West Virginia Department of Environmental Protection
Watershed Improvement Branch

West Virginia Save Our Streams Program Level-One Standard Operating Procedures Manual

The mission of West Virginia Save Our Streams is to promote the preservation and restoration of our state's waters by providing a better understanding of their ecological integrity.

Introduction

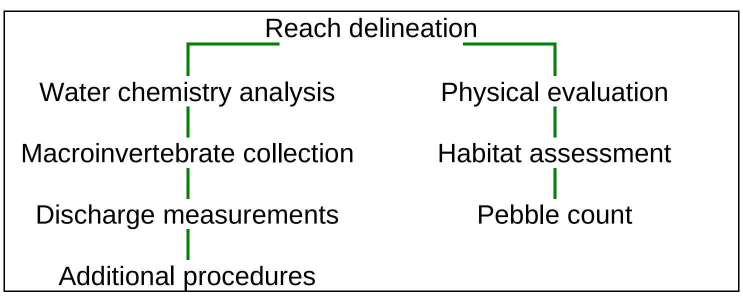
This manual describes the standard operating procedures (SOPs) for completing a **biosurvey** using WV Save Our Streams methods. The SOPs are designed and intended for the assessment of wadeable streams; they consist of three basic elements: (1) water quality analysis; (2) physical characterizations, mostly by observations using the characteristics and conditions described on the survey data sheet; and (3) the bioassessment of the benthic macroinvertebrate **(BMI)** community. For more information about general hydrologic and ecological concepts visit the Volunteer Monitoring Manual section of the West Virginia Save Our Streams' Program website.

Prior to your site visit you should prepare for your survey making sure you have all the necessary equipment. The equipment should be in working condition and replaced or repaired if needed. Check batteries if electronic equipment such as cameras or GPS units are used. Check the expiration dates of chemicals, make sure all meters all calibrated, all nets are to be secured to their poles and have no tears or holes, and all sample containers should be clean and dry. Review the appropriate topographic maps and/or aerial photos prior to the site visit and possibly have copies on-hand during your survey. Make sure all sites are accessible and that permission to cross private property is acquired prior to your site visit. During surveys, always wear the correct footwear (waders, boots, and closed toed shoes) and cloths for working in and around the stream. Your footwear should be cleaned prior to visiting the next site to avoid possible transfer of any biological or chemical components. You should have a thorough knowledge of the risks associated with stream survey work in your area and have a corresponding safety plan to reduce those risks. The flow chart below provides the general steps of the stream survey procedure.

Clean your equipment

Felt glued to the bottom of the wading shoe will improve your traction for walking in the stream; however felt will also easily transfer certain biological components (i.e. algae, bacteria etc.) if they are not properly cleaned. Equipment and wading apparel should be cleaned between uses and especially if multiple streams are visited.

Before deciding to begin a monitoring project/program it is very important for you to describe your study design (i.e., monitoring plan). Think carefully about the why, what, where, when and how questions, and consider the quality assurance and quality control (**QAQC**) measures that are necessary to insure accuracy and precision. The questions you ask, the methods you choose, and the way the data is analyzed and checked should be written into your study design. Your monitoring is much more likely to be successful and sustainable over a longer time, with the right plan.



The steps of the procedures can vary slightly, depending upon the number of volunteers available to perform the survey. However, most of the physical observations and water quality analysis should occur prior to any sediment disturbance that may be caused by walking in the stream while performing pebble counts or habitat observations, or macroinvertebrate collections.

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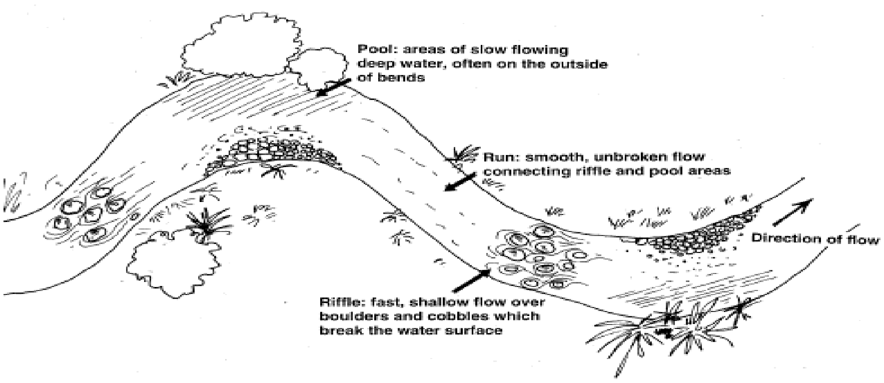
Happy workshop participants

Photo courtesy of Jennifer Liddle, Southern Basin Coordinator

Reach Delineation



The sampling locations on a stream should be a minimum of 50-yards upstream from a road or bridge crossing. Being upstream of these or other types of human encroachments minimizes the effects on stream velocity, channel shape and size, and overall habitat quality. In other words, your reach should be as representative as possible of the natural characteristics of the stream. Additionally, no major tributaries (2^{nd} order or higher) should be discharging within the reach.

