Hillsborough County

STREAM WATERWATCH

Level I & II Volunteer Field Guides

ACKNOWLEDGMENTS

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City of Tampa Advanced Wastewater Treatment Plant
EPA Office of Water
Florida Department of Environmental Protection
Georgia Adopt-A-Stream
Hillsborough River Greenways Task Force
Hillsborough Community College
Hillsborough County Public Works Stormwater Management Division
Hillsborough County Environmental Protection Commission
Save our Streams, Izaak Walton League of America

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LEVEL I FIELD GUIDE

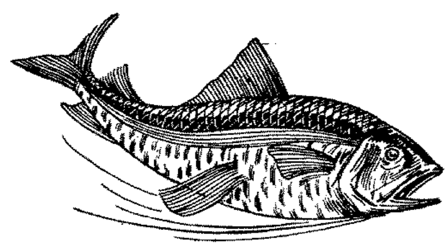
TABLE OF CONTENTS

INTRODUCTION

Hillsborough County Stream-Waterwatch is a program developed by Hillsborough Community College and the Hillsborough County Department of Public Works Stormwater Management Division. The program was originally funded by a grant from the Florida Game and Freshwater Commission's Advisory Council on Environmental Education. The program currently receives funding from the Southwest Florida Water Management District and is designed to promote citizen involvement in learning about and protecting streams, rivers, and lakes. Stream-Waterwatch gives volunteers the tools to understand and then start protecting their water resources. It's a unique "hands-on" approach that brings citizens and government together to manage and protect our water resources.

This manual describes how to start a Stream-Waterwatch project including how to find a stream segment to adopt, and how to conduct a visual assessment and watershed walk. This manual covers Stream-Waterwatch Level I activities. Levels II and III involve biological monitoring, chemical testing, and/or habitat enhancement activities, in addition to Level I activities. Training workshops are required for Level I and Level II biological monitoring and chemical testing.

LEVEL I



Level I is the starting point for new volunteers and Stream-Waterwatch projects. Volunteers regularly evaluate a stream segment, pick up litter, and report results to Hillsborough County Stream-Waterwatch. Stream-Waterwatch projects are long term protection efforts. Volunteers commit to adopt a stream or river section for at least one year. Follow steps I through XI outlined in this manual to complete a one year Stream-Waterwatch project.

Level I activities include:

- finding a stream site/segment for adoption
- conducting an initial watershed walk
- visual assessments of water quality and physical habitat at one site four times a year
- regular litter pick ups

These activities help protect streams because:

A **watershed walk** provides a record of potential impacts to water quality such as pipe effluent, eroding stream banks, illegal dumps and surrounding land uses. Regular visual assessments at one site can provide important clues to the overall health of your stream or river. Documenting changes in water quality and habitat are important to understanding water quality trends. Volunteers evaluate water color, clarity, streambank and stream bed habitat. **Litter picks ups** remove hazards and pollutants to aquatic life as well as improve an area for recreation. And finally, **sharing the results** of your project with others helps everyone understand that these are our streams, and we all have to work to protect them.

Volunteers help improve water quality, one stream at a time, by regularly recording stream conditions, notifying authorities if problems arise, removing litter, and telling others in the community about their findings. Understanding local water quality conditions is the first step toward protecting our water resources.

I. IDENTIFY A STREAM SEGMENT TO ADOPT

Find a stream (or river) segment to adopt. Many groups adopt between a ½ and 1 mile segment of stream. When choosing a stream, think of your goals. Do you want to learn more about a section of stream that flows by your school or home? Volunteers may want to study the quality of the local drinking water source. Comparing the effect of land use on water quality can be interesting (sample upstream and downstream of a farm, an urban area, etc.). Also, topographical or county maps are good sources of water resource information.

Generally, however, follow these guidelines:

- Select a stream meaningful to you or your group.
- Select a stream that has **easy, safe and legal** access.
- Select a project that you can have fun with!

II. NAME YOUR PROJECT

Think of a name for your group or project. Your project name will help identify you as an established effort to protect a local stream. As an example, the Environmental Technology Students at HCC adopted a site on English Creek and call their project the "English Creek Water Quality Team."

III. CONDUCT A WATERSHED WALK

(based in part on work done by Georgia Adopt-A-Stream)

Start your Level I project with a Watershed Walk. A watershed walk involves creating a record of land uses and potential impacts on your adopted stream. Runoff from different land uses, pipes discharging into the water, natural springs flowing into the stream, highway crossings, and other impacts can all have significant effects on a stream. A thick stand of forest adjacent to a stream may filter pollutants running over land, provide shade, and hold soil in place. A highway or a parking lot near the stream may collect oil and gasoline that runs into the stream when it rains. A pipe may discharge wastes from a nearby city or industry, or a stormwater pipe may directly route runoff into a stream.

What Is a Watershed?

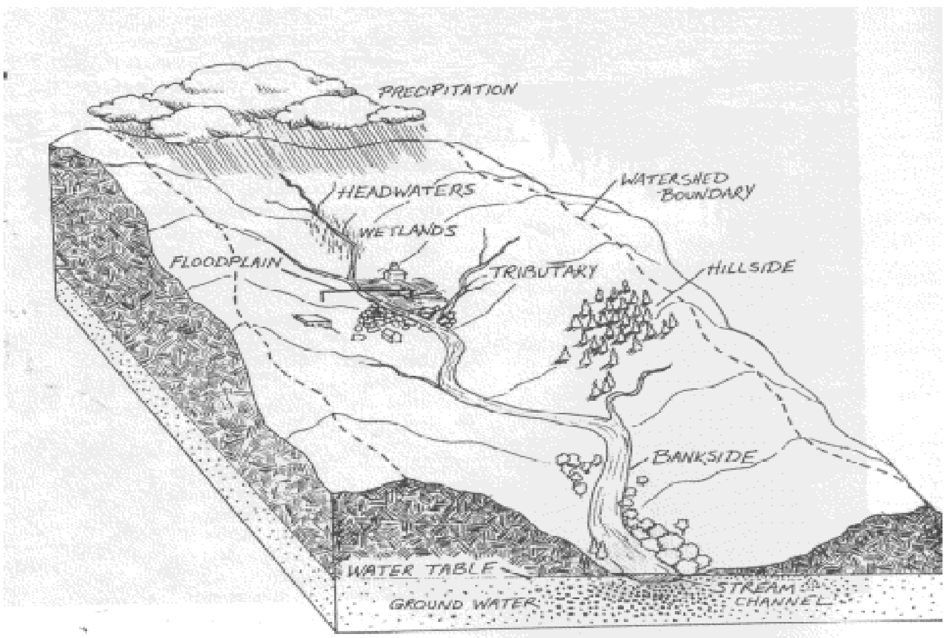


Figure 1 Cross section of a watershed

A watershed includes the entire area drained by a certain stream or river. Hills and mountains determine which direction water flows, a drop of rain falling on one side of a hill may eventually find it's way to your stream. If the drop of rain falls on the other side of the hill, it will follow a different path to a different stream or river (Figure 1). Looking at a topographical map will help you determine what area makes up your watershed.

Water draining into your stream may carry with it soil, fertilizer from lawns and fields, oil and gas from parking lots and roads, or anything the water comes in contact with. Streams drain water from land in the surrounding area, so every activity on the land can have an impact on your stream. A natural area of vegetation next to the stream helps keep these pollutants out of the water. See the appendices for more detail.

Equipment List

- topo map of area surrounding stream
- Pen or pencil
- Boots/waders or old tennis shoes
- Camera
- watershed walk survey and summary form

WHERE TO START

Before the watershed walk:

- Read the watershed information in the Appendix.

- Read "Think Safety" in the Appendix.

- Obtain the topographical map of your area. Find the stream you plan to walk or canoe and mark the beginning and end points of the study segment, usually ½ to 1 mile. Study the map before the walk and note important features along the way. The location of crossing roads, feeder streams, electric power lines, or dams can be used for navigation and as reference points. Also, note the surrounding land area--will you expect to find urban, residential, or rural areas or a combination?

- Review the Watershed Walk Survey and Summary Form.

- You must have permission of landowners **if you walk** across private property. The county planning commission office will have a list of property owners along the chosen section of stream. The office will have tax maps showing all property lines and the lot number for each property. Make a list of each lot number, then look up the property in the tax books to obtain a full name and address for the owners. You can prepare an announcement to take or mail to all the property owners. Tell them who you are, what your group is doing, and why you are doing it. Make sure to provide a phone number of someone to contact in case they have any questions. If possible, hand deliver the announcements. This gives you the opportunity to introduce yourself to the property owners, and provide them with additional information. If they are not at home, leave the announcement on the outside of the mailbox. You'll likely discover that many of the property owners will be very interested in learning more or in helping in the effort. You may want to include a Stream Water-Watch brochure or flyer with the announcement

If you canoe your section, you may not need to contact all the property owners. Please just use common sense, don't walk across private land and be sure not to leave anything behind.

In urban areas, it may be not be practical to contact all landowners adjacent to a stream segment. In this case, your watershed walk may actually be a drive. Visit several sites where the stream crosses a road. **Use caution** when getting in and out of your car, especially on bridges. Other vehicles may not see you.

<u>During the walk</u>:

- Assign tasks to the team members such as taking notes, marking map, and wading in the stream.

- Walk or canoe a length of stream to assess what may be influencing your adopted section. Start at the upstream portion. As you proceed downstream, mark the significant features on the map (you may want to cover the map with plastic and use a wax pencil). These features may include the location of erosion, runoff, livestock wading, sewer pipes, storm drains or land use along the stream that is likely to cause problems. Use your best judgement as to what may be significant. If unsure, make a note and ask later. Make a sketch of the details, showing North and approximate distances along the stream.

- Complete the Watershed Walk Survey Form.

<u>After the walk</u>:

- On the basis of the Watershed Walk Survey Form, notes and map details, you should be able to do the Watershed Summary. The Summary should reflect the actual conditions in the stream at the time of observation.

- Select one or more sites for quarterly visual assessments. Place the location of the selection(s) on the stream map.

Select Site(s) for Quarterly Visual Assessments

Consider these criteria to select one or more sites to conduct quarterly visual assessments:

1. Physical Accessibility: There is ease reaching the stream site. The stream site is easy and safe to reach.

2. Legal Accessibility: There are NO trespass problems or safety problems.

IV. VISUAL SURVEY

A great deal of information can be gained by simply observing your stream at sites selected during your watershed walk. The idea is to record a set of observations every time you visit your stream site(s). In this way, both short and long term changes can be documented. Visit your stream site(s) quarterly or once every three months. Set dates now so your group can plan accordingly. For example, plan to do a visual survey the last Saturday in February, May, August and November.

Equipment List:
clipboard
pencil
Visual Survey Form
tape measure
yardstick
thermometer

Optional:
tree or shrub identification guide
camera
leaf press
sunscreen
insect repellent
hip waders or boots
rubber ball or orange

Follow these directions to complete the Visual Survey Form:

1. Look at the amount and speed of the water. How high is the stream? (hint-look for high water marks on the streambank) Is the water flowing slower or faster compared with your last visit? Use your best judgement to estimate high, normal, or low flow. Stream flow can be calculated flow by measuring the cross section of a stream segment and then taking a velocity measurement (see appendix on Stream Flow for details). Record.

2. Observe where the water is flowing, if there are rocky areas where the water moves quickly, these areas are called riffles. They provide good habitat for macro invertebrates and fish. Does the water slow down in some spots and form pools? Pools provide a place for fish to rest and feed. Estimate the number of pools and riffles in your section of stream. Record.

3. Look at the stream depth and width. Riffles will be shallow, pools will be deeper. Measure or estimate the depth at the center of the stream and the width of an average section of the stream. Record.

4. Water color and odor are associated with specific conditions--some naturally occurring and some influenced by human activity. Brown or muddy water may indicate sedimentation in your stream. In Florida many streams are clear, but naturally tea-colored due to decaying leaves and plants. Very green water may indicate excessive algae growing in the water. Learn to recognize "normal" water colors and odors in your stream. Refer to the "Evaluation of Stream Conditions" chart in the Appendix. Record the colors and odors that best describe your stream site.

5. Fish and aquatic insects need certain conditions in a stream to survive. One critical condition is called habitat--the availability of good places to search for food, hide from predators, and reproduce. The bed of the stream can tell you a lot about habitat available for aquatic life. Rocks and vegetation provide good habitat while sediment covers the places to hide and lay eggs. Use Chart B in the Appendix to rank the stream bed and sediment deposits and record on stream assessment survey form. For a quantitative method, see "Soil Classification" in the Appendix.

6. Stream banks function as a part of the whole stream system. Streambank stability describes how well soil and vegetation are held in place. If stream banks are unstable, soil will erode into the stream during a rain. The amount and type of vegetation on stream banks is also very important. Vegetation holds soil in place and prevents erosion on stream banks. Trees and large shrubs can provide shade for the stream, many types of fish and insects need cooler water to survive. You can record both left and right stream banks (facing downstream) or the general condition.

7. Algae are simple plants without roots or leaves. They are naturally present in streams, rivers and lakes. Algae are found growing on rocks or logs, floating in clumps, or in long strands. They may be green, brown, or reddish. Sometimes, however, algae grow out of control when excessive nutrients are present. Nutrients like nitrogen and phosphorus are found in waste water, animal wastes, and fertilizers. Fertilizers from lawns, golf courses, and cropland may run into streams. The nutrients are food for algae, and the more they get, the more they multiply. Excessive algae in a stream can cause oxygen levels to drop when algae decompose. Low oxygen levels make it impossible for fish and other organisms to live. Record the appearance and location of algae.

8. Finally, note general observations--did you see any wildlife? Are there human activities in the area that impact the stream? How about litter? Write down anything about the area that you think is important.

V. LITTER PICK UP

Litter can harm aquatic life. Cans can rust, batteries can leak acid into water, and plastic can cut or tangle fish or birds. Litter also can impair the recreational use of streams for people and is just plain ugly. Regular litter pick ups will help improve the water quality in your stream.

Bring a trash bag(s) with you during your quarterly visual surveys and pick up litter. One person may do this while others complete the visual survey. You may want to plan a day to pick up litter on your ½ to 1 mile stream segment. If you have large items, talk to the city or county about getting some assistance from the public works or fire department. You may want to wear gloves to protect your hands from broken glass or sharp objects.

VI. SEND RESULTS

Send a copy of your Watershed Walk Survey and Summary, your quarterly visual surveys with the Level I Activity Summary to Hillsborough County Stream-Waterwatch each quarter. You efforts are important, don't keep the results to yourself! Also, we know your group is active only when we regularly receive your results.

Complete a new Level I Activity Summary each quarter. The Activity Summary is a record of your group's activities each quarter and for the entire year. Make a copy of the Activity Summary. Send the copy to Hillsborough County Stream-Waterwatch no later than March 31. June 30, September 30 and December 31. Keep the original for your records.

Feel free to send a copy of your results to anyone else interested in the health of your stream. Your local newspaper may want to run a story about your group and your findings. Your group may want to send your results to everyone in your watershed, including private homes and businesses. Public outreach is probably the most important Stream-Waterwatch activity. This is a chance to share with others in the community information about your project, the condition of your stream, and your dedication to protecting local water resources. Many groups will be interested in learning about local streams through an article or presentation.

One way to keep the public informed is to make available the water quality results that your group finds. This can be accomplished by installing a sign that identifies your group and the section of stream or river that you've adopted. We have signs available for installation at your site upon request. By sharing the results of your group's findings the local community will become aware of your group's efforts and outcomes regarding the water quality in their area.

IF YOU WANT TO LEARN MORE ABOUT YOUR STREAM OR IMPROVE THE HABITAT...

Consider participating in Stream-Waterwatch Level II or III. Level II involves choosing either biological monitoring, chemical monitoring, or a habitat improvement project. You conduct these activities in addition to your Level I project. Level III involves two or more of the Level II activities, plus Level I participation. You can greatly increase your understanding of the chemical and biological forces at work in your stream or actively improve a section of stream. Flip through the Level II and III manual and see if you are interested. If you are, sign up for a workshop or contact Stream-Waterwatch for more details.

FOR QUESTIONS REGARDING STREAM -WATERWATCH TRAINING CONTACT:

Erik Garwell, Ph.D
Chemical Training Coordinator
Email: stream-waterwatch@juno.com

Pamela Vergara, Ph.D., P.E.
Stream Waterwatch Coordinator
1206 N. Park Road
Plant City, FL, 33566
(813) 757-2186
Email: streamwaterwatch@bellsouth.net

APPENDICES

UNDERSTANDING YOUR WATERSHED: THE VITAL LINK BETWEEN LAND USES AND WATER QUALITY

by Larry LeBeouf, Save Our Streams

Over the last decade, significant achievements have been made in the protection and enhancement of water quality. However, most of the significant reductions in pollution have centered around decreasing the amount of toxics from factory discharge pipes through water conservation, better technology and stricter legislation. However, our rivers continue to be polluted even with these improvements due to runoff pollution from the land. When you want to protect a particular river from pollution you cannot simply consider the pollution problems immediately in your river. You must ask yourself the question, where did this pollution come from? In order to learn where the pollution originates from, so that you can undertake solutions, you must be familiar with your watershed. By defining the area of your watershed, mapping it to show possible pollution sources, and reporting these sources to local and state authorities you can finally put an end to the pollution that has claimed so many of our streams and rivers.

What Is A Watershed?

It comes in many shapes and sizes. It may be nearly flat or hilly or rocky; it may even be in your own backyard. What is it? It's a watershed, an area of land from which water drains into a given point, usually a larger body of water. Smaller watersheds make up larger watersheds, creating a series of watersheds, known as a drainage basin, which may encompass several states. What happens in these smaller watersheds, whether good or bad, affects the larger watersheds downstream. The Mississippi River watershed, for example, drains about 1,243,000 square miles, carrying agricultural pesticides, city runoff and other pollutants into the Gulf of Mexico.

Defining Your Watershed:

Defining the area which makes up your watershed is important because all land uses in a particular watershed affect the water quality of streams that drain the land. Since water runs downhill, the lay of the land determines the size of your watershed. By locating the area sloping down to your stream you can determine what land practices may affect your stream's water quality. Topographic maps from your local office of the U.S. Geological Survey (USGS) can be used to map out your watershed's drainage pattern and to pinpoint possible pollution problems.

For example, if your watershed consists primarily of farms, your stream may suffer from pesticide and fertilizer pollution when it rains. If factories are also present in your watershed, toxic pollution may be contaminating your river. If large, paved areas, such as shopping malls or dense housing developments, exist in your watershed, oil from parking lots and urban runoff may harm stream life.

There are two types of pollution sources in your watershed: point sources and nonpoint sources. Point sources consist of pollutants which originate from a clearly identifiable source and move through a conduit, such as a factory discharge pipe. Nonpoint sources consist of runoff from the land, which may contain pesticides, fertilizers, metals, manure, road salt and other pollutants. Sources of these nonpoint pollutants include farms, lawns, paved urban areas, construction sites, timber harvesting operations, landfills and home septic systems.

Mapping Your Watershed:

Mapping your watershed will aid you in determining what possible pollution sources may be affecting your river. To understand what pollution problems are present in your watershed and are affecting the water quality of your river, draw a sketch of your watershed using USGS topographic maps to determine the size of your watershed, then identify locations of different land uses and point and nonpoint sources of pollution. This will help determine where pollution sources are located and what potential pollution problems exist. If you notice a pollution problem in your stream, you will be able to pinpoint possible causes using your watershed map.

Improving Water Quality In Your Watershed

Rainfall and other water that does not evaporate or soak into the soil becomes surface runoff and drains into various bodies of water. If a great deal of rain falls over a short period of time, however, it might cut gullies and carry off topsoil vital to farms, ranches and crops. Excess water may also cause flooding, which damages property and highways and can even destroy spawning beds for fish. High sediment levels in streams can clog stream channels, smother fish and destroy aquatic life.

Nonpoint sources of pollution can be abated by implementing soil and water conservation practices and adding flood prevention measures can reduce damage. For instance, grass, trees, bushes, shrubs and even weeds can help hold soil in place. Planting stream banks with stabilizing vegetation can reduce problems caused by erosion and slow down flood waters. Application of Best Management Practices (BMPs) such as terraces, strip-cropping and improved pasture practices, can be used on farms to make more water soak into the soil and to reduce the potential for erosion.

LAND USE AND WATER QUALITY

Urbanization

The urbanization of land concentrates people, and the pollutants that result from their lifestyles, in areas that are largely covered with impervious surfaces--buildings, driveways, roads, sidewalks, and parking lots. This combination of people, pollutants, and pavement produces urban runoff that can carry a greater pollutant load than municipal sewage.

The amount of pollutants carried in urban runoff with stormwater or snow melt is influenced by traffic density, littering, fertilizer and pesticide use, construction site practices, animal wastes, soil characteristics, topography of the area, percentage of impervious surfaces, atmospheric deposition, and amount of precipitation.

