# THE SOURCE AND THE IMPACT

Identifying that a stream has been impacted by acid mine drainage and determining the extent of the impact may require months of careful observation. Monitoring several physical, chemical, and biological parameters of the stream environment will provide the information necessary to accurately assess its quality. These parameters measure flow and dissolved materials, and reveal what lives and does not live in the water. Conducting these simple tests and sampling techniques provide important pieces to the complicated puzzle of understanding and correcting mine drainage.

## Talkin' Chemistry

*Several easy-to-perform chemical tests in the form of kits and meters are available to provide a general understanding of what is dissolved in the water at the time the test is performed. While these simple tests provide a quick field reference, trained laboratory professionals are necessary for an accurate analysis of water quality.*

### pH

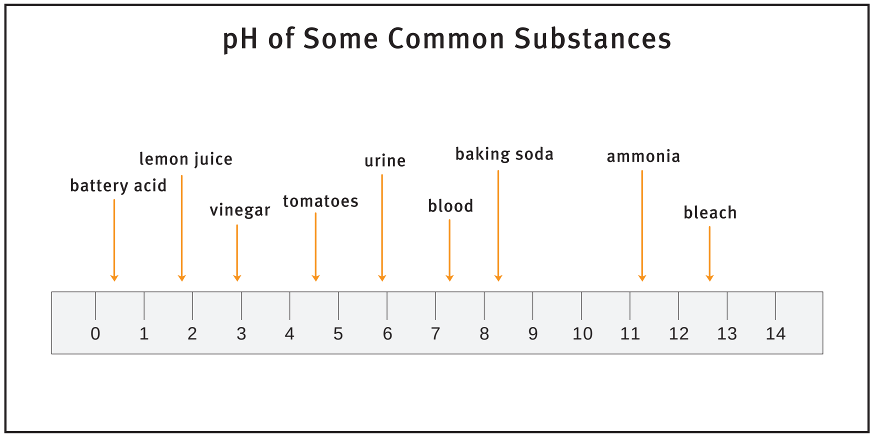
***pH*** is a measurement of the acidity of water. pH is measured on a scale that ranges from 0 -14, with 7 being neutral, anything below 7 being acidic, anything above 7 being basic. The pH scale is logarithmic, meaning that each change in pH is ten times greater than the preceding number on the scale. Typically mine drainage is acidic.

*Performing a simple analysis of water quality (Photo courtesy of Jennings Environmental Education Center)*

The acidity of water ultimately affects what will live there and what will be dissolved in the water. Healthy streams should have a pH no lower than 6 and no higher than 9.

### Alkalinity

***Alkalinity*** measures the water's ability to ***buffer***, or neutralize acids. For example, if acid is introduced to two glasses of water, one with high alkalinity and one with none, the pH of the water containing alkalinity would remain stable while the pH of the water with little or no alkalinity would drop. Alkalinity is determined by the soil and bedrock through which a stream flows. A stream flowing through limestone bedrock will have considerably more alkalinity than one flowing through sandstone. The measure of a stream's alkalinity will determine how that stream will respond to the introduction of acidic




mine drainage. Alkalinity is measured as ***parts per million (ppm)***. Parts per million is the same as ***milligrams per liter (mg/l)***. Levels between 20 ppm - 200 ppm are typical for freshwater.

**Dissolved Oxygen (DO)**

Oxygen dissolved in water is necessary for the survival of most aquatic life, including fish. There are three ways in which oxygen can become dissolved in water: ***aeration***, ***diffusion***, and ***photosynthesis***.

Aeration is the introduction of air into water by stirring or mixing. Waterfalls and ***riffle areas*** (rapids are riffle areas on a larger scale) in a stream provide a natural method of mixing and stirring.

Diffusion from the atmosphere occurs whenever water comes in direct contact with the air. This takes place on the surface of a body of water.

***Photosynthesis*** is a process in which green plants use carbon dioxide, water, and sunlight to produce food. Oxygen is a by product of this process and is released into the water by aquatic vegetation. Plants also consume oxygen during respiration. A proper balance of aquatic vegetation is needed for optimum dissolved oxygen levels.

Many factors such as temperature, flow, and turbidity affect ***dissolved oxygen*** (DO). Dissolved oxygen is measured in parts per million with levels in a stream varying between 0 ppm - 18 ppm. It is physically impossible for a stream to contain more than 18 ppm of DO. Most aquatic life cannot withstand DO below 5 ppm. A healthy stream generally has DO higher than the minimum level required by aquatic life to buffer against possible fluctuations caused by drought, temperature, or pollutants.





