a first aid kit, and Material Safety Data Sheets for chemical handling.

Safety precautions can never be over-emphasized.

At the site:

- ✓ Never go alone.
- ✓ Honor property rights- never cross a landowner's property without permission (sample at public access points).
- ✓ Never wade in swift or high water or deeper than knee height.
- ✓ Have a first aid kit on hand and know how to use it.
- ✓ Develop a safety plan- know medical information about each volunteer.
- ✓ Never monitor in severe weather.
- ✓ Never drink water from the stream or wash food in the stream.
- ✓ Do not walk on unstable stream banks.
- ✓ Beware of animals and plants.
- ✓ If sampling from a bridge, do not lean over.

When using chemicals:

- ✓ Avoid contact between chemical reagents and your skin, eyes, nose and mouth.
- ✓ Wear safety goggles and rubber gloves.
- ✓ Do not mix chemicals indiscriminately.
- ✓ Know your equipment and sampling procedure before going out into the field.
- ✓ Do not expose chemical and equipment to extreme temperatures or long-term direct sunshine.
- ✓ Supervise children at all times.
- ✓ Know chemical cleanup and disposal procedures.

Disposal of chemical waste

To discard chemical waste, place all liquids and solids in a plastic container with a secure lid (such as a gallon milk jug) and several cups of clay cat litter. Allow the liquid to evaporate. The chemical waste is now in solid form and can be thrown in the garbage.

Important:
Be sure to read the MSDS for information on disposal of extra chemicals. If you have any questions or concerns, contact the RiverWatchers coordinator or give them the chemicals to dispose of in the proper fashion.

Introduction to Material Safety Data Sheets

The United States Occupational Safety and Health Administration (OSHA) requires all manufacturers to issue Material Safety Data Sheets (MSDS) with the first shipment of any hazardous chemical product. The purpose of the MSDS is to relay important information about the nature of the chemical -- such as its flammability, toxicity, possible need for protective equipment, and spill or clean-up requirements -- to ensure the safety of any potential user of that chemical. If you need a MSDS, please contact HACH at 1-800-227-4224. MSDSs can also be downloaded online at www.hach.com and riverlearning.org/program/volunteermonitoringprograms/resources/

What to look for in an MSDS

1. The **chemical product and company identification section** provides an overall product summary, including manufacturer address, MSDS date, emergency phone numbers, and a brief description of any hazard.
2. The **composition and ingredients section** spells out the following information about each component of the product:
   PCT Percent by weight of this component.
   CAS Number Chemical Abstract Services or CAS registry number.
   TLV Threshold Limit Value is the maximum airborne concentration allowable for an 8-hour exposure, as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).
   PEL Permissible Exposure Limit is the maximum airborne concentration allowable for an 8-hour exposure, as regulated by the Occupational Safety and Health Administration (OSHA).
   HAZARD any physical or health hazards posed by this chemical are explained here.
3. The **hazards identification summary** starts out with an emergency overview, plus ratings of the product from the Hazardous Materials Information System and the National Fire Protection Association (NFPA). This section also outlines the potential harmful effects of this product.
4. The **first aid section** spells out the medical attention required in the event of an exposure. Be sure to read this section carefully!
5. The **fire fighting measures section** lists all of the flammability concerns, what media to use to extinguish a fire, and what safety precautions to take, should you be put in a position to fight a fire.

6. The **accidental release measures section** spells out the personnel who are qualified to respond to an emergency involving hazardous substances and outlines containment techniques, clean-up techniques, and any necessary evacuation procedures.
7. The **handling/storage section** provides general guidelines for safe handling of the product and lists all storage requirements.
8. The **exposure controls/protective equipment section** outlines safe laboratory practice and any necessary protective gear, such as eye, skin, and inhalation protection.
9. The **physical/chemical properties section** spells out information such as the physical state, color, odor, solubility, boiling point, melting point, specific gravity, pH, vapor density, evaporation rate, corrosivity, stability, and storage precautions.
10. The **stability/reactivity section** spells out storage conditions, including moisture and temperature requirements and compatibility with substances stored nearby.
11. The **toxicological information section** summarizes data gathered from research with animals, including lethal dosages and concentrations, effects on reproduction, skin toxicity data, and mutation data.
12. The **ecological information section** assesses the material's environmental impact on aquatic and terrestrial plants and animals and the potential of the material to persist in the environment.
13. The **disposal considerations section** outlines any dilution guidelines, container information, and national environmental regulations.
14. The **transportation information section** spells out proper shipping name, hazard class, ID number, and packing group for all chemicals regulated by D.O.T., I.C.A.O., and I.M.O.
15. The **regulatory information section** outlines all known regulatory guidelines spelled out by OSHA, SARA Title III, the Clean Water Act, RCRA, and any known state regulations.
16. The **other information section** states the product's intended use and lists all reference materials used to write the MSDS.

Chapter 3: Chemical Testing

Chemical Parameters

Eight chemical tests are considered by the National Sanitation Foundation to be the most useful in determining stream water quality:

1. **Dissolved Oxygen**
2. ***E. coli***
3. **pH**
4. **Biochemical Oxygen Demand- 5 day (BOD-5)**
5. **Water Temperature Change**
6. **Total Phosphate**
7. **Nitrates**
8. **Turbidity**

Times and Locations for Completing the Tests

The table below provides estimated times for performing each of the tests and whether they must be completed on-site or off-site. If samples are taken off-site, they must be kept on ice or refrigerated until testing is complete (except BOD and turbidity). All tests should be completed the same day and as soon as possible to obtain the best results.

Chemical Test	Time to Complete	Location
Dissolved Oxygen	5 min.	On-site
E. coli	24-48 hrs. to incubate	On-site/Off-site
pH	2 min.	On-site
Biochemical Oxygen Demand	5 days to incubate; 5 min. to test	Off-site
Water Temp. Change (1 mi.)	<5 min. at each site	On-site
Total Phosphate	45 min. – 1 hr.	On-site/Off-site
Nitrates	15-20 min.	On-site/Off-site
Turbidity	5 min.	On-site/Off-site

Water Quality Index

RiverWatchers utilizes a Water Quality Index (WQI). The Water Quality Index provides a simple analysis of the results of the eight chemical tests. If you complete at least six of the eight tests, you can derive a single score that will indicate if the stream results are Excellent, Good, Medium, Bad or Very Bad for that particular monitoring session. Each of the tests is weighted according to its level of importance to the overall water quality (for this particular index). Example: Dissolved oxygen has the largest weighting factor; therefore, the results are the most important value in determining the Water Quality Index.

In order to obtain a WQI Rating, you must first determine the Q-value for each test. You can think of a Q-value as a "Quality-value." It helps interpret your results in terms of the overall

health or water quality of your stream because it is a unitless value (unlike the measurement you are taking which a reported in a variety of units). The higher the Q-value, the better the test results (100 is the maximum value; 0 is the minimum). After completing a chemical test, use the results to find the Q-value on a Q-chart. Each chemical has its own Q-chart. To find the Q-value: 1) Locate your test result on the bottom of the appropriate chart (x-axis); 2) Draw a vertical line up from your test result until it intersects the curved line (Q–line). From this point of intersection, draw a line across to the left hand side (y-axis); 3) Read the number on the left side of the chart closer to the intersection; this is the Q-value for that particular test result; 4) Record the Q-value in the second column on the Water Quality Index sheet.

You can also check the Q-value table if your result is close to a given value.

Station Approach

Many RiverWatchers groups test water in a classroom setting. It is often difficult to arrange students and tests so that maximum learning is occurring. A station approach is one way to accomplish this. The stations are grouped with related tests together. Not all RiverWatchers have the test kits necessary for all of these tests, so there is also information that can be used in general classroom discussions about water quality tests. Please feel free to modify the plans to fit your needs.

Reporting Water Quality Monitoring Data

Water Quality Data can be reported in several ways:

1. ***Mail***
RiverWatchers Coordinator
5735 Kellogg Avenue
Cincinnati, OH 45230

2. ***Internet and Email***
https://riverlearning.org/program/volunteermonitoringprograms/data-submission/
eburton@orsanco.org

Chemical Testing Instructions

Information for the Chemical Testing Instructions was modified with permission from the *Hoosier Riverwatch Volunteer Stream Training Manual*, which were modified with permission from the HACH Company and the Student Watershed Research Project/Saturday Academy of Oregon.

Dissolved Oxygen

Primary Importance:
Aquatic organisms require oxygen in the free elemental state as a dissolved gas. The amount of dissolved oxygen in the water is fundamental to the survival of most aquatic plants and animals.

Problem:
Lack of significant levels of dissolved oxygen required by most aquatic organisms for respiration can cause impairment or death.
Some organisms have adapted to low oxygen in water or are able to ingest air directly.

Causes

- Rapid decomposition of organic materials, including dead algae, shoreline vegetation and manure or wastewater sources, decreases oxygen concentrations.
- High ammonia concentrations in the stream use up oxygen in the process of oxidizing NH^{4+} to NO^{3-} (nitrification).
- At higher temperatures, less oxygen can dissolve in water.
- Lack of turbulence or mixing to expose water to atmospheric oxygen results in low dissolved oxygen concentrations in the stream.

Instructions:
These instructions are for use with the HACH Company Dissolved Oxygen test kit, Catalog No. 1469-00, Model OX-2P, for 60 mL sample.

CHECKLIST

- ☐ DO glass collection bottle and glass stopper
- ☐ 23 mL square mixing bottle
- ☐ Plastic measuring tube
- ☐ DO Reagent 1 powder pillows (manganous sulfate)
- ☐ DO Reagent 2 powder pillows (lithium hydroxide)
- ☐ DO Reagent 3 powder pillows (sulfamic acid)
- ☐ Sodium Thiosulfate Solution dropper bottle
- ☐ Waste container
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

Steps 1-4 of this test MUST be done at the site when the sample is collected. If any oxygen bubbles are seen during these steps, dispose of your sample, rinse and collect a new sample.

1. After rinsing thoroughly with distilled water and sample water, lower the DO bottle (or other clean collection bottle) in an upside-down position to a point 3-4 inches below the water's surface. Turn the bottle upright to an angle tilting upstream to reduce the risk of air bubbles. **Allow water to flow into the bottle for approximately 2 minutes until the bottle is full and no air bubbles are present.** While the bottle is underwater, place stopper in the top. Remove the bottle from the stream with the stopper in place. DO NOT pour off the excess water around the rim of the stopper. (Note: If pouring your sample from a collection bottle into the DO bottle, be careful not to agitate or splash the water into the bottle.)

2. Add Dissolved Oxygen 1 Reagent and Dissolved Oxygen 2 Reagent Powder Pillows to the DO bottle (the order does not matter). Stopper the bottle, being very careful not to introduce air bubbles. (Note: Allow the excess water to spill over into a waster container.) If you get an air bubble, start over with step one. With your thumb firmly holding the stopper in place, grip the bottle and shake vigorously until the contents are evenly mixed. A flocculent (floc) precipitate will form. **If oxygen is present in the sample, the precipitate will appear brownish-orange in color.** A small amount of powdered reagent may remain at the bottom of the bottle. This will not affect the test results.

3. Allow the sample to stand until the floc has settled below the DO bottle's white line. **The upper half of the sample will be clear.** Shake the bottle again to remix and allow it to resettle in the same manner as above. (Note: the floc will not settle in samples with high concentrations of chloride. Allow a maximum of five minutes for the floc to settle. If no additional progress is made, proceed with the next step.)

4. Add the contents of Dissolved Oxygen 3 Reagent Powder Pillow. Carefully replace the stopper and shake the bottle to mix. **The floc will dissolve, creating a yellowish-amber color if DO is present.** (Note: Small, rust colored flakes may remain, but will not affect the test results.) At this point, the oxygen is "fixed" and any oxygen bubbles formed after this step will not affect the results of the test.

5. Fill the sturdy, 5 mL measuring tube (1 cm width x 8.5 cm length—if you can stick your little finger inside the tube, it's the wrong one!) to its top with the prepared sample into the square mixing bottle. (Note**: Do not discard the rest of the fluid in the DO bottle until you have successfully completed the rest of this test**.)

6. Using the dropper located within the brown bottle marked Sodium Thiosulfate Standard Solution, add this solution drop by drop to the prepared sample in the mixing bottle. **Count each drop as it is added and gently swirl to mix the solution until it becomes colorless.** Once the prepared sample is clear, add one more drop to ensure a complete color change, if there is no change in color, do not count the last drop. (Note: Hold the dropper vertically above the mixing bottle's mouth when adding drops to ensure the proper volume of titrant. Do not place the dropper inside the mouth of the square bottle as you may contaminate the dropper.) Also, rinse thoroughly any surface, including your hands, that has contacted the above chemical as it may eat holes in your clothing or irritate your skin.)

7. Each drop added to bring about the color change in Step 6 equals the presence of 1.0 mg/L of dissolved oxygen. (Note: If the result of Step 6 is 3 mg/L or less, follow the Low-range instructions provided below.)

8. Use the graph on the next page to calculate percent saturation. By running a straight edge from the appropriate water temperature reading to oxygen mg/L, you will be able to determine percent saturation along the angled scale. Look at the water temperature change directions for the Celsius/Fahrenheit conversion.

9. Record DO to the nearest 1.0 mg/L and record the percent saturation.
   EXAMPLE:
   Water temperature at site=16°C
   Dissolved oxygen=**8 mg/L** = **80% saturation** (look on chart)

10. You may also use the following formula to determine percent saturation:
    DO mg/L (your sample) / DO mg/L needed for your sample to be 100% saturated
    EXAMPLE:
    At your sampling location, you recorded a water temperature of 19°C and a DO of 6 mg/L. Based upon the chart in your book, the DO reading (mg/L) for the water to be 100% saturated at 19°C = 9.3 mg/L. Therefore, 6 / 9.3 * 100 = 64.5%.

Dissolved Oxygen Low-range (0.2-4 mg/L)

1. Use the prepared sample left from Step 5 of the High-range test. Pour off the contents of the DO bottle until the level reaches the 30 mL mark on the bottle.