Pollutants transported in urban storm sewer systems to nearby waters include nutrients, bacteria, litter, soil, toxic chemicals, and organic (oxygen-consuming) materials.

Construction sites

Construction activities can harm nearby waters in three ways. The first occurs when natural land cover is disturbed during excavation and grading operations. Soil stripped of its protective vegetation can be easily washed into nearby surface waters. Second, stormwater runoff often carries materials used on the site, such as oil, grease, paints, glues preservatives, acids, cleaning solutions, and solvents, into nearby lakes or streams. And third, inadequate planning--failure to design and construct projects with water quality factors in mind, such as peak runoff and flow routing--can accelerate runoff.

Septic Systems

Many homes are not connected to municipal wastewater treatment systems and rely on septic tanks and field lines for sewage treatment. If they are well designed, installed, and maintained, septic systems will safely treat wastewater for 20 to 50 years. Improper design, installation, or operation of septic systems or holding tanks can lead to pollution of surface or groundwater by bacteria, nutrients, and household toxic chemicals. A recent U.S. Environmental Protection Agency (EPA) report stated that most waterborne diseases are probably caused by old or poorly designed and operated septic systems.

Septic systems use natural decomposition to treat wastes. Holding tanks do not treat wastes, but simply contain them on site. Both septic systems and holding tanks must be periodically pumped out or cleaned. Care must be taken in disposing of the materials removed in this cleaning. Solids cleaned out of septic systems can be land-spread since they are partially treated, but continuous spreading on a single site of land should be avoided. Wastes removed from holding tanks need additional treatment since they generally have not undergone much decomposition.

Croplands

Stormwater and snow melt runoff from croplands can carry sediments, nutrients, bacteria, and organic contaminants into nearby lakes and streams. Nitrates and pesticides can seep from agricultural lands and contaminate underlying groundwater supplies. By volume, sediment is the pollutant entering waters in the largest quantity. Cropland erosion is the most significant source of sediment. Good water quality and soil erosion management practices by individual land managers is the key to stopping valuable soil loss. This also protects water quality by preventing the movement of sediment and other pollutants from croplands to waters.

Livestock Operations

Animal feedlots are defined as lots and buildings used to confine animals for feeding, breeding, raising, or holding purposes. This definition includes open ranges used for feeding and raising poultry, but does not include pastures. Poor or inadequate feedlot management can allow stormwater runoff to carry pollutants from accumulating manure into surface and groundwaters. Feedlots can create significant pollution problems. Pollutants coming from animal feedlots include nutrients, oxygen-demanding materials, and pathogens that may affect humans and animals. High nitrate levels in groundwater have been associated with improper storage of animal manure.

Fertilizers

Nitrogen, phosphorus, and potassium are the three primary nutrients applied to crops, gardens, and lawns as fertilizers. Phosphorus and nitrogen entering water bodies in runoff from over fertilized areas can cause nuisance conditions, such as heavy algal blooms and excessive weed growth, making lakes unsuitable for swimming, waterskiing, and other uses. The presence of nitrates in rural well water presents a risk to infants under six months old whose formula is prepared with nitrate-contaminated water. Young infants lack the ability to handle high levels of nitrate and may develop methemoglobinemia (blue-baby syndrome), a disease impairing the ability of blood to carry oxygen throughout the body. Studies have indicated that nitrogen in fertilizers and manures is a probable source of elevated nitrate concentrations in rural groundwater supplies.

Pesticides

Pesticides are used to control undesirable plants or animals. They include herbicides, insecticides, fungicides, and rodenticide. Pesticides are used on agricultural lands, on urban and suburban lawns and gardens, as aquatic nuisance controls in lakes, and in forest management. Pesticide application can lead to groundwater contamination. Surface waters can be contaminated by drift from pesticide spraying and by runoff from pesticide-treated soil. Both surface and groundwaters are vulnerable to contamination by stormwater runoff flowing from storage, mixing, loading, and spray-tank cleaning areas.

Mining Activities

Mining activities can cause dramatic changes in surrounding watersheds. Lakes, streams, and groundwater can be polluted by sediment, tailings, dust, chemicals, and wastes from open pit, strip, and underground mines. Regulations to control mining activities have been instituted at both U.S. Federal and state levels.

Forest Practices

Waters in forested areas usually are of very high quality, so pollution, when it does occur, is likely to harm a valuable and relatively sensitive ecosystem. Forestry activities that can transfer pollutants from land to water are road construction, clearing land for fire breaks, stacking and loading operations during harvest, mechanical site preparation, controlled burning for site preparation, and application of pesticides and herbicides. Many large forested areas are managed by the U.S. Forest Service and state agencies. These agencies have authority to protect water quality by regulating forestry practices on public lands. Establishing effective forest management practices on private land is the primary concern for continued water quality protection from forestry activities.

SOURCE: Tennessee Valley Authority, Teacher/Student Water quality Monitoring Network Fall Workshop Teacher Guide, TVA, Norris, Tennessee, 1992.

GLOSSARY OF STREAM RELATED TERMS

Acid rain - rain with a pH of less than 5.6; results from atmospheric moisture mixing with sulphur and nitrogen oxides emitted from burning fossil fuels; causes damage to buildings, car finishes, crops, forests, and aquatic life.

Algae - simple plants which do not grow true roots, stems, or leaves and live mainly in water providing food for the food chain.

Algal bloom - a heavy growth of algae in and on a body of water as a result of high nitrate and phosphate concentrations from farm fertilizers and detergents.

Best management practices - an engineered structure or management activity, or combination of these, that eliminates or reduces an adverse environmental effect of pollutants.

Clearcutting - felling and removing all trees in a forest area.

Cobble stone - 2-10 inch size stones where aquatic insects are commonly found.

Culvert - a closed passageway (such as a pipe) under roadways and embankments which drains surface water.

Effluent - an out-flowing branch of a main stream or lake; waste material (i.e. liquid industrial refuse, sewage) discharged into the environment.

Erosion - the wearing away of land by wind or water.

Fish kill - the sudden death of fish due to the introduction of pollutants or the reduction of dissolved oxygen concentration in a water body.

Floodplain - a low area of land, surrounding streams or rivers, which holds the overflow of water during a flood.

Flow - the direction of movement of a stream or river.

Groundwater - a supply of fresh water under the earth's surface which forms a natural reservoir.

Leaching - the process where material in the soil (such as nutrients, pesticides, chemicals) are washed into lower layers of soil or are dissolved and carried away by water.

Nonpoint source pollution - pollution that cannot be traced to a specific point, but rather from many individual places (e.g., urban and agricultural runoff).

Nutrient - substance which is necessary for growth of all living things (i.e. phosphorous, nitrogen and carbon).

Nutrients - substances such as fertilizer; phosphorous and nitrogen compounds which enhances the growth of plants and animals.

Pesticide - a chemical that kills insects and rodents. Pesticides can poison aquatic life when they reach surface waters through runoff.

Point source pollution - a type of pollution that can be tracked down to a specific source such as a factory discharge pipe.

Pollutant - something that makes land, water and air dirty and unhealthful.

Riffle - shallow area of a stream or river with a fast moving current bubbling over rocks.

Runoff- water, including rain and snow, which is not absorbed into the ground -instead it flows across the land and eventually runs into streams and rivers. Runoff can pick up pollutants from the air and land, carrying them into the stream.

Sediment - soil, sand, and materials washed from land into waterways. Other pollutants may attach to sediment and be carried into stream.

Sedimentation - when soil particles (sediment) settle to the bottom of a waterway.

Septic tank - a domestic wastewater treatment system into which wastes are piped directly from the home; bacteria decompose the organic waste, sludge settles to the bottom of the tank, and the treated effluent flows out into the ground through drainage pipes.

Slumping - sections of soil on a streambank that have come loose and slipped into the stream.

Stagnation - when there is little water movement and pollutants are trapped in the same area for a long period of time.

Surface water - precipitation which does not soak into the ground or return to the atmosphere by evaporation or transpiration, and is stored in streams, lakes, wetlands, and reservoirs.

Toxic substances - poisonous matter (either chemical or natural) which causes sickness, disease and/or death to plants or animals.

Undercutting - a type of erosion which occurs when fine soils are swept away by the action of the stream, especially around curves. The result is an unstable overhanging bank.

Water cycle - the cycle of the earth's water supply from the atmosphere to the earth and back which includes precipitation, transpiration, evaporation, runoff, infiltration, and storage in water bodies and groundwater.

Watershed - land area from which water drains to a particular water body.

Watertable - the upper level of groundwater.

Waterway - a natural or man-made place for water to run through (such as river, stream, creek, or channel).

Wetland - an area of land that is regularly wet or flooded, such as march or swamp.

THINK SAFETY!

To ensure a fun and educational trip to your stream, please keep these simple precautions in mind:

- Always visit a site with at least one other person, then someone can go for help if one person is unable to.

- Never sample if a stream or river is flooding, or even one day after a heavy rain. Fast moving water is very dangerous. Also, avoid steep stream banks as access points. Wear a life jacket if near deep water.

- When sampling, avoid touching your mouth and eyes and be sure and wash hands before eating. If a waterbody is polluted or water quality is unknown, wear plastic gloves and rubber boots.

- Know the location of the nearest available phone or take a portable phone with you. Have an emergency plan ready if you are taking a group out--who will go for help, does anyone know CPR, does anyone have allergies?

- Don't go near the water if there is a strong chemical smell, a fish kill, or other dangerous conditions. Leave immediately and report the condition to appropriate authorities.

- Watch out for snakes, alligators, and snapping turtles. Hit the ground and trees with a stick as you walk to your site to scare snakes and other creatures away. Leave them alone and they will leave you alone.

- Look out for broken glass, poison ivy, ticks, bees, fire ants, and other hazards. Bring a first aid kit.

- Be aware of road hazards, both driving to the site and while conducting activities. Vehicles may not see you getting in and out of your car, bridges are narrow--make sure you have enough room to walk or go around to streambank, if under a bridge watch for objects knocked off the road from overhead.

WHO TO CALL

FOR LOCAL STREAM QUALITY PROBLEMS

Sewer spills or leaks, overflowing manholes:
Report to city or county public works, engineering or utilities department:
274-8084

Leaking Underground Storage Tanks:
Report immediately to fire department: 911

Game & Fresh Water Fish Commission/ Wildlife Alert - Reporting Wildlife violations:
1-800-282-8002

Poison Control: 253-4444

Florida Department of Environmental Protection: 744-6100

Hillsborough Environmental Protection Commission: 272-5960

Hillsborough River Greenways Task Force: 276-8417

Hillsborough County Public Works Dept.: (813) 272-5912 ext. 3616

SOIL CLASSIFICATION

This technique is a more quantitative method used to characterize streambeds. It is a good monitoring tool to evaluate the type of sediment in a stream. The sediment can be classified using a soil texture classification system. Sediment texture is often measured annually for several years. Generally, individuals are interested in measuring changes in fine sediments due to activities such as timber harvest, road construction, or development. It is widely accepted that increases in fine sediment is detrimental to fisheries and aquatic insects.

Collection Materials

Garden shovel or hand auger
Plastic Bag/ Bucket

Collect a representative bottom sediment using the shovel or hand auger. Place sample in bucket or bag and mix throughly.

Soil Texture Procedure

Testing Materials - LaMott Company

QUANTITY	CONTENTS	CODE
60 mL	Soil Flocculating Reagent	5643PS-H
60 mL	*Texture Dispersing Reagent	*5644PS-H
1	Soil Texture Stand	1053
3	Test Tubes, Soil Texture, 50 mL, w/cap	0760
2	Pipets, 1 mL, plastic, w/cap	0372

*WARNING: Reagents marked with a * are considered hazardous substances. Material Safety Data Sheets (MSDS) are supplied for these reagents. For your safety, read label and accompanying MSDS before using.

Background

This test is designed to separate soil into its three basic mineral fractions: sand, silt, and clay. The amount of time required for the soil particles of various sizes to settle in the soil separation tubes forms the basis for this test. From the amount of material collected in each tube it is possible to determine the approximate percentage of each fraction as represented in the original soil sample.

The separation tubes should be marked for identification in the following manner: Mark the first sedimentation tube "A", the second "B", and the third "C".

PROCEDURE

1. Place the three Soil Separation Tubes in the rack.

2. Add the soil sample to Soil Separation Tube "A" until it is even with line 15.
NOTE: Gently tap the bottom of the tube on a firm surface to pack the soil and eliminate air spaces.

3. Use the pipes (0372) to add 1 mL of *Texture Dispersing Reagent (5644PS) to the sample in Soil Separation Tube "A". Dilute to line 45 with tap water.

4. Cap and gently shake for two minutes, making sure all the soil sample is thoroughly mixed with water.

The sample is now ready for separation. The separation is accomplished by allowing a predetermined time for each fraction to settle out of the solution. Be sure that you continue to gently shake the separation tube up to the time of the first separation (Step 5).

5. Place Soil Separation Tube "A" in the rack. Allow to stand undisturbed for exactly 30 seconds.

6. Carefully pour off all the solution into Soil Separation Tube "B". Return Tube "A" to the rack. Allow Tube "B" to stand undisturbed for 30 minutes.

7. Carefully pour off the solution from Soil Separation Tube "B" into Soil Separation Tube "C". Return Tube "B" to the rack.

8. Add I mL of Soil Flocculation Reagent (5643PS) to Soil Separation Tube "C". Cap and gently shake for one minute.

9. Place the Soil Separation Tube "C" in the rack and allow to stand until all the clay in suspension settles. This may require up to 24 hours.

NOTE: Unless there is further use of the clay sample for air drying and study as described later, it is not necessary to wait for the Suspension to settle.

Due to the colloidal nature of clay in solution and its tendency to swell and form a gel, the portion of clay remaining in Tube "C" is not used to determine the clay fraction present in the soil. The clay fraction is calculated by adding the sand and silt fractions and subtracting this total from the initial volume of soil used for the separation.

EXAMPLE:

Tube "A" Sand	2	Initial Volume 15	
Tube "B" Silt	+8	Total "A" & "B"	-10
Total "A" & "B"	10	Clay	5

10. Read Soil Separation Tube "A" at top of soil level. To calculate percentage sand in the soil, divide reading by 15. Multiply by 100. Record as % sand.

11. Read Soil Separation Tube "B" at top of soil level. To calculate percentage silt in the soil, divide reading by 15. Multiply by 100. Record as % silt.

12. Calculate volume of clay as shown above. To calculate percent clay in the soil, divide value by 15. Multiply by 100. Record as % clay.

CALCULATION

EXAMPLE: Soil Separation Tube "A" reads 2. Soil Separation Tube "B" reads 8.

$$\text{Percent Sand} = \frac{\text{Reading A} \times 100}{\text{Total Volume}} = \frac{2 \times 100}{15} = 13\%$$

$$\text{Percent Silt} = \frac{\text{Reading B} \times 100}{\text{Total Volume}} = \frac{8 \times 100}{15} = 53\%$$

$$\text{Percent Clay} = \frac{\text{Calculated Volume} \times 100}{\text{Total Volume}} = \frac{5 \times 100}{15} = 33\%$$

Since the scientific basis of the test is the particle size and its mass, as related to its settling time when dispersed in solution, the following table is included for reference.

Soil Particle	**Diameter in mm**
Very Course Sand	2.0 - 1.0
Course Sand	1.0 - 0.5
Medium Sand	0.5 - 0.25
Fine Sand	0.25 - 0.10
Very Fine Sand	0.10 - 0.05
Silt	0.05 - 0.002
Clay	Less than 0.002

INTERPRETATION

Sandy soil is described as soil material that contains 85% or more sand. Silt soil is described as soil material that contains 80% or more silt and less than 12% clay. Clay soil is described as soil material that contains 40% or more clay, less than 45% sand and less than 40% silt.

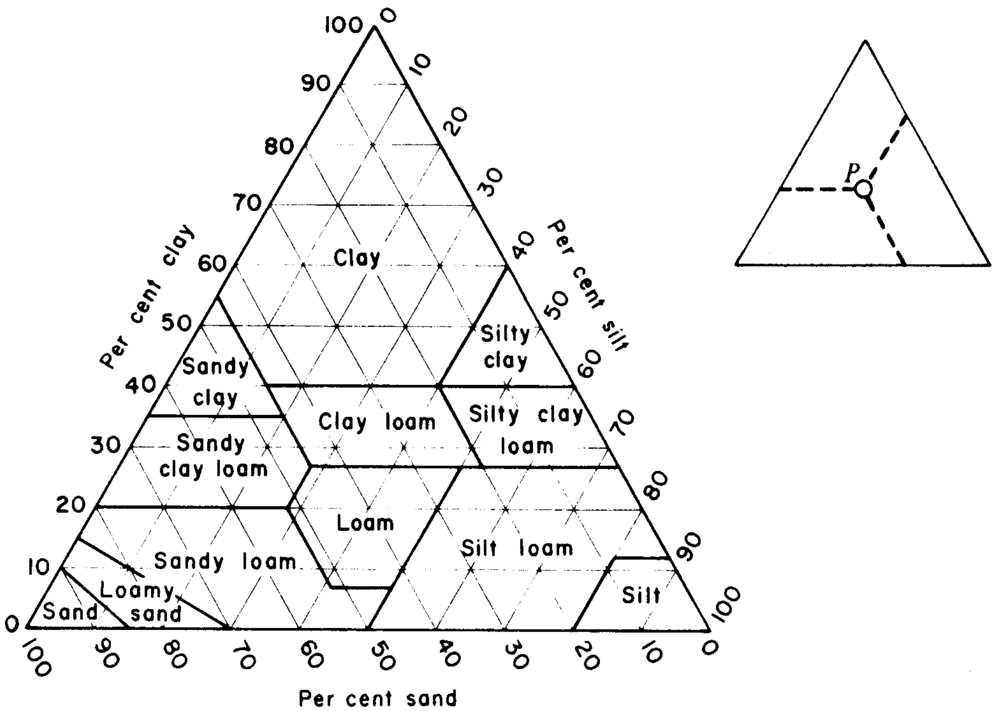


Figure 2. USDA textural classification chart.

To further describe the various graduations possible under each general soil texture classification mentioned above, additional terms have been applied. Some examples of these are loamy sand, sandy loam, silty clay loam, sandy clay or a silty clay. Soil texture classification can be determined through the use of the U.S. Department of Agriculture Textural Classification Chart as shown in Figure 2 .

Once the three textural classes for a soil have been determined it may be of further interest to place the material from each Soil Separation Tube in individual piles on a piece of paper. Allow sufficient time for air drying. Now it is possible to determine the feel of the various textural classes. This experience will be helpful when you are in the field.

The following statements give the more obvious characteristics of a textural class based on its feel when rubbed between the fingers.

Sand is loose and single grained and will fall apart after being squeezed when dry. When sand is wet it will form a cast that falls apart after being squeezed.

Sandy loam contains mostly sand, but also some silt and clay. Individual sand grains can be felt and seen.

Silt loam has a moderate amount of the very find grains of sand, is fine-textured and contains only a small amount of clay. A dry sample feels smooth and silky like flour or talcum powder.

Clay loam is a fine-textured soil that after working breaks up into clods or lumps that are hard to break when dry. A wet cast forms a smooth smear and is sticky when squeezed.

WATER SEDIMENTATION TEST

These tubes may also be used as sedimentation tubes for the study of turbid waters.
1. Fill tubes to the 50 mL mark with sample water. Cap and place in the plastic rack. Leave undisturbed until the solid material has settled.

CALCULATION:

Each 0.5 mL collected is equivalent to 1% of the total volume.

STREAM FLOW

(from EPA Volunteer Stream Monitoring: A Methods Manual)

What is stream flow and why is it important?

Stream flow, or discharge, is the volume of water that moves over a designated point over a fixed period of time. It is often expressed as cubic feet per second (ft^3/sec).

The flow of a stream is directly related to the amount of water moving off the watershed into the stream channel. It is affected by weather, increasing during rainstorms and decreasing during dry periods. It also changes during different seasons of the year, decreasing during the summer months when evaporation rates are high and shoreline vegetation is actively growing and removing water from the ground. August and September are usually the months of lowest flow for most streams and rivers in most of the country.

Water withdrawals for irrigation purposes can seriously deplete water flow, as can industrial water withdrawals. Dams used for electric power generation, particularly facilities designed to produce power during periods of peak need, often block the flow of a stream and later release it in a surge.

Flow is a function of water volume and velocity. It is important because of its impact on water quality and on the living organisms and habitats in the stream. Large, swiftly flowing rivers can receive pollution discharges and be little affected, whereas small streams have less capacity to dilute and degrade wastes.