Once the station is established the length of the reach is determined and set. WV Department of Environmental Protection's (WVDEP), Watershed Assessment Branch uses a 100-meter reach. Volunteer monitors are encouraged to use the same length, but other lengths are acceptable. Most hardware or home stores sell open-reel tape measures of up to 300-feet (100-meter open-reel tape measures are usually available from engineering supply companies). The 300-foot distance is allowable for the maximum reach length. In some cases, younger volunteers may be monitoring so it is best to keep them within your line-of-sight. Certain stream-types may meander and have thick vegetation so the entire length of the reach may not be visible. Under these circumstances the length of the reach can be reduced as a safety precaution. The recommended minimum length is 150-feet. The reach should have at least one or more of the following channel features:

1. **Riffles** have shallow, fast moving water broken on the surface by the presence of coarse substrate such as stacked gravel, cobble, and boulders. Its channel shape is variable and often has portions of incline and decline. This channel feature is the best place from which to collect benthic macroinvertebrates.
2. **Runs** are deeper than a riffle with a fast to moderate current and usually no breaks in the surface. The channel shape is relatively consistent with only a slight incline or decline. The substrate is variable but is mostly coarser materials. Your water samples should be collected here, and the width, depth and velocity should be measured within a run. Choose a representative run that is as close to your x-site as possible. The X-site is the most downstream portion of the reach.
3. **Pools** have deep, slow-moving water. The channel shape is generally bowl-like and often some of the bottom substrates consist of finer sediments such as sand and silt. In steep-gradient mountain streams, pools are often deep but may have many areas of very fast velocity and larger substrate. These types of pools are often referred to as steps.

Determine the average **width and depth** of the channel features. Once the length is determined and set it should remain the same throughout the life of the station. Use flagging or natural features to mark the upper and lower boundaries of the reach. For the first few visits it is a good practice to measure the length of the reach by laying an open-reel tape measure along the banks (not in the stream). The tape measure provides you with many points of reference along the length and is useful for marking the location of pebble count transects and other notable habitat features such as point bars, islands, or eroding banks that may occur within the reach. The latitude and longitude (**X-SITE**) of your reach is determined at the downstream end of the reach. If you are using a GPS and cannot get a reading at the downstream end, do not move your tape measure once it is in place. Walk up stream until a signal is received and then indicate the location of the signal on your survey data sheet (i.e., middle reach, upper reach etc.).

Station Locations

The number and location of your stations depends on what questions your monitoring study has been designed to answer. Table 2 provides some general considerations based upon two types of common monitoring criteria. Prior to selecting the site in the field, use a topographic map to do preliminary selection of sites that meet your criteria. Always visit the site before making final determinations to make sure the site is easily and safely accessible and that it is on public access areas whenever possible.

Site codes are important for keeping track of your stations and for reporting purposes. WV Save Our Streams recommends that you use a code consisting of series of numbers and letters that easily designate the site locations and allow for more sites to be added. For example, you have decided on three stations along Spruce Creek.
The stations could be coded as follows:

SP-001 - most downstream site; **SP-010** - about 1-mile from the mouth; **SP-015** - about 1.5-miles from the mouth. The number to the far right is 0.1-mile, the next place to the left is 1.0-miles, the next is 10.0-miles etc.

(**SP**): First two-letters of the name

(**001**): Miles from the mouth

Choose the site that best fit the type of monitoring your group would like to perform. Most volunteer monitoring groups choose sites that determine baseline conditions and will be used to establish long-term or short-term trends. These sites are visited on a regular basis and the information collected is compared to determine if changes are occurring. The other type is for analysis of a particular impact or activity that is occurring on the stream. In this situation the stations are compared against a reference or control to determine the extent of the impact or activity.

Table 1 - Monitoring stations considerations based upon criteria.