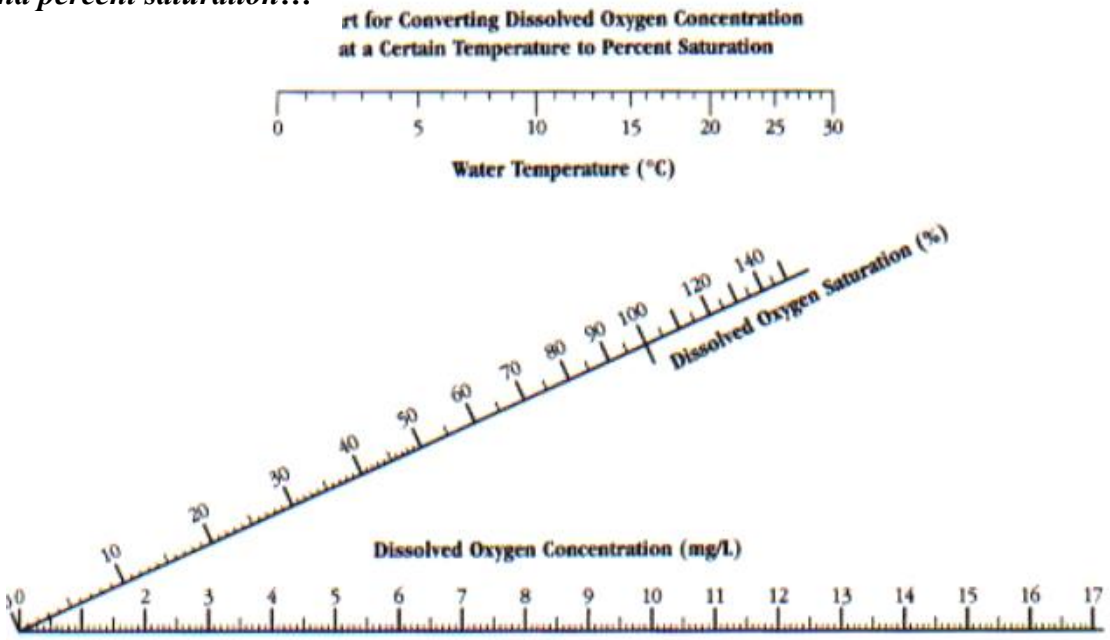
2. Add Sodium Thiosulfate Standard Solution one drop at a time to the DO bottle. Count each drop as it is added and gently swirl to mix the solution until it becomes colorless. Once the prepared sample is clear, add one more drop to ensure a complete color change. If there is no change in color, do not count the drop.

3. Multiply the number of drops used by 0.2 to obtain the mg/L Dissolved Oxygen.
   EXAMPLE: 15 drops x 0.2=3 mg/L DO

4. Record DO in mg/L and percent saturation.

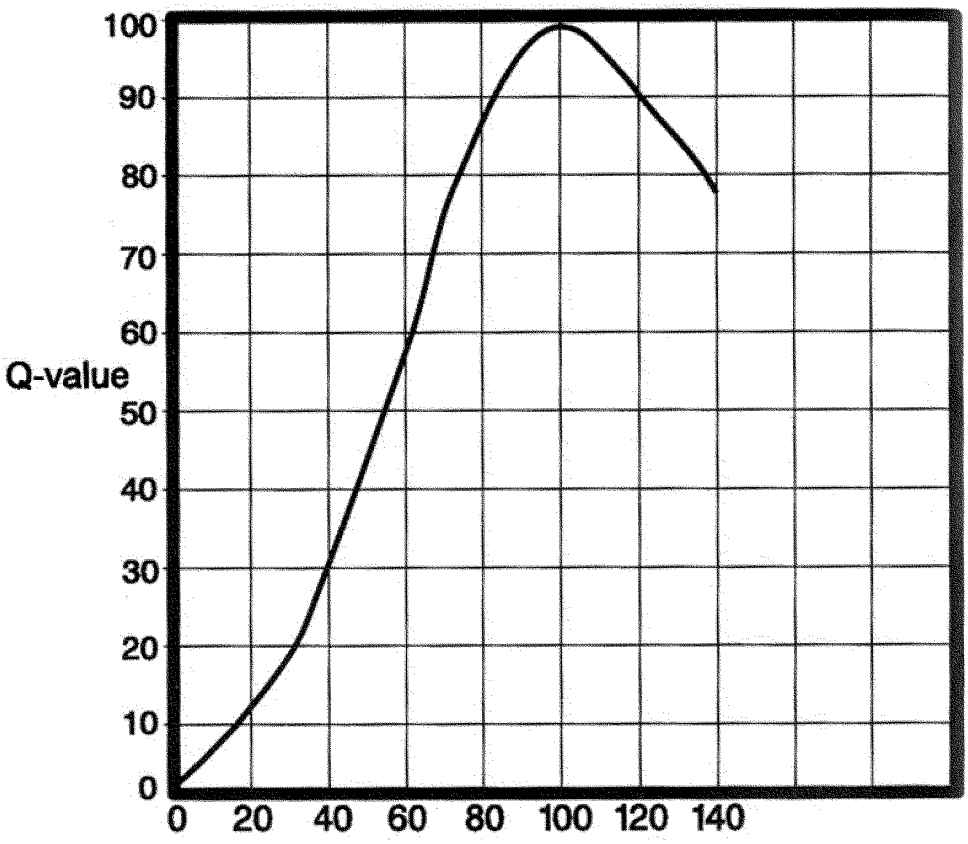
TYPICAL RANGE FOR DO = 5.4 to 14.2mg/L

First find percent saturation…



Then find the Q-value…

Dissolved Oxygen Q-values



DO % Saturation)	Q-Value
0	0
10	8
20	13
30	20
40	30
50	43
60	56
70	77
80	88
85	92
90	95
95	97.5
100	99
105	98
110	95
120	90
130	85
140	78
>140	50

Note: if DO % saturation > 140.0, Q = 50.0

E. coli

Primary Importance:
Fecal coliform bacteria are found in the feces of warm-blooded animals, including humans, and are naturally present in the intestines of animals. *E. coli* is a type of fecal coliform bacteria that can lead to illness and indicate other pathogenic (disease-causing) bacteria in water. The presence of *E. coli* is an indicator of fecal contamination.

Problem
A high number of *E. coli* colonies indicate a potential problem for humans. Fecal coliforms are bacteria found in the feces of warm-blooded animals. While fecal coliforms themselves are not particularly harmful, the presence of large amount can indicate the presence of more harmful bacteria such as those that cause typhoid, cholera, and Hepatitis A. Ingestion of the other bacteria sometimes found with *E. coli* could lead to gastrointestinal distress and eye, nose and throat infections.

Causes
- ❖ Raw sewage dumped into rivers through Combined Sewer Overflows during heavy rains.
- ❖ Movement of feces to stream from animal farms or from animals utilizing streams or lakes for wading, drinking, or cooling.

Instructions:
The following instructions are adapted from those provided by Micrology Laboratories, Inc., for use with their patented Coliscan Easygel method. Please refer to the Color Guide identification sheets for interpretation of results.

CHECKLIST
- ☐ *Pre-treated* petri dishes (only available from Micrology Laboratores)
- ☐ Sterile pipettes
- ☐ Whirl-pac bags or other sterile container
- ☐ Bottle of Coliscan Easygel
- ☐ Permanent marker
- ☐ Tape
- ☐ Rubber gloves
- ☐ Ice and cooler (if plating off-site)
- ☐ Bleach and water-tight bag for disposal
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

DO NOT rinse these materials before or after use. Follow instructions below.

1. Before you begin, label the top (lid) of the petri dish with a permanent marker. Include the date, time, location and volume (mL) of sample used. Also, remove Coliscan Easygel bottle from freezer and allow to defrost.

2. Wearing gloves and using only sterile equipment, obtain a sample for testing in one of two ways. Either collect your water sample in a sterile container (e.g. Whirl-pak Bag) and transport the water to an appropriate test site, or take a measured sample directly

from the source using a sterile pipette and immediately place it into the bottle of Coliscan Easygel. In either case, obtain the sample slightly below the surface of the waterway you are testing. (Note: Water samples kept longer than 1 hour prior to plating, or any Coliscan Easygel bottle that has a sample placed into it for transport longer than 10 minutes, should be kept on ice or in a refrigerator.)

3. Transfer a measured amount of water from the sample container/source into the bottle of Coliscan Easygel. (*Note: For safety purposes and easier identification, the amount of sample transferred will vary according to the suspected condition of the surface water you are testing. If you suspect a high fecal coliform count due to contamination, transfer only 1 mL of sample. Typically, however, 3-5 mL is appropriate*.) Once the sample is transferred, swirl the bottle to distribute the Easygel mixture and then pour into the labeled petri dish. Being careful not to splash over the side or onto the lid, gently swirl and rock the filled dish until the mixture is evenly distributed.

4. While its contents are still in liquid form, place the dish right side up directly into a warm level spot indoors. **Solidification will occur in approximately 45 minutes.**

5. Turn the petri dish upside down (to reduce condensation) and incubate at 35°C for 24 hours or at room temperature for 48 hours.

6. After the appropriate incubation period, inspect the dish. **Count all of the purple colonies in the dish and record the results in terms of *E. coli* per 100 mL of water.** Disregard the light blue, blue-green, or white colonies. DO NOT count pinpoint colonies < 1 mm in size. To report the total number of *E.coli* per 100 mL, first divide 100 by the number of mL you used for your sample. Then multiply your count by that number.

EXAMPLE:
If a 3 ml sample displays 4 *E.coli* colonies, then first divide 100 by 3=33.3
Then multiply 33.3 x 4=**133.2 colonies/100mL**

7. To prepare your sample bottle and petri dish for disposal, place 5 mL (about 1 teaspoon) of straight bleach onto the surface of the medium. Allow mixture to sit for at least 5 minutes. Place in a watertight bag and discard in the trash.

TYPICAL RANGE FOR *E. coli* = 133 to 1,157 col/100 mL

U.S. EPA Standards for *E. coli* in water (/100mL of sample)

From Alabama Water Watch: based on 1986 report (Ambient Water Quality Criteria for Bacteria, U.S. EPA, Washington, D.C., EPA 440/5-84-002)

Piped Drinking Water	0
Drinking Water Source (pre-treatment)	2,000-4,000
Designated Beach Area	235
Moderate Swimming Area	298
Light Swimming Area	406
Rarely Used Swimming Area	576

If you wonder if you can swim in your area, contact your local health department.

INTERPRETING COLISCAN® POUR PLATES

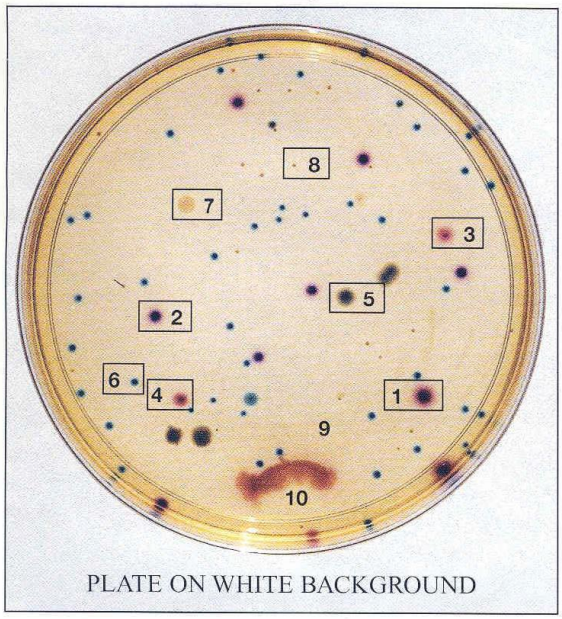
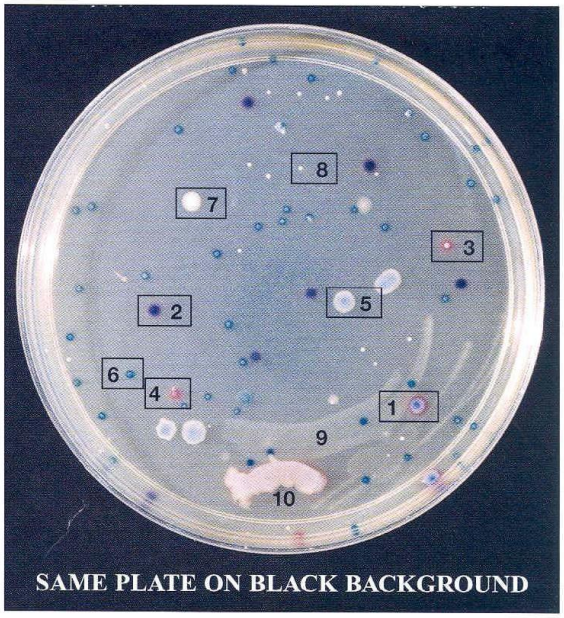


PLATE ON WHITE BACKGROUND



SAME PLATE ON BLACK BACKGROUND

Explanation of colony types (24-48 hrs. incubation)

1. purple surface colony (hazy halo)
2. purple submerged colony
3. pink surface colony
4. pink submerged
5. blue-green surface colony (white halo)
6. blue-green submerged colony
7. white surface colony
8. white submerged colony
9. white spreader on plate bottom
10. pink spreader on surface

Note that submerged colonies are smaller than the same type growing on the exposed surface and color and appearance are different when viewed over different backgrounds.
No's. 1 & 2 are typical *E. coli* (fecal coliform) colonies which produce both galactosidase and glucuronidase and are purple due to the combination of the pink and blue-green chromagens that indicate the presence of the respective enzymes.

No's. 3 & 4 are typical general coliforms (Genera *Citrobacter, Enterobacter, Klebsiella*) which produce galactosidase and are therefore a pink colony color.

No's. 5 & 6 are characteristic of less common bacteria that produce glucuronidase only and are therefore a blue-green colony color.

No's. 7 & 8 are characteristic of bacteria that produce neither galactosidase nor glucuronidase and therefore are a white or colorless colony.

No's. 9 & 10 are spreaders and can each be counted as only one colony.

Bacteria that appear like No's. 5, 6, 7, 8 & 9 are likely members of the family Enterobacteriaceae, but are not technically coliforms because they don't produce the characteristic enzyme pattern. However, these types include such important genera as *Proteus, Salmonella and Shigella* and should not be ignored as insignificant.