**Turbidity**

Turbidity measures the amount of suspended solids (sand, silt, organic materials, etc.) in the water. Turbidity in a stream can increase as a result of erosion. Mining, construction and agriculture are activities that may contribute to erosion. Increased turbidity reduces the amount of light that can penetrate the water. As a result, photosynthesis in plants is reduced, decreasing the amount of oxygen dissolved in the water. Soil particles in the water also absorb heat, raising a stream's temperature, which also affects dissolved oxygen levels. Increased turbidity decreases visibility and makes it difficult for aquatic organisms to locate food. Turbid water can clog gills making breathing difficult.

Turbidity is measured in ***nephelometric turbidity units (NTU's)***. To safely maintain aquatic life a freshwater stream should not exceed 100 NTU.

*Dissolved oxygen meter* (Photo courtesy of Alan J. King)

### Sulfates

Sulfate in water is the result of the weathering of sulfate bearing minerals such as pyrite. Since pyrite is the principle cause of acid mine drainage, sulfate is an excellent indicator that streams may be impacted by a mine discharge. A sulfate level of 250 ppm or higher in water is considered to be unsafe to drink.

### Conductivity

Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids such as iron and sulfates. Distilled water, having no dissolved solids, has virtually no conductivity. Conductivity is primarily affected by the geology of the area through which the water flows. Conductivity is measured in micromhos per centimeter. Streams that support a healthy population of fish and aquatic insects range from 150 to 500 micromhos per centimeter.

These parameters are all interrelated. What affects one will affect the other.

Abandoned Mine Drainage. An Epic Tale



## Acid Mine Drainage: A Profile in Pollution

Unfortunately, there is not one set of standards that will identify mine drainage 100% of the time. However there are many typical characteristics that may lead you to believe that there is abandoned mine drainage impacting a stream.

Color—Mine Drainage may take on a variety of colors that can be easily recognized as a pollution problem. Most common is an orange/red residue and staining called ***yellow boy***. This sludge like material is iron that was previously dissolved in the water but has since returned to its solid form. Certain types of mine drainage may appear milky or have a white cast to it. This signifies the presence of aluminum. Often the most polluted mine drainage is crystal clear, appearing to be pure water. This is the result of the water being so acidic that all pollutants are completely dissolved.

pH—Typical acid mine drainage has a pH of less than 6 although mine drainage greater than 6 (alkaline mine drainage) can also occur. For this reason pH should never be the sole method of determining a mine drainage problem.

Iron—Elevated levels of iron are almost always associated with mine drainage. Levels greater than 5 ppm are usually indicative of mine drainage. It is not uncommon for levels of iron to exceed 100 ppm. If the stream bottom is coated with yellow boy, the iron may no longer be dissolved in the water and will not register on an iron test.

Dissolved Oxygen—Typically mine drainage has very low (less than 3) levels of dissolved oxygen.

Sulfates—High concentrations of sulfates are typically found in mine drainage. For this reason, sulfates are generally a good indicator of mine drainage. Sulfate levels exceeding 50 ppm reveal a possible mine drainage problem.

*Abandoned Mine Drainage*
*(Photo courtesy of Jennings Environmental Education Center)*

## Life On the Bottom

*A healthy stream contains a myriad of interconnected and often unnoticed life that precariously depends on an ever changing environment. These organisms act as a natural barometer measuring a stream's health over an extended period of time.*

Life in a stream begins when organic materials, such as fallen leaves, land in the water and sink to the bottom. Bacteria, attracted to this material as a food source, quickly begin the decomposition process. The resulting bacteria-laden organic material, called ***detritis***, is the keystone for an intricate underwater food web.

Detritis is the primary food source for many cold-blooded aquatic organisms called ***macroinvertebrates***. These are organisms with no backbone but are large enough to see with the unaided eye. Organisms such as stonefly nymphs and mayfly nymphs tear apart the decaying plant material with powerful mouth parts. This beneficial dismemberment of detritis has earned these animals the distinction of being called ***shredders***. Other aquatic insects armed with mouth parts specifically adapted for removing algae from rocks and vegetation are called ***scrapers***.

*Students collecting aquatic organisms (Photo courtesy of Jennings Environmental Education Center)*





These shredders and scrapers are sloppy eaters. They reduce the decaying plant material and algae into bite size particles that become suspended in the stream. Many aquatic organisms depend on this floating food. ***Collectors***, such as caddisfly larvae, attach themselves where food continuously floats by.

Ferocious predators, such as dobsonfly larvae, tirelessly hunt the stream bottom for tasty shredders, scrapers, and collectors. Strong and fast, these organisms are the lions of the stream.

Acid mine drainage can have a devastating impact on the stream environment and on the creatures that live there. Yellow boy (pg. 47) coats the bottom of a stream, suffocating all organisms that live on the bottom and destroys their food supply. High acidity affects respiratory functions and reproduction. Dissolved metals act as lethal poisons. Silt clogs gills, lowers visibility and can ultimately affect the amount of oxygen dissolved in the water.

The PA Fish and Boat Commission estimates the value of lost recreational fishing opportunities due to AMD at $67 million per year.

*Common adult, aquatic organisms*