pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION Coastal Resources MANAGEMENT PROGRAM

# Water Monitoring Program: Protect our Waterways!

Silver Lake Nature Center™

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## What is a Watershed?

A watershed is defined as a "collecting area that includes all the water that flows into a particular sink" (Olsen and Chapman 1972). These areas are often defined by geologic features, such as mountain ranges, that cause water to flow to particular sinks such as streams, rivers, oceans, and deltas. Watersheds come in all sizes and depend on the scale at which people want to study them. For example, at Silver Lake Nature Center we study the Mill Creek Watershed which includes the streams and water runoff that drains into Silver Lake. However, this smaller watershed drains into the Delaware River which means it is also considered part of the Delaware River Watershed! While our local watersheds are small, they are important parts of a much larger watershed that affects the lives of many people.

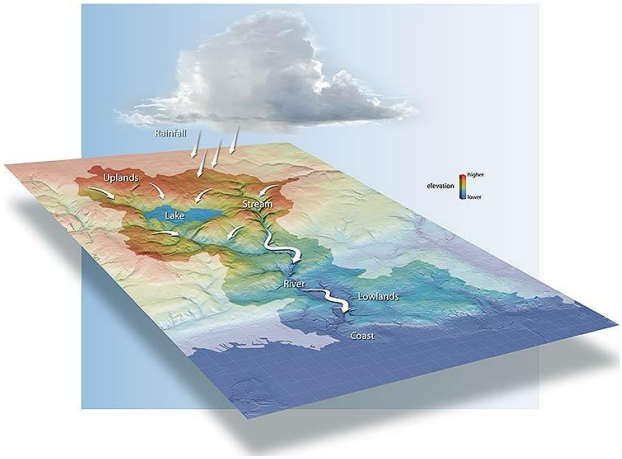


**Figure 1: Diagram of a Typical Watershed**

**Figure 2: Picture of Stream Erosion in Texas**

## Why are Watersheds Important?

Rivers and streams aren't just "another pretty face" of the landscape; they do a lot of work! Watersheds that include sufficient wetlands and riparian areas (vegetated areas surrounding waterways) help sequester pollutants. These pollutants that would otherwise stay in the water are taken up by plants and animals or become trapped in sediments (Brinson and Eckles 2011). Watersheds do more than help plants and animals downstream; they help to clean the water used for human consumption as well. While difficult to quantify the economic benefit, one report from the EPA *The Importance of Water to the U.S. Economy: Synthesis Report* (listed below in the Sources section) states that water sources for drinking water are much cleaner where healthy watersheds exist.

Healthy watersheds also help to reduce flooding. Permeable, vegetated areas within watersheds allow rainwater to percolate into the aquifer and to be taken up by the plants. This slows the amount of water that flows directly into streams or waterways. When areas become

more developed, roads, parking lots and buildings cover more land area. These areas are impermeable to water, and as a result more storm runoff goes directly into our waterways during rain events. This increased storm runoff easily overwhelms rivers and streams, which results in more frequent and extreme flooding events. Flooding events often result in erosion of stream banks and property damage within surrounding areas.

Finally, watersheds are important for the enjoyment of the community. Watersheds offer a wide variety of recreational opportunities including fishing, birding, hiking, and water sports like kayaking and boating. Having quality natural spaces adds value to your life and to your community as a whole. In addition to being a source of entertainment and relaxation, quality watersheds within your community make your community a healthier, more desirable place to live.

**Figure 3: Great Egret**

**Figure 4: Bull Frog**

## How Does One Determine the Health of a Watershed?

Unless a watershed is severely degraded, it is difficult to quickly determine the health of a watershed. To determine this, the Silver Lake Nature Center has established a monthly testing protocol to look at abiotic (chemical and physical) and potentially biotic (living) characteristics. The characteristics tested and the importance of each are described below.

### Abiotic Charcteristics

- Salinity - This is the total of dissolved salts in water. Aquatic organisms are quite sensitive to salinity, and these levels determine where particular organisms live. Changes in salinity can indicate increased rates of erosion or increased pollution.

- Conductivity -This parameter measures how well the water conducts electricity. This ability is also determined by the amount of salts within the water and can be influenced by salts and contaminants within the water.

- Chlorine - This chemical is a water additive used to control microbes. While perfectly fine, this chemical can cause eye and nose irritation and stomach discomfort if found above recommended EPA levels (EPA 2014).