MICROLOGY LABORATORIES, LLC., P.O. BOX 340, GOSHEN, IN 46526
PHONE: 219-533-3351 ▪ FAX: 219-533-3370

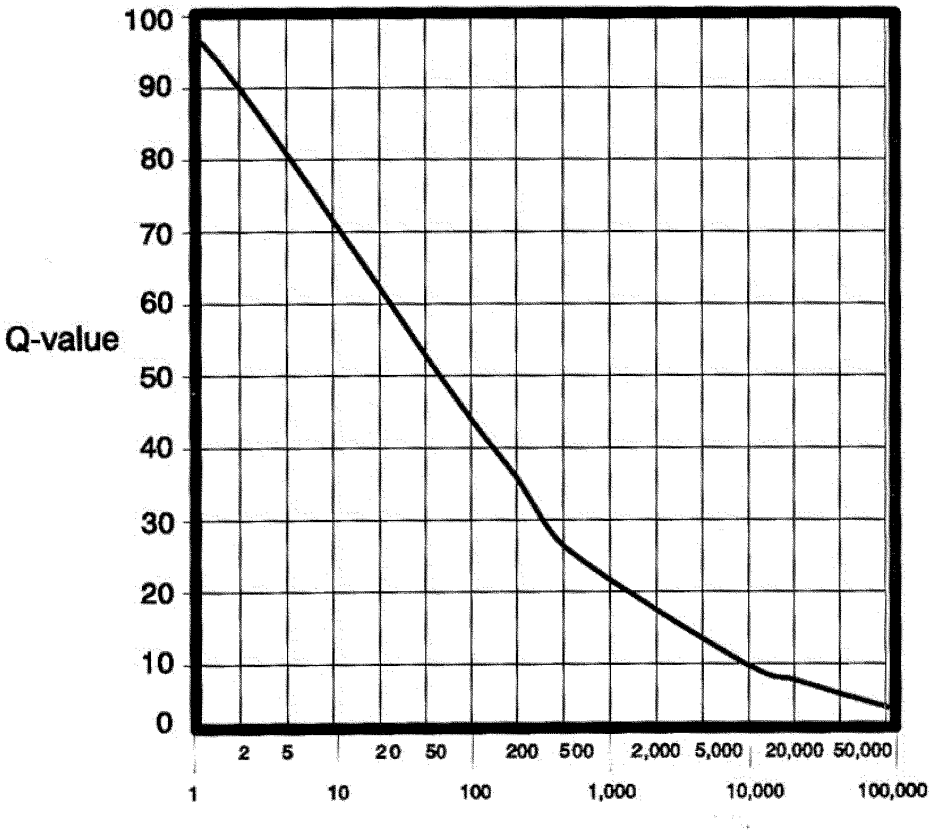
Interpreting the Plates

What to count as *E. coli*	What not to count as *E. coli*
Purple, no halo	White
Purple with pink halo	Pink, no halo
Purple with purple halo	Pink with pink halo
Blue or dark blue, no halo	Teal green
Blue with purple or pink halo	Pinpoints
Dark blue with teal halo	Teal with teal halo
Actual size of countable colonies = 1-2 mm.	*E. coli*/100 ml = $\frac{(\text{\# colonies counted x } 100)}{\text{size of sample in ml}}$

Ecolichart.cdr
hp5500psdriver

Count dark blue and purple colonies only!

E. coli Q-values



FC: colonies/100 mL

Note: If FC > 10^5, Q = 2.0

E. coli (colonies/100mL)	Q-value
0-1	98
2	89
5	80
10	71
20	63
50	53
100	45
200	37
500	27
1,000	22
2,000	18
5,000	13
10,000	10
20,000	8
50,000	5
100,000	3
>100,000	2

pH

Primary Importance:

pH is a measure of hydrogen ions and hydroxide ions in water. The concentrations of these ions determine if a substance is acidic or basic. Aquatic organisms are sensitive to pH, especially during reproduction. pH also affects the toxicity of many substances in water that can potentially affect humans and aquatic life.

Problem

Aquatic organisms can be very sensitive to high or low pH, particularly pH values that are less than 6 or greater than 8. The reproductive portion of the growth cycle is especially sensitive. Adult organisms may continue to live, but young will not be produced. Even small fluctuations in pH levels can adversely affect organisms.

Causes

- Algal blooms may raise pH. In extreme cases, the pH may be above 9.
- Many industrial processes result in release of acids and bases, thus raising or lowering pH.

Instructions:

These instructions are for use with the HACH Company portable pH meter, Catalog No. 44350-00, Model Pocket Pal Tester. To prolong the life of your pH meter, you must follow the maintenance instructions. Batteries can be replaced with watch batteries #675/AC675E-4.

CHECKLIST

- ☐ pH pen
- ☐ Black calibration key (located in the back of the tester) or small screwdriver
- ☐ Small plastic cup, 50 or 100 mL beaker or baby food jar
- ☐ Graduated cylinder or 50 mL HACH square mixing bottle
- ☐ pH 7.0 buffer powder pillows
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

For LaMotte pH test kit instructions:
*Please refer to the manual provided in the blue test kit.

After each use, turn off the pH meter to lengthen the life of the battery.

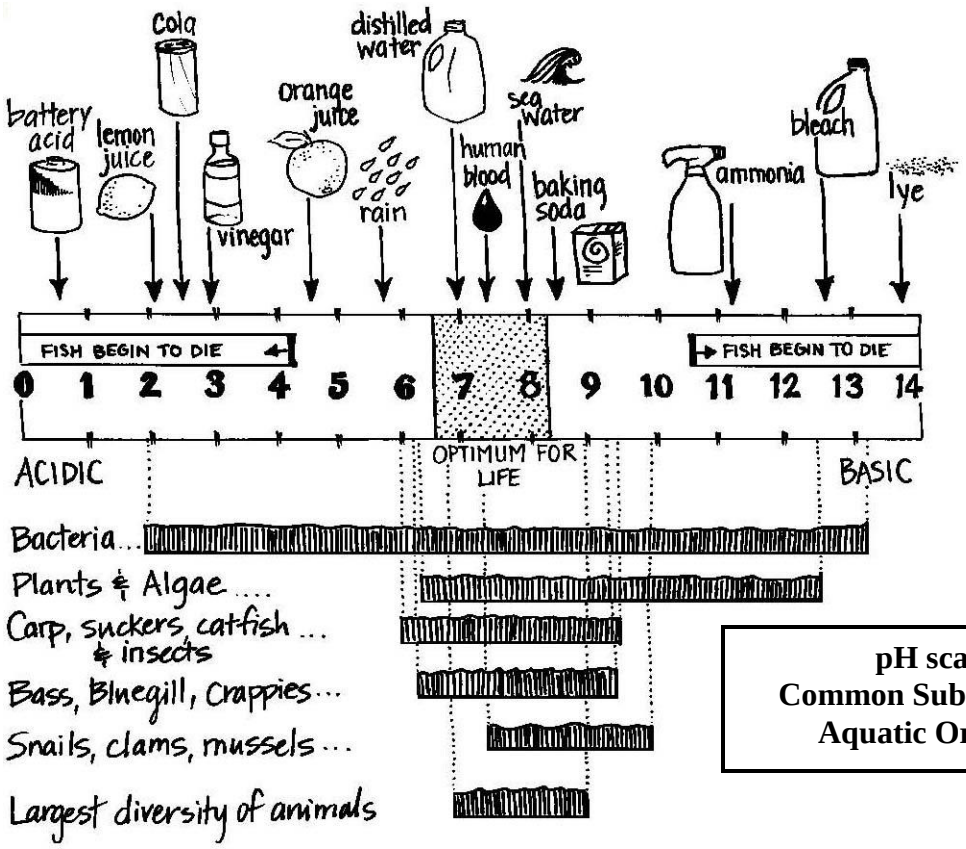
1. For accurate results, ALWAYS begin by calibrating the pH meter before each sampling trip. Prepare buffer solution by mixing one pH 7 powder pillow with 50mL **distilled** water.

2. Remove the cap and dip the meter into the neutral buffer solution and allow the digital reading to stabilize. If the reading is not 7.0 ($\pm$ 0.1), place a small screwdriver into the hole in the back of the meter (specific to pH 7 buffer) to adjust its reading to 7.0. After one use of the buffer solution, discard buffer in the sink, flushing with 3-5 times the volume of the solution.

3. Rinse probe with distilled water. Place the pH meter into the stream or water sample so that 1/3 of its length is submerged below the water's surface. Gently swirl the meter in the water during the reading.

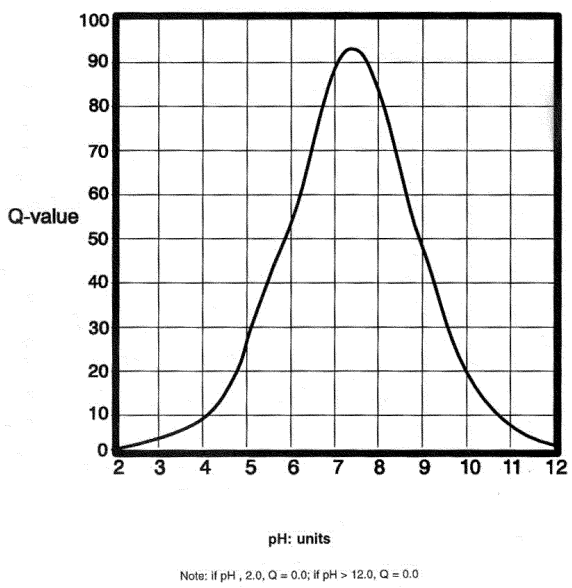
4. Turn the meter on and allow the digital reading to stabilize. Once stabilized, record the reading. Turn the meter off before storing in kit.

TYPICAL RANGE FOR pH = 6.6 to 8.8



pH scale of Common Substances and Aquatic Organisms

pH Q Values



pH (units)	Q-Value
<2	0
2	2
3	4
4	8
5	24
6	55
7	90
7.2	92
7.5	93 (max)
7.7	90
8	82
8.5	67
9	47
10	19
11	7
12	2
>12	0

Biochemical Oxygen Demand (BOD 5-Day)

Primary Importance:
The amount of oxygen consumed by bacteria in water (BOD) affects the amount of dissolved oxygen available for aquatic life. High BOD levels are associated with excessive plant growth and decay and high amounts of other organic matter in a river or stream.

Problem
High levels of organic matter and some ions (ammonia in particular) can lead to rapid exhaustion of dissolved oxygen.

Causes
- ❖ Municipal wastewater that has not been completely treated to allow decomposition of organic materials will use up oxygen supplies.
- ❖ Septic tank effluent, which is characterized by green patches of vegetation during the dry season also uses up oxygen supplies.
- ❖ Cool periods can kill some algae, and the dead algae decompose rapidly.

Instructions:
In addition to a black, light-free bottle, use the HACH Company DO test kit with Catalog No. 1469-00, Model OX-2P, for 60 mL sample.

CHECKLIST
- ☐ Black BOD bottle (or use aluminum foil around DO bottle)
- ☐ All materials required for DO test (see list on page 16)

1. In the same manner described in the DO testing instructions, lower a stoppered black (light-free) bottle below the water's surface. Once it is submerged to the appropriate depth, remove the stopper and allow water to flow into the bottle for approximately two minutes. Ensuring that no air bubbles exist, replace the stopper and remove the bottle from the water.

2. Place the biochemical oxygen demand (BOD) sample in a light-free location and allow it to sit undisturbed for 5 days.

3. After 5 days, remove the BOD bottle and carefully transfer the water to a clean DO bottle until the sample overflows. Cap the DO bottle and do not pour off the water gathered around the rim. Avoid splashing, as oxygen could enter the sample through aeration. Retain the water remaining in the BOD bottle in case more sample water is needed.

4. Perform Steps 2 through 8 of the DO test. If results are <3 mg/L, follow Low-range DO test instructions.

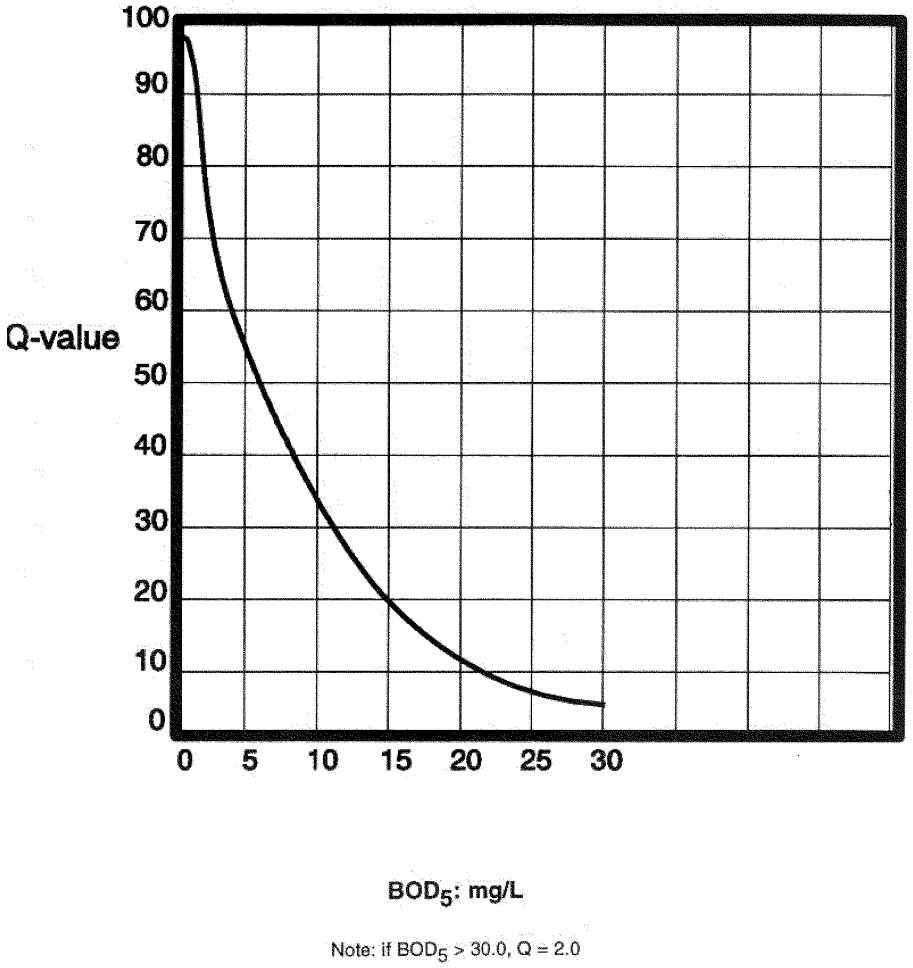
5. Determine the BOD level by **subtracting the mg/L of the BOD sample from that of the <u>original DO sample taken 5 days prior</u>.**

EXAMPLE:
11.5 mg/L (original DO sample) – 6 mg/L (BOD_5) = **5.5 mg/L**

NOTE: Collect water samples for the BOD-5 test and the DO test on the same day. When pouring the sample from the BOD bottle to the DO bottle, pour slowly so you don't create bubbles, since this will alter your results.