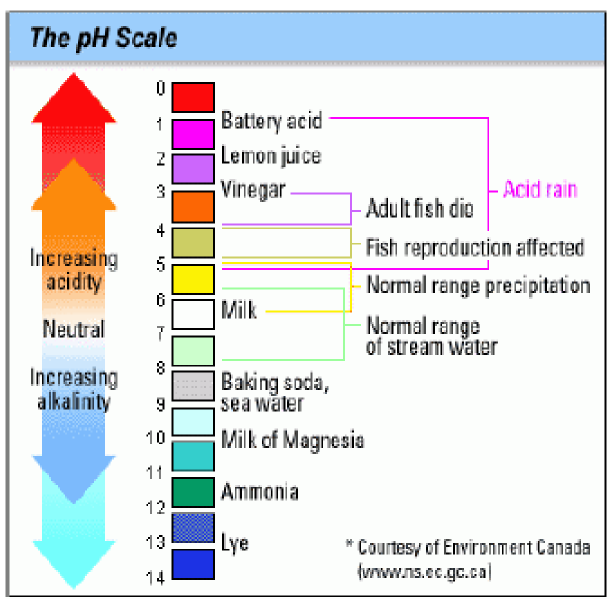
Characterization study (baseline/trends)	**Impact assessment study**
(1) Site is typical of the part of the river that interests your group. (2) Site has a variety of characteristics that represents those of the watershed. (3) Site may have some special natural or historical significance. (4) Site may be the location of previous monitoring activity.	(1) A reference or control station is established upstream of the potential impact. In some cases, references may be in an adjacent watershed with similar characteristics, or they may be theoretical. (2) The impact station is at, or slightly downstream from the alteration or pollutant. (3) The recovery site is downstream of the impact where it is believed that the stream is beginning to recover from the insult.

How often should you monitor your stations?

Your study design should help you answer this question. But in general, bioassessment surveys are performed either once or twice within an **index period**. If there is a reason, volunteers may monitor water quality at a station more frequently such as seasonal or even monthly depending upon the situation. At a minimum, the station can be monitored only once within the index period. The WV Save Our Streams index period is from April through October.

Water Quality Analysis

This section describes procedures and considerations for collecting water samples from wadeable stream reaches. For more specific considerations regarding the design of a water quality monitoring program refer to the program's Volunteer Monitoring Manual on the WV Save Our Streams website. Water analysis is the first task that should be performed following the delineation of your reach.



Where do I collect my samples?

Water samples should be collected from the most represented portion of the reach, which is usually the run, and as close to the downstream end (**X-SITE**) as possible. If the most downstream end of the reach is a riffle or pool, walk upstream until you encounter a run. Collect the water sample in the deepest section of the run. This may not be the center of the channel depending upon physical features or the curvature of the channel. For example, a curved (meander) channel is usually deepest on the outside bend. When wading to your sample location, be careful not to disturb the bottom sediments (or at least keep the disturbance to a minimum). Once you have located the deepest section (thalweg) and have a clean sample container ready, follow the procedure below. In most wadeable streams it is not necessary to locate the thalweg because the water is well mixed; however, you should never collect your samples from backwater areas.

1. Stand facing upstream. Collect the water sample on your upstream side, in front of you. You may also tape your bottle to an extension pole to sample from deeper water if the area cannot be reached.
2. Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream. Collect a water sample 8 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.
3. Turn the bottle underwater into the current and away from you. In slow moving stream reaches, push the bottle underneath the surface and away from you in an upstream direction.
4. Leave about ½ inch air space (Except for DO and BOD samples). Do not fill the bottle completely, so that the sample can be shaken just before analysis. Recap the bottle carefully, remembering not to touch the inside.
5. Fill in the bottle number and/or site number on the appropriate field data sheet. This is important because it tells the lab coordinator which bottle goes with which site.
6. If the samples are to be analyzed in the lab, place them in the cooler for transport to the lab. Some types of samples may need to be preserved to reduce the possible changes that could occur during transport. Your local laboratory can provide you with the necessary preservatives and chain-of-custody forms.

Typically, volunteer monitors focus on physical and biological assessments and collect minimal water quality chemistry. WV Save Our Streams recommends that level-two monitors monitor for changes in **pH**, **temperature** and perhaps one or more condition such as **dissolved oxygen** and nutrients (**nitrate**/**nitrite** and **phosphate**) depending upon the suspected insults. If water quality issues are suspected, chemical monitoring should occur more frequently. Your group should develop a regular schedule to monitor for the pollutant(s) of concern. Below are several water monitoring schedule examples.

Seasonal	Once in the winter, spring, summer, and fall
Monthly	Once from January – December (Winter months are often difficult and dangerous)
Water conditions	Based on precipitation events (High, normal, and low flows)

WV Save Our Streams does not provide chemical kits, nor can the program pay for laboratory analysis. However, we do recommend custom **LaMotte kits**, or individual kits, and can work with the monitoring group to perform a more thorough chemical analysis at their stations. Your water quality monitoring should be based upon the types of land uses common in your watershed. Table 2 provides several examples of land use activities and the recommended water quality analysis.