- TDS (Total Dissolved Solids) - This test looks at the amount of dissolved solids within our water, including both sediments and contaminants. Samples with higher TDS measurements occur when water flows through soluble substrates such as limestone or when water flows through contaminated areas (Campbell and Wildberger 2001). This characteristic can be an indicator of excess erosion or contamination upstream.

- Turbidity -This is a measure of the "cloudiness" of the water and is an indicator of water quality and filtration effectiveness. Haziness is caused mainly by two factors, either suspended solids in the water or photosynthetic algae that diffract and scatter light. This characteristic is used as an indicator of overall pollution, and it is often correlated with higher instances of disease.

- D.O. (Dissolved Oxygen) - This measures the amount of oxygen in the water. Oxygen can only enter water two ways: it can physically enter from the atmosphere through diffusion; or it is added to the water as a byproduct of photosynthesis by algae and aquatic plants. Low levels of D.O. indicate little or no photosynthetic activity and/or high levels of decomposition. Above normal levels of D. O. can occur as a result of algal blooms. For more information, see the following section on Eutrophication.

- pH - This is a measure of the acidity of the water, with 1 being the most acidic and 14 being the most alkaline. This is measured by looking at the activity of hydrogen ions within a sample. The pH range of 6.5-8.2 is optimal for most aquatic life. Changes in pH are important because different pH levels affect the solubility of compounds in the water used for biological functions. The pH also affects the solubility of pollutants, such as heavy metals, which can have a lethal effect on fish at certain levels.

- Alkalinity - this measurement quantifies the capacity of the water to resist changes in pH. This buffering ability is important to resist drastic changes in water chemistry from everyday input like acid rain, snow melt, and storm surges. Fluctuations in pH stress aquatic species and can be detrimental to their health.

- Phosphates – While a naturally occurring compound from water runoff in natural areas and excrement from wildlife, phosphates are continuously added to our waterways from agricultural runoff and domestic and industrial wastewater (Hubbard et al 2004, Weaver 1969). Phosphates, and also nitrates and nitrites, are important nutrients for photosynthetic organisms that are often in short supply in natural environments. When these nutrients are introduced to waterways, eutrophication often occurs. More on this condition will be described in the following section.

- Nitrates and Nitrites - This is measured as an indicator of Non-Point (NP) pollution. These substances often get into the water supply from fertilizer runoff, leakage from septic tanks, and sewage. When these are present above the Maximum Contaminate Level as set by the EPA, children under six months of age who ingest this water can become seriously ill or die (EPA 2014).

**Biotic Characteristics**

- Benthic macro invertebrates - This characteristic includes populations of organisms that live within our watershed. These organisms, which are defined as creatures without backbones that are visible to the naked eye, can be quite sensitive; they alert monitors to the overall health of a stream. Particular species, known as “indicator species,” are present when water quality is high and are either absent or found in low numbers when satisfactory conditions are not met. We hope to add this to our current water monitoring program, and we will strive to conduct macro invertebrate sampling on a seasonal basis.

## What Does a Healthy Watershed Look Like? What Do We Want to Avoid?

With human development always expanding and encroaching on natural areas, it is no longer possible to reasonably consider natural areas separately from human activities. As a result, no natural areas are exempt from feeling human impacts. In this section, I am going to

describe the characteristics of a “healthy” watershed and some unhealthy conditions that occur as a result of human activities and development.

Healthy watersheds contain waters that support a variety of wildlife, are free of invasive plant species and algal blooms, have little sedimentation, and have very little pollution. These places are the most visually inviting and can provide the most ecological services like flood control, pollution sequestration, and opportunities for recreational opportunities.

Unfortunately, these places are not common. As more area is developed or farmed and more land is covered in impermeable surfaces like concrete and asphalt, less water percolates into the ground water and instead goes directly into our streams and rivers. As this runoff travels over the land, it picks up various chemicals and waste products on its way to the watershed. These contaminants often pose health risks for wildlife and may pose risks to humans.

In addition to contaminants that can directly harm wildlife and flora and drinking water, water runoff often contains phosphorus and nitrogen. These nutrients, often found in fertilizer and sewage, are extremely important in plant growth and development and are in short supply in natural settings. When this occurs, a process called eutrophication occurs.