TYPICAL RANGE FOR BOD = 0 to 6.3 mg/L

Biochemical Oxygen Demand Q-values



BOD (mg/L DO)	Q-Value
0	96
1	92
2	80
2.5	73
3	66
4	58
5	55
7.5	44
8	40
10	33
12.5	26
15	20
17.5	16
20	14
22.5	10
25	8
27.5	6
30	5
>30	2

Water Temperature Change

Primary Importance:
Temperature affects metabolic rates and reproductive function of many aquatic organisms. Temperature also affects other chemical parameters, such as the amount of dissolved oxygen in water. *Dissolved oxygen levels are lower at higher temperatures.*

Problem
Aquatic organisms have narrow optimal temperature ranges. In particular, oxygen gas is not as soluble in warm water as it is in cold water, so it is easier for biological processes to run out of oxygen.

Causes
- ❖ Loss of shading in the riparian zone can allow temperature to increase due to sunlight hitting the water.
- ❖ In summer, passage through shaded sections can lead to cooling. This occurs because soils are cooler than air during much of the summer.
- ❖ Release of water from ponds or other exposed standing water sources can increase temperatures.
- ❖ Municipal wastewater and industrial discharges can have elevated temperatures.

Instructions:

CHECKLIST
- ☐ Celsius thermometer (Don't forget to convert if using Fahrenheit readings!)
- ☐ Testing Instructions
- ☐ Data Sheets

1. At the sampling site, lower the bottom half of the thermometer below the water's surface (the same depth at which the other tests were performed). If possible, obtain the temperature reading in an area where the water is flowing.

2. Swirling gently, hold the thermometer in the water for approximately two minutes or until the thermometer reading stabilizes.

3. Record your reading in **degrees Celsius**.
   (Note: Use the following equation to convert Fahrenheit to Celsius.)
   C= (F-32.0)/1.8 OR F=(C x 1.8) + 32

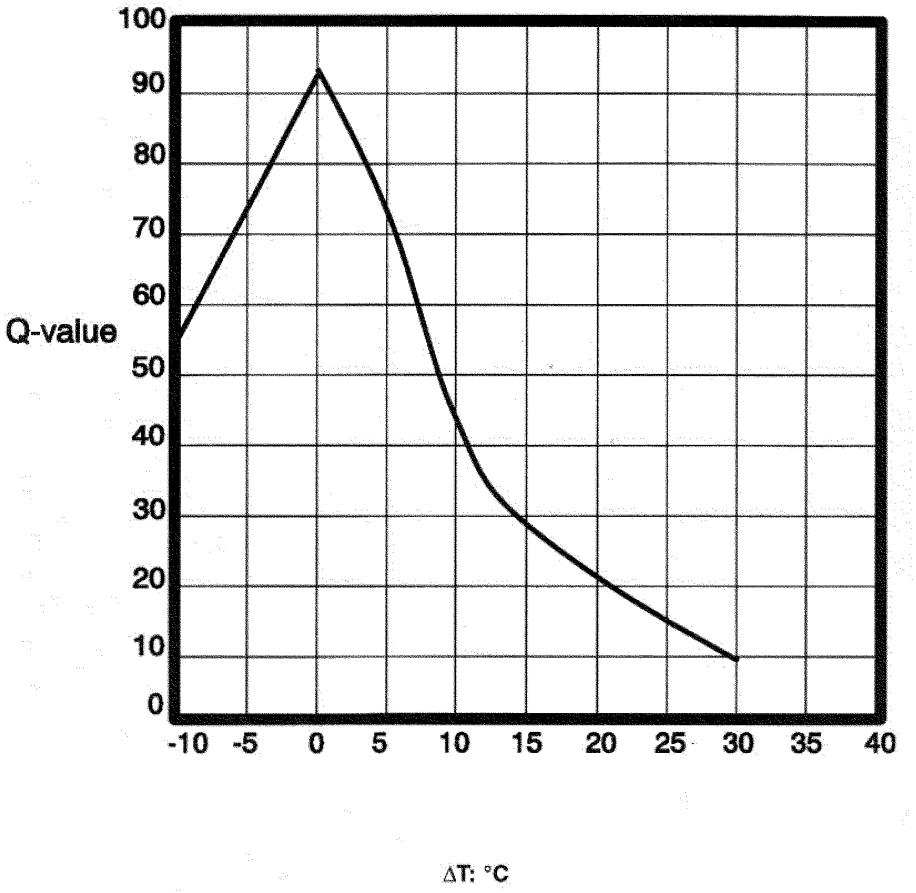
4. Choosing a portion of the stream with roughly the same degree of shade and velocity as in step 1, conduct the same test approximately 1 mile upstream as soon as possible.
   (Note: Use the same thermometer in order to reduce the possibility of equipment error.)

5. Calculate the difference between the upstream and downstream results. Record the temperature change in degrees Celsius.

EXAMPLE: 15°C downstream -14°C upstream= **1°C temperature change**

TYPICAL WATER TEMPERATURE CHANGE = <5°F

Water Temperature Change Q-values



Change in Temp. (°C)	Q-Value
-10	56
-7.5	63
-5	73
-2.5	85
-1	90
0	93 (max)
1	89
2.5	85
5	72
7.5	57
10	44
12.5	36
15	28
17.5	23
20	21
22.5	18
25	15
27.5	12
30	10

Orthophosphate & Total Phosphate

Primary Importance:
Phosphorus is an essential nutrient for plant and animal life. It occurs naturally in the environment in small amounts. High levels of phosphorus can lead to algal blooms and excessive nutrients in the water. Fertilizers, detergents and sediment are major sources of added phosphorus in the environment.

Problem
Most fresh water, but not all, is naturally deficient in phosphorus, thus algal growth is limited. If excessive phosphorus enters the surface waters, it can support rapid algal growth rates. When the algae die, their decomposition uses up oxygen and produces odors and toxins.

Causes
- Phosphorus occurs naturally in geological and soil sources, and enriched groundwater can contain high levels of phosphorus.
- Phosphorus can come from manure sources, such as treatment lagoons, over-fertilized fields, and runoff from agricultural fields and turf grass.
- Suspended sediments are often a significant source of phosphorus. These may enter the stream via stream bank erosion or runoff from forestry, agriculture, and urban lands. In soils that contain it, phosphorus can be removed from particles and enter solution.
- Runoff from parking lots and urban lands is often excessively high in phosphorus. Inadequately treated municipal wastewater and septic tank effluent that has not fully reacted with soil are both sources of phosphorus.

General Instructions:
All glassware to be used for these tests should be acid washed with a dilute hydrochloric acid solution (10:1) and triple washed with distilled water before each use. The glassware (droppers and tubes) should be dedicated for the purpose of analyzing phosphorus samples and should never be washed with detergent or soap as these often contain phosphorus.

Orthophosphate vs. Total Phosphate
Orthophosphate readings include only the phosphate loose in the water, while Total Phosphate includes phosphate loose in the water in addition to phosphate connected to other molecules or substances in the water. Therefore, Orthophosphate (OP) is a component of Total Phosphate (TP), thus OP<TP. **The Water Quality Index calls for the Total Phosphate reading, and should not be confused with the Orthophosphate reading.**

Range Tests
These tests have three levels: low, medium and high range. The "range" corresponds to the relative amount of chemical in the sample. If a high phosphate reading is suspected, the high range test (dilution) should be performed. If the high range test is not performed, the color change will be too dark to determine an accurate phosphate reading.

To determine which level of the Total Phosphate test to perform, you should complete the Orthophosphate test first because the Total Phosphate test is time consuming and will be ruined if the appropriate range test is not chosen. Start with the Low-range test. If the reading is above

1 mg/L, there is a shortcut for the Medium-range test. If the reading is still too high, (the color is too dark to read accurately with the color wheel), complete the High-range test. By doing this, you will know which range of test to complete for the Total Phosphate test. (Note: If your reading is close to the upper range of the appropriate Orthophosphate test, you might want to consider completing the next higher range test for Total Phosphate because TP>OP.)

Orthophosphate Instructions:

These instructions are for use with the HACH Orthophosphate test (Catalog No. 27120-00) for 25 mL sample, which is included in the Stream Survey Kit.

CHECKLIST

- ☐ 23 mL square mixing bottle
- ☐ PhosVer 3 phosphate powder pillows
- ☐ Color comparator (black box)
- ☐ Phosphate color disk (blue-violet)
- ☐ Glass test tubes
- ☐ Mirrors (inside color comparator) for low range
- ☐ Distilled water
- ☐ Watch or stopwatch
- ☐ Waste container
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

For greater accuracy and safety, it is recommended that this test be performed inside a well-ventilated setting.

Orthophosphate Low-range test (0-1 mg/L)

1. Rinse and fill the square mixing bottle to the 20 mL mark with the water to be tested.

2. Open one PhosVer 3 Phosphate Powder Pillow and add its contents to the bottle. Gently swirl to mix. **Allow at least two, but not more than ten minutes for full color development**. (Note: If phosphate is present, a blue-violet color will form.)

3. **Place the mirrors onto the shelf in the color comparator**. Place the Phosphate (blue-violet) color disk into the comparator. (Note: The mirrors are used only during the Low-range tests.)

4. Fill one of the glass color viewing tubes to the top line with prepared sample. Place the tube on the right side of the comparator. (Note: Keep the rest of the prepared sample in the square mixing bottle until the test is complete. If the results are greater than 1 mg/L, you can use the same sample for the 0-5 mg/L test.)

5. Fill the other glass tube to the top line with untreated sample water and place it on the left side of the comparator.

6. Do not place caps on the tubes. Orient the comparator with the tube tops pointing to a window or light source. Rotate the disc until a color match is obtained. **Divide the reading from the scale window by 50 to obtain the mg/L Orthophosphate.**

Orthophosphate Medium-range test (0-5 mg/L)

SHORTCUT:

Take the sample left in the square mixing bottle from the Low-range test. Pour the sample to the 5 mL mark on the glass viewing tube and place it on the right side of the comparator. REMOVE THE MIRRORS and obtain a color match**. Read the results and divide by 10 to obtain the mg/L Orthophosphate.**

REGULAR METHOD:

1. Follow steps 1 and 2 of the Low-range test. Do not use the mirrors in the comparator for this test.

2. Fill one of the glass tubes to the bottom line with prepared sample (approximately 5 mL). Place the tube on the right side of the comparator.

3. Fill the other glass tube to the bottom line with untreated sample water and place it on the left side of the comparator.

4. Do not use the mirrors in the comparator. Holding the comparator up to a light source, view the tubes through the center windows. Rotate the disc until a color match is obtained. **Divide the reading from the scale window by 10 to obtain the mg/L Orthophosphate.**

Orthophosphate High-range test (0-50 mg/L)

1. Rinse the square mixing bottle and dropper with demineralized or distilled water. **Add 2.0 mL of the water to be tested by twice filling the dropper to the 1.0 mL mark**. (*This is a dilution of the sample*.)

2. Add demineralized or distilled water to the 20 mL mark of the mixing bottle. Swirl to mix.

3. Open one PhosVer 3 Phosphate Reagent Powder Pillow. Add the contents to the bottle. Gently swirl to mix. Allow at least two minutes, but not more than 10 minutes, for color development.

4. Fill one of the glass tubes to the bottom line with prepared sample (approximately 5 mL). Place the tube on the right side of the comparator.

5. Fill the other glass tube to the bottom line with untreated sample water and place it on the left side of the comparator.

6. Do not use the mirrors in the comparator. Holding the comparator up to a light source, view the tubes through the center windows. Rotate the disc until a color match is obtained. **Read the mg/L Orthophosphate directly through the scale window.**

Total Phosphate Instructions:

These instructions are for use with the HACH Total Phosphate (Catalog No. 2250-01, Model PO-24) for 25 mL sample, which is included in the Stream Survey Kit.

CHECKLIST

- ☐ 23 mL square mixing bottle
- ☐ Potassium persulfate powder pillows
- ☐ PhosVer 3 phosphate powder pillows
- ☐ Color comparator (black box)
- ☐ Phosphate color disk (blue-violet)
- ☐ Glass test tubes
- ☐ Mirrors (inside color comparator) for low range
- ☐ Distilled water
- ☐ 50 mL Erlenmeyer flask (for Total Phosphate)
- ☐ 5.25N sulfuric acid solution (for Total Phosphate)
- ☐ 5.0N sodium hydroxide (for Total Phosphate)
- ☐ Hot plate or other heating apparatus (for Total Phosphate)
- ☐ Tongs or oven mitt to remove Erlenmeyer flask from heating source
- ☐ Watch or stopwatch
- ☐ Waste container
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

1. Rinse and fill the square mixing bottle to the 20 mL mark with the water to be tested. Pour the sample into a clean 50 mL Erlenmeyer flask.

2. Open one Potassium Persulfate Powder Pillow and add its contents to the flask. Gently swirl to mix.

3. Add 2 mL of 5.25N Sulfuric Acid Solution to the sample by twice filling the dropper to the 1 mL mark and pouring the contents into the flask. Gently swirl to mix. (Note: Rinse thoroughly any surfaces, including your skin that may have contacted the acidic solution.)

4. Set up the boiling apparatus. (Note: A hot plate or camping stove is easier and more reliable than the fuel tablets provided with the kit.)

5. Boil the sample for 30 minutes, **occasionally adding demineralized or distilled water to keep the liquid volume near 20 mL.** Do not bring the volume above 20 mL. **Do not let it boil to dryness.**

6. Allow the liquid to cool.

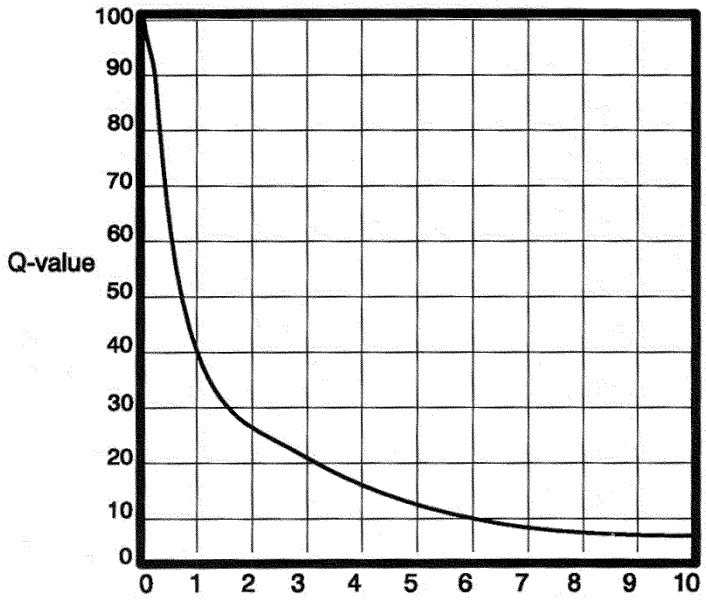
7. Add 2 mL of 5.0N Sodium Hydroxide Solution by twice filling the dropper to the 1 mL mark and pouring the contents into the flask.