Stream velocity, which increases as the volume of the water in the stream increases, determines the kinds of organisms that can live in the stream (some need fast-flowing areas; others need quiet pools). It also affects the amount of silt and sediment carried by the stream. Sediment introduced to quiet, slow-flowing streams will settle quickly to the stream bottom. Fast moving streams will keep sediment suspended longer in the water column. Lastly, fast moving streams generally have higher levels of dissolved oxygen than slow streams because they are better aerated.

This Appendix describes one method for estimating flow in a specific area or reach of a stream. It is adapted from techniques used by several volunteer monitoring programs and uses a float (an object such as an orange, ping-pong ball, orange, etc.) to measure stream velocity. Calculating flow involves solving an equation that examines the relationship among several variables including stream cross-sectional area, stream length, and water velocity. One way to measure flow is to solve the following equation:

$$\text{Flow} = \frac{A\,L\,C}{T}$$

where:

A = Average cross-sectional area of the stream (stream width multiplied by average water depth).

L = Length of the stream reach measured (usually 20 ft.)

C = A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams). This allows you to correct for the fact that water at the surface travels faster than near the stream bottom due to resistance from gravel, cobble, etc. Multiplying the surface velocity by a correction coefficient decreases the value and gives a better measure of the stream's overall velocity.

T = Time, in seconds, for the float to travel the length of L

How to Measure and Calculate Stream Flow

TASK 1 Prepare before leaving for the sampling site

Refer to the Level I Appendix for details on safety considerations. In addition to the standard sampling equipment and apparel (rubber boots or waders), when measuring and calculating flow, include the following equipment:

- Ball of heavy-duty string, four stakes, and a hammer to drive the stakes into the ground. The string will be stretched across the width of the stream perpendicular to shore at two locations. The stakes are to anchor the string on each bank to form a transect line.
- Tape measure (at least 20 feet)
- Waterproof yardstick or other implement to measure water depth
- Twist ties (to mark off intervals on the string of the transect line)
- An orange and a fishing net (to scoop the orange out of the stream)
- Stopwatch (or watch with a second hand)
- Calculator (optional)

TASK 2 Select a stretch of stream

The stream stretch chosen for the measurement of discharge should be straight (no bends), at least 6 inches deep, and should not contain an area of slow water such as a pool. Unobstructed riffles or runs are ideal. The length that you select will be equal to L in solving the flow equation. Twenty feet is a standard length used by many programs. Measure your length and mark the upper and lower end by running a transect line across the stream perpendicular to the shore using the string and stakes (Figure 3). The string should be taut and near the water surface. The upstream transect is Transect #1 and the downstream one is Transect #2.

TASK 3 Calculate the average cross sectional area

Cross-sectional area (A in the formula) is the product of stream width multiplied by average water depth. To calculate the average cross-sectional area for the study stream reach, volunteers should determine the cross-sectional area for each transect, add the results together, and then divide by 2 to determine the average cross-sectional area for the stream reach.

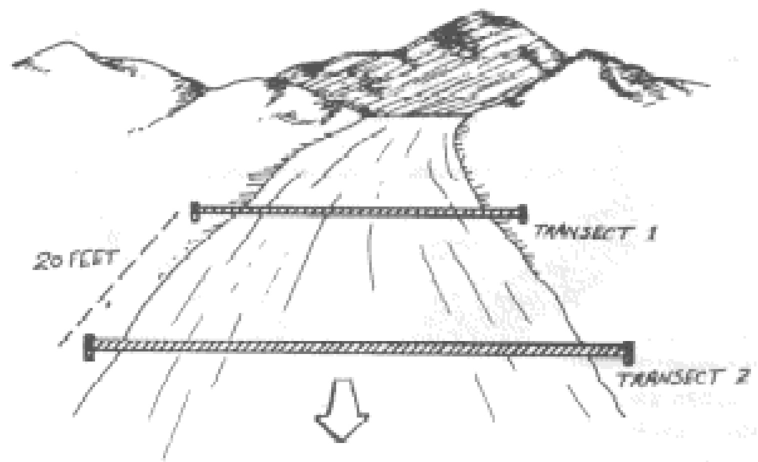


Figure 3. A diagram of a 20 foot transect.

To measure cross-sectional area:

1. Determine the average depth along the transect by marking off equal intervals along the string with the twist ties. The intervals can be one-fourth, one-half, and three-fourths of the distance across the stream. Measure the water's depth at each interval point (Figure 4). To calculate average depth for each transect, divide the total of the three depth measurements by 4. (You divide by 4 instead of 3 because you need to account for the ⌀ depths that occur at the shores) In the sample calculation shown, the average depth of Transect #l is 0.575 feet and the average depth of Transect #2 is 0.625 feet.

2. Determine the width of each transect by measuring the distance from shoreline to shoreline. Simply add together all the interval widths for each transect to determine its width. In the example given (Figure 4), the width of Transect #l is 8 feet and the width of Transect #2 is 10 feet.

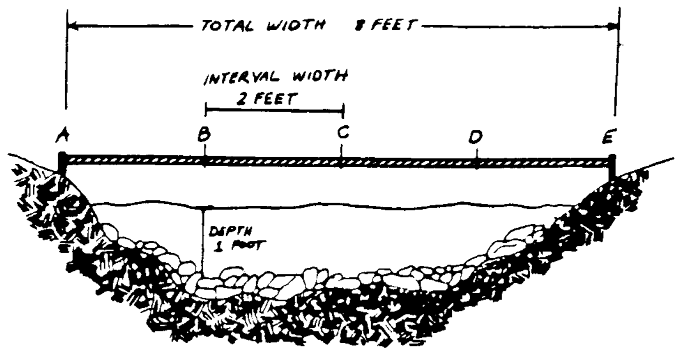


Figure 4. A cross-section view to measure stream width and depth.

Example Determining Average Cross-Sectional Area (A)

Transect #1 (upstream)				**Transect #2 (downstream)**			
	Interval Width (feet)	**Depth (feet)**			**Interval Width (feet)**	**Depth (feet)**	
A to B =	2.0	1.0	(at B)	A to B=	2.5	1.1	(at B)
B to C =	2.0	0.8	(at C)	B to C=	2.5	1.0	(at C)
C to D =	2.0	0.5	(at D)	C to D=	2.5	0.4	(at D)
D to E =	2.0	0.0	(shoreline)	D to E=	2.5	0.0	(shoreline)
Totals	**8.0**	**2.3**				**10.0**	**2.5**

Average depth = 2.3/4 = 0.575 feet
Cross-sectional area of Transect #1
= Total width X Average depth
= 8ft X 0.575
= 4.60 ft^2

Average depth = 2.5/4 = 0.625 feet
Cross-sectional area of Transect #2
= Total width X Average depth
= 10.0ft X 0.625
= 6.25 ft^2

Average area = (Cross-sectional area of Transect #1 + Cross-sectional area of Transect #2) /2 = (4.60 ft^2 + 6.25 ft^2) /2 = 5.42 ft^2

3. Calculate the cross-sectional area of each transect by multiplying width times average depth. The example shows that the average cross-sectional area of Transect #l is 4.60 square feet and the average cross-sectional area of Transect #2 is 6.25 square feet.

4. To determine the average cross sectional area of the entire stream reach (A in the formula), add together the average cross-sectional area of each transect and then divide by 2. The average cross-sectional area for the stream reach depicted in Figure 4 is 5.42 square feet.

Task 4 Measure travel time

Volunteers should time with a stopwatch how long it takes for an orange (or some other object) to float from the upstream to the downstream transect. An orange is a good object to use because it has enough buoyancy to float just below the water surface. It is at this position that maximum velocity typically occurs.

The volunteer who lets the orange go at the upstream transect should position it so it flows into the fastest current. The clock stops when the orange passes fully under the downstream transect line. Once under the transect line, the orange can be scooped out of the water with the fishing net. This "time of travel" measurement should be conducted at least three times and the results averaged—the more trials you do, the more accurate your results will be. The averaged results are equal to T in the formula. It is a good idea to float the orange at different distances from the bank to get various velocity estimates. You should discard any float trials if the object gets hung up in the stream (by cobbles, roots, debris, etc.)

Task 5 Calculate flow

Recall that flow can be calculated using the equation:

$$\text{Flow} = \frac{ALC}{T}$$

Continuing the example in Fig. 5.6. say the average time of travel for the orange between Transect #1 and #2 is 15 seconds and the stream had a rocky bottom. The calculation of flow would be:

A = 5.42ft^2

L = 20 ft

C =0.8 (coefficient for a rocky-bottom stream)

T = 15 seconds

$$\textbf{Flow} = \frac{(5.42\text{ ft})(20\text{ ft})(0.8)}{15\text{ sec.}} = \frac{86.72\text{ ft}^3}{15\text{ sec}}$$

Flow = 5.78 ft^3/sec.

Task 6 Record flow on the data form

On the following page is a form volunteers can use to calculate flow of a stream.

References

Adopt-A-Stream Foundation. *Field Guide: Watershed Inventory and Stream Monitoring Methods,* by Tom Murdoch and Martha Cheo. 1996.

Everett, WA. Mitchell, M.K., and W. Stapp. *Field Manual for Water Quality Monitoring*. 5th Edition. Thompson Shore Printers.

Missouri Stream Teams. *Volunteer Water Quality Monitoring*. Missouri Department of Natural Resources, P.O. Box 176. Jefferson City, MO 65102.

DATA FORM FOR CALCULATING FLOW

Solving the equation: **Flow = $\frac{ALC}{T}$**

Where:

A = Average cross-sectional area of the stream. L = Length of the stream reach measured (usually 20 ft.).C = A coefficient or correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams). T = Time, in seconds, for the float to travel the length of L.

A: Average Cross-Sectional Area

Transect #1 (upstream)	**Interval Width (feet)**	**Depth (feet)**		**Transect #2 (downstream)**	**Interval Width (feet)**	**Depth (feet)**	
Ato B =	____	____	(at B)	A to B =	____	____	(at B)
B to C =	____	____	(at C)	B to C =	____	____	(at C)
C to D =	____	____	(at D)	C to D =	____	____	(at D)
D to E =	____	____	(shoreline)	D to E =	____	____	(shoreline)
Totals	_____	_____ /4		**Totals**	_____	_____ /4	
= Avg. depth ______ ft				= Avg. depth ______ ft			

Cross-sectional area of Transect #1Cross-sectional area of Transect #2

= Total width (ft) X Avg. depth (ft)   = Total width (ft) X Avg. depth (ft)

_____ X _____ = _____ft^2 _____ X _____ = _____ft^2

(Cross-sectional area of Transect #1 + Cross-sectional area of Transect #2) ÷ 2 =

Average Cross-sectional area =

(______ ft^2 + _______ft^2) ÷ 2 = ________ft^2

C: Coefficient________

L: Length of Stream Reach ___________ ft

T:Travel Time of Float (sec.)	Trial #1	_____sec
	Trial #2	_____sec
	Trial #3	_____sec
	Total time=	_____ sec

T = Average time = Total time/3 = ______ sec

$$\textbf{Flow} = \frac{\textbf{ALC}}{\textbf{T}} = \frac{\textbf{Average Cross-sectional Area x Length x C}}{\textbf{Average time}} = \_\_\_\_\_\_\_\_ \ \textbf{ft}_3\textbf{/sec}$$

UNUSUAL COLORS AND ODORS IN WATERS
Evidence of Point and Nonpoint Sources

Condition	Possible Cause
Muddy Water	Erosion of soil in upstream area; in tidal waters it could also be caused by high winds.
Greenish Color	Microscopic plant cells called algae. Algae growth may be caused to exceed normal limits due to excessive amount of nutrients entering the water. Nutrient sources include: fertilizers, pet waste, grass clippings, leaves, etc.
Yellow-brown to dark brown water	Acids released from decaying plants. Naturally occurs each fall when dead leaves collect in the stream. Also common in streams, draining marsh or swampland.
Orange to red coating on stream bed	Results from bacteria action upon iron. May indicate a high erosion rate or industrial pollution.
Colored sheen on water surface	May indicate oil has entered the stream, particularly if there is water surface also an oily odor.
Foam	When foaming occurs in only a few scattered patches and is less than 3 inches high and cream-colored, it is probably natural. If the foaming is extensive, white in color or greater than 3 inches, it may be due to detergents entering the stream.
Rotten egg odor	Indicates sewage pollution. Odor may also be present in marsh or swampland.
Musky odor	May indicate presence of untreated sewage, livestock waste, algae or other conditions.
White cottony masses on stream bed	Could be "sewage fungus." The presence of this growth indicates sewage or other organic pollution.
Blue-green algae	Could indicate nutrients input if growth is excessive.

Evaluation of Stream Conditions

Observable Condition	Likely Causes	For Further Investigation
Sediment: the stream bottom is almost completely covered with deposition and there may be moving sand bars. Sedimentation may be associated with brown stream color during high now.	Mud, silt, or sand on the stream bottom may result from surface runoff from construction sites or exposed soils, channel alterations, or bank undercutting and slumping.	Examine upstream areas for development activities with inadequate sediment control, streambank modification, or severely undercut or slumping stream banks. Unpaved roads can also be a significant source of sediment.
Aquatic Weeds: covering the water surface or stream bottom, especially in pond or slow moving areas with sunlight.	This may be a difficult problem to assess because aquatic plants can be indicators of a high quality habitat, such as a wetland, or a shallow, muddy backwater. Sometimes, however, they are a symptom of excessive nutrients, especially when there are long streamers present.	Examine upstream areas for sources of nutrients such as sewage, heavily fertilized areas (i.e. golf courses or croplands), car washes, livestock areas, or washwater discharges from food processing industries.
Algae: floating or attached tiny plants which can color the water green, resemble seaweed when affixed to the stream bottom, form a surface scum, or have an oil-like appearance.	Algal growth indicates an upstream nutrient source.	Examine upstream areas for sources of nutrients (see above).
Foam or Bubble: floating on the water surface.	When foaming occurs in only a few, scattered patches and is less than 3 inches high and cream colored it is probably natural. If the foaming is extensive, white in color or greater than 3 inches, it may be due to detergents or surfactants entering the stream. White foam can also be caused by fertilizer leachate.	Examine upstream areas for industrial, municipal, or residential wastewater sources, or other sources of nutrients.
Bank Stains or Dry Weather Discharges From Pipes: stains may be observed on stream banks . (which would indicate a spill, leachate, or a sporadic discharge) or below pipes (which suggests an intermittent or periodic discharge). Dry weather flow may be discharged from pipes protruding from the sreambank or from storm sewer pipes (normally large and composed of concrete).	Bank stains and mats of dried materials, especially below pipes, are likely to indicate sporadic discharges of oil, organic wastes, or the discharges of washwaters or process wastes. Dry weather flow from storm sewer pipes would suggest washwaters from paved areas or direct connections to commercial or industrial drains. Flow from other pipes along the stream banks may be non-contact cooling water (legal with a permit) or washwaters or process wastewaters from nearby activities.	Examine the stain or discharge and its texture. Is it familiar? Stains and discharges from pipes along the stream banks are likely to result from nearby or adjacent activities. However, dry weather flows discharged from storm sewers can come from remote locations. The procedure for locating the source of such discharges is to follow the storm sewer. Continue looking or listening for flow in curbside inlets or storm sewer manholes until you find the discharge source or identify the activity which is discharging.
Leaking or Surcharging Sanitary Sewers or Manholes: white to grey musky smelling discharges from a joint or a crack in a plies (normally-cast iron) or a sewer manhole. Sewage may be seen gushing from a manhole top. Grey matty material draped on or deposited near a manhole may indicate past overflows.	Sanitary sewers and manholes can Gil or clog over the course of time and leak or surcharge from manholes .	Report immediately to the local public works department.
Dingy White or Grey (or even Brown stained) Cotton-like Tufts: hair-like growths which are attached to the stream bottom or objects in the stream.	This growth is probably Sphaerotilus, a sheath or iron bacterium, which thrives on organic matter. When a continuing abundance of organic wastes is available they grow in colonies which resemble dingy cotton. This could also be sulphur bacteria.	Look for nearby wastewater discharges or sources of nutrients and organic wastes such as food processing plants.
Red Mats: on the stream bottom, which appear to be shimmering with the current and disappear when disturbed. (Not to be confused with iron bacteria).	These are colonies of aquatic, segmented worms called sludge worms or aquatic worms. These individuals resemble small earthworms and are also an indication of heavy organic waste loads	Examine upstream areas for sources of organic wastes.

Observable Symptoms	Likely Causes	For Further Investigation
Orange-Red Surface Film or Floc-like Deposits in slow or pond areas. The surface film breaks up when stirred.	This is nominally a naturally occurring phenomenon resulting from iron bacteria growth. It is generally associated with acidic soils, or can be enhanced by iron in surface runoff or leachates.	Examine upstream areas for sources of organic wastes or wastewater.
Sludge Deposits/Bubbles Rising to Surface: normally deposits of thick dark grey to black, "mucky" material. The top few inches of sediment and objects in the water may be stained black. Sometimes bubbles may be observed rising to the surface.	Sludge deposits are the result of solid organic matter which has settled to the bottom in quiet areas. When the dissolved oxygen level in the water is severely depleted, anaerobic bacteria (they function without oxygen) reduce nitrogen and sulphur compounds creating gases which bubble to the surface and create the characteristic rotten egg (hydrogen sulfide) odor.	Examine upstream areas for sources of heavy oil such as industries or fuel storage areas. Bank stains are likely to be evident.
Oil Released From Sediment: when sediment s stirred up.	Heavy oils may settle out and be deposited in sediment. When the sediment is stirred up the oil is resuspended.	
Barrels or Containers - : in stream or on stream banks.	Empty barrels and containers may contain traces of hazardous or polluting substances.	Look for a label to identify the contents of the barrel or container. If there is no label or the barrel is labeled hazardous, call the DEP Hazardous Waste Program. DO NOT REMAIN NEAR OR ATTEMPT TO DEAL WITH HAZARDOUS MATERIALS AS THEY COULD BE HAZARDOUS TO SMELL OR TOUCH
Water Color		
Light Brown: (muddy or cloudy), especially during high flows.	Mud, slit, sand on bottom or entering the stream from such sources such as surface runoff from construction activities, channel alterations, or bank undercutting and scouring is suspended in the water column.	Examine upstream areas for development activities with inadequate sediment control practices, streambank modifications, or severely undercut stream banks.
Green: especially deep green or blue-green.	If the stream is noticeably green, this could be an indication of Organic pollution being released into the stream feeding algae (hence the term algal bloom) and other aquatic plants.	Examine upstream areas for sources of nutrients such as sewage, heavily fertilized area (i.e. golf courses or croplands), car washes, livestock areas, or washwater discharges from food processing industries.
Multi-Color Film or Reflection: over an extensive portion of the stream surface which does not break apart when stirred.	The is typically a hydrocarbon product such as oil or gasoline resulting from spills, discharges, or washoff from vehicle maintenance areas.	IF continuously flowing, follow the sheen back to its point of origin or look for dark bank stains, dripping pipes, stains in tributaries, or likely sources of oil and gas such as service stations, car dealers, storage tanks, or vehicle service areas.
Dark Red, Purple, Blue or Black: in comparison to normal stream color in the area.	This would normally indicate organic dye from bather tanning or clothing manufacturers	Examine upstream areas for potential sources such as pipes or ditches from industrial plants.
Odor		
Rotten egg	This may indicate sewage pollution or sludge deposits, but this odor may also be present in swamps, marshlands, or slow moving streams where Oaf leaf litter and other organic matter has settled.	Examine upstream areas for a source of sewage, heavy organic wastes, or animal wastes.
Sewage	Noticeable sewage odors result from the discharge of inadequately treated wastewater.	Examine upstream areas for raw wastewater discharges, grey discolored flows, septic tank leachate, or leaking sewers or manholes.
Acrid Smell	May indicate the presence of industrial or pesticide pollution.	Examine upstream areas for industrial dischargers.

Observable Symptom	Likely Causes	For Further Investigation
Chlorine	This may mean that a sewage treatment plant or chemical industry is over-chlorinating its effluent or that a chlorine spill has or occurred.	Report the odor to the local Public Works or Water and Sewer Department. IF THE SMELL IS STRONG LEAVE THE STREAM UNTIL THE SOURCE IS IDENTIFIED AND CORRECTED
Ammonia	This generally indicates the presence of ammonia or an ammonia compound, frequently resulting from a leak in a cooling system.	Follow odor upstream and look for an industrial discharge. IF THE SMELL IS STRONG LEAVE STREAM, AS PER ABOVE.
Other Odors	Strong odors may be associated with the discharge of chemicals or wastes from manufacturing.	Follow odor upstream to a discharge and note likely sources.
Fish		
Erratic Swimming: near the surface, fish gasping for air at the surface, or swimming in circles	This may indicate the presence of toxic substances or low dissolved oxygen conditions.	Report condition to the nearest Game and Fish Division Office or a Conservation Ranger.
Dead: on the water surface or stream bank	This may indicate toxic substances or low dissolved oxygen conditions.	Report to Florida Game and Fish Commission
Disease: such as the presence of red sores or cotton-like growth on fish	Disease may be the result of environmental stress or natural phenomena.	Report condition to nearest Game and Fish Division Office or a Conservation Ranger.