Note: This manual does not provide information on the use of any specific chemical kits or meters. The program recommends that whatever type of kit you choose to use, always follow the manufactures instructions and recommendations for its maintenance. If you are using a meter; these must be calibrated at regular intervals and always before using them in the field. When submitting chemical data to WV Save Our Streams always describe the kit you are using, unless the kit was provided by WV Save Our Streams. This description should include the manufacturer, kit-type, range, model number etc.

Table 2 - Water quality monitoring and land use.

Land use practices	Recommended water quality analysis
Active construction	DO and BOD, Temperature, TDS and TSS, Turbidity
Forestry harvest	Temperature, TSS, Turbidity
Industrial discharges	Conductivity, pH, Temperature, TDS and TSS, Toxics
Mining	Acidity/Alkalinity, Conductivity, Metals, pH, TDS
Pastureland/Cropland	Bacteria, Nutrients, Temperature, TDS and TSS, Turbidity
Septic systems	Bacteria, Conductivity, DO and BOD, Nutrients, Temperature
Sewage plants	Bacteria, DO and BOD, Conductivity, Nutrients, pH, Temperature, TDS and TSS
Urban run-off	DO and BOD, Conductivity, Nutrients, Temperature

Bacteria – E-coli/Fecal coliform; BOD – Biochemical oxygen demand; DO – Dissolved oxygen; TSS – Total suspended solids; TDS – Total dissolved solids; Nutrients (Nitrates, Phosphates etc.)

Note: Because of the expense and difficulty involved, volunteers generally do not monitor for toxic substances such as heavy metals and organic chemicals such as pesticides, herbicides (agriculture/urban), solvents, and PCBs (industrial/urban). They might, however, collect water samples for analysis at accredited laboratories.

Filtering water samples

Filtering involves forcing water through a membrane filled with tiny holes, about 25 microns across (¼ of a human hair). The filter removes suspended solids from the water, and in fact, the weight of the solids caught in the filter is one common analysis parameter: total suspended solids (TSS). Such solids can be virtually invisible to the naked eye, but not dissolved, so they will eventually settle out if the sample is left undisturbed. For example, polluted coalmine water can have tiny bits of iron hydroxide (a.k.a. YELLOW BOY) suspended in it. In a water sample fixed with acid but not filtered in the field, this iron hydroxide will dissolve into the water before it arrives at the laboratory, which will give incorrect test results for metals.

Although filtering water samples eliminates these errors to some extent, it requires special equipment and training. Many volunteer groups leave filtering to the analysis laboratory, accepting any inaccuracies that creep in beforehand. Ultimately, the decision to filter relies on a group's capacity and requirements, and it should be discussed with the laboratory that receives the water samples. The recommended preservative for various constituents related to water monitoring are based on a wide variety of references and information.

Physical Evaluation

This portion of the survey includes a wide variety of observations using all senses, making several judgments based on established rating descriptions, as well as some collection and measurement procedures. In this section we discuss general physical observations. These observations should be completed prior to or immediately following the water quality analysis. Table 3 provides a list of the conditions that are assessed as wells as some general guidelines regarding what certain characteristics indicate. Water observations are made in a run or riffles, sediment observations are also made in a run or riffle and benthic algae observations are made in a riffle. These observations should be made multiple times throughout the reach to make sure conditions are consistent. You should write comments on the survey data sheet if any notable differences within the reach are observed.

Table 3 - Stream physical condition characteristics.

Watercolors

Brown: Usually caused by sediment in the water. Some muddiness (brown color) is natural after storms, but if the condition persists look for an activity upstream that has disturbed the soil such as construction sites, logging, storm water runoff from roads or urban areas, or agricultural activities such as cattle in the stream.
Black: Usually caused by coalmine drainage, tar, or sometimes waste material from road construction.
Green: Usually due to an algae bloom caused by excessive nutrients in the water. The source could be sewage, fertilizers from farms, homes or golf courses or waste from animal feedlots.
Multi-colored sheen: Can occur naturally in stagnant waters, but a sheen that is moving or does not break up easily may be an indication of oil pollution. The source could be runoff from streets or parking areas or illegal dumping. In some areas the use of all-terrain (ATV's) vehicles may contribute to stream oil pollution.