8. Return the sample to the square mixing bottle. Add demineralized or distilled water to return its volume to 20 mL.

9. Now perform the orthophosphate test of the appropriate range (pgs. 37-38) since all of the possible phosphate present in the sample is now in the "free" state. **However, read the final result as mg/L Total Phosphate (PO_4).** ***Note: Total Phosphate should be greater than the Orthophosphate since Orthophosphate is a component of Total Phosphate. (TP>OP)***

TYPICAL RANGE FOR TOTAL PHOSPHATE = 0 to 0.85 mg/L

Total Phosphate Q-values



Total Phosphate (mg/L P)	Q-Value
0	99
0.05	98
0.1	97
0.2	95
0.3	90
0.4	78
0.5	60
0.78	50
1	39
1.5	30
2	26
3	21
4	16
5	12
6	10
7	8
8	7
9	6
10	5
>10	2

Nitrate

Primary Importance:
Nitrogen makes up about 80% of the air we breathe, and it is found in all living things. Nitrates are essential for plant growth; however high levels of nitrogen work with phosphorus to cause algal blooms and excessive nutrients in the water.

Problem
In some waters, where phosphorus does not limit algal growth, nitrogen may be the limiting factor. Excessive nitrogen can support algal growth. High ammonia leads to loss of dissolved oxygen through nitrification. Nitrate, while an important indicator of external sources of nutrients, is not particularly harmful.

Causes
- ❖ Nitrogen can come from manure sources, such as treatment lagoons and over-fertilized fields.
- ❖ In commercial inorganic fertilizers, nitrogen is used in greater quantities than any other nutrient. Runoff from agriculture, forestry, golf courses, and lawns is high in nitrogen, especially if runoff occurs shortly after fertilizer application.

Instructions:
These instructions are for use with the HACH Company Low-range Nitrate test kit 0-1, 0-10 mg/L as Nitrate Nitrogen Catalog No. 14161-00, Model NI-14, for 5 mL sample.

CHECKLIST
- ☐ Plastic test tubes and stoppers
- ☐ NitraVer 6 Nitrate reagent powder pillows
- ☐ NitriVer 3 Nitrite reagent powder pillows
- ☐ Color comparator (black box)
- ☐ Nitrate color disk (pink)
- ☐ Distilled water
- ☐ Watch or stopwatch
- ☐ Separate waste container labeled “Hazardous”
- ☐ Material Safety Data Sheets
- ☐ Testing Instructions
- ☐ Data Sheets

Nitrate Nitrogen 0-1 mg/L
1. Rinse one plastic test tube with the sample to be tested.

2. Fill the test tube to the lowest mark (the bottom of the frosted band, approx. 5 mL) with sample.

3. Add the contents of the NitraVer 6 Nitrate Reagent Powder Pillow to the sample to be tested. **Stopper the tube and shake for three minutes**. Allow the sample to sit undisturbed for an additional 30 seconds.

4. Add the contents of one NitriVer3 Nitrite Reagent Powder Pillow to the sample. Stopper the tube and shake for 30 seconds. A pink or red color will develop if nitrate is present. **Allow at least 10 minutes, but not more than 20 minutes before completing steps 5-7.**

5. Insert the tube of prepared sample into the right top opening of the color comparator.

6. Fill a second test tube to the lowest mark with untreated sample water and place in the left side of the comparator.

7. Hold the comparator up to a light source and view through the opening in front. Do not use mirrors in the comparator. Rotate the pink disc to obtain a color match. (Note: Holding a piece of white paper 6-8 inches behind the comparator may help in viewing the color. Also, remove stoppers from the test tubes for the most accurate color reading.) Read the mg/L nitrate nitrogen (N) through the scale window. To obtain results needed for the Water Quality Index [mg/L nitrate (NO_3)], **multiply the reading on the scale by 4.4.**

8. Dispose of ALL waste in a hazardous waste container.

Nitrate Nitrogen 0-10 mg/L

1. Rinse one test tube with the sample to be tested.

2. Rinse the plastic dropper with the sample. Fill the test tube to the 0.5 mL mark and add contents of the dropper to the rinsed color viewing tube.

3. Fill the test tube containing 0.5 mL of sample to the lowest mark (the bottom of the frosted band) with demineralized or distilled water.

4. Add the contents of the NitraVer 6 Nitrate reagent Powder Pillow to the sample to be tested. **Stopper the tube and shake for three minutes**. Allow the sample to sit undisturbed for an additional 30 seconds.

5. Add the contents of one NitriVer3 Nitrite Reagent Powder Pillow to the sample. Stopper the tube and shake for 30 seconds. A pink or red color will develop if nitrate is present. **Allow at least 10 minutes, but not more than 20 minutes before completing steps 6-8.**

6. Insert the tube of prepared sample into the right top opening of the color comparator.

7. Fill a second test tube to the lowest mark with untreated sample water and place in the left side of the comparator.

8. Hold the comparator up to a light source and view through the opening in front. Do not use mirrors in the comparator. Rotate the pink disc to obtain a color match. (Note: Holding a piece of white paper 6-8 inches behind the comparator may help in viewing the color. Also, remove stoppers from the test tubes for the most accurate color reading.) Read the mg/L nitrate nitrogen (N) through the scale window. Multiply that reading by 10 to the mg/L nitrate nitrogen (N) present in the sample. To obtain results needed for the Water Quality Index [mg/L nitrate (NO_3)], **multiply the reading on the scale by 4.4**.

9. Dispose of ALL waste in a hazardous waste container.

FYI…
Nitrates can be measured in two ways:

- as NO_3-N: the amount of nitrogen in the nitrate ion (NO_3^-) form
- as NO_3^-: total nitrate ion

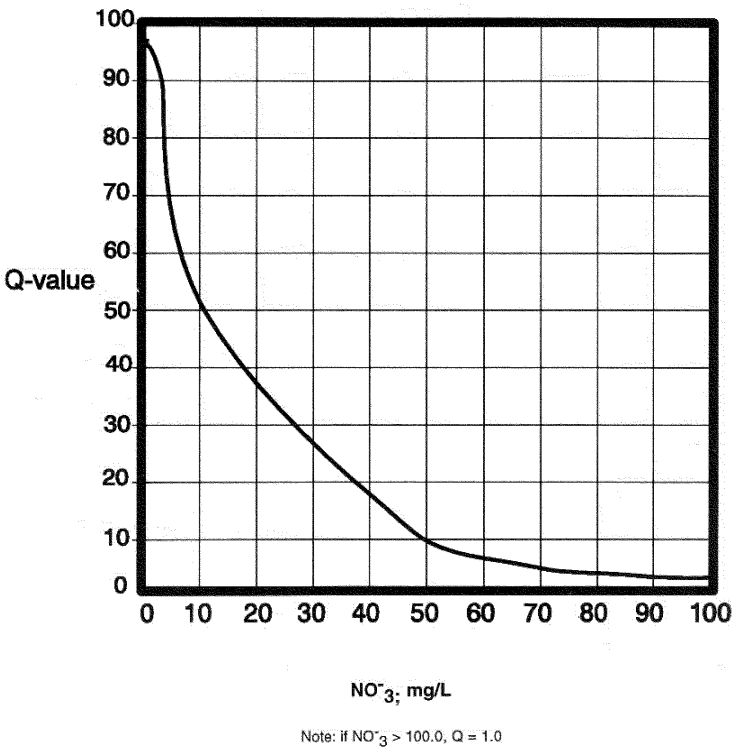
Our results are reported as total NO_3^-. Use the following to compare…

10 mg/L nitrate-nitrogen (NO_3-N) = 44.3 mg/L nitrate (NO_3^-)

The drinking water standard for NO_3-N is 10mg/L or 44.3 mg/L nitrate (NO_3^-). Unpolluted waters generally have a nitrate level below 4 mg/L.

TYPICAL RANGE FOR NITRATE = 0 to 13.86 mg/L

Nitrate Q-values



Nitrate (mg/L NO_3)	Q-Value
0	98
0.25	97
0.5	96
0.75	95
1	94
1.5	92
2	90
3	85
4	70
5	65
10	51
20	37
30	24
40	17
50	7
60	5
70	4
80	3
100	1
>100	1

Turbidity

Primary Importance:
Turbidity is the relative clarity of the water and is measured by shining a light through the water column. Turbidity is a significant indicator of overall water quality. Photosynthesis is impaired and excessive suspended particles absorb heat, raising water temperature and lowering dissolved oxygen levels. High turbidity levels are caused from erosion, runoff, and algal blooms.

Problem
When light transmission decreases, algae can only grow in the surface of the water. The water looks "dirty" and organisms on the stream bottom receive no light.

Causes
- Most of the particles come from erosion of soils, either from fields, parking lots, or the stream bank itself.
- Algae and organic particles also contribute to turbidity.
- Construction can have a large effect on the amount of light-scattering materials that enter a stream.

Instructions:
Turbidity can be measured with many types of equipment from an electronic turbidimeter to a homemade Secchi disk or turbidity tube (see "How to Make a Turbidity Tube").

CHECKLIST
- ☐ Turbidity tube
- ☐ Bucket or other sample container
- ☐ Testing Instructions
- ☐ Data Sheets

1. Collect sample water in a bucket or other container from which you can pour the water into a calibrated turbidity tube. Do not allow the sample to settle. (Note: For a more accurate assessment of stream turbidity, avoid stirring the bottom sediments when sampling.)

2. Slowly pour the sample water into the tube while looking vertically down into it. When the water level reaches a point at which you can barely see the "X" on the bottom of the tube, stop pouring. (Note: Placing the bottom of the tube on a white surface will help in reading the result. In addition, allow air bubbles to dissipate before taking the reading.)

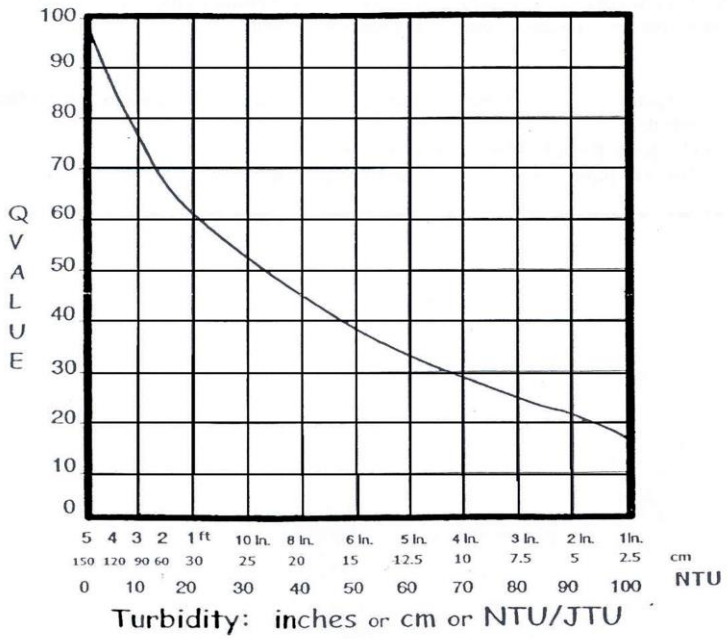
3. Read the measurement of water in the tube and record it in centimeters or inches.

4. Repeat the above steps to verify the result. (Note: Allowing one or two additional people to repeat the test may help in obtaining a more accurate result.)

5. To report results, convert your reading from cm to Nephelometer Turbidity Units (NTU's) using the Turbidity Q-value chart.

TYPICAL RANGE FOR TURBIDITY = 4.5 to 173 NTUs

Turbidity Q-values



Turbidity (NTU)	Transparency (cm)	Q-Value
0	150	97
5	120	84
10	90	76
<15 (turb tube)	>60 (turb tube)	70
15	60	68
20	30	62
25	27.5	57
30	25	53
35	22.5	48
40	20	45
50	15	39
60	12.5	34
70	10	28
80	7.5	25
90	5	22
100	2.5	17
>100	<2.5	5

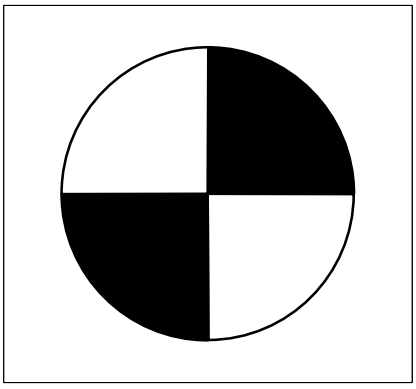
How to Make a Turbidity Tube:

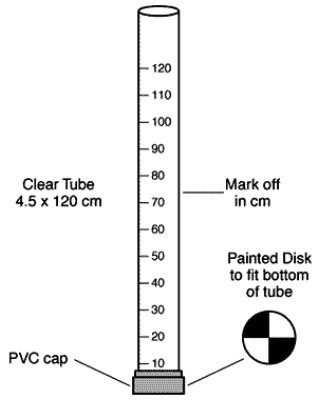
For instructions on how to correctly use the turbidity tube, see the Chemical Testing Instructions.

Directions:

1. Put a PVC cap or other covering on one end of a clear tube (a florescent light bulb tube cover works great). Cap should fit tightly so water will not leak out. Clear packing tape can also be used to secure the cap.
2. Cut a disk from the template provided. It should be the same size as the tube diameter.
3. Seal the disk by laminating or covering with clear packing tape to make it waterproof.
4. Adhere the disk to the cap at the bottom of the tube with clear packing tape.
5. Use a permanent marker and meter stick to make a scale on the side of the tube, beginning with 0 cm at the disk. Number the tube in increments of 5 or 10 ending with 150 cm at the top.

Sample Disk Template





Sample Turbidity Tube

Note: JTUs versus NTUs

Jackson Turbidity Units (JTUs) and Nephelometer Turbidity Units (NTUs) are not *exactly* equivalent but are approximately the same.
Ex) 40 JTU ~ 40 NTU

Chemical Monitoring Worksheet

Site Information:

School/organization name _____

River/stream name _____ Date _____

Time _____

Water Temp _____°C Air Temp _____ °C

Today's weather: sunny partly cloudy overcast light rain heavy rain

Yesterday's weather: sunny partly cloudy overcast light rain heavy rain

Chemical Test	**Units**	Sample # 1	**Sample # 2**	**Sample # 3**	**Average**
Dissolved Oxygen	mg/L % saturation				
E. Coli	colonies/ 100 ml				
PH	pH units				
Biochemical Oxygen Demand	mg/L				
Water Temperature Change	°C				
Total Phosphates	mg/L				
Nitrate	mg/L				
Turbidity	NTU = JTU				
Ammonia	mg/L				
Orthophosphate	mg/L				

How to complete the Water Quality Index

Site Information:
School/organization name *Ohio River Academy*

River/stream name *Local Creek* Date *8/12/04*

Time *2:30 pm* Water Temp *26* °C Air Temp *30* °C

Today's weather: (sunny) partly cloudy overcast light rain heavy rain

Yesterday's weather: sunny partly cloudy overcast light rain (heavy rain)

Test Results	
Dissolved Oxygen	*85* **% Saturation**
E. Coli	*200* **colonies/ 100mL**
pH	*8.3* units
B.O.D. 5	*2* mg/L
H_2O Temperature Change	*1* °C
Total Phosphate	*0.06* mg/L
Nitrate (NO_3)	*7* mg/L
Turbidity	*50* **NTU's**

As you complete each chemical test or average the results from the worksheet, record the values in the first column of the chemical monitoring data sheet.