Prepared by the Georgia Environmental Protection Division. Direct comments or suggestions regarding this form to Ted Mikaben, Georgia EPD, LK Jr. Dr., S.W., SuKe 643, Atlanta, Georgia 30334. Telephone 404~656 4988.

Group:____________________________________
Stream site:________________________________
Date:_____________________________________
Quarter:___________________________________
Form Completed by:__________________________
Phone:____________________________________

Hillsborough County Stream Waterwatch Level I Activity Summary

Send, e-mail, or fax a copy to Hillsborough County Stream-Waterwatch (HCC Stream Waterwatch) 1206 N. Park Road, Plant City , FL 33566; e-mail streamwaterwatch@bellsouth.net, fax: (813) 757-2148. each quarter, before March 31, June 30, September 30 and December 31. Attach latest results from Watershed Walk or Visual Survey.

Activity	Date Completed
Watershed Walk (one per year)	
Visual Surveys (one per quarter)	
1st Quarter	
2nd Quarter	
3rd Quarter	
4th Quarter	
Litter Pick Ups (one per quarter)	
1st Quarter	
2nd Quarter	
3rd Quarter	
4th Quarter	
Other? Please describe	

Comments:____

HILLSBOROUGH COUNTY STREAM WATERWATCH
WATERSHED WALK SURVEY FORM

Stream Name:_______________________________________Date:________________________

Stream Segment. Include a map with starting and ending points: a road crossing, a county park, another stream.

____

Group Leader:___________________________Phone:____________________________________

Participants:____

Date of last rainfall:_____________ Water flow ☐ high ☐ normal ☐ low

Weather conditions:__________________Air temperature:______________________________

Water temperature:______________

AFTER THE WATERSHED WALK: SUMMARY

In each of the five areas listed below, comment on:

1. Overall conditions,
2. Any conditions that warrant particular attention, or
3. Any conditions in which you noticed a major change along the length of your segment.

LAND USE:____

BANK CONDITIONS:____

SURFACE WATER AND WATER CLARITY:_______________________________________

STREAM BED:____

HUMAN IMPACTS:____

OVERALL ASSESSMENT (from Chart A):
☐ EXCELLENT ☐ GOOD/FAIR ☐ POOR

HILLSBOROUGH COUNTY STREAM WATERWATCH
WATERSHED WALK SURVEY

Check the column that best describes your stream segment for each category. Consider the area within 1/4 mile of your stream segment as the watershed for ranking purposes.

Chart A

	POOR	FAIR/GOOD	EXCELLENT
LAND USE BY THE STREAM	BARE DIRT OR COMPLETELY PAVED MAXIMUM DISTURBANCE	LITTLE TO MODERATE COVER, SOME BARE GROUND AND SOME PAVED	UNDISTURBED, GOOD COVER ALL YEAR
BANKS (EROSION)	SEVERE EROSION Exposed dirt, obvious loss of soil, steep slope	MODERATE EROSION some exposed dirt and some evidence of soil loss	NO EROSION dirt is covered no evidence of soil loss
WATER SURFACE	FILM OR FOAM IS PRONOUNCED	SLIGHT FILM OR FOAM	NO SLICK OR FILM OR FOAM
WATER CLARITY/COLOR	HIGHLY COLORED OR LOW CLARITY	LITTLE COLOR OR LOSS OF CLARITY	CLEAR WATER
WATER ODOR	SEVERE ODOR	SLIGHT ODOR	NO ODOR
STREAM BED SILTATION	MUCH SILT SHOWS EROSION	SLIGHT SILT	NO SILT NO EROSION
ALGAL GROWTH IN STREAM	OVERABUNDANT ALGAL GROWTH	NO ALGAE	MODERATE ALGAL GROWTH
ANIMAL LIFE	NONE	FEW	ABUNDANT
BACTERIA IRON IN STREAM BED	OVER ABUNDANT	MODERATE	NONE
LITTER	VERY COMMON	SMALL AMOUNT	NONE
HUMAN IMPACTS ON STREAM	MAJOR (dams, pipes, road culverts, etc.)	MODERATE some evidence of damage	LITTLE seems natural

HILLSBOROUGH COUNTY STREAMWATERWATCH

Visual Survey

Use this form to record important information about the health of your stream. By keeping accurate and consistent records of your observations, you can document current conditions and changes in water quality and habitat.

Name of Stream **Location**

Individual or Group **Members Present**

Date **County**

Weather Conditions

☐ clear ☐ cloudy ☐ rain ☐ rain within last 24 to 48 hours?

Visual Survey

Water Flow ☐ high ☐ normal ☐ low ☐ measured _______ cfs

Number of pools _______Number of riffles_____Stream Width_____ft. Stream Depth______ft.

USDA Texture Classification_____________% Sand_______% Silt________%Clay________

Water Appearance

☐ clear	☐ milky/gray	☐ none	☐ rotten egg
☐ muddy	☐ green	☐ natural	☐ sewage
☐ oily	☐ brown	☐ gasoline or oil	☐ chemical
☐ foamy	☐ black	☐ chlorine	☐ other________
☐ scum	☐ other ________		

Habitat Description (use Chart B)	**Excellent**	**Good**	**Fair**	**Poor**
Stream Bed	☐	☐	☐	☐
Sediment Deposits	☐	☐	☐	☐
Streambank Stability	☐	☐	☐	☐
Streambank Cover	☐	☐	☐	☐

Algae Appearance:

☐ light green
☐ dark green
☐ brown coated
☐ matted on stream bed
☐ hairy

Algae Located:

☐ not present
☐ in spots
☐ attached
☐ everywhere

☐ Other Observations? Wildlife?____
☐ Evidence of Pollution? How much/what kind?________________________________
☐ Litter or Trash in area? How much/what kind?_______________________________

Chart B

Habitat Description	Excellent	Good	Fair	Poor
Stream Bed	More than 50% rocks, logs, vegetation, undercut banks or other stable habitat. insects.	50% to 30% rocks, logs, vegetation, or undercut banks. Adequate habitat for fish and aquatic habitat for fish and aquatic insects.	30% to 10% rocks, logs, vegetation, or undercut banks. Less than desirable habitat for fish and aquatic insects.	Less than 10% rocks, logs, vegetation, or undercut banks. Obvious lack of Habitats for fish and aquatic insects.
Sediment Deposits	Little or no sediment deposits. Less than 5% of stream bed has sediment.	Some sediment deposits, mostly in pools. 5% to 30% of stream bed has sediment.	Moderate sediment deposits. 30% to 50% of stream bed has sediment.	Heavy deposits of sediment. More than 50% of stream bed has sediment.
Streambank Stability	Stable. No evidence of erosion.	Moderately stable. Only small areas of erosion.	Moderately unstable. Up to 60% of banks have evidence of erosion.	Unstable. 60%to 100% of banks have evidence of erosion.
Streambank Cover	More than 80% of streambank covered with vegetation, rocks and other stable material.	80% to 50% of streambank covered with vegetation, rocks and other stable material.	50% to 25% of streambank covered with vegetation, rocks and other stable material.	Less than 25% of streambank covered with vegetation, rocks and other stable material.

Hillsborough County Stream Waterwatch
Stream Registration Form

Complete the following questions to help you structure your program. This form must be completed and returned to register your adopted site with Hillsborough County Stream Waterwatch.

Name of Adopted Site Date

Location of Stream/River Segment

Initiating Organization

Lead Coordinator

Mailing Address Zip Code

Phone Number(s) Fax

Street Address (if different from mailing address)

What is the name of your adopted project?

Hillsborough County Stream-Waterwatch

Level II Field Guide

Biological and Chemical Monitoring

ACKNOWLEDGMENTS

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EPA Office of Water
Florida Department of Environmental Protection
Georgia Adopt-A-Stream
Hillsborough River Greenways Task Force
Hillsborough Community College
Hillsborough County Public Works Stormwater Management Division
Hillsborough County Environmental Protection Commission
Save our Streams, Izaak Walton League of America

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LEVEL II FIELD GUIDE
TABLE OF CONTENTS

INTRODUCTION

Hillsborough County Stream-Waterwatch encourages volunteers to learn about water quality conditions of local streams, rivers and lakes. This manual describes methods to further evaluate water quality and more opportunities to protect and improve water quality.

Level I emphasizes watershed walks and visual surveys as evaluation tools. Levels II and III focuses on biological and chemical monitoring of water quality and habitat. Likewise, Level I volunteers help improve water quality by cleaning up litter in and around their adopted stream. In Levels II and III, volunteers can choose a habitat enhancement project to improve water quality. In all levels, gathering and sharing information about the adopted stream, and reporting problems when noticed, helps protect water quality.

The difference between Levels II and III is one of increasing activity. Level II volunteers choose one of the activities below, in addition to the Level I activities. Level III volunteers choose two or more of the activities below, in addition to Level I activities.

· Biological Monitoring 4 times a year (quarterly)
· Physical/Chemical Monitoring 12 times a year (monthly)
· Habitat Enhancement one time project (arranged with Hillsborough County)

Biological and Chemical Monitoring require training. Training workshops are available through the Hillsborough County Stream-Waterwatch at the Regional Environmental Training Center at HCC's Plant City Campus. Training will include an overview of the program, monitoring techniques and quality assurance tests.

These activities **help protect water quality and streams because:**

Regular monitoring provides specific information about the health of your local stream. Both long-term trends and immediate changes in water quality can be documented. Biological monitoring will detect changes in water quality and habitat and provides an indication of overall stream health. Chemical monitoring, however, provides specific information about water quality parameters that are important to aquatic life--such as dissolved oxygen and pH. Habitat enhancement projects improve streambanks or the streambed. Habitat enhancement projects may stop a streambank from eroding, and therefore decrease the amount of sediment entering a stream or improve in-stream habitat for fish to feed, hide and lay eggs.

Quality Assurance Certification

If volunteers wish to ensure their data is of the highest quality, volunteers can become quality assurance (QA/QC) certified. Quality assured volunteer data will be used by various local and state assessments of water quality conditions. Quality assurance certification will be a part of every chemical and biological training workshop. Water quality data collected on streams, rivers and lakes has many informational purposes. However, a permanent record of only data collected by quality assured volunteers will be kept.

Chemical Certification

- Volunteer's methods and test kits must achieve results within 10% of those obtained by a certified trainer.

- Volunteers and their test kits must be QA/QC certified annually.

- Volunteers must sample once a month for one year and send results to Hillsborough County Stream-Waterwatch.

Biological Certification

- Volunteers must demonstrate the ability to collect a macro invertebrate sample to a certified trainer.

- Volunteers must identify, with 90% accuracy, not less than 20 macro invertebrates and correctly calculate the SOS Index for water quality.

- Volunteers must be QA/QC certified annually.

- Volunteers must sample once every three months for one year and send results to Hillsborough County Stream-Waterwatch.

BIOLOGICAL MONITORING

(based on the Save Our Streams program Izaak Walton League of America)

Biological monitoring involves identifying and counting macro invertebrates. The purpose of biological monitoring is to quickly assess both water quality and habitat. The abundance and diversity of macro invertebrates found is an indication of overall stream quality.

Macro invertebrates are aquatic insects, crayfish, and snails that live in various stream habitats and are used as indicators of stream quality. Macro invertebrates are present during all kinds of stream conditions--from drought to floods. These insects and crustaceans are impacted by all the stresses that occur in a stream environment, both man-made and naturally occurring. Follow steps one through three to complete a biological sample of your stream.

1. Find a sampling location in your stream. Macro invertebrates can be found in many kinds of habitats--places like riffles (where shallow water flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the stream bed. **If present, riffle areas will have the most macro invertebrates. If you have a stream with riffles, follow step 2a below. If your stream has a muddy or sandy bottom (and no riffles), you will sample using the method in step 2b below.** Sample the same stretch of stream each time, to ensure consistency (for example 50 yard stretch). Sample every three months, approximately once each season (spring, summer, fall, and winter).

Equipment List:
D-frame net or kick seine
sorting pan
forceps
pencils and clipboard
hand lens
Biological Survey
SOS Macro invertebrate guide
rubber waders or old tennis shoes
rubber gloves

Optional:
preservation jars or baby food jars
rubbing alcohol, for preservation,
bucket with screen bottom
(for muddy bottom sampling)

2. Sampling Methodology

a) For streams with riffles:

In this "rocky bottom" method, you will sample two different habitats--riffles and leafpacks. First, identify three riffle areas. Collect macro invertebrates in all three riffles with a kick seine, sampling a 2 x 2 foot area (the kick seines are usually 3 x 3 feet). Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the stream bed. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a 2 x 2 foot area, kick the stream bed with your feet. Push rocks around, shuffle your feet so that you really kick up the stream bed. Now gently lift the seine, being careful not to lose any of the macro invertebrates you have caught. Take the seine to an area where you can look it over or wash the contents into a bucket. Now look for decayed (old, dead) packs of leaves next to rocks or logs or on the stream bed. Add 4 handfuls of decayed leaves to your sample. The total area of stream you will sample is 16 square feet.

b) For muddy bottom streams:

In this method, you will sample three different habitats, using a D-frame (or dip) net. The habitats are: vegetated margins, wood debris with organic matter, and sand/rock/gravel stream bed (or substrate). In this method you will scoop the stream a total of 14 times or 14 square feet. Each scoop involves a quick forward motion of one foot. To maintain consistency, collect the following numbers of scoops from each habitat each time you sample:

- 7 scoops from vegetated margins
- 4 scoops from woody debris with organic matter
- 3 scoops from sand/rock/gravel or coarsest area of the stream bed

As you collect your scoops, place the contents of the net into a bucket. Separate the samples collected from the rocky stream bed and vegetated margin or woody debris samples. Keep water in the bucket to keep the organisms alive. Note descriptions below of each muddy bottom habitat and collection tips:

Vegetated margins

This habitat is the area along the bank and the edge of the waterbody consisting of overhanging bank vegetation, plants living along the shoreline. and submerged root mats. Vegetated margins may be home to a diverse assemblage of dragonflies, damselflies, and other organisms. Move the dip-net quickly in a bottom-to-surface motion, jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Woody debris with organic matter

Woody debris consists of dead or living trees, roots, limbs, sticks, leafpacks, cypress knees and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators, such as fish.

To collect woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. It is also good to dislodge some of the bark as organisms may be hiding underneath. You can also collect sticks, leaf litter, and rub roots attached to submerged logs. Be sure to thoroughly examine any small sticks you collect with your net before discarding them. There may be caddisflies, stoneflies, riffle beetles, and midges attached to the bark.

Sand/rock/gravel stream bed

In slow moving streams, the stream bottom is generally composed of only sand or mud because the velocity of the water is not fast enough to transport large rocks. Sample the coarsest area of the stream bed--gravel or sand may be all you can find. Sometimes, you may find a gravel bar located at a bend in the river. The stream bed can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water.

If you have large rocks (greater than two inches diameter) you should also kick the bottom upstream of the net to dislodge any burrowing organisms. Remember to disturb only one foot upstream of the net for each scoop.

Each time you sample you should sweep the mesh bottom of the D-Frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt from the net. This will avoid a large amount of sediment and silt from collecting in the pan, which will cloud your sample.

3. Place macro invertebrates in a white sorting pan or plastic sheet. Separate creatures that look similar into groups. Use the SOS identification guide to record the types and numbers of each kind of insect. As you sort through your collection, remember that each stream will have different types and numbers of macro invertebrates. Calculate a score for your stream using the index on the survey form. Use the table below to interpret your results.

If you find:	**You may have:**
Variety of macro invertebrates, lots of each kind	Healthy stream
Little variety, with many of each kind	Water enriched with organic matter
A variety of macro invertebrates, but a few of each kind, or No macro invertebrates but the stream appears clean	Toxic pollution
Few macro invertebrates and the stream bed is covered with sediment	Poor habitat from sedimentation

PHYSICAL/CHEMICAL TESTS

Physical/Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water--including temperature, dissolved oxygen, pH, turbidity, water clarity, phosphorus, nitrogen, chlorine, total dissolved solids, and many others. Hillsborough County Stream-Waterwatch recommends that five core measurements be taken when doing physical/chemical testing--temperature, dissolved oxygen, pH, turbidity/clarity and salinity (if necessary). Phosphorus, nitrogen and alkalinity may be added as interest and equipment allows. See "Why Chemical Testing is Important" in the Appendix for detailed descriptions of each water quality characteristic.

If you choose to conduct chemical testing as an activity, plan on sampling regularly--at least once a month at the same time and the same location. Regular monitoring helps assure that your information can be compared over time. Water quality and environmental conditions can change throughout the day so monitoring at approximately the same time of day is important. Also, chemical testing during or immediately after a rain may produce very different results than during dry conditions. Therefore, it is very important to record weather conditions. If conditions are unsafe for any reason including high water or slippery rocks, DO NOT SAMPLE.

Equipment List:

- Water testing kit with dissolved oxygen, pH, temperature, turbidity tube or Secchi disk
- rubber gloves
- safety glasses
- container to bring back waste chemicals (old milk jug)
- bucket with rope (if sampling off a bridge or in deep water)
- Physical/Chemical Stream Survey Form
- pencil
- first aid kit

Optional

- refractometer (for salinity measurement)

Detailed instructions on each chemical test are available with the kit and are listed in the Appendix, however a few recommendations are listed below.

1. Measure air and water temperature in the shade, avoid direct sunlight.

2. Rinse glass tubes or containers twice with stream water before running a test.

3. Collect water for tests approximately midstream, one foot below surface. If water is less than one foot deep, collect approximately one-third of the way below surface.

4. Read values on titrators (small syringe) at the plunger tip.

Safety Notes: Read all instructions before you begin and note all precautions. Keep all equipment and chemicals out of the reach of small children. In the event of an accident or suspected poisoning, immediately call the Poison Control Center (listed on the inside cover of most telephone books). Avoid contact between chemicals and skin, eyes, nose or mouth. Wear safety goggles or glasses, and rubber gloves, when handling chemicals. After use, tightly close all chemical containers. Be careful not to switch caps.

HABITAT ENHANCEMENT

***(from Protecting Community Streams: A Guidebook for Local Governments in Georgia, Atlanta Regional** Commission, 1994)*

Stream habitat enhancement projects directly improve the health of streams by improving the adjacent (riparian), stream bank or stream bed habitat. All three of these areas function together to make up a stream ecosystem.

Stream habitat enhancement projects can be complicated. Check with your local Soil and Water Conservation Service, Cooperative Extension Service, the Fish and Wildlife Service, or a private consultant to be sure your efforts will yield the results you seek. Also, a Corps of Engineers permit may be needed before any material is placed in a stream or adjacent wetlands. Small projects are usually exempt.

Stream habitat enhancement projects may occur on private property, with permission of landowners, or on public property, in cooperation with the local or state agency responsible for property management. Habitat enhancement projects involve three major activities:

· riparian reforestation
· streambank stabilization
· stream bed restoration

Riparian Reforestation

The contribution of trees and woody understory vegetation to the maintenance of stream health cannot be overstated. Stream side forested areas not only provide habitat, shade, and forage for both aquatic and land based species, but their ability to filter pollutants and rainfall provides a buffer - a last line of defense - from watershed runoff. Restoring Stream side areas is one of the most cost-effective steps one can take to protect stream health. The objective should be to replicate or mimic the natural ecosystem as much as possible, therefore a mix of young and older native plant and tree species are preferred. Follow these steps to conduct a riparian reforestation project:

1. Evaluate current water quality conditions -- take "before" pictures and/or conduct physical/chemical, biological or visual assessments.

2. Choose a site(s) that needs additional vegetation to protect water quality from stormwater runoff.

3. Purchase a variety of plants that will tolerate wet conditions.

4. Plant trees, shrubs and grasses in the area immediately adjacent to your stream. Plant enough so that the vegetation will actually protect the stream--filter pollutants in stormwater, stops sediment from entering water, etc.

5. Water after planting and as needed.

6. Check each week for four to six weeks to ensure that plants are healthy.

7. Once plants are well established, evaluate water quality improvement -- take "after" photograph and/or compare with initial water quality tests.

Streambank Stabilization

If you have an eroding or collapsing streambank, you need to first determine the cause of the problem. Streambank erosion occurs for a number of reasons, including increased stream velocity, obstacles in the stream, floating debris, wave action, and direct rainfall. Streambank failure occurs when a large section of streambank collapses into the stream channel. Among the causes of streambank failure are down cutting of the stream bed and undercutting of the bank, increased load on the top of the bank, and internal pressure from uneven water absorption.

Selection of an appropriate bank stabilization method requires careful analysis of each site. No single method is appropriate in all situations. Technical advice will often be needed. Consult the Soil and Water Conservation Commission's "Guidelines for Streambank Restoration".