Eutrophication is the process in which a body of water becomes oversaturated with nutrients and abnormally productive. While this is a natural process, it has become accelerated in many water bodies because of artificial input. Most lakes take hundreds of years to reach a eutrophic state, but with artificial input from runoff this process has started to occur over just a few decades. Agricultural fertilizers and sewage rich in phosphorus and nitrogen, which are important plant nutrients often in short supply, become available to aquatic life as runoff enters our streams and rivers. This input of nutrients results in increased growth for vascular plants and algae populations. Rivers become full of rocks covered in slime, making habitats less suitable for aquatic life. Lakes become covered in unsightly mats of algae, the water becomes more turbid, and less light can penetrate the water column. Less photosynthetic activity occurs at deeper depths, which kills many of the vascular plants and algae and reduces the amount of oxygen available within the water column as a result of reduced photosynthetic activity. This also indirectly affects the organisms, like zooplankton and fish, which eat these primary producers.

These large algae populations make waters unattractive, they have an unattractive odor, and certain kinds of algae can be dangerous to humans. Blooms of cyanobacteria, or blue-green algae, create toxins that negatively affect a wide variety of organ systems. Just this August residents of Toledo, Ohio, were banned from drinking their tap water. The water, which is sourced from the western portion of Lake Erie, was found to have dangerously

high levels of microsin. This chemical, produced by cyanobacteria, can cause liver failure at high doses (Zimmer 2014).


**Figure 5: Aerial Photo of Dangerous Algal Bloom in Lake Erie. August 2014**

If the influx of phosphorus and nitrogen suddenly stops, this can also be problematic. When these extra nutrients disappear, the large algae populations die off and settle to the bottom of lakes and rivers. Once here, bacteria decompose the biomass into energy and in the process consume large amounts of oxygen. In large water bodies, water layers stratify during the summer as the water near the surface heats up. The warmer water, which is less dense, stays near the surface as the denser, colder water stays at the bottom of the lake. Since the water layers do not mix until fall when air temperatures drop and the water temperature of the upper layer cools to allow mixing, the bottom of the lake has a set amount of oxygen available for consumption. In these larger water bodies the extra decomposition of the algal blooms quickly depletes the finite oxygen supply. This results in the death of the fish and other organisms that live deep in these water bodies.

## How is Testing Performed? And is it Expensive?

Under the current water monitoring protocol, we strive to test each site for the above characteristics on a monthly basis or immediately after concerning environmental events such

as fish kills or known chemical spills. Each feature mentioned above is tested using chemical protocols of water samples collected from each site. Procedures for water testing are included with chemical testing kits.

Water monitoring equipment, after initial purchase of the kits, is relatively inexpensive. The cost of these kits is generally $500, but thanks to numerous grants there is funding available to buy 3-4 starter kits. For some of you reading this document, your start up cost may be nothing! The cost of upkeep is not expensive once a program is started; annual upkeep costs range from $50-150. The testing here at Silver Lake Nature Center is quite extensive, so those of you more concerned with budget can limit the scope of testing to reduce costs.

Sampling for benthic macro invertebrates does have an initial set-up cost, but once done supplies last for many years. A sorting pan, tweezers, field guides, and assorted nets to capture macro invertebrates can range in cost depending on budget constraints but are generally a few hundred dollars. However, it is likely that grants and other sources of funding exist to alleviate these costs.

## Healthy Watersheds are Important, but Why Should We Monitor?

As mentioned before, healthy watersheds provide ecological services that greatly improve quality of life for both people and flora and fauna in the area. What we failed to mention before was the impact this project can have on the community on a personal level. Creating water monitoring programs offers students in the area opportunities to connect with their natural surroundings and get hands-on scientific experience. Making these connections with young people can inspire a connection with nature that may result in a cooperative relationship between people and the environment. Experience with the scientific method and systematic sampling methods can also encourage young people to pursue scientific degrees or help them gain acceptance into universities.

By getting older members of the community involved, we are encouraging a sense of stewardship that can translate into more immediate change for the community. Involvement in these kinds of programs can encourage residents to adopt more environmentally friendly practices, like planting native plant species instead of invasive species or installing rain gardens on their property. These feelings could also translate into action on the political side; increased connection to the surrounding area could result in more environmentally-friendly policies and “greener” development.

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