How to complete the Water Quality Index

Site Information:
School/organization name *Ohio River Academy*

River/stream name *Local Creek* Date *8/12/04*

Time *2:30 pm* Water Temp *26* °C Air Temp *30* °C

Today's weather: (sunny) partly cloudy overcast light rain heavy rain

Yesterday's weather: sunny partly cloudy overcast light rain (heavy rain)

Test Results	Q-Value
Dissolved Oxygen *85* **% Saturation**	***92***
E. Coli 200 **colonies/100mL**	***37***
pH *8.3* units	***75***
B.O.D. 5 *2* mg/L	***80***
H_2O Temperature *1* °C Change	***89***
Total Phosphate *0.06* mg/L	***98***
Nitrate (NO_3) *7* mg/L	***60***
Turbidity *50* **NTU's**	***39***

Find the Q-value using the graphs following the testing procedures for each parameter. Using the appropriate units, find the test result values on the bottom of the graph (x-axis). Follow this value up to the line on the graph. Where your value intersects the line, follow this point over to the left side of the graph (y-axis). This number is your Q-value. Record this value in the table.

How to complete the Water Quality Index

After the Q-values have been determined and recorded in the second column, multiply the Q-value for each test by the Weighting Factor and record the value in the Calculation column.

Test Results	Q-Value		Weighting Factor		Calculation
Dissolved Oxygen *85* **% Saturation**	***92***	X	.18	=	***16.56***
E. Coli *200* **colonies/ 100mL**	***37***	X	.17	=	***6.29***
pH *8.3* units	***75***	X	.12	=	***9***
B.O.D. 5 *2* mg/L	***80***	X	.12	=	***9.6***
H_2O Temperature Change *1* °C	***89***	X	.11	=	***9.79***
Total Phosphate *0.06* mg/L	***98***	X	.11	=	***10.78***
Nitrate (NO_3) *7* mg/L	***60***	X	.10	=	***6***
Turbidity *50* **NTU's**	***39***	X	.09	=	***3.51***

Once the calculations are completed for each parameter, you can then sum the Weighting Factor column and the Calculation column. Divide the total of the Calculations column by the total of the Weighting Factor column to obtain the Water Quality Index Rating.

Totals ***1.00***
71.53

Excellent	90-100%	Bad	25-50%
Good	70-90%	Very Bad	0-25%
Medium	50-70%		

Water Quality

Index Rating ***71.53***

If you complete all eight tests, the total of the Weighting Factor column is 1.00 (or 100%). If you are missing one or two tests (but no more than two!), you can calculate an adjusted Water Quality Index Rating. Just follow the same procedures: divide the total of the Calculations column by the total of the Weighting Factor column to obtain the adjusted Water Quality Rating.

For example, if the *E. Coli* and Total Phosphate tests were not completed, the total of the Weighting Factor column would be 0.72, and the total of the Calculation column would be 54.46. The Water Quality Index Rating would be 75.64 (54.56 divided by 0.72).

Water Quality Index- Sample Page

You may perform as many of the following tests as you wish; however, at least 6 must be completed to obtain a Total Water Quality Index value. Divide the total of the Calculation column by the total of the Weighting Factor column to obtain the Water Quality Index rating.

Site Information:
School/organization name *Ohio River Academy*

River/stream name *Local Creek* Date *8/12/04*

Time *2:30 pm* Water Temp *26* °C Air Temp *30* °C

Today's weather: (sunny) partly cloudy overcast light rain heavy rain

Yesterday's weather: sunny partly cloudy overcast light rain (heavy rain)

Test Results	Q-Value		Weighting Factor		Calculation
Dissolved Oxygen *85* **% Saturation**	***92***	X	.18	=	***16.56***
E. Coli *200* **colonies/ 100mL**	***37***	X	.17	=	***6.29***
pH *8.3* units	***75***	X	.12	=	***9***
B.O.D. 5 *2* mg/L	***80***	X	.12	=	***9.6***
H_2O Temperature Change *1* °C	***89***	X	.11	=	***9.79***
Total Phosphate *0.06* mg/L	***98***	X	.11	=	***10.78***
Nitrate (NO_3) *7* mg/L	***60***	X	.10	=	***6***
Turbidity *50* **NTU's**	***39***	X	.09	=	***3.51***

Totals ***1.00***

71.53

Excellent	90-100%	Bad	25-50%
Good	70-90%	Very Bad	0-25%
Medium	50-70%		

Water Quality Index Rating ***71.53: Good***

Water Quality Index

You may perform as many of the following tests as you wish; however, at least 6 must be completed to obtain a Total Water Quality Index value. Divide the total of the Calculation column by the total of the Weighting Factor column to obtain the Water Quality Index rating.

Site Information:
School/organization name _____

River/stream name _____ Date _____

Time _____ Water Temp _____°C Air Temp _____ °C

Today's weather: sunny partly cloudy overcast light rain heavy rain

Yesterday's weather: sunny partly cloudy overcast light rain heavy rain

Test Results	Q-Value		Weighting Factor		Calculation
Dissolved Oxygen _____ **% Saturation**		X	.18	=	
E. Coli _____**colonies/ 100mL**		X	.17	=	
pH _____ units		X	.12	=	
B.O.D. 5 _____ mg/L		X	.12	=	
H_2O Temperature Change _____ °C		X	.11	=	
Total Phosphate _____mg/L		X	.11	=	
Nitrate (NO_3) _____mg/L		X	.10	=	
Turbidity _____**NTUs**		X	.09	=	

Totals _____

_____

Excellent	90-100%	Bad	25-50%
Good	70-90%	Very Bad	0-25%
Medium	50-70%		

Water Quality Index Rating

_____

Guide for Water Quality Ranges - (Ohio River)

Dissolved Oxygen (% Saturation)

91 to 110	Excellent
71 to 90, >110	Good
51 to 70	Fair
<50	Poor

Total Phosphate

< .10	Excellent
.11 to .16	Good
.17 to .58	Fair
.59 to 2.99	Poor
>3.0	Very Poor

E. Coli (colonies per 100 mL)

< 50	Excellent
51 to 200	Good
201 to 1000	Fair
>1000	Poor

Nitrate (NO_3) (mg/L)

< 1.32	Excellent
1.76 to 3.52	Good
3.96 to 8.36	Fair
> 8.8	Poor

pH (pH units)

6.5 to 7.5	Excellent
6.0 to 6.4, 7.6 to 8.0	Good
5.5 to 5.9, 8.1 to 8.5	Fair
<5.5, >8.6	Poor

Turbidity (JTU, NTU)

1 to 10	Excellent
10.1 to 40	Good
40.1 to 150	Fair
> 150	Poor

Biochemical Oxygen Demand (mg/L)

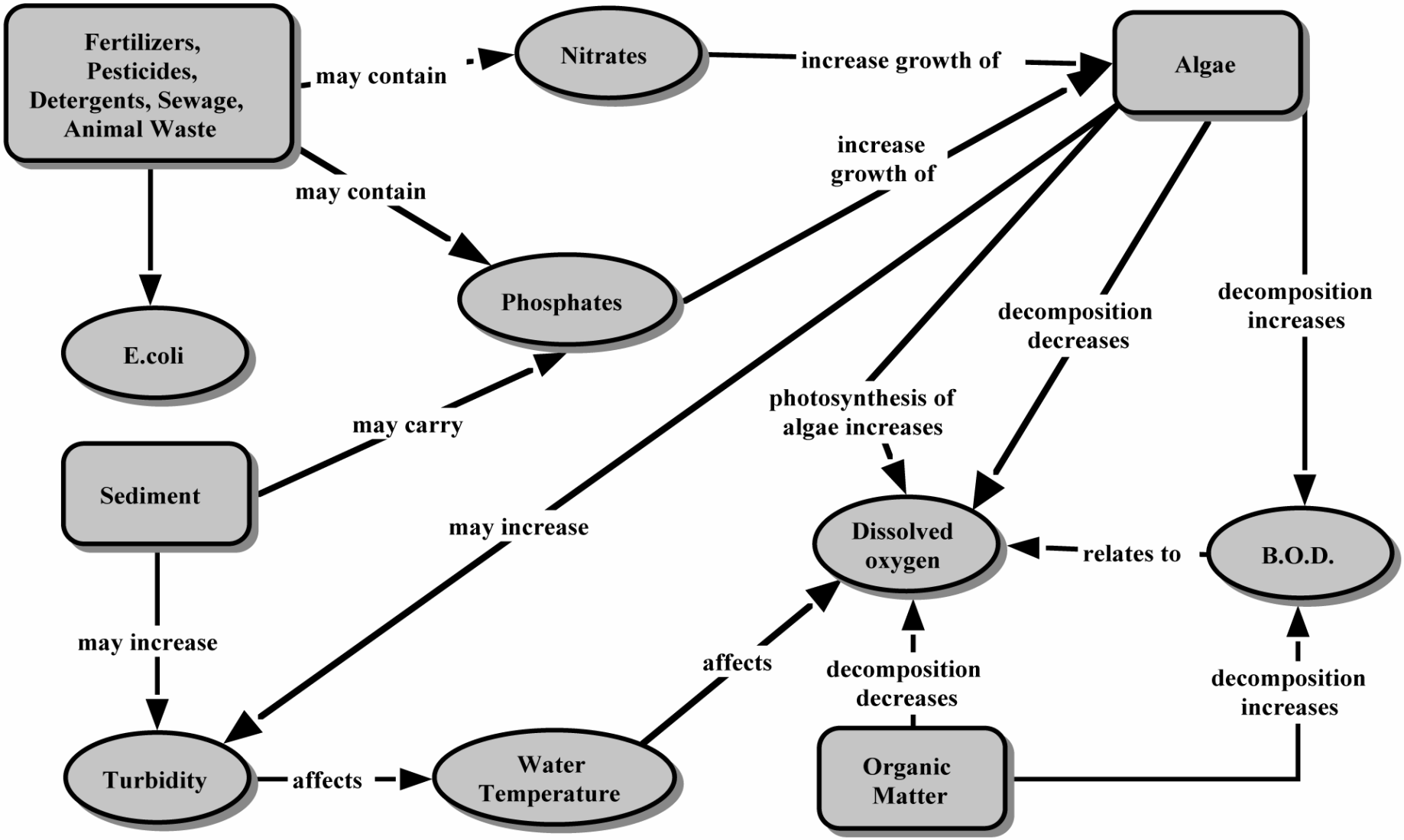
< 2	Excellent
2.0 to 4.0	Good
4.1 to 10	Fair
>10	Poor

Water Temperature Change (°C)

0 to 2	Excellent
2.2 to 5	Good
5.1 to 9.9	Fair
>10	Poor

Note: These numbers represent a guideline for water quality values in the Ohio River. Because a variety of factors influence water quality, including wind, rainfall, temperature, overhanging vegetation, these values will change seasonally and may not accurately represent conditions in all instances.

Parameter	Pollution Problem	Possible Causes
Water Temperature Increases	-Aquatic organisms have narrow optimal temperature ranges -Oxygen is not as soluble in warm water as it is in colder water, low DO levels can stress organisms -Warmer temperatures can increase toxicity of some pollutants, and can increase solubility of solid pollutants	-Shade or loss of shade -Release of water from standing water (temperature increases) -Wastewater discharges (temperature increases) -Stormwater runoff from warmed surfaces -Loss of shading vegetation
pH	-Aquatic organisms are sensitive to low or high pH -Affects reproductive portion of growth cycle -Can affect toxicity of elements or other substances in water	-Algal blooms -Industrial processes release acids and bases -Acid mine drainage -Acid rain and other emissions getting into to stormwater or rainwater
Dissolved Oxygen	-Low levels of dissolved oxygen can be harmful to aquatic organisms that require dissolved oxygen for respiration -Levels are affected by temperature, salinity, and atmospheric pressure	-Rapid decomposition of organics (dead algae, manure, shoreline vegetation, sewage) by microbes consumes oxygen -Nitrification of ammonia in fertilizers by aquatic microbes -Stagnation , lack of turbulence or movement in a waterway -Respiration of aquatic plants and algae can cause low levels of dissolved oxygen over different periods of a day
High Turbidity	-Many fish need clear water to spot prey -Sediments can smother fish eggs and aquatic insects -Decreases light penetration, which is needed for photosynthesis	-Sediment from erosion -Road building, construction, agriculture, logging, anything that removes vegetation and causes sediment to be washed into a waterway -Highly erodable rock in stream geology
E. coli	-Associated with fecal matter of warm blooded animals -Presence of large amounts can indicate presence of pathogens such as typhoid, cholera, Hepatitis A -Ingestion of bacteria found with *E.coli* could lead to gastrointestinal distress and eye, nose and throat infections	-Raw sewage from Combined Sewer Overflows during heavy rains -Feces from animals utilizing streams for wading, drinking and cooling -Raw sewage from malfunctioning sanitary sewage systems -Illegal straight pipes -Illegal sewage pump-outs from boats and watercraft
Nitrite	-High levels in the body oxidize hemoglobin in the blood, causing oxygen to be improperly transported through the body.	-Sewage and fertilizer -Intermediate product in Nitrification
Nitrate	-Can cause excessive algal growth	-Over-fertilized fields -Runoff from agriculture, lawns, golf courses
Ammonia Nitrogen	-Depletes water of oxygen through nitrification -Toxic to fish, causing them to become lethargic and to not eat	-Biological decay of plant and animal matter -Raw sewage, industrial effluents, fertilizers
Orthophosphate	-Can support rapid algal growth rates (algal decomposition uses oxygen and produces odors and toxins)	-Sewage and fertilizer (agricultural runoff) -Enriched groundwater, suspended sediments -Runoff from parking lots
Total Phosphate	-Can support rapid algal growth rates (algal decomposition can consume oxygen and produces odors and toxins)	-Detergents and fertilizer (agricultural runoff) -Enriched groundwater -Suspended sediments -Runoff from parking lots


Fertilizers, Pesticides, Detergents, Sewage, Animal Waste
may contain
Nitrates
increase growth of
Algae
may contain
increase growth of
Phosphates
E.coli
may carry
Sediment
may increase
photosynthesis of algae increases
decomposition decreases
decomposition increases
Dissolved oxygen
relates to
B.O.D.
may increase
affects
decomposition decreases
decomposition increases
Turbidity
affects
Water Temperature
Organic Matter

Chapter 4: Biological Testing

Benthic Macroinvertebrate Survey

Introduction

The water quality of the streams of the Ohio River Valley can be assessed with some accuracy using macroinvertebrates as indicators. Macroinvertebrates are those animals that lack a backbone (invertebrate), are large enough to be seen with the naked eye (macro), and live at least part of their lives in or on the bottom (benthos) of a body of water. Macroinvertebrates found in the streams of the Ohio River Valley include mussels, snails, worms and numerous insects.