One technique to stabilize stream banks is called soil stabilization or soil bioengineering, which involves using vegetation as the structural control to stabilize banks. Planting of woody vegetation, such as willows. (either as individual live cuttings or in bundles of cuttings), grow inta dense network of protective vegetation. See Figures 1 through 3. The vegetation's root structure provides resistance to the sliding and shear displacement forces involved in slope erosion. In some cases, a solely vegetative approach may be all that is needed. In others, conditions such as excessive stream velocities or poor soil conditions may require a combination of vegetative and structural elements (such as stone walls or bulkheads).

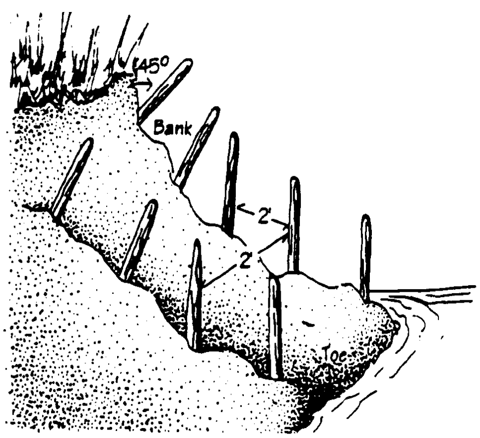

Figure 1. Examples of soil bioengineering techniques, willow cuttings.

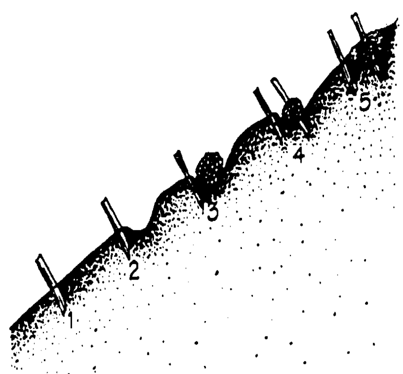

Figure 2. Examples of soil bioengineering techniques, live fascines or wattles.

Stream bed Restoration

Prior to any stream bed restoration, upstream conditions should be assessed. Without corrective measures or retrofitting upstream, stormwater flows could quickly destroy any stream bed restoration work. If the stream is in equilibrium, or if appropriate corrective measures are in place, stream bed restoration can recreate the habitat conditions needed to support aquatic life. Several goals may be accomplished when restoring a stream bed, including:

- Replacement of pools and riffles
- Velocity control
- Restoration of the stream gradient and normal flow channel
- Removal of major stream obstructions
- Restoration of suitable channel patterns such as:

  meandering -- repetitive bends
  irregular -- more or less straight
  braided -- stream separates and rejoins around islands

- Restoration of substrate (removal of sediment and replacement with gravel and cobbles, as appropriate)

Some of these techniques permit the stream water flows to work to restore healthier stream bed conditions; others require excavation and physical realignment of the stream channel. Three basic techniques include deflectors, in-stream boulders and drop structures.

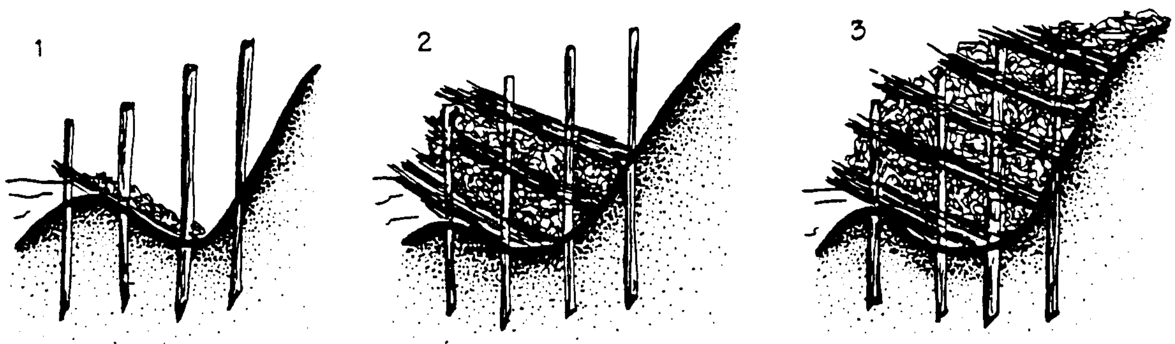

Figure 3. Examples of soil bioengineering techniques, branch packings.

Deflectors can easily be constructed of common, local materials such as cobbles, boulders and logs and are adaptable to a variety of conditions and stream sizes. They are sited in the channel with the intent of deflecting the current into a narrower channel. Deflectors can use the streamflow for a variety of purposes, including deepening channels, developing downstream pools, enhancing pool riffle ratios and assisting in the restoration of meander patterns with channelized reaches. There are several deflector designs. Figure 4 (left) shows a simple double "wing deflector" that consists of rock structures on each bank deflecting the streamflow to a central channel. Single deflectors along one bank are also used as shown in Figure 4 (center). Deflectors can be offset on opposite banks of a stream to imitate meanders, as shown in Figure 4 (right). (Pennsylvania DER, 1986). A third type of deflector is the V-type, which is placed in the middle of the channels with the point of the "V" pointing upstream deflecting water towards both banks. This type of deflector helps re-establish riffles and pools downstream. An underpass deflector is a log placed across a small stream several inches off the bottom. Water is deflected under the log which helps remove sediment deposits and restore pools. (Gore, Ed. 1985) (Kumble, 1990).

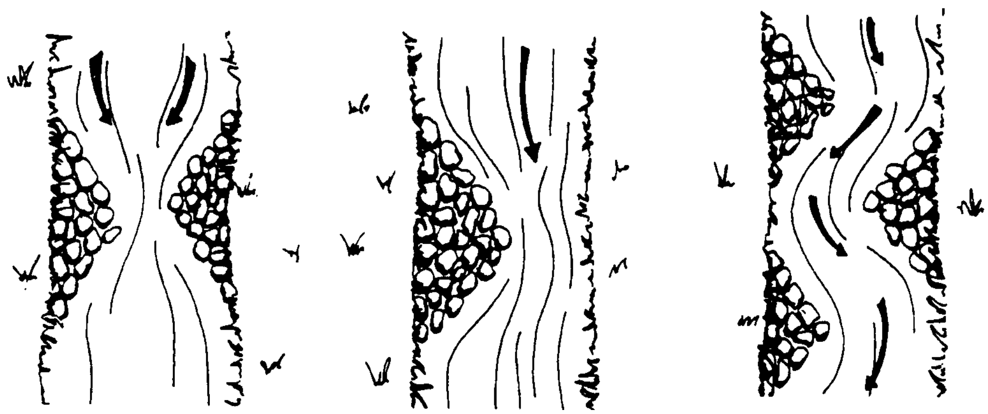

Figure 4. Double wing, Single and Offset deflectors.

Drop structures include a number of variations such as weirs, check dams, sills and plunges. They can serve a variety of functions in stream bed restoration depending upon their design, including: slowing streamflow; deepening existing pools; and creating new pools upstream and downstream. Structures with notches can be used to control heavy stormwater flows and can help re-establish deep pools immediately downstream. Drop structures can be made of concrete, logs or boulders. Log or boulder structures can be used to replicate small falls or rapids. Single log dams across a stream bed are simple and effective in restoring plunge pools (Figure 5). The K-dam is a variant of the single log dam, so named by adding downstream bracing. In some areas, especially headwater areas, reintroducing beavers has been effective in restoring habitat. Their dams function as drop structures in headwaters and on small streams.

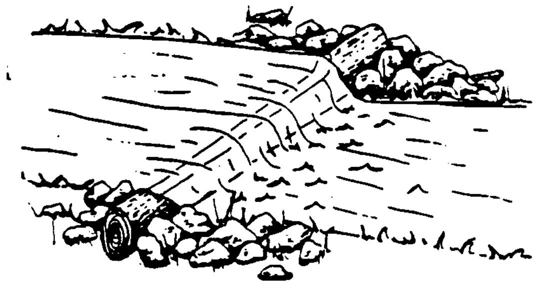

Figure 5. Log drop structure.

Figure 6. Upstream “V” boulder placement.

Boulder placement is a third in-channel treatment that can assist stream bed restoration. Boulders can be used to reduce velocity, restore pools and riffles, restore meanders, provide cover and protect eroded banks by deflecting flow. Boulders can be placed randomly or in a pattern. Placing them in a "V"pointed upstream produces eddies that replicate riffles as well as restores downstream pools (Figure 6). Combined with placement of cobbles and gravel, boulder placement can also help restore the stream substrate.

Excavation and fill may also be necessary to restore the stream gradient, the normal flow channel and the stream channel pattern, including meanders and braids, where appropriate. Channel pattern restoration should be combined with streambank restoration and re-vegetation.

Streams that have been severely degraded by large amounts of sediment or heavy stormwater flows may require greater restoration work. Sediment may have to be removed mechanically and replaced with gravel and cobbles to replicate the original stream bed. Major debris accumulation that is obstructing flows may also need removal.

Additional references:

Guidelines for Streambank Restoration. Georgia Soil and Water Conservation Commission. 1994.
A Georgia Guide to Controlling EROSION with Vegetation. Georgia Soil and Water Conservation Commission. 1994.
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Gore, James A., editor. The Restoration of Rivers and Streams. 1985.
Barnett, John L. Stream Restoration Along the Greenways in Boulder, Colorado. 1991.
Commonwealth of Pennsylvania, Department of Environmental Resources. A Streambank Stabilization and Management Guide for Pennsylvania Landowners. 1986.

APPENDICES

SOME BACKGROUND ON AQUATIC INSECTS

To understand and identify aquatic insects, one must start with how all animals are classified. The most general category is first, with the species level being the most specific. Volunteers will learn to identify aquatic insects to the order level. A stonefly is classified as an example.

Kingdom	Animal (all animals)
Phylum	Arthropoda
Class	Insecta (all insects)
Order	Plecoptera (all stoneflies)

Life Stages of Insects
Identifying insects is complicated because of the different stages they pass through during their development. The changes that occur from the egg stage to the adult are often dramatic. The incredible change of a caterpillar into a butterfly is well known. Most aquatic insects experience similar changes. The process of changing form during the life cycle is called metamorphosis. Three types of metamorphosis are possible: ametabolous, incomplete, and complete.

Ametabolous Metamorphosis This type of metamorphosis means without change and refers to the lack of change between the immature and adult stages. It's found only in a few very primitive orders of insects that have no wings as adults. Some species are semiaquatic.

Incomplete Metamorphosis.
Insects with incomplete metamorphosis pass through three distinct stages: egg, nymph, and adult. The time required to complete each stage varies widely. Normally the greatest amount of time is spent in the nymphal stage. In most cases, the entire cycle requires one year to complete, although this also varies with different species. Nymphs often look similar to their adult stage. As nymphs mature, the adult wings begin developing in stiff pouch-like structures on the thorax called wing pads. This is an obvious and unique characteristic of insects with incomplete metamorphosis. The wing pads on fully mature nymphs will be quite dark, almost black, in color. The orders of aquatic insects with incomplete metamorphosis include:
Mayflies (Order Ephemeroptera)
Dragonflies and Damselfies (Order Odonata)
Stoneflies (Order Plecoptera)
Water Bugs (Order Hemiptera)

Complete Metamorphosis

Insects with complete metamorphosis pass through four distinct stages: egg, larva, pupa, and adult. The addition of the pupal stage separates insects with complete metamorphosis from those with incomplete metamorphosis. While the length of time needed to complete each stage again varies widely, the entire cycle usually takes one year. Most of the cycle is generally spent in the larval stage. Unlike nymphs, larvae bear little resemblance to the adults and show no development of wing pads. It is during the pupal stage that the wing pads and other adult features develop. The orders of aquatic insects:

Dobsonflies and Alderflies (Order Megaloptera)
Caddisflies (Order Trichoptera)
Aquatic Moths (Order Lepidoptera)
Aquatic Flies (Order Diptera)
Aquatic Beetles (Order Coleoptera)

Growth and Development

The growth of insects occurs in a series of stages called instars. The exoskeleton of insects must be periodically shed in order for growth to continue. The process of shedding the old exoskeleton is called molting. When the old exoskeleton is cast aside, a new, slightly larger one is present underneath. The old empty exoskeleton is often referred to as a shuck. Except for mayflies, molting stops once the insect reaches the winged adult stage. Most insects molt five or six times during their development. Mayflies, stoneflies, dragonflies, and damselfies, however, may molt 15-30 times before reaching their adult stage.

Recognizing the insects's stage and degree of development can help the angler determine what insect to imitate. Mature nymphs and larvae often become more active in the water as they move to emergence or pupation sites. This increased activity makes them more available to fish and, thus, makes them more important to imitate. Looking for and imitating the most mature insects will nominally produce the best fishing.

One of the most vulnerable periods in the insect's life cycle is during emergence from immature to the adult stage. At the time of emergence, mature nymphs or pupae typically crawl out of the water or swim to the water's surface. Those that emerge in the surface film must break through the surface tension, and that can take from several seconds to over a minute. Thus during emergence, the insects are no longer protected by the shelter of the lake of stream bottom. Fish readily take advantage of the insects' vulnerability and often feed selectively on emerging nymphs or pupae. The angler who recognizes this activity will find fast fishing by imitating the shape and action of the natural. Adult insects often rest on the water's surface after emerging from the nymphal or pupal shuck. Then, after mating, most aquatic insects return to the water to lay their eggs. Insects resting or laying eggs on the surface provide fish with many easy meals.

Source: An Angler's Guide to Aquatic Insects and their Imitations, Hafele and Roederer.

THE AQUATIC REALM

In order to understand the environment and the animal life subsisting in that environment, it is necessary to understand the physical and chemical characteristics of the medium in which aquatic life exists

Water

Water is a highly complex medium, about 800 times more dense than air. Successful locomotion, or the ability to remain in a particular area, is dependent on the development of effective streamlining in the organism. Species present in moving water must present a low profile or smooth contour. Many of the forms have developed structures allowing them to adhere to the surface of the substrate, while other form have developed burrowing habits.

Animals living in water must have available oxygen for their existence. Aquatic forms are able to extract oxygen dissolved in the water. The amount of oxygen dissolved in the water is directly related to the temperature of the water, cold water retaining a higher amount of dissolved oxygen.

Although pure water is highly transparent, we are not working with "pure" water in any aquatic habitat. Silt or clay particles, algal blooms and decaying vegetation reduce the penetration of light waves through the water.

The penetration of light through water is important for the process of photosynthesis in plants, which adds dissolved oxygen to the water. In highly turbid waters, photosynthetic activity may be restricted to only the upper strata of water.

The dissolving capabilities of water are such that it has been termed the universal solvent. As water falls as rain and runs along the ground, it collects numerous substances. Water falling as rain collects both oxygen and carbon dioxide from the atmosphere. Air contains nearly 21% oxygen by volume, but water contains about one-twentieth that of air. Carbon dioxide has a much higher solubility in water, therefore, rain water is slightly acidic.

Freshwater Habitats

Fresh waters, in the form of habitable lakes and rivers, comprise an almost negligible portion of the available surface waters of the earth. The seas and oceans cover approximately 75% of the earth's surface. Freshwater occupies about 0.01%, but harbors about 41% of the fish species.

Running Water (The Lotic Environment)

As water drains off a watershed, a natural progression of flowing water habitats develop. Small rivulets join to form small brooks that may be seasonally intermittent in their flow. These join larger streams that eventually combine to form rivers and river systems.

Rapidly moving shallow water is usually highly oxygenated. The scouring action of the water results in a substrate that is typically composed of rocks and cobble of varying texture.

Temperatures of brooks in forested areas will result in lower water temperatures. The canopy also effectively limits the amount of light reaching the water.

Of utmost importance in structuring an aquatic community is its productivity, its capacity to produce food for its component species. In high gradient streams, there is little opportunity for rooted plants to develop. As the gradient of the stream diminishes, there is a greater opportunity for biotic diversification, and the food base is consequently enhanced.

The lower reaches of streams possess a greater variety of habitats. As streams increase in size, currents become more sluggish, depth increases, bottom materials become finer and water correspondingly becomes more turbid.

INDICATORS OF POLLUTION

The concept of aquatic organisms being "useful" indicators of environmental condition, and particularly of the degree of pollution of water with organic wastes, has a long history.

The term "pollution" does not have the same meaning to everyone. We have to understand that there is natural pollution and man-made pollution.

In an environment devoid of human occupation and influence, certain situations will occur. Rain water flowing across the land and draining into a stream will carry humus extracts, organic particulate matter and inorganic salts leached from the soil. Fecal material from wild animals will find their way into the stream. Animals drinking from the stream will add bacteria and dead animals will be found decaying in the water or near the shore.

Whether the origin of the pollution is natural or from a sewer outlet, the stimulatory effect upon organisms in the stream will be the same. Man-made pollution occurs in such volume that the stream is incapable of recovering from the effects.

Effects of Pollution on Biological Environment

The entry of pollutants changes the stream bottom, the physical and chemical properties of the water and the competitive relationships of organisms. Organic material undergoes decomposition, utilizing the dissolved oxygen in the water. The dissolved oxygen content in a badly polluted zone can be reduced to zero, destroying all animal life depending on dissolved oxygen for survival.

As the pollutant moves downstream from the source, decomposition continues. The pollutant is diluted with clean water, but the effects continue to be deleterious on animal life. If the source of pollution is eliminated, the stream will eventually clean up, but if the source of pollution continues, then the zone of degradations continues to expand.

In addition to removing the dissolved oxygen content from the water, pollutants also cover the stream with sludge. The presence of solid materials in the water reduces the amount of sunlight available for the continuous growth of plankton populations necessary in the animal food chain.

Significance of Biological Populations (see Appendix on Stream Insects and Crustaceans)

Group One Taxa: pollution sensitive organisms found in good quality water

Group Two Taxa: Somewhat pollution tolerant organisms can be in good or fair quality water.

Group Three Taxa: Pollution tolerant organisms can be in any quality of water.

The presence of Group Three Taxa and the absence of Group One Taxa does not prove that pollution exists in a particular area. As in agricultural land, certain bottom types are more productive than other types, which means dissolved oxygen is being used at a faster rate. This is the reason for referring to biological populations as being "**indicators**" of pollution.

AQUATIC ANIMALS

Our study will focus on the aquatic animals which live in or the bottom materials, attached to rocks and swimming freely in or on the surface of the water. Terrestrial insects falling into the water do not reflect the quality of the water.

Animal Groups to Be Considered

OLIGOCHAETA: aquatic earthworms (sludgeworms)

HIRUDINEA: leeches

MOLLUSCA: snails and clams

ARTHROPODA: insects

The identification of aquatic forms collected will be to the Order level. Although the identification of aquatic animals to the species level is important in a scientific study, the gross identification of the forms will provide the information desired.

The arthropods (insects and crustaceans) are the most common form encountered in the aquatic environment.

Crustacea - crabs, lobster, shrimp, crayfish

Diploda - millipedes

Chilopoda - centipedes

Xiphosura - horseshoe crabs

Arachinida - spiders, scorpions

Insecta - insects

Ephemeroptera: mayflies

Odonata: dragonflies and damselflies

Plecoptera: stoneflies

Coleoptera: beetles

Trichoptera: caddisflies

Diptera: flies, mosquitoes

AQUATIC EARTHWORMS

Aquatic earthworms are commonly found in areas with muddy bottoms. Their presence does not imply the area is polluted. Their presence, though, in large numbers, and the absence of other aquatic forms does indicate a highly productive area, which could be caused by pollution.

Sludge worms, another form of aquatic earthworms, are very common in areas polluted by sewage.

LEECHES

The presence of leeches does not imply pollution. They are occasionally found in a variety of aquatic habitats. They are pollution tolerant organisms, and can be in any quality of water.

SNAILS AND CLAMS

These forms are quickly affected by the presence of pollution. They are highly sensitive to various forms of chemical pollution, but not necessarily killed by the pollution. Some species are placed in

Group Two Taxa and some are placed in Group Three Taxa.

INSECTS

Ephemeroptera

Mayflies are often common around ponds and streams, the immature forms (nymphs) found in a variety of habitats. Some are streamlined in their structure and are active, whereas, other forms are burrowing in habit. The aquatic stage requires a year or more to develop.

The nymphs are very sensitive to pollution. They require a high level of dissolved oxygen in the water to exist. They are placed in Group One Taxa.

The species of mayflies exhibit a wide range of ecological habitat preferences. Some species are found only in lakes, some in shallow, rapid streams with sandy bottoms and some species occur on the underside of stones.

Odonata

The adult dragonflies and damselflies are usually found near or around water. The immature stages are aquatic, and all stages are predacious, feeding on insects and other organisms.

They are placed in Group Two Taxa, being somewhat pollution tolerant and can exist in good or fair quality water. They are found on rocks and other substrate materials.