Sediment colors

Brown: An indication of silt deposits from sediment sources. Most stream bottoms are normally brown in color.
Black: This deposit can occur naturally in heavy organic soils but can also be due to fine coal particles, tars, ashes, sludge etc.
Green: Possible indication of excessive algae growth from organic (nutrient) enrichment sources.
Orange, **yellow** or **red**: A coating of flocculates on the sediments is usually due to polluted coalmine drainage.
White or **gray**: A white cottony mass is a sewage fungus common to organic polluted waters. An even coating of white or gray flocculates may be metals (aluminum) precipitated out of solution from contamination due to mine drainage.

Water/sediment odors

Collect your sediment and water sample separately to assess the odors.

Algae color

Algae color varies from brown to dark green in most streams and rivers; although color is a noticeable condition of the algae it is not a particular indicator of the types or of the condition represented by the algal community.

Algae abundance

Coverage in a riffle is estimated based upon the following: none, scattered, moderate or heavy. A heavy coating of matted and floating algae is often an indication of nutrient rich conditions caused by excess nitrogen and phosphorous.

Algae growth habit

The growth habit characteristics are critical to understating the algae. Most stream algae will be evenly coated on the rocks and have a smooth or slimy texture; other types will be filamentous and have a hairy texture; and others

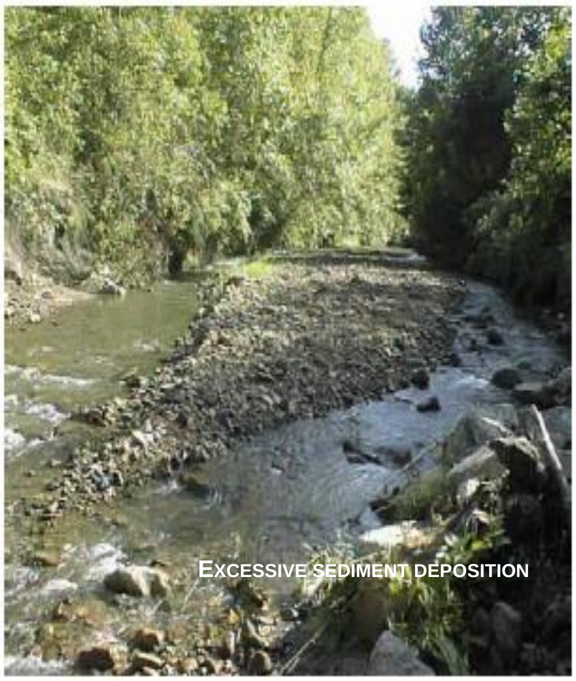
Orange or **red**: Usually associated with mine drainage (high iron content in the stream).
Tea colored: Usually associated with wetlands.
White or **gray**: Can be caused by runoff from landfills, dumps, or sewage.

Rotten eggs: This strong sulfur-like odor can be an indication of sewage pollution or polluted coalmine drainage.
Musky: This slight organic odor is often natural, but in some cases may indicate nutrient enrichment from organic waste products or sewage contamination.
Oily: This odor may indicate pollution from oil and gas wells.
Chemical: There are a wide variety of chemical odors usually the result of industrial discharges, solvents, and detergents.

will be matted. Matted algae are easily removed from the surfaces by slowly scraping with your fingers. If the algal community is mostly matted pieces will come off in junks like carpet when it has been removed from flooring.

Foam occurs naturally due to the decomposition of leaves (this foam is generally less than three inches high and cream colored). Excessive white foam may be due to detergent pollution.

Habitat Assessment



The habitat assessment process involves rating and scoring many different **habitat conditions** as optimal, suboptimal, marginal or poor based upon criteria (descriptions and a rating scale) included on the survey data sheets. The optimal category is a description of conditions that meet natural expectations; suboptimal includes descriptions of criteria that are less than desirable but satisfies expectations under most circumstances; marginal is a description of moderate levels of degradation with severity at frequent intervals throughout the reach; and poor are descriptions of criteria for streams that have been substantially altered with severe degradation characteristics.

Descriptions of the habitat conditions are provided below. For additional information refer to Chapter 5 of the US EPA's Rapid Bioassessment Protocols Manual. The conditions here should be applied when describing the habitats of rocky-bottom streams and rivers.

Embeddedness refers to the extent to which rocks (gravel, cobble, and boulders) are surrounded by, covered, or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, fewer living spaces are available to macroinvertebrates and fish for shelter, spawning and egg incubation. To estimate the percent of embeddedness, observe the amount of silt and sand sediments overlying and surrounding the larger gavel and cobble size particles. You should base your embeddedness assessment on the composition of the materials that you observe. Embeddedness is always evaluated in the riffles used for your BMI collections. In most cases the best person(s) to comment about this condition is the person(s) collecting BMIs. If cobble and gravel are easy to remove from the riffle and there is little sand or silt either in the net or suspended during collections, embeddedness is minimal. In some cases, chemicals can cement (armoring) the substrate together and cause severe embeddedness.