Macroinvertebrates live in the sand and mud, and on rocks, logs, sticks and vegetation in water bodies. The flow of water provides a steady stream of organic material for the organisms to feed on. The numerous rocks, submerged logs and plants provide nooks and crannies for the organisms to hide in and plenty of surface area for attachment.

There are thousands of different macroinvertebrate species in the Ohio River Valley, each with its own unique requirements for survival. Many organisms require high levels of oxygen and cannot tolerate substantial amounts of toxic substances. Those few organisms that can withstand very low oxygen levels or high toxicity are known as pollution-tolerant species.

Macroinvertebrates are suitable for assessing water quality for many reasons:

- Macroinvertebrates are relatively immobile. They cannot escape from changes in water quality. When pollution has an impact on a water resource, macroinvertebrate populations are adversely affected and require considerable time to recover. It is thus possible to assess the overall health of a water resource by determining the number and variety of organisms present. In general, the greater the diversity of organisms the better the water quality.
- Macroinvertebrates are easy to sample. They are abundant and can be easily collected.
- Macroinvertebrates are a critical part of the aquatic food web. They form a vital link in the food chain connecting aquatic plants, algae, and leaf litter to the fish species of streams. The stability and diversity of the larger aquatic food web is reflected by macroinvertebrate health.

Unlike chemical parameters that indicate water quality at the time of testing, macroinvertebrate populations reflect something of past influences. A pollution event that occurred a few days ago will not be detected by chemical testing, but may still be reflected in the macroinvertebrate community.

Life cycle

Most of the benthic macroinvertebrates you will encounter are aquatic insects. Aquatic insects have complex life cycles and live in the water only during certain stages of development (see pictures in Appendix A). There are two types of metamorphosis: complete and incomplete.

Complete metamorphosis

Aquatic insects may go through one or two kinds of development or metamorphosis. Aquatic insects that go through complete metamorphosis undergo four stages of development: egg, larva,

pupa and adult. They lay their eggs in water. The eggs then hatch into larvae that feed and grow in water. These larval insects do not resemble the adult insects; many appear wormlike. The fully-grown larvae develop into pupae and then into adults. The fully formed adults of some species emerge from the water and live in the habitat surrounding the stream. Others continue to live in the stream as adults.

Incomplete metamorphosis

Aquatic insects that go through incomplete metamorphosis undergo only three stages of development: eggs, nymphs and adults. The eggs hatch into nymphs (also called larvae). Nymphs feed and grow in the water while they develop adult structures and organs.

Feeding habits

Feeding groups categorize macroinvertebrates by the type of food that they eat and the manner in which food is obtained.

Shredder: feeds on coarse, dead organic matter (leaves, grasses, algae, and rooted aquatic plants), breaking it into finer material that is released in their feces. Shredders include stonefly nymphs, caddisfly larvae and cranefly larvae.

Collector: feeds on fine, dead organic matter, including that produced by the shredders.

Filtering collector: filters particles out of the flowing current. Examples include blackfly larvae and net-building caddisflies.

Gathering collector: gathers matter while crawling along the river bottom. Gatherers include mayfly nymphs, adult beetles and midge larvae.

Grazer: grazes on algae growing on rocks in the substrate or on vegetation. Grazers include snails and water pennies.

Predator: feeds on other invertebrates and small fish. Jaws are specially adapted to feed on prey. Dragonflies and damselflies have scoop-like lower jaws, the jaws of dobsonflies are pincer-like, and water strider's jaws are spear-like. Also includes beetles (adult and larvae).

Sampling data

Included in this manual is a River Quality Index sheet. Using the techniques for macroinvertebrate collection on the following pages, it is possible to complete this worksheet and receive a water quality index rating. Refer to the following list to interpret water quality index results after sampling macroinvertebrates:

A. Great variety of macroinvertebrates with few of each kind: clean water
B. Less variety, but greater abundance of each kind: water is overly enriched with organic matter (nutrients from agricultural runoff, sewage runoff)
C. Only one or two kinds of macroinvertebrates, with great abundance: severe organic pollution
D. Few or no macroinvertebrates, but the river or stream appears clean: toxic pollution

Sampling techniques

Net Sampling Method

1. Choose a "riffle" portion of the stream with shallow, faster-moving water and a stream bed of one-quarter inch gravel or sand to ten-inch cobbles.
2. Select an area and avoid disturbing the area upstream.
3. Have one person hold the net perpendicular to the flow.
4. Another person should stand beside the sampling area and remove stones and other objects, holding below the water as the organisms from the rocks go into the net.
5. When objects have been brushed into the net, kick the sampling area vigorously from the upstream edge toward the net. Also, jab the net into the bottom of the stream to loosen other organisms.
6. Dump the collected materials into a shallow white container.
7. Identify macroinvertebrates using the macro scope directions and identification keys below.
8. Once identified, arrange the organisms into a tray (ice cube trays work well) according to groups of the same kind and keep a tally on the data sheet.
9. Once all organisms are identified and recorded, empty the tray, returning organisms to the stream.

Sampling By Hand

1. Choose a portion of the stream with shallow, slower-moving water and a stream bed of one-quarter inch gravel or sand to ten-inch cobbles.
2. Using only your hands and magnifying glass, begin to look for macroinvertebrates present in the stream. Turn over rocks and lift them up out of the water. Look along the stream edge for anything that may be crawling. Comb through moss and check under leaf litter for any organisms that may be hiding.
3. When you find an organism, pick it up with your hands or forceps and place it in the shallow white bin provided to your group.
4. Identify macroinvertebrates using the macro scope directions and identification keys below.
5. Once identified, arrange the organisms into a tray (ice cube trays work well) according to groups of the same kind and keep a tally on the data sheet.
6. Once all organisms are identified and recorded, empty the tray, returning organisms to the stream.

Macroinvertebrate Identification

Directions

Once organisms have been collected, use the macro scopes provided to identify each macroinvertebrate. Remove macroinvertebrates one at a time from the white collection bin they were placed in. Place the individual on a petri dish and place a macro scope overtop to magnify the organism. Use the dichotomous key and identification keys below to identify each organism. As you go, check off the type of organism found on the laminated stream quality index sheets provided to each group.

Dichotomous Key

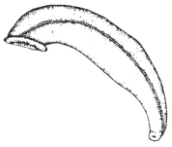
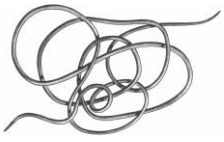
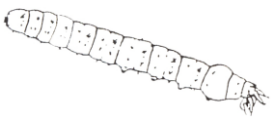
Below is a simplified version of a dichotomous key used by scientists to identify macroinvertebrates. It was created by Hoosier RiverWatch (see sources below) to be used by volunteer monitors who have not had much experience identifying aquatic macroinvertebrates. Each couplet has two or three options to choose from before moving to the next couplet.

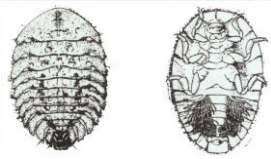
Information in this section was modified from the following sources

An Introduction to the Aquatic Insects of North America, Second Ed., Edited by R.W. Merritt and K.W. Cummins
Aquatic Entomology, Patrick McCafferty
Clinton River Watershed Council *Teacher Training Manual*, Michigan, Meg Larson
Field Manual for Water Quality Monitoring, 10th Ed., Mark K. Mitchell and William B. Stapp
Macroinvertebrate Identification Flash Cards, GREEN/Earth Force, Ann M. Faulds, et al.
Pond and Stream Safari, Karen Edelstein, Cornell Cooperative Extension
Save Our Streams Monitor's Guide to Aquatic Macroinvertebrates, Loren Larkin Kellogg

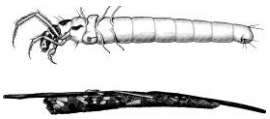
Please be aware that some macroinvertebrates may have missing body parts

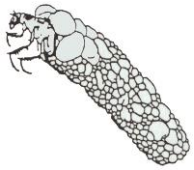
CHOOSE ONE:		GO BELOW TO:
1a. Has a shell (s)		**2**
1b. Has no shell		**5**
2a. Has a hinged double shell		**3**
2b. Has a single shell		**4**
3a. Adult under 2 inches long		**19**
3b. Adult 2-4 inches long		**Mussel**

4a. Right-handed opening		**Right-handed snail**
4b. Left-handed opening		**Left-handed snail**
5a. Has segmented body or looks like a tiny tick		**6**
5b. Has an unsegmented body and has an "arrow shaped" head; 2 pigment spots (eyes)		**Planaria**
6a. No obvious legs		**7**
6b. Obvious legs		**12**
7a. Has no obvious appendages (long, tubular body)		**8**
7b. Has some appendages (small tubes, tiny bumps, or feathery structures)		**9**
8a. Has a smooth body and suckers		**Leech**
8b. Has a round body and a rat tail		**Rat-tailed maggot**
8c. Has a rounded body		**Aquatic worms**
9a. Body black or brown; more than 1/3 inch long; plump and caterpillar-like		**Crane fly larva**

9b. Has a distinct head		**10**
10a. One end of body wider than other end; two tiny feather structures on smaller end		**Black fly larva**
10b. No difference in diameter along body		**11**
11a. Bright red body		**Blood midges**
11b. Grey body		**Other midges**
12a. Has four pairs of legs		**Water mite**
12b. Has three pairs of legs		**13**
12c. Has many pairs of legs		**25**
13a. Has no wings or short wing pads on back		**14**
13b. Has two pairs of wings that cover the abdomen		**23**
14a. Has a flat, round body with legs underneath (wings are not obvious)		**Water penny beetle larva**
14b. Not flat, has long body with legs		**15**

15a. Lives in a tube or case or has two hooks in its last segment and is green with three plates on back behind head. (The "green caddisfly" builds a net and tube, but will be washed into the kicknet as free-living)





Caddisfly larvae

15b. Free-living **16**

16a. Abdomen possesses lateral filaments similar in size to legs **21**

16b. Abdomen does not have "leg-like" filaments (may have feathery "gills") **17**

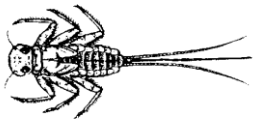
17a. Always with only two tail appendages and no abdominal gills

Stonefly nymph

17b. Usually has three tail appendages, and with no lateral gills on abdominal segments **18**

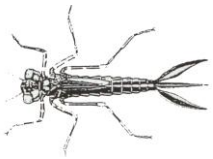
17c. Tail has no appendages **24**

18a. Has long, bristle-like tail appendages, sometimes two or three



Mayfly nymph

18b. Lower lip formed into extensible scoop-like structure and has leaf-like tail appendages

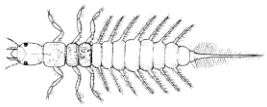
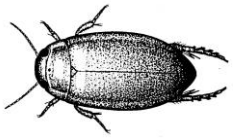
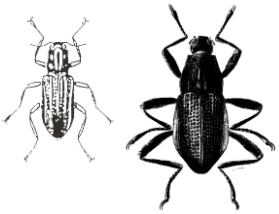


Damselfly nymph

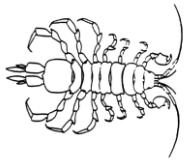
19a. Small rounded shell (<2 inches) **20**

19b. Small triangular shell with alternating cream and dark brown bands **Zebra mussel (exotic)**

20a. Numerous very fine concentric rows of elevated lines, white or cream colored with smooth lateral teeth **Fingernail clam**

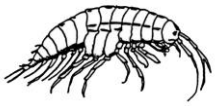
20b. Numerous concentric elevated ridges, yellowish brown to black shell with serrated lateral teeth		**Asiatic clam (exotic)**
21a. Head narrower than widest body segments		**Beetle larva**
21b. Head as wide or wider than other body segments		**22**
22a. Abdomen with single long filament at end		**Alderfly**
22b. Abdomen ending with a pair of tiny hooked legs, large head with pincer-like jaws		**Dobsonfly or fishfly larva**
23a. Oval-shaped body, legs with feathery swimming hairs		**Adult water bugs and water beetles**
23b. All legs smooth, without hairs		**Riffle beetle adult**
24a. Lower lip formed in scoop-like structure		**Dragonfly nymph**
24b. Looks like tiny millipede		**Riffle beetle larva**

25a. Flattened top to bottom, crawling looks like roly-poly" or a "pill bug"



Sowbug

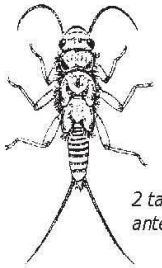
25b. Flattened side to side, swimming looks like tiny shrimp