Plecoptera

Stoneflies are small, somewhat flattened, soft-bodied forms found near streams or rocky lake shores. They are often found under stones in streams.

They are placed in Group One Taxa, being pollution sensitive organisms found in good quality water.

Coleoptera

The beetles are the largest order of insects. Many species are aquatic or semi-aquatic, and are found in a wide variety of ecological habitats. Members of this Order are placed in both Group One Taxa and in Group Two Taxa.

Neuroptera

Alderflies and dobsonflies are usually found under stones in streams. The aquatic forms are predacious, feeding on small aquatic insects.

They are placed in both Group One and Group Two Taxa.

Trichoptera

The caddisfly larvae occur in lakes, ponds and streams. Some are case makers, others construct nets under water and a few are free living. The free-living larvae are generally predacious.

The members of this Order are highly sensitive to pollution and are found only in good quality water. They are placed in Group One Taxa.

Diptera

The members of this Order constitute the largest order of insects. Its members are abundant almost everywhere. This Order includes mosquitoes, midges (no-see-ums), horse flies, blow flies and lice. A large proportion live in water (i.e. streams, ponds, lakes, temporary puddles, brackish water and alkaline water.

The majority of the members of this Order are highly tolerant to pollution and are placed in Group Three Taxa.

RAPID BIOASSESSMENT PROCEDURE

Studies determining the biological health of a stream by assessing the quantity and quality of macroinvertebrate populations have been conducted for many years. Historically, these studies covered varying periods of time. many of the past studies covered periods of time ranging from one to ten years. Although these past benthic studies were very important, they were very expensive and required large commitments of time by scientists.

As populations grew and expanded, the adverse affects of growth on natural resources, such as streams, dramatically increased. Intensive agricultural practices, increased use of fertilizers and pesticides, uncontrolled garbage disposal, increased numbers of parking lots which created increased water runoff, and many other factors placed unnatural biological stresses on streams.

Rapid population and industrial growth, the expense associated with benthic studies and the lack of qualified personnel made it impossible to conduct scientific studies on the large number of streams affected.

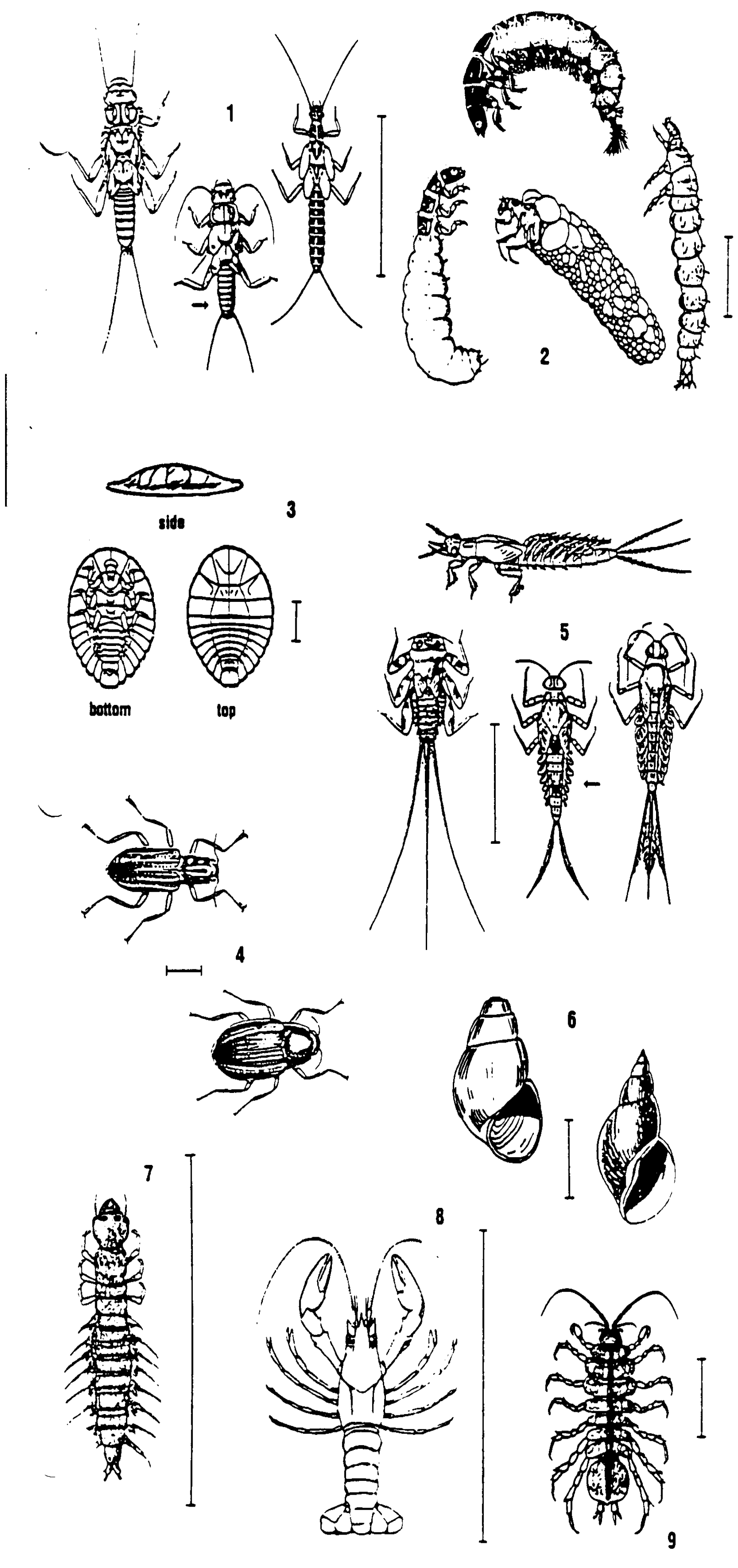
Past scientific studies have demonstrated that certain macroinvertebrates were indicators of water quality. Certain forms were known to survive only in water with high levels of dissolved oxygen, while other organisms were capable of surviving in badly polluted waters.

In the mid-1980's, the Rapid Bioassessment Procedures for use in wadeable streams, 3 feet or less in depth, were developed. Biomonitoring utilizes biological organisms to indicate environmental stress. The U.S. Department of Environmental Protection developed the protocols. The Florida Department of Environmental Protection adapted the protocols for use in Florida, developing the Stream Condition Index (SCI).

The reliability of the protocols depends on adequate sampling being employed and the correct identification of the macroinvertebrates to the **ORDER** level.

Collecting macroinvertebrates from the stream selected for study will be conducted every three months in approximately the same area, approximately a 50-yard stretch, for consistency. The D-frame dip net will be employed to collect macroinvertebrates from different ecological environments within the study sample area. The specific sampling methodology employed will be dependent on the specific stream habitat.

Review the **BIOLOGICAL MONITORING SECTION** in the Level II training manual for specific sampling methodology.



Bar lines indicate relative size

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 *Stonefly: Order Plecoptera.* 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)

2 *Caddisfly: Order Trichoptera.* Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on lower half.

3 *Water Penny: Order Coleoptera.* 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle.

4 *Riffle Beetle: Order Coleoptera.* 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.

5 *Mayfly: Order Ephemeroptera.* 1/4" - 1", brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.

6 *Gilled Snail: Class Gastropoda.* Shell opening covered by thin plate called operculum. Shell usually opens on right.

7 *Dobsonfly (Hellgrammite): Family Corydalidae.* 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

GROUP TWO TAXA

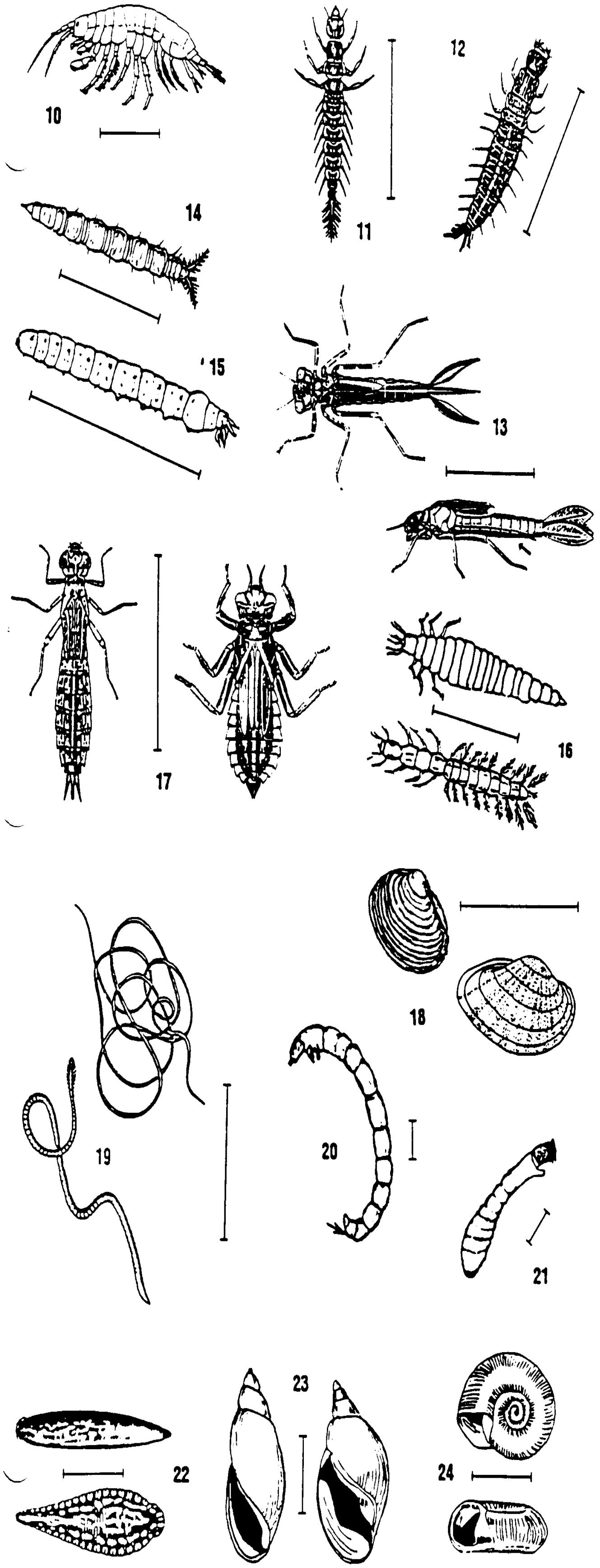
Somewhat pollution tolerant organisms can be in good or fair quality water.

8 *Crayfish: Order Decapoda.* Up to 6", 2 large claws, 8 legs, resembles small lobster.

9 *Sowbug: Order Isopoda.* 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Save Our Streams

Izaak Walton League of America
1401 Wilson Blvd. Level B
Arlington, VA 22209



Bar lines indicate relative size

GROUP TWO TAXA continued

10 *Scud: Order Amphipoda.* 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.

11 *Alderfly larva: Family Sialidae.* 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.

12 *Fishfly larva: Family Corydalidae.* Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

13 *Damselfly: Suborder Zygoptera.* 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)

14 *Watersnipe Fly Larva: Family Athericidae (Atherix).* 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.

15 *Crane Fly: Suborder Nematocera.* 1/3" -2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.

16 *Beetle Larva: Order Coleoptera.* 1/4" 1", light-colored, 6 legs on upper half of body, feelers, antennae.

17 *Dragon Fly: Suborder Anisoptera.* 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 *Clam: Class Bivalvia.*

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 *Aquatic Worm: Class Oligochaeta.* 1/4" - 2", can be very tiny; thin worm- like body.

20 *Midge Fly Larva: Suborder Nematocera.* Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.

21 *Blackfly Larva: Family Simulidae.* Up to 1/4", one end of body wider. Black head, suction pad on end.

22 *Leech: Order Hirudinea.* 1/4" - 2", brown, slimy body, ends with suction pads.

23 *Pouch Snail and Pond Snails: Class Gastropoda.* No operculum. Breathe air. Shell usually opens on left.

24 *Other snails: Class Gastropoda.* No operculum. Breathe air. Snail shell coils in one plane.

Speed Key for use with the IzaacWalton Stream Insects & Crustaceans ID Sheet

Snails (6, 23, 24)	have single spiral shells
Clams (18)	have 2 hard shells that close together
Crayfish (8)	look like tiny lobsters
Sowbugs (9) and Scuds (10)	have long antennae and more than 6 legs

Aquatic worms (19) are legless, pink when alive, and can "tie themselves in knots"
Leeches (22) are legless and have a distinct sucker at each end

Everything else is an insect; 97% of these can be correctly identified by the following;

1. No legs, or legs look fleshy, without joints (14, 15, 20, 21) **True Fly larvae**

2. Legs long and sprawly, lower lip is folded beneath the head (13, 17) **Damselfly and Dragonfly nymphs**

3. Two long straight tails, 2 claws per foot (1) **Stonefly nymphs**

4. Three long straight tails (some with 2), 1 claw per foot (5) **Mayfly nymphs**

5. Somewhat caterpillar-like, with a single pair of hooks on the back end (2); may be in a stick or stone case **Caddisfly larvae**

6. Sides of body with pointed, fleshy projections (7, 11, 12) **Heligrammite, Alderfly, and Fishily larvae**

7. Body hard of soft, usually cylindrical (16) **Beetle larvae**

8. Body round or oval, brown (3) **Water Penny (a beetle larvae)**

9. Small, resembling a black spider, moves very slowly (4). **Riffle Beetle adults**

This Key by: Dr. Fred Sherberger, Fembank Science Center 156 Heaton Park Dr. NE, Atlanta GA 30307-1398
Voice Mail 404-378-4314, ext. 323; FAX 404-370-1336 e-mail. fred.sherberger@fembank.edu

Stream Study Home Page Internet Address

http://www.people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.HTML

WHY ARE CHEMICAL TESTS IMPORTANT?

(based in part on the Citizen Monitoring Handbook, published by the LaMotte Company)

This section describes some chemical and physical tests you can conduct and why they are important. Physical/Chemical testing should be conducted at least once a month because this type of testing measures the exact sample of water taken, which can vary weekly, daily or even hourly. A basic set of tests includes temperature, dissolved oxygen, pH, and turbidity or clarity. Advanced tests include total alkalinity, ortho-phosphate, nitrate and chlorophyll (a).

TEMPERATURE

Water temperature is one factor in determining which species may or may not be present in the system. Temperature affects feeding, reproduction, and the metabolism of aquatic animals. A week or two of high temperatures may make a stream unsuitable for sensitive aquatic organisms, even though temperatures are within tolerable levels throughout the rest of the year. Not only do different species have different requirements, but optimum habitat temperatures may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adult fish.

Measuring Temperature

A thermometer protected by a plastic or metal case should be used to measure temperature in the field. Record air temperature by placing the dry thermometer in the shade until it stabilizes. Record the temperature of the air before measuring water temperature. To measure water temperature, submerge the thermometer in a sample of water large enough that it will not be affected by the temperature of the thermometer itself or hold directly in the stream. Record temperature when reading stabilizes.

Significant Levels

Temperature preferences among species vary widely, but all species can tolerate slow, seasonal changes better than rapid changes. Thermal stress and shock can occur when water temperatures change more than 1° to 2°C in 24 hours.

Many biological processes are affected by water temperature. Temperature differences between surface and bottom waters help produce the vertical water currents which move nutrients and oxygen throughout the water column.

What Measured Levels May Indicate

Water temperature may be increased by discharges of water used for cooling purposes (by industrial or utility plants) or by runoff from heated surfaces such as roads, roofs and parking lots. Cold underground water sources, snow melt and the shade provided by overhanging vegetation can lower water temperatures.

pH

The pH test is one of the most common analyses in water testing. An indication of the sample's acidity, pH is actually a measurement of the activity of hydrogen ions in the sample. pH measurements are on a scale from 0 to 14, with 7.0 considered neutral. Solutions with a pH below 7.0 are considered acids, those between 7.0 and 14.0 are designated bases.

The pH scale is logarithmic, so every one-unit change in pH actually represents a ten-fold change in acidity. In other words, pH 6 is ten times more acidic than pH 7; pH 5 is one hundred times more acidic than pH 7.

pH Measurement Technique (HACH kit, wide range 4-10))

1. Fill test tube to the 5 mL line of the glass tube.

2. Add 6 drops of the pH indicator (holding indicator bottle vertical). Cap and gently invert the sample several times to ensure mixing.

3. Use the color comparator box to determine pH. Read pH to the nearest .5 unit. ***Hint - Hold a piece of white paper behind the comparator to differentiate colors more easily***

Significant Levels

A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation remove carbon dioxide ($C0_2$) from the water during photosynthesis. This can result in a significant increase in pH levels. Low or high pH can effect egg hatching, kill sources of food for fish and insects, or make water impossible for any aquatic life to survive. Hillsborough County streams will have pH ranges of 6.0 to 8.6.

pH values of some common substances:

0.5	battery acid
2.0	lemon juice
5.9	rain water
7.0	distilled water
8.0	salt water
11.2	ammonia
12.9	bleach

DISSOLVED OXYGEN

Like land organisms, aquatic animals need dissolved oxygen (DO) to live. Fish, invertebrates, plants and aerobic bacteria all require oxygen for respiration.

Sources of Dissolved Oxygen

Oxygen dissolves readily into water from the atmosphere at the surface until the water is "saturated" (see below). Once dissolved in water, the oxygen diffuses very slowly, and distribution depends on the movement of aerated water by turbulence and currents caused by wind, water flow and thermal upwelling. Oxygen is produced by aquatic plants, algae and phytoplankton as a by-product of photosynthesis.

Dissolved Oxygen Capacity of Water

The dissolved oxygen capacity of water is limited by the temperature and salinity of the water and the atmospheric pressure (which corresponds with altitude). These factors determine the highest amount of oxygen dissolved in water that is possible.

Temperature Effect

As water temperature changes, the highest potential dissolved oxygen level changes. Table 1 shows the amount of dissolved oxygen at 100% saturation as a function of temperature.

TABLE 1 Solubility of Dissolved Oxygen in Water

Temperature Degrees °C	Solubility mg/L (ppm)*	Temperature Degrees °C	Solubility mg/L(ppm)*
0	14.6	16	10.0
1	14.2	17	9.8
2	13.8	18	9.6
3	13.5	19	9.4
4	13.1	20	9.2
5	12.8	21	9.0
6	12.5	22	8.9
7	12.2	23	8.7
8	11.9	24	8.6
9	11.6	25	8.4
10	11.3	26	8.2
11	11.1	27	8.1
12	10.9	28	7.9
13	10.6	29	7.8
14	10.4	30	7.7
15	10.2		

* 100% saturation

As can be seen from Table 1:

Lower temperature = Higher potential dissolved oxygen level

Higher temperature = Lower potential dissolved oxygen level

The temperature effect is compounded by the fact that living organisms increase their activity in warm water, requiring more oxygen to support their metabolism. Critically low oxygen levels often occur during the warmer summer months when decreased capacity and increased oxygen demand, caused by respiring algae or decaying organic material, coincide.

Altitude

Oxygen is more easily dissolved into water at low altitudes than at high altitude.

Dissolved or Suspended Solids (salt)

Oxygen is more easily dissolved into water which has low levels of dissolved or suspended solids. Therefore salt water tends to have lower concentrations of dissolved oxygen than fresh water.

Significant Levels

The amount of oxygen required varies according to species and stage of life. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Fish and invertebrates that can move will leave areas with low dissolved oxygen and concentrate in areas with higher levels.

What Measured Levels May Indicate

A low dissolved oxygen level indicates a demand on the oxygen in the system. Pollutants, including inadequately treated sewage as well as decaying natural organic material, can cause such a demand. Organic materials accumulate in bottom sediments and support microorganisms (including bacteria) which consume oxygen as they break down the materials. Some wastes and pollutants produce direct chemical demands on any oxygen in the water. In ponds or impoundments, dense populations of active fish can deplete dissolved oxygen levels. In areas of dense algae, DO levels may drop at night or during cloudy weather due to the net consumption of dissolved oxygen by aquatic plant respiration.

High dissolved oxygen levels can be found where stream turbulence or choppy conditions increase natural aeration by increasing the water surface area and trapping air under cascading water. On sunny days, high dissolved oxygen levels occur in areas of dense algae or submerged aquatic vegetation growth due to photosynthesis. In these areas, watch for the lowest DO levels before sunrise each morning and highest levels just after noon.

DO Measurement Technique

Dissolved Oxygen - LaMotte Company

1. Carefully collect the water sample into the glass water sampling bottle, avoiding trapping air bubbles or bubbling air into the sample (which may add dissolved oxygen).
`*ADD THE REAGENTS HOLDING THE BOTTLES VERTICAL*`

2. Add the next two reagents in quick succession. Add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide to the sample. Cap the sample and invert several times. Wait until the precipitate settles below the neck of the bottle before proceeding.