Sediment deposition is an estimate of the amount of sediment that has accumulated and the changes that have occurred to the stream channel because of deposition. Deposition occurs from large-scale movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals or result in the filling of runs and pools. Usually, deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms. Sediment deposition should be rated throughout your reach and should not be confused with embeddedness. Sediment deposition is probably the most difficult condition to assess. It is a natural process and bars often form in streams that are very stable and have little sediment from the surrounding land or few problems with erosion. When assessing this condition look for indicators that are unusual or beyond what is expected to be normal for the stream. The most effective way to learn is to view many different stream types representing both degraded and natural conditions. In most cases island formation, especially in small streams (1st through 3rd order), is an indication of excessive deposition. The most common cause for unusual or un-natural deposition in most streams is human encroachment (i.e., structures such as bridges, roads, culverts etc. to close to the stream or built so that the stream is narrowed) and bank erosion. Steep sloping banks with exposed surfaces are more likely to erode. Undercut banks can often erode but are sometimes very stable if covered with vegetation, tree roots and rocks. Look for deposition around eroding banks, especially if they show bare soils consisting mostly of fine materials (fine gravel, sand, and silt). Hard surfaces no matter how steep or undercut are less likely to erode.

The remaining conditions are assessed on the left and right sides. Note: The **LEFT** and **RIGHT** sides are determined by looking downstream.

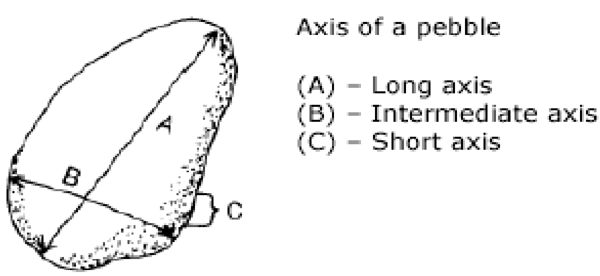
The **bank stability** condition evaluates whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are therefore considered to be unstable. Signs of erosion include crumbling, un-vegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of sediment movement and deposition and suggest a scarcity of cover and organic input to streams.

Riparian buffer width is an estimate of the width of natural vegetation from the edge of the stream bank out through the riparian zone. A relatively undisturbed riparian zone supports a robust stream system; narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the stream bank. Residential developments, urban centers, golf courses, and rangeland are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of old fields, paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores. Riparian buffers are the most valuable protection a stream system has against outside influences. In most cases healthy riparian directly reflects upon the condition of the stream unless the source of the insult is a specific pollutant. Enhancement of the riparian buffer by re-planting native grasses, forbs, shrubs and trees is the first step in the recovery of the stream back to a more natural condition. Below is a list of just a few of the many benefits a healthy riparian buffer provides.

1. Provides organic material as food for macroinvertebrate, fish and wildlife.
2. Supplies large and small pieces of woody debris that provide habitat for fish, macroinvertebrates and amphibians.
3. Alters how sunlight reaches the stream and is an important temperature moderator.
4. Stabilizes stream banks and reduces erosion.
5. Filters sediment and materials from overland runoff and roots of many plants traps and holds the sediments.
6. Absorbs nutrients from overland and sub-surface flows.
7. Reduces the impacts of flooding through temporary storage, interception/diversion and slow releases (especially wetlands) from heavy rains.

Pebble count

The composition of the streambed and banks is an important facet of stream character, influencing channel form and hydraulics, erosion rates, sediment supply, and other parameters. Observations tell us that steep mountain streams with beds of boulders and cobbles act differently from low-gradient streams with beds of sand or silt. You can document this difference by collecting representative samples of the bed materials using a procedure called a Wolman pebble count. This method requires a person with a metric ruler who walks through the stream and a note taker who remains on the bank with the field book or survey data sheet. The note taker records the count is recorded by size classes or categories like those shown in Table 4. Pebble counts can be made using grids, transects, or a random step-toe procedure.



Select the portion of the reach that you wish to measure (this may be the entire reach or riffles only). For stream characterization, sample pools, runs, and riffles in the same proportions as they occur in the study reach. For other purposes, it may be more appropriate to use a more random method. The professional SOP recommends a minimum of 100 particles to obtain a valid count. WV Save Our Streams ask that volunteers using this procedure collect a minimum of 50 particles.

Table 4 - Pebble count size classes.