Scud

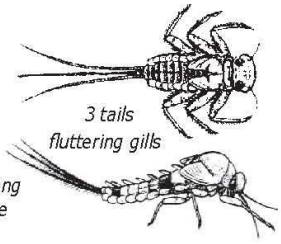
Macroinvertebrate Identification Key

GROUP 1 – Very Intolerant of Pollution



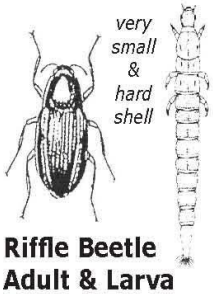
2 tails long antennae

Stonefly Nymph



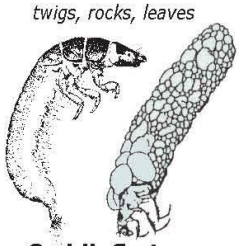
3 tails fluttering gills

Mayfly Nymph



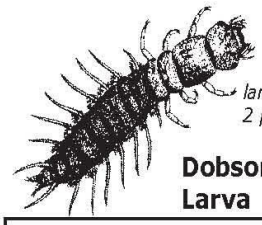
very small & hard shell

Riffle Beetle Adult & Larva



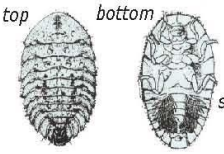
makes a case from twigs, rocks, leaves

Caddisfly Larva



large head & 2 pinchers

Dobsonfly Larva



top bottom

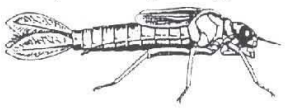
looks like a suction cup

Water Penny Larva

Right-Handed Snail

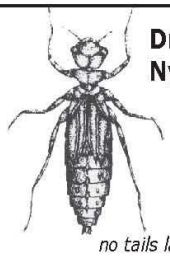
must be alive to count

GROUP 2 – Moderately Intolerant of Pollution



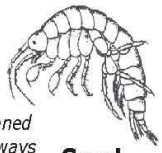
3 paddle-like (feathery) tails

Damselfly Nymph



Dragonfly Nymph

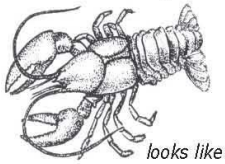
no tails large eyes



flattened side-ways & swims on side

Scud

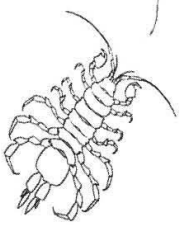
Crayfish

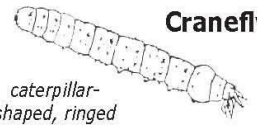


looks like a mini-lobster

Sowbug

flattened top to bottom (looks like a pill bug)





Cranefly

caterpillar-shaped, ringed

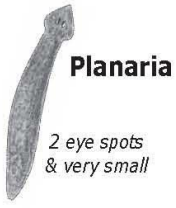
must be alive to count

Clam/Mussel

GROUP 3 – Fairly Tolerant of Pollution

Midge Larva

small, but visible head intense wiggler

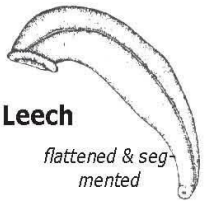


Planaria

2 eye spots & very small

one end is swollen

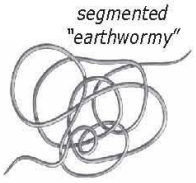
Black Fly Larva



Leech

flattened & segmented

GROUP 4 – Very Tolerant of Pollution

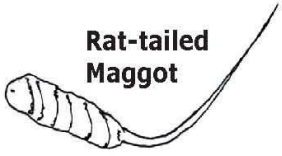


segmented "earthwormy"

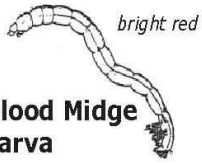
Aquatic Worms

must be alive to count

Left-Handed Snail



Rat-tailed Maggot



bright red

Blood Midge Larva

www.HoosierRiverwatch.com


Water Penny


Stonefly


Caddisfly


Dobsonfly


Mayfly


Riffle Beetle


Gilled Snail
(Right-Handed)


Shrimp


Crane Fly


Diving Beetles


Crayfish


Scuds


Damselfly


Dragonfly


Clams


Isopod


Black Fly


Aquatic Worm


Midge


Mosquito


Flies


Leech


Pouch Snail
(Left-Handed)


Ghost Snail


Planaria

Stream Quality Index

Group 1 Very Sensitive	Group 2 Sensitive	Group 3 Pollution Tolerant
☐  Water Penny	☐  Crane Fly Larva	☐  Black Fly Larva
☐  Stonefly Nymph	☐  Diving Beetle Larva	☐  Aquatic Worm
☐  Caddisfly Larva	☐  Crayfish	☐  Midge Larva
☐  Dobsonfly Larva	☐  Scud	☐  Mosquito Larva
☐  Mayfly Larva	☐  Damselfly Nymph	☐  Other Fly Larva
☐  Riffle Beetle	☐  Dragonfly Nymph	☐  Leech
☐  Gilled Snail	☐  Clam	☐  Pouch Snail
☐  Shrimp	☐  Isopod	☐  Other Snail
	☐  Diving Beetle	☐  Planaria
Number of checks in this column: _____ x3 Total: _____	Number of checks in this column: _____ x2 Total: _____	Number of checks in this column: _____ x1 Total: _____

Excellent >22 Good 22-17 Fair 16-12 Poor 11-0	Total from all three groups: _____ Result: _____

Chapter 5: Habitat Survey

Introduction

In order to find an appropriate site to survey, first familiarize yourself with the Ohio River watershed. Obtain a good map and take a drive or walk through your local area. This will help you establish a feeling for the land characteristics and the distribution of industrial, agricultural, residential, and forested areas. Decide if you would like to help resolve problems along a degraded stream section or if you would rather help preserve a more pristine section. In addition, keep in mind the accessibility of your survey area. If you need to cross private lands, you must contact the landowners for permission. The landowners may be interested in your project and eager to provide you with additional information.

Large river habitat surveys

This manual is designed for monitoring groups conducting water quality tests on large rivers. It is often difficult for volunteers to complete habitat surveys on large rivers because of the types of evaluation necessary (viewing substrates on the bottom, measuring river depth, etc.). A Citizens Qualitative Habitat Evaluation Index (CQHEI) is included in this manual solely for informational purposes. Volunteers should not venture into a large river to gather the necessary information. If a volunteer group is studying a small river or stream, however, completing the CQHEI would be helpful in assessing the overall health of that waterbody. Some information on large rivers (including stream flow) can be found on the USGS web site, http://water.usgs.gov/realtime.html.

Habitat Survey Data Sheet

Site Information

Date _____ Time_____

Name of stream or river _____

River mile _____

Nearest city/town _____ State _____

Surveyor(s) name _____

Organization's name _____

Today's weather _____

Recent weather conditions _____

Site Survey (check all that apply)

Inorganic substrate
____ boulders
____ rubble
____ gravel
____ sand
____ silt
____ clay

Organic substrate
____ muck/mud
____ pulpy peat
____ fibrous peat
____ detritus
____ logs/limbs

Bank Slope
____ steep
____ moderate
____ slight
____ other _____

Bank material:
____ clay
____ mud
____ dirt
____ rock
____ stones
____ other _____

Cross-section:
____ rectangular
____ U-shaped
____ V-shaped
____ W-shaped

Flow Rate
___ Dry
___ Ponded
___ Low
___ Normal
___ Bank Full
___ Flood!

Land use: (approximate percentage)

_____urban ____suburban ____agricultural

_____grassland ____forest ____other _____

Water condition:

Water odor:	Water color:	Surface coating:
____ rotten eggs	____ muddy	____ scum
____ chlorine	____ clear	____ foam
____ fish	____ tea	____ oily
____ other _____	____ milky	____ other _____
____ none	____ brownish	____none
	____ other _____	

Water use:

_____swimming _____ fishing _____ boating _____drinking
_____industrial _____agricultural _____ other _____

Manmade structures:

____ dams _____ piers _____ entry ramps

____ bank stabilizers _____ other _____

Litter:

____ paper, small trash _____ cans, bottles _____ large trash

Animals _____

Bank Vegetation:

____ barren ____ grasses _____ herbaceous ____ brush

____ deciduous _____ conifer ____ other _____

Stream Shading:

____ 75-100% _____ 50-75% ____ 25-50%

____ 0-25%

Bank Stability:

____ stable ____slightly eroded _____moderately eroded ____ severely eroded

Chapter 6: Quality Assurance Plan

RiverWatchers Volunteer Monitoring Program

Personnel and Responsibilities:

RiverWatchers Coordinator:

Supplies

- Issue initial HACH chemical kit, Coliscan Easy Gel and macroinvertebrate samplers to all new groups
- Replenish supplies of kits as needed
- Inspect kits for outdated reagents or broken equipment once yearly

Training

- Provide one training session to each RiverWatchers group each year
- Provide training year round on specific topics or issues
- Provide resource for questions about testing or reporting procedures

Data

- Receive data at the ORSANCO/FORE offices
- Compile data in database

Leadership

- Write mission and goal statement
- Outline safety procedures
- Outline quality assurance procedures
- Provide resource on information about the Ohio River Valley

RiverWatchers Group Leaders:

Supplies

- Be responsible for all materials loaned by FORE
- Check supplies on a regular basis for outdated reagents or broken equipment

Safety

- Ensure that all safety measures are in place
- Ensure that all volunteers follow the safety measures

Training

- Give training on chemical and biological test procedures before and during tests

Quality Assurance

- Follow quality assurance procedures

Data

- Fill out data sheets completely and check for accuracy before submitting
- Report data to RiverWatchers Coordinator in a timely manner after every test, either by e-mail, mail, or on-line submission

RiverWatchers Volunteers:

Testing

- Follow directions given by leader

Safety

- Follow all safety procedures

Quality Assurance

- Follow all quality assurance procedures

Test Methods

Using common test methods is essential for receiving reliable and verifiable data that can be compared across the Ohio River Basin and over time.

Replication
Three different samples of water from the river are taken and tested for every parameter. This tests for natural variability.

Suppliers
HACH test kits and refill supplies are used for chemical tests.
Coliscan Easy Gel kits and refill supplies are used for fecal coliform testing.
Turbidity tubes are used for turbidity tests and are supplied by the RiverWatchers Coordinator.
Hester-Dendy Samplers are the preferred method for macroinvertebrate sampling.

Instructions
All test kit instructions are followed as recommended by the suppliers.

Materials

Materials should be of the highest quality. Materials are purchased from reputable companies. Materials should be controlled, in storage and in use, to ensure continued quality.

Disposal
All materials are disposed of in an acceptable manner. All paper waste is thrown into a wastebasket designated for that use. All liquid waste is be placed in container and hardened with kitty litter, and then thrown away as paper waste. All waste from HACH nitrate tests should be placed in a separate container and taken to the local hazardous waste disposal site (contact solid waste management district in your area).

Storage
All materials are stored in temperature, light and humidity controlled areas. Caps are kept on all applicable materials.

Expiration Control
Materials are regularly inspected for expiration dates. All materials that have expired are destroyed following instructions on MSDS, unless recertified by the manufacturer. For HACH chemicals, check out this website for expiration dates using lot numbers and catalog numbers… http://www.hach.com/cs/knowledge.htm under Reagent Expiration Date Search.

Inspections
Visual inspections occur to look for changes in color or clarity or the formation of solids. Materials which have changed appearance are destroyed.

Labels
Labels must remain on all materials.

Replacement
All materials are replaced in a timely manner.

Training

Training is necessary to ensure that quality data is produced and distributed. The training program has a built-in process to determine the extent of the learning.

Training Plan
The RiverWatchers Coordinator and the RiverWatchers Leaders present training every fall to the RiverWatchers volunteers. This ensures that new techniques can be quickly incorporated into the testing methods. Annual training also ensures personal contact with every volunteer every year.

Volunteer Training Procedure
RiverWatchers Coordinator
Training consists of a slide show on the Ohio River Basin, reasons for testing, and introduction to macroinvertebrates. Chemical testing is then demonstrated, and where possible hands-on practice occurs.
RiverWatchers Leaders
Training consists of detailed explanation and repeated practice with the test methods.

Certification
All RiverWatchers volunteers should complete pre and post test on quality assurance and testing procedures. Successful certification will result from completion of an approved RiverWatchers training workshop, pre and post test scores and a determination by the RiverWatchers leader that the volunteer understands testing methods.

Equipment

Proper equipment is essential for completing chemical and biological tests in a reliable manner. Care should be taken before and during the testing.

Calibration
Equipment is calibrated every day testing will occur. The pH meter is calibrated with a buffer solution.

Sample Collection
Rinse collection bottles or tubes with sample water before collecting sample.
Do not use an open container (such as a bucket) to collect samples (unless collecting from the side of a bridge); instead use sealable containers.

Testing
After completing a test, rinse tubes and bottles with distilled water.
For the phosphorus tests, use dedicated glass test tubes and mixing bottles that are not washed with any detergent. Dedicated droppers and equipment and distilled water are used to wash all equipment.

Data Usage

Thorough documentation is good science. Accuracy and timeliness are critical parameters for a useful data retrieval system.

Data Completion
Data sheets are completed accurately and completely at the time of testing.
All units are checked. Data are written to the farthest possible decimal point.

Data Submission
Data sheets are submitted in a timely manner to the RiverWatchers Coordinator. They can be submitted online, by e-mail or by regular mail. Hard copies are kept for a period of one year by the RiverWatchers Leaders.

Data Compilation
Data is compiled in an Access database.

Data Retrieval and Reporting
At this time, data can be retrieved by contacting the RiverWatchers Coordinator.

Safety

The overall safety of volunteers is the number one concern.

Training
All volunteers have training in basic safety procedures. Procedures have been explained and practiced. RiverWatchers leader model acceptable safety procedures and insist that they are followed.

Equipment
Goggles and gloves are worn at all times. A first-aid kit is nearby at all times.

Material Safety Data Sheets (MSDS)
MSDS's are read once yearly and leaders have access to them during testing. Leaders understand the MSDSs.

Housekeeping

All potential sources of contamination, whether biological, chemical or physical, are identified and controlled. The front line of defense is basic housekeeping.

Cleanliness
All work areas have a clean and orderly appearance. Work areas should be swept and dusted on a regular basis. Work areas are cleaned just prior to testing.

Waste Disposal
All paper waste is thrown into a wastebasket designated for that use. All liquid waste is placed in container and hardened with kitty litter, and then thrown away like paper waste. All waste from HACH nitrate tests is placed in a separate container and taken to the local hazardous waste disposal site.

Quality Assurance Measures

What can we do to assure that we produce quality data?

- ❑ Field duplicates (samples taken at the same time & date, by a different team, and analyzed separately)
- ❑ Lab replicates (split samples in lab into sub-samples, analyze them separately)
- ❑ Calibrate before EVERY sampling date
- ❑ External field duplicates (sample taken at same time and place by another independent lab- usually professional lab)
- ❑ Split samples (sample divided into sub-samples in lab, one of which is analyzed in the lab and the other is sent to a professional lab for analysis)
- ❑ Keep water samples on ice during transport from site to lab
- ❑ Administer QA/QC test from field guide before monitoring
- ❑ Practice tests before "official" sampling date

Supplies

Check the following list before you head out into the field:

- ❖ Clipboard
- ❖ Pens and pencils
- ❖ Calculator
- ❖ Stopwatch
- ❖ Insect collection tools
- ❖ White sampling trays (ice cube trays work well for sorting organisms)
- ❖ Hands-lens or magnifying glass
- ❖ Tweezers or forceps
- ❖ Rubber gloves
- ❖ Goggles
- ❖ First-aid kit
- ❖ Water for drinking
- ❖ Chemical test kits
- ❖ Sealable containers for collecting water samples