3. Next, use the 1.0 gram spoon to add one measure of Sulfamic Acid Powder. Cap and gently shake until the precipitate dissolves. The solution is now "fixed" and may range in color from yellow to orange brown.
* *Fixed Solution* - Contact between the water sample and the atmosphere will not affect the test result because the dissolved oxygen has been bound into solution and no more oxygen will dissolve into the sample and no dissolved oxygen can be lost from the sample.

4. Place 20 mL of the fixed sample into the glass titration tube.

5. Fill the titrator (small syringe) with Sodium Thiosulfate, 0.025 N. Make sure no bubbles are in the titrator. Place the titrator into the hole in the cap of the glass titration vial.

6. While gently shaking the tube, slowly add Sodium Thiosulfate from the titrator into the sample. Continue one drop at a time until the solution turns a pale straw color (very faint yellow). ***Hint-High light intensity degrades Sodium Thiosulfate- keep bottle out of the sun for long periods of time.**

7. Remove the titrator cap and syringe CAREFULLY so as not to lose any of the Sodium Thiosulfate (you will continue titrating in step 9).

8. Add 8 drops of Starch Solution to the titration vial that is holding the sample. The sample will turn dark blue.

9. Continue titrating with Sodium Thiosulfate **ONE DROP AT A TIME** until the solution turns from blue to clear.

10. Read the amount of dissolved oxygen in your sample directly from the syringe (direct reading titrator). Tick marks are in 0.2 ppm. Use the tip of the syringe plunger for dissolved oxygen value.

TURBIDITY

What is turbidity and why is it important?

Turbidity is a measure of water clarity—how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt, and sand), algae, plankton, microbes, and other substances. These materials are typically in the size range of 0.004 mm (clay) to 1.0 mm (sand). Turbidity can affect the color of the water. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn, reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Higher turbidity also reduces the amount of light penetrating the water, which reduces photosynthesis and the production of DO. Suspended materials can clog fish gills, reducing resistance to disease in fish, lowering growth rates, and affecting egg and larval development. As the particles settle, they can blanket the stream bottom, especially in slower waters, and smother fish eggs and benthic macro invertebrates. Sources of turbidity include:

- Soil erosion
- Waste discharge
- Urban runoff
- Eroding stream banks
- Large numbers of bottom feeders (such as carp), which stir up bottom sediment.

- Excessive algal growth.

Sampling and equipment considerations

Turbidity can be useful as an indicator of the effects of runoff from construction, agricultural practices, logging activity, discharges, and other sources. Turbidity often increases sharply during a rainfall, especially in developed watersheds, which typically have relatively high proportions of impervious surfaces. The flow of stormwater runoff from impervious surfaces rapidly increases stream velocity, which increases the erosion rates of stream banks and channels. Turbidity can also rise sharply during dry weather if earth-disturbing activities are occurring in or near a stream without erosion control practices in place.

Regular monitoring of turbidity can help detect trends that might indicate increasing erosion in developing watersheds. However, turbidity is closely related to stream flow and velocity and should be correlated with these factors. Comparisons of the change in turbidity over time, therefore, should be made at the same point at the same flow. Turbidity is not a measurement of the amount of suspended solids present or the rate of sedimentation of a steam since it measures only the amount of light that is scattered by suspended particles.

Turbidity is generally measured by using a turbidity meter. Volunteer programs may also take samples to a lab for analysis. Another approach is to measure transparency (an integrated measure of light scattering and absorption) instead of turbidity. Water clarity/transparency can be measured using a Secchi disk or transparency tube. The Secchi disk can only be used in deep, slow moving rivers; the transparency tube, a comparatively new development, is gaining acceptance in programs around the country but is not yet in wide use (see Using a Secchi Disk or Transparency Tube).

A turbidity meter consists of a light source that illuminates a water sample and a photoelectric cell that measures the intensity of light scattered at a 90° angle by the particles in the sample. It measures turbidity in nephelometric turbidity units or NTUs. Meters can measure turbidity over a wide range—from O to 1000 NTUs. A clear mountain stream might have a turbidity of around 1 NTU, whereas a large river like the Mississippi might have a dry-weather turbidity of around 10 NTUs. These values can jump into hundreds of NTU during runoff events. Therefore, the turbidity meter to be used should be reliable over the range in which you will be working. Meters of this quality cost about $800. Many meters in this price range are designed for field or lab use.

Using a Secchi Disk or Transparency Tube

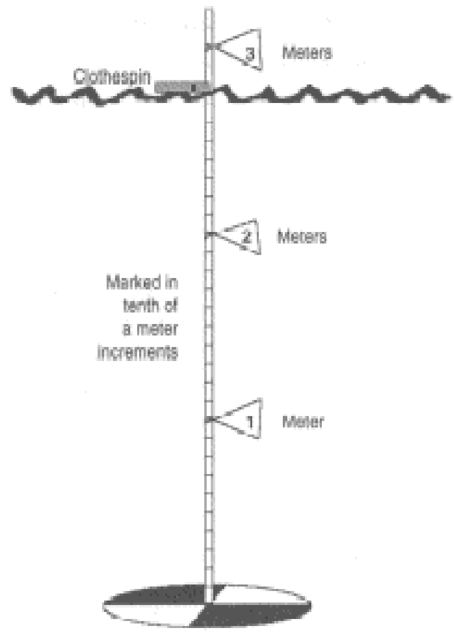
Secchi Disk

A Secchi disk is a black and white disk that is lowered by hand into the water to the depth at which it vanishes from sight (Figure 7). The distance to vanishing is then recorded. The clearer the water, the greater the distance. Secchi disks are simple to use and inexpensive. For river monitoring they have limited use, however, because in most cases the river bottom will be visible and the disk will not reach a vanishing point. Deeper, slower moving rivers are the most appropriate places for Secchi disk measurement although the current might require that the disk be extra-weighted so it does not sway and make measurement difficult. Secchi disks cost about $50 and can be homemade.

The line attached to the Secchi disk must be marked according to units designated by the volunteer program, in waterproof ink. Many programs require volunteers to measure to the nearest 1/10 meter. Meter intervals can be tagged (e.g., with duct tape) for ease of use.

To measure water clarity with a Secchi disk:

- Check to make sure that the Secchi disk is securely attached to the measured line.
- Lower the Secchi disk into the water, keeping your back toward the sun to block glare.
- Lower the disk until it disappears from view. Lower it one third of a meter and then slowly raise the disk until it just reappears. Move the disk up and down until the exact vanishing point is found.
- Attach a clothespin to the line at the point where the line enters the water. Record the measurement on your datasheet. Repeating the meas urement will provide you with a qualit y control check.



Fig
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The key to consistent results is to follow standard sampling procedures and, if possible, have
the same individual take the reading at the same site throughout the season.

Transparency Tube

Pioneered by Australia's Department of Conservation, the transparency tube is a clear, narrow plastic tube marked in units with a dark pattern painted on the bottom. Water is poured into the tube until the pattern disappears (Figure 8). Some U.S. volunteer

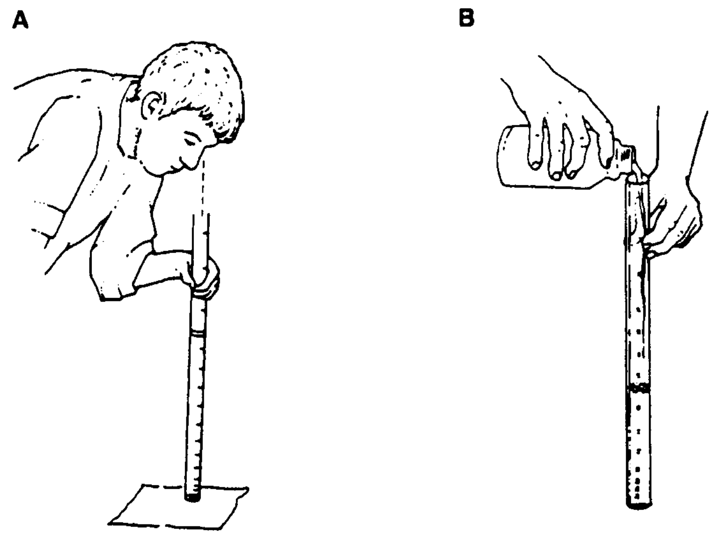


Figure 8. Using a transparency tube. (A) Prepare the transparency tube to take a reading. Place the tube on a white surface and look down vertically down the tube to see the wave pattern at the bottom. (B) Slowly pour the water sample into the tube stopping intermittently to see if the wave pattern has disappeared.

monitoring programs (e.g., the Tennessee Valley Authority (TVA) Clean Water Initiative and the Minnesota Pollution Control Agency (MPCA)) are testing the transparency tube in streams and rivers. MPCA uses tubes marked in centimeters, and has found tube readings to relate fairly well to lab measurements of turbidity and total suspended solids (although they do not recommend the transparency tube for applications where precise and accurate measurement is required or in highly colored waters).

The TVA and MPCA recommend the following sampling considerations:

- Collect the sample in a bottle or bucket in mid-stream and mid-depth if possible. Avoid stagnant water and sample as far from the shoreline as is safe. Avoid collecting sediment from the bottom of the stream.
- Face upstream as you fill the bottle or bucket.
- Take readings in open but shaded conditions. Avoid direct sunlight by turning your back to the sun.
- Carefully stir or swish the water in the bucket or bottle until it is homogeneous,

taking care not to produce air bubbles (these will scatter light and affect the measurement). Then pour the water slowly in the tube while looking down the tube. Measure the depth of the water column in the tube when the symbol just disappears.

NUTRIENTS—Nitrate and Phosphate

Eutrophication

The addition of phosphorus, nitrogen and other nutrients to a body of water results in increased plant growth. Over time, dead plant material builds up and, combined with sediments, fills in lakes and reservoirs. When excess nutrients and sediment are added, the speed of this natural process is increased significantly.

Plants, especially algae, are very efficient users of phosphorus and nitrogen. By the time an algae bloom is observed, the nutrients may no longer be measurable but may continue to impact the ecosystem. By sampling upstream from areas of algae blooms, the source of excess nutrients may be identified. Algae blooms will usually be found in lakes and reservoirs. If excessive algae are found in streams, the nutrient content is probably very high. The macro invertebrate population will reflect a high input of nutrients--you will find little variety of macro invertebrates but many of one or two kinds.

High flow rates in streams may prevent the establishment of floating aquatic plants and algae despite the presence of high levels of nutrients. As the summer progresses and flow rates drop, once rapidly flowing streams can become choked with algae. Wide, slow moving and tidal areas downstream may exhibit algae blooms weeks earlier.

Sources of Nutrients

Nitrogen and phosphorus enter water from human and animal waste, decomposing organic matter and fertilizer runoff. Phosphates also are found in some industrial effluents, detergent wastewater from homes, and natural deposits.

Measuring Nitrate

Nitrogen occurs in natural waters as nitrate (NO_3), nitrite (NO_2), ammonia (NH_3) and organically bound nitrogen. Nitrate test results are expressed as "nitrate nitrogen" (NO_3-N), meaning "nitrogen that was in the form of nitrate." Some test kits and the literature express levels only as nitrate (NO_3). Both expressions refer to the same chemical and concentrations, but use different units of measure:

Nitrate Nitrogen ppm x 4.4 = Nitrate ppm

Significant Levels

Unpolluted waters generally have a nitrate-nitrogen level below 1 ppm. Nitrate-nitrogen levels above 10 ppm (44 ppm nitrate) are considered unsafe for drinking water.

Phosphorus

Phosphorus occurs in natural waters in the form of phosphates - orthophosphates, polyphosphates and organically bound phosphates. Simple phosphate test kits measure reactive phosphorus (primarily orthophosphate) which is the form of phosphate applied as fertilizer to agricultural and residential lands.

Organically bound phosphates in water come from plant and animal matter and wastes. Organically bound phosphates and polyphosphates cannot be measured directly. They must first be broken down or "digested" by adding an acid and oxidizer and boiling the sample. After the digested sample cools, an orthophosphate test is performed to measure total phosphorus. Results are expressed as phosphate ($P0_4$).

Significant Levels

Total phosphorus levels higher than 0.03 ppm contribute to increased plant growth (eutrophication). Total phosphorus levels above 0.1 ppm may stimulate plant growth sufficiently to surpass natural eutrophication rates.

ALKALINITY

Alkalinity of water is its acid neutralizing capacity. It is the sum of all the bases found in a sample including carbonate, bicarbonate, and hydroxide content. The alkalinity, and therefore buffering capacity, of natural waters will vary with local soils.

SALINITY

Salinity can be referred to as the total amount of soluble salts in water or soils. There is a constant ratio between the six major elements (chlorine, sodium, magnesium, sulfur, calcium, and potassium) and the three minor elements (bromine, strontium, and boron) in marine water. Therefore, if the concentration of one element is known, the others can be calculated for salt water environments. In some fresh water locations, with minimal salts, this may not hold true.

Freshwater contains few salts, drinking water usually has a salinity of less than .5 ppt, while sea water averages 35 ppt. Since seawater enters the Bay and its tributaries through the Bay's mouth, the salinity is highest at that point and diminishes as it approaches the headwaters of creeks and other freshwater sources.

SIGNIFICANCE

During times of low rainfall or low freshwater runoff, salinity increases, potentially having an adverse effect on the flora and fauna. Conversely, when storm events create increased freshwater runoff, salinity decreases also with potentially adverse effects. With the addition of salt to water osmotic pressure increases, reflected by the increased amount of ions in the water, conductivity increases. Water density increases with increased salinity. The effects of density may result in a majority of functional changes such as feeding, movement, and dispersal differences. Increased salinity results in boiling point elevation and freezing point depression, which can produce temperature differences in shallow systems.

There are several procedures for measuring salinity. A hydrometer can be used to measure water density. Additionally, chlorinity can be determined using the Knudsen titration procedure. Also, salinity can be determined rapidly by using the principals of the refraction of light using a hand held refractometer.

Measurement of Salinity

Materials

Water collection bottles, plastic pipette, refractometer.

Procedure

In the field collect water in the collection bottles. Take care to collect water from below the surface. Surface water may be diluted by rainwater. Using the plastic pipette, take a drop and apply it to the refractometer. Slide the tab back on the instrument, hold it to the light and look through. The salinity reading will show up as a line through the gauge. The reading will be in parts per thousands (ppt). Record the salinity on the data sheet.

MEASURING RAINFALL

Placement of Rain Gauge:

The rain gauge should stand far enough from trees, hills, overhead power lines and other obstructions to minimize interference with sampling. (Natural and manmade obstructions may cause turbulence and/or contamination, i.e. bird droppings, which can result in nonrepresentative samples.) Specifically, there must be no obstruction above a 45 degree angle from the top of the gauge. (This means that a tree 30 feet tall should be at least 30 feet away.)

Installation of Rain Gauge:

The gauge should be installed so that the opening is parallel to the ground and at least 1 m (3 feet) above the ground.

Reporting Rainfall Amount:

Record the amount of rainfall and empty the gauge after each rain. During heavy storm events the gauge may need to be emptied frequently because it measures only 5.5 inches or 140 millimeters (mm).The gauge should be read and emptied after it stops raining so that evaporation does not cause false readings especially during hot weather. Record the weekly accumulations of rain in mm in the space provided on the data collection form.

WATER QUALITY CRITERIA FOR THE STATE OF FLORIDA

Waters in the state of Florida are classified by use. For example, most streams, rivers and lakes are designated as Class III (either fresh or marine): Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife. Other classifications include Class I: Potable Water Supply, Class II: Shellfish Propagation or Harvesting, Class IV: Agriculture Water Supplies and Class V: Navigation, Utility, and Industrial Use. Different protection levels are assigned to different uses. Thus as an example, Classes I-IV may have stricter requirements for dissolved oxygen than Class V water which is classified as Navigation, Utility and Industrial Use.

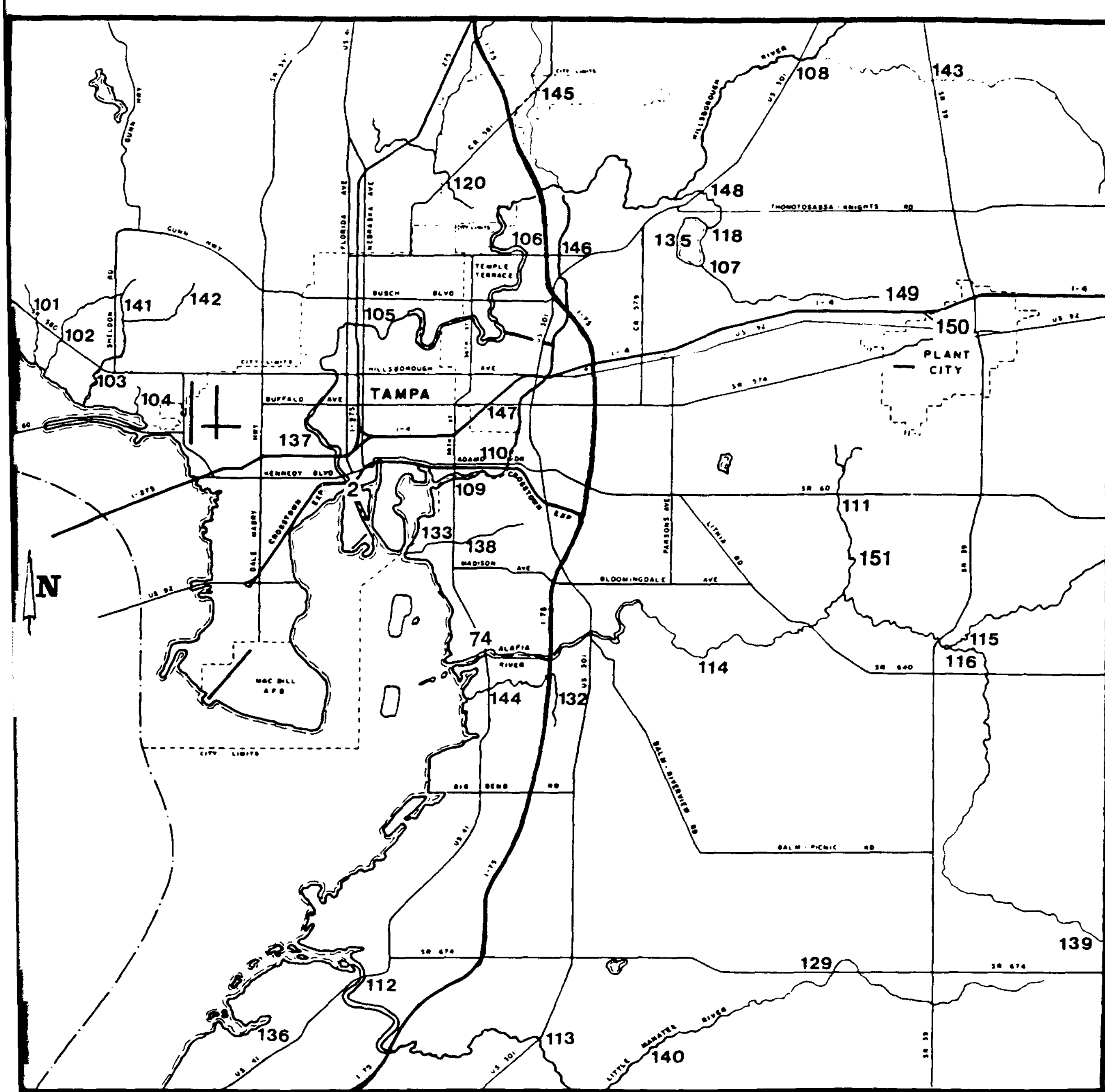
There are numerous criteria for specific chemicals and metals. Several parameters are listed below for Class III waters.

Class III	Fresh	Marine
Dissolved Oxygen (mg/L)	Shall not be less than 5.0. Normal daily and fluctuations above these levels shall be maintained.	Shall not be less than 5.0 in 24-hour period and shall never be less than 4.0. Normal daily and fluctuations above these levels shall be maintained.
pH	Shall not vary more than one unit above or below natural background of predominately fresh waters and coastal waters or more than .2 unit above or below natural background of open waters provided that the pH is not lowered to less than 6 units in fresh waters or less than 6.5 units in marine waters or raised above 8.5 units.	
Turbidity (NTU)	< 29 above natural background conditions	
Nutrients	In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna.	