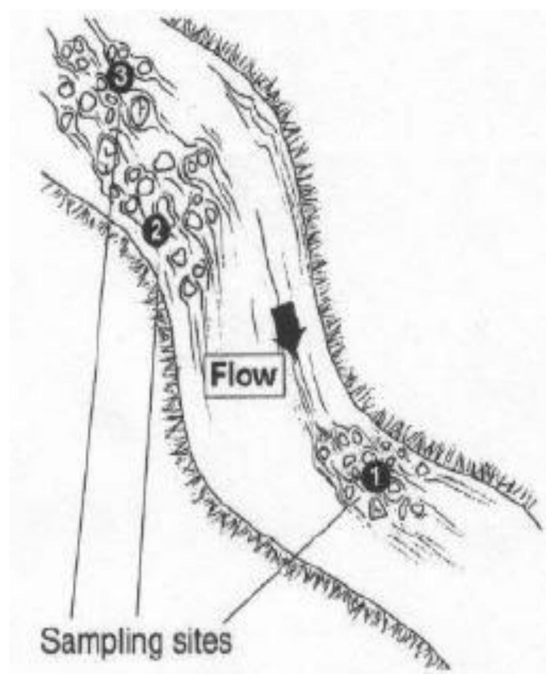
Categories	**Description** (size)	**Size range** (mm)	**Categories**	**Description** (size)	**Size range** (mm)
Silt/clay	Slick/smooth	Determined by feel	Cobble	Tennis ball - basketball	65 - 256
Sand	Very small grainy	< 2	Boulder	Basketball – car size	> 257
Fine gravel	Pea – golf ball	2 - 24	Bedrock	Large solid surface	NA
Coarse gravel	Golf ball – tennis ball	25 - 64	Woody debris	Sticks, leaves etc.	NA

Pebble count collection procedure

Start at a randomly selected point near the downstream end of the reach. Start on the shoreline and take steps across the stream. Averting your gaze, pick up the first particle touched by the tip of your index finger at the toe of your wader. Measure the intermediate axis (neither the longest nor shortest of the three mutually perpendicular sides of each particle picked up). Measure embedded particles or those too large to be moved in place. For these, measure the smaller of the two exposed axes. Call out the measurement. The note taker tallies it by size class, repeats it back for confirmation and keeps count. Continue across the channel slightly upstream in the direction of the opposite bank and repeat the process, continuing to pick up particles until you have the requisite number (100 or more) of measurements. Traverse across the stream perpendicular to the flow or in a zigzag pattern.

BMI Collection and Assessment

The groups of aquatic animals found in leaf packs, rocks, woody debris and other areas of streams, rivers, ponds, and wetlands are collectively called **benthic macroinvertebrates** (**BMIs**). Benthic refers to the ability to cling to bottom surfaces such as rocks, leaves or roots. BMIs are animals without a backbone that can be seen with the naked eye. These bottom-dwelling animals include crustaceans, mollusks, and annelids but in many aquatic environments, most are larvae of aquatic insects. BMIs are an important link in the food web between the producers (leaves, algae) and higher consumers such as fish. They are the key indicators of biological integrity in a wide variety of aquatic environments.



Depending upon the stream type a variety of methods and equipment are used to collect benthic macro-invertebrates from wadeable streams. In rocky-bottom streams, WV Save Our Streams recommends using a two-pole screen-barrier net (or two-pole kick-net) or a single pole rectangular style kick-net. Groups may purchase other nets as needed but only the two-types discussed here are recommended for rocky-bottom collections. Ultimately, the nets chosen to depend upon the goals and objectives of the volunteer monitoring program.

Collecting BMIs

BMIs live in a wide variety of aquatic environments. In lakes, wetlands, and large river systems they are common in shallow edge micro-habitats along shorelines in tangles of vegetation, roots, and leaves, in gravel shoals or along rocky and undercut banks, some kind's burrow in mud and sand of shallow flowing water. In streams and rivers with swift-flowing water they are more common and diverse in rocky areas (riffles), but are also found in runs, which are sampled when riffles are not present. The collection procedure described here is designed for rock-bottom streams from riffle habitats. For information about the muddy-bottom bioassessment procedure visit WV Save Our Streams Volunteer Monitoring Manual web page. The procedure is described in Chapter 4: Macroinvertebrate and Habitat.

The number of samples collected depends upon the type and size of the net. Standard two-pole kick-nets are about 3-feet wide (1-meter ^{2}) so usually, three-samples are adequate. These types of nets can only be used in riffles and runs. Other nets such as the rectangular kick-net or D-nets are also used. These nets are much smaller but more versatile than the two-pole net. However, more samples are necessary to collect and adequate representation of BMIs. For example, if you use the rectangular kick-net, six to eight samples should be collected.