Source: Department of Environmental Regulation 17-302, Surface Water Quality Standards

Figure 11-1

ENVIRONMENTAL PROTECTION COMMISSION WATER MONITORING STATIONS HILLSBOROUGH COUNTY, FLORIDA



HILLSBOROUGH COUNTY ENVIRONMENTAL PROTECTION COMMISSION
WATER QUALITY MONITORING STATIONS

STATION NUMBER	LOCATION
2	Hillsborough River at Platt St.
74	Alafia River at U.S. 41
101	Double Branch Creek at Hillsborough Ave.
102	Channel "A"at Hillsborough Avenue
103	Rocky Creek at Hillsborough Avenue
104	Sweetwater Creek at Memorial Highway
105	Hillsborough River at Rowlett Park Drive
106	Hillsborough River at Fowler Avenue
107	Baker Creek at Thonotosassa - Plant City Road.
108	Hillsborough River at U.S. 301
109	Palm River at U.S. 41
110	Palm River at U.S. 60
111	Turkey Creek at U.S. 60
112	Little Manatee River at U.S. 41
113	Little Manatee River at U.S. 301
114	Alafia River at Bell Shoals Road
115	North Prong of Alafia River, upstream of the confluence
116	South Prong of Alafia River, upstream of the confluence
118	Lake Thonotosassa at mouth of Flint Creek
120	Cypress Creek at S.R. 581
129	Little Manatee River at S.R. 674
132	Bullfrog Creek at Symmes Road
133	Delaney Creek at U.S. 41
135	Middle of Lake Thonotosassa
136	Cockroach Bay
137	Hillsborough River at Columbus Avenue
138	Delaney Creek at 36th Avenue and 54th Street
139	South Prong of Alafia River at Bethlehem Road
140	Little Manatee River at S.R. 579
141	Rocky Creek at Waters Avenue
142	Sweetwater Creek at Anderson Rd.
143	Blackwater Creek at U.S. 39
144	Bullfrog Creek at U.S. 41
145	Trout Creek at S.R. 581
146	Tampa By-Pass Canal at Fowler Avenue
147	Tampa By-Pass Canal at M.L. King Blvd.
148	Flint Creek at U.S. 301
149	Mill Creek at 1-4
150	Mill Creek at Alexander St.
151	Turkey Creek at Durant Rd.

EPC of Hillsborough County
SAMPLING STATIONS AND DATA

Sarnpling Stations

The table on page 45 lists the location of each sampling station while Figure 11 -1 on page 44 locates the corresponding stations on a map of Hillsborough County.

Annual Averages

The1997 annual averages for the Tampa Bay stations are presented in the following tables for each water quality parameter measured.

The unit of measure for each parameter is as follows:

Biochemical Oxygen Demand (mg/l)
Chlorophyll a (ug/l)
Chlorophyll b (ug/l)
Chlorophyll c (ug/l)
Chlorophyll, Total (ug/l)
Coliform, Fecal (colonies/100 ml sample)
Coliform, Total (colonies/100 ml sample)
Color (Platinum-Cobalt Units))
Conductivity (micromhos/cm)
Depth, Bottom (feet)
Depth, Sample (feet)
Effective Light Penetration (inches)
Fluoride (mg/l)
Metals: Pb, Fe (ug/l)
Ca, Mg, Na, K (mg/l)

Nitrogen, Ammonia (mg/l)
Nitrogen, Kjeldahl (mg/l)
Nitrogen, Nitrate (mg/l)
Nitrogen, Nitrite (mg/l)
Nitrogen, Organic (mg/l)
Oxygen, Dissolved (mg/l)
Phosphate, Dissolved Ortho (mg/l)
Phosphate, Total (mg/l)
Salinity (parts per thousand)
Solids, Suspended (mg/l)
Temperature, Air (degrees C)
Temperature, Water (degrees C)
Turbidity (NTU)

All information presented in this section is taken from "Surface Water Quality 1995-1997" compiled by the Environmental Protection Commission for Hillsborough County. For more information please contact, the Environmental Protection Commission of Hillsborough County 1900 9th Avenue Tampa, FL 33605. (813) 272-5960.

TRIBUTARY STATIONS
1997 ANNUAL AVERAGES - PHYSICAL

STATION	DEPTH Boftom feet	DEPTH Sample feet	COLOR Pt-CO	TURBIDITY NTU	SECCHI inches	TEMP.WAT Top degrees C	TEMP.WAT Middle degrees C	TEMP.WAT Bottom degrees C	TEMP.AIR degrees C
2	9.1	4.5	14.3	3.3	53	24.2	25.3	25.3	23.0
74	10.8	5.4	19.9	7.5	47	23.8	24.1	24.3	26.6
101	3.3	1.6	80.7	5.8	31	24.0	23.2	23.9	24.9
102	5.8	2.8	21.9	6.4	37	23.6	23.7	23.7	24.6
103	3.3	1.6	35.3	3.7	37	25.1	23.7	25.5	24.1
104	6.6	3.3	26.6	4.8	47	22.9	24.4	25.1	23.7
105	7.6	3.8	62.3	3.7	37	23.2	23.4	23.5	26.6
106	5.2	2.6	63.9	2.2	46	21.5	22.5	21.2	29.5
107	2.8	1.4	66.7	7.0	26		22.8		31.1
108	6.5	3.2	57.2	3.2	50	22.3	22.3	22.3	30.7
109	10.1	5.1	13.0	4.9	60	24.5	24.9	24.8	25.7
110	16.3	8.1	13.5	11.9	38	25.9	25.0	24.8	30.0
111	1.1	0.5	58.9	9.3	12		22.0		30.5
112	9.4	4.7	55.2	4.2	51	24.2	24.2	24.2	28.3
113	2.3	1.2	74.8	3.6	23	17.5	21.6	17.5	26.9
114	6.1	3.1	40.3	3.7	55	22.0	22.0	22.0	24.3
115	2.9	1.5	43.2	6.7	31	20.8	21.9	20.8	30.5
116	2.3	1.2	57.6	2.9	26	17.3	22.5	17.2	30.5
118	4.3	2.1	32.0	15.9	19	23.7	25.0	22.7	30.3
120	3.9	2.0	125.9	3.4	35	20.7	21.0	20.7	27.9
129	1.7	0.8	100.1	2.8	20		21.5		29.0
132	2.2	1.1	48.8	3.6	27		21.4		25.8
133	1.8	0.9	49.6	3.6	21		23.6		23.7
135	12.6	6.3	32.8	12.0	20	24.9	24.4	23.7	30.4
136	1.1	0.5	23.2	6.6	13		25.4		28.5
137	12.0	6.0	47.3	4.2	47	23.5	23.9	24.4	22.8
138	1.7	0.8	52.2	3.3	20		21.6		24.0
139	1.9	0.9	25.0	3.8	22	19.4	22.8	19.4	29.6
140	2.3	1.1	70.2	3.8	23	22.8	21.9	22.8	28.4
141	4.3	2.2	38.9	1.9	49	22.5	23.7	22.4	26.1
142	1.5	0.7	36.8	1.8	18		22.2		27.7
143	1.4	0.7	73.9	4.5	15		21.4		30.1
144	6.5	3.3	33.3	8.2	38	23.2	23.2	23.8	27.2
145	1.8	0.9	111.3	4.3	18	14.1	20.4	14.1	29.2
146	6.4	3.1	65.0	7.3	25	24.3	23.5	22.5	29.8
147	18.3	9.2	31.8	5.0	37	25.3	24.6	23.7	28.7
148	5.7	2.9	65.0	9.7	22	22.1	22.2	21.6	30.1
149	1.4	0.7	22.9	6.8	17		28.1		29.9
150	1.4	0.7	17.4	4.5	16		30.4		30.4
151	1.6	0.8	41.8	3.3	20	18.1	22.6		31.1

TRIBUTARY STATIONS
1997 ANNUAL AVERAGES - PHYSICAL- Continued

STATION	CONb.T	COND.M	COND. B	PH.T	PH.M	PH.B	DO.T	DOM	DO.B	SAL.T	SAL. M	SAL. B
	umhos	umhos	umhos				mg/l	mg/l	mg/l	ppt	ppt	ppt
2	27584	38892	41083	7.5	7T	7.7	5.2	4.4	3.7	16.9	24.8	26.3
74	28697	35975	39683	7.7	7.8	7.8	5.6	4.9	4.3	17.7	22.8	25.3
101	11594	18809	12132	7.2	7.4	7.2	3.1	4.4	4.4	8.1	12.3	8.6
102	29998	32817	36742	7.6	7.6	7.6	5.2	4.2	3.7	18.7	20.6	23.3
103	8545	15530	16000	7.2	7.3	7.1	4.3	4.5	3.2	4.9	10.0	9.5
104	11562	25156	32617	7.3	7.3	7.3	4.3	3.3	2.2	6.6	15.6	20.3
105	4623	5213	5490	7.4	7.3	7.2	6.1	5.2	4.7	4.0	4.7	4.9
106	316	333	313	7.2	7.2	7.1	5.2	5.0	4.9			
107		420			7.0			3.0				
108	348	346	346	7.5	7.5	7.5	6.5	6.5	6.6			
109	35209	38333	41142	7.8	7.8	7.7	5.4	4.5	3.6	22.3	24.4	26.3
110	33633	38583	40842	7.8	7.6	7.4	5.0	2.9	1.8	21.1	24.6	26.2
111		339			7.3			7.0				
112	19121	19423	19942	7.3	7.3	7.3	5.1	5.0	5.0	12.5	12.6	13.0
113	210	381	225	6.2	7.0	6.3	8.1	7.5	8.4			
114	570	571	571	7.1	7.1	7.1	6.6	6.6	6.6			
115	814	700	814	5.9	7.3	6.0	7.4	7.8	7.4			
116	363	355	363	7.4	7.6	7.4	8.0	7.9	7.9			
118	418	1092	420	9.1	9.3	8.9	11.2	10.8	9.8			
120	290	334	292	6.8	7.0	6.8	3.2	3.2	3.3			
129		393			7.0			6.8				
132		482			7.2			7.6				
133		9635			7.1			3.3			8.4	
135	451	451	467	9.4	9.3	8.5	10.9	9.4	4.9			
136		38233			7.8			6.2			25.7	
137	16623	21148	29041	7.3	7.3	7.3	4.7	4.3	3.7	12.1	15.7	20.0
138		714			7.3			4.2			1.0	
139	510	486	510	7.4	7.7	7.3	7.4	7.4	7.8			
140	284	436	284	6.7	7.1	6.7	7.1	7.7	7.0			
141	521	585	521	7.1	7.2	7.1	5.8	5.5	5.8			
142		289			6.7			3.1				
143		466			7.2			6.4				
144	16098	19047	28975	7.4	7.4	7.4	5.4	5.0	3.0	9.4	11.2	17.9
145	186	313	188	7.0	7.0	7.1	7.8	5.8	7.9			
146	290	298	293	8.0	7.8	7.7	7.6	6.8	5.6			
147	545	550	589	8.2	7.9	7.4	8.3	6.9	3.3			
148	522	530	509	7.2	7.1	7.0	5.0	4.5	3.9			
149		488			7.3			3.6				
150		413			7.9			7.4				
151		449			7.5			6.8				

TRIBUTARY STATIONS
1997 ANNUAL AVERAGES - NUTRIENTS

STATION	P.ORTHO mg/l	P.TOTAL mg/l	N.ORG mg/l	N.KJEL mg/l	NH3N mg/l	$NO_3.NO_2$ mg/l	N.TOTAL mg/l
2	0.19	0.23	0.67	0.75	0.09	0.044	0.80
74	0.43	0.54	0.85	0.91	0.07	0.097	1.01
101	0.11	0.18	0.96	1.07	0.11	0.044	1.12
102	0.13	0.27	1.30	1.35	0.06	0.076	1.43
103	0.12	0.20	0.89	0.99	0.10	0.186	1.18
104	0.11	0.21	0.89	1.02	0.13	0.132	1.15
105	0.19	0.27	0.92	1.00	0.09	0.098	1.10
106	0.21	0.25	0.57	0.61	0.05	0.414	1.03
107	0.44	0.64	0.84	0.94	0.10	0.160	1.10
108	0.25	0.29	0.43	0.45	0.03	1.324	1.77
109	0.26	0.36	1.00	1.05	0.05	0.035	1.09
110	0.22	0.31	1.28	1.37	0.09	0.170	1.54
111	0.59	0.93	0.91	0.95	0.04	2.513	3.46
112	0.33	0.38	0.85	0.93	0.08	0.124	1.06
113	0.38	0.44	0.62	0.66	0.04	0.802	1.46
114	11.46	21.00	0.53	3.55	3.63	1.284	4.84
115	14.41	21.53	1.34	4.42	3.08	0.910	5.33
116	0.73	0.77	0.60	0.62	0.02	0.542	1.16
118	0.10	0.36	2.94	2.95	0.02	0.038	2.99
120	0.07	0.13	1.24	1.44	0.20	0.045	1.48
129	0.63	0.64	0.72	0.75	0.04	0.178	0.93
132	0.28	0.33	0.54	0.60	0.06	0.497	1.09
133	0.49	0.55	1.09	1.41	0.32	1.144	2.56
135	0.09	0.30	2.47	2.48	0.01	0.031	2.51
136	0.23	0.35	1.16	1.21	0.05	0.028	1.24
137	0.21	0.26	0.86	0.95	0.10	0.092	1.05
138	0.46	0.51	0.85	0.99	0.14	0.592	1.58
139	1.10	1.29	0.57	0.61	0.04	0.591	1.21
140	0.45	0.54	0.66	0.71	0.05	0.986	1.70
141	0.15	0.18	0.65	0.76	0.11	0.305	1.07
142	0.06	0.10	0.55	0.60	0.05	0.065	0.66
143	0.47	0.54	0.91	0.99	0.08	0.528	1.52
144	0.30	0.42	0.94	1.06	0.12	0.287	1.34
145	0.18	0.21	0.88	0.90	0.02	0.044	0.94
146	0.21	0.31	0.96	0.99	0.03	0.029	1.02
147	0.18	0.25	0.70	0.74	0.04	0.100	0.84
148	0.30	0.47	1.95	2.26	0.31	0.187	2.45
149	0.28	0.38	0.36	0.59	0.23	0.527	1.12
150	0.21	0.28	0.21	0.39	0.18	0.551	0.94
151	0.62	0.72	0.53	0.56	0.03	0.676	1.23

TRIBUTARY STATIONS
1997 ANNUAL AVERAGES - BIOLOGICAL

STATION	CHL.A ug/1	CHL.B ug/1	CHL.C ug/l	CHL.T ug/l	BOD.5 Mg/l	MF.COLI #/l 00ml	MFFECAL #/100ml	MRSTREP #/l 00ml
2	12.6	0.2	2.2	14.9	1.5	260	87	91
74	19.0	0.2	4.2	23.4	1.9	72	29	
101	5.4	1.1	1.7	8.2	1.3	813	293	317
102	51.3	0.4	11.4	62.9	4.4	250	63	95
103	16.9	0.2	2.9	20.1	2.3	708	262	352
104	18.7	0.5	2.8	21.9	2.6	2100	695	627
105	22.7	1.8	3.0	27.0	2.4	953	340	20
106	3.2	0.1	0.1	3.8	1.5	300	85	
107	8.0	1.1	0.5	9.6	1.8	1317	115	785
108	4.0	0.2	0.2	5.6	1.0	575	122	302
109	17.1	0.3	3.3	20.7	3.4	107	47	105
110	44.6	6.3	7.6	56.9	5.0	133	83	
111	2.9	0.6	0.8	4.2	1.5	8225	2800	8150
112	5.4	0.5	0.8	6.7	1.3	108	48	
113	0.9	0.1	0.2	2.1	1.1	1650	307	1075
114	3.4	0.1	0.2	4.8	0.8	575	53	180
115	1.3	0.5	3.2	4.9	0.7	1058	135	
116	1.3	0.7	0.9	2.8	0.7	458	102	
118	113.8	8.6	8.9	131.3	6.8	337	187	
120	1.3	0.7	0.9	2.9	2.3	1142	247	
129	0.6	0.2	0.5	1.3	0.9	658	58	
132	2.6	0.5	1.0	4.0	1.0	2200	880	
133	2.7	0.4	0.8	3.7	1.3	1533	725	1275
135	103.9	5.9	7.6	117.4	5.6	60	48	
136	12.2	0.7	1.8	14.6	3.1	112	58	
137	11.5	0.6	2.5	14.6	2.5	312	143	227
138	0.9	0.0	0.1	1.2	1.4	1525	758	
139	4.8	0.7	0.9	6.5	1.0	1308	223	
140	1.8	0.1	0.2	3.0	1.0	1592	400	
141	2.1	0.1	0.1	2.8	1.1	332	128	420
142	3.1	0.6	0.6	4.4	1.2	725	175	
143	5.7	0.9	0.3	6.9	1.3	413	143	
144	14.1	0.9	4.8	19.3	1.9	1343	620	
145	3.3	0.5	0.8	4.6	1.4	407	187	418
146	26.8	2.2	2.3	31.3	3.0	93	53	80
147	32.7	3.4	3.5	39.5	3.0	237	155	302
148	59.2	7.8	4.0	70.0	3.5	1258	347	
149	1.9	1.0	1.4	4,2	1.1	3083	225	1725
150	1.9	0.8	0.9	3,6	0.9	5267	733	1692
151	1.9	0.7	0.5	2.9	0.8	833	130	

HOW TO MAKE A KICK SEINE

For collecting macroinvertebrates
(courtesy of the Tennessee Valley Authority)

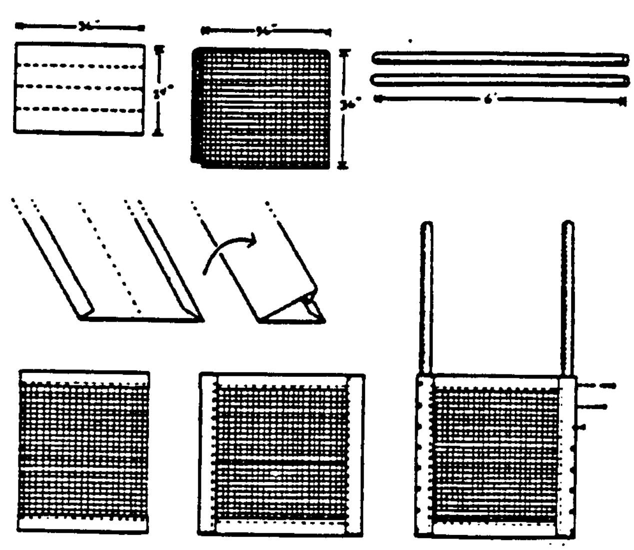
Materials:

3 foot by 3 foot piece of nylon or metal window screening
4 strips of heavy canvas (6 inches by 36 inches)
2 broom handles or wooden dowels (5 or 6 feet long)
finishing nails
thread
sewing machine
hammer
iron and ironing board

1. Fold edges of canvas strips under, 1/2 inch, and press with iron.
2. Sew 2 strips at top and bottom and then use other 2 strips to make casings for broom handles or dowels on left and right sides. Sew bottom of casings shut.
3. Insert broom handles or dowels into casings and nail into place with finishing nails.

Speed method:

1. Lay 3 foot by 3 foot piece of screening over broom handles.
2. Staple or nail screen to broom handles.



Hillsborough County Stream-Waterwatch Level II and III Activity Summary

Group:______________________________________
StreamSite:__________________________________
____
Date:_______________________________________
Quarter:_____________________________________
Form Completed by:___________________________
Phone:______________________________________

Send a copy to Hillsborough County Stream Waterwatch each quarter, before March 31, June 30, September 30 and December 31. (HCC Stream Waterwatch) 1206 N. Park Road Plant City, FL 33566; e-mail streamwaterwatch@bellsouth.net fax: (813) 757-2148. Attach latest results from Physical/Chemical or Biological Monitoring.

Activity	Date Completed
Physical/Chemical Testing (once each month)	January ________ February ________ March ________ April ________ May ________ June ________ July ________ August ________ September ________ October ________ November ________ December ________
Biological Monitoring (once each quarter) 1st Quarter 2nd Quarter 3rd Quarter 4th Quarter	 ____________________ ____________________ ____________________ ____________________
Habitat Enhancement Project (one time project) Riparian Reforestation Streambank Stabilization Stream bed Restoration	

Level I Activities Current ______yes ______no
Are you a quality assured volunteer ______yes ______no
Comments:____

HILLSBOROUGH COUNTY STREAM-WATERWATCH
Biological and Physical/Chemical Survey

Use this form to record important information about the health of your stream. By keeping accurate and consistent records of your physical/chemical tests and data from your macro invertebrate samples, you can document current conditions and changes in water quality.

Name of Stream **Location**

Individual or Group Present? **Members Present** **QA/QC Certified Volunteer**

Date **County**

Weather Conditions
□ clear □ cloudy □ rain □ rain within last 24 to 48 hours?

Physical/Chemical Tests

	Sample 1	Sample 2	
Basic Tests			
Air Temp.	_______	_______	(○ C)
Water Temp.	_______	_______	(○ C)
pH	_______	_______	(4-10)
Dissolved Oxygen	_______	_______	(mg/L)
Turbidity	_______	_______	(NTU)
Clarity	_______	_______	(m)
Salinity	_______	_______	(ppt)
Rainfall	_______ (mm)		

Comments:____