1. **Choose the best habitats**

   Your goal is to collect BMIs from three different riffle areas. (If the riffles are as wide as the stream, then multiple samples could be collected within the same riffle.) The riffles should have different characteristics (i.e., different composition but mostly cobble and gravel and different velocities). Often different types of riffles hold different varieties of BMIs, so to properly assess the biological conditions you need to collect a representative sample. Of course, your choices of habitats will ultimately depend upon what your reach provides. Once you have chosen your location always approach from the downstream end, sampling the site farthest downstream first. This approach ensures that the sample is representative of its location and reduces the chances of biasing your second and third sample.

2. **Get into position**

   Select an area approximately the same width (or slightly less) than the width of your kick-net. Most two-pole screen-barrier kick-nets are about 3-feet to 1-meter wide. The width of the single-pole rectangular kick-net is about ¼ to ½ meter. If you are using a smaller diameter-net, you will need to collect more samples (About two-three samples using the rectangular kick-net is equivalent to one sample with the screen-barrier kick-net). The net holder will place the net snugly against the bottom of the streambed; rocks can be removed, if necessary, to make sure you have a close-fit. Once you are satisfied with the position, line the front of the net with rocks heavy enough to hold the net in-place. However, be careful to choose rocks that are not too heavy, or too wide or high. Large rocks will damage the net and will influence how the BMIs flow into the net thus making capture less successful. The net holder now tips the kick-net backward at about a 45-degree angle from the water's surface. This provides greater surface area and more even flow into the net. If the net is held to high some of the macroinvertebrates will wash around the sides and not be captured in the net. While holding the kick-net backwards the net-holder must make sure that water does not wash over the top of the net. Have one 3 ½ to 5-gallon bucket ready before you begin collecting the sample. The bucket will be needed during sample collection.

3. **Begin disturbing the streambed**

   The second person approaches the sample area from upstream and determines the approximate sample-size. Once the area is delineated, the sampler begins disturbing the streambed directly in front of the net. The process starts with rock rubbing. First, pick-up all large rocks (cobble size and larger) and inspects them. You are looking for snails, clams, and caddisfly cases. These animals often cling very tightly to the rocks and are not removed by just a simple rub with the hands or a small brush. If the rocks have any of these animals, remove them from the rocks and place them inside the bucket. Move the rocks you picked-up towards front of and slightly into the net; brush all sides of the rocks with your hands or a small vegetable-brush to dislodge other clinging BMIs. Continue the rock rubbing process until the larger sized stones have been thoroughly cleaned. If the rocks cannot be lifted from the streambed, simply rub them where they lay. As much as possible the rock rubbing should proceed from the upstream portion of the sample area towards the front of the net. After the rocks are rubbed, they should be placed aside (outside of the sample area) so they are not rubbed a second time. Some volunteer programs choose a timed approach to rock rubbing since this is a rather intensive and somewhat time-consuming step. The recommended time frame for adequate rock rubbing is two-four minutes depending upon the abundance of cobbles and boulders within your sample area. If you choose a timed approach, you should make a note on the survey data sheet and record the time frame you use.

   After you are satisfied that all or most of the larger rocks have been cleaned you will disturb the remainder of the streambed using a kicking method. Position yourself upstream from the net inside your sample area and begin shuffling your feet back and forth from one side of the sample area to the other. Slowly move towards the net while kicking from side to side. The action dislodges BMIs from smaller size gravels and disturbs those that might be burry themselves down into the soft bottom sediments. While you are moving from side to side and forward you are also pressing your feet downward to make a depression in front of the kick-net. If you have chosen a timed approach, then you should limit your kick-time as well. The recommended kick-time is two minutes, so your entire sample should take about six minutes to collect.

4. **Remove the kick-net from the streambed and capture the collection**

This is a very important step; since the sample collection is laborious you do not want to lose any of the BMIs collected by sloppy procedures here. Very slowly remove the rocks that have acted as anchors to hold the kick-net in place, rub them off while you remove the rocks, or you may choose to rub them before using them to anchor the kick-net in place. While the net-holder grabs and holds the top of the net in-place the kicker grabs the bottom edge of the net near the handles. The net is removed with a scooping motion, the kicker moved slightly forward and upward while the holder keeps the net steady so that no BMIs are lost from washing over the top of the kick-net. Both persons then pick-up the net and roll it into a loose cylinder, securing the ends and taking it to the shoreline. The bucket that was used earlier in the procedure should be at the ready to accept the contents of the kick-net.

5. **Place the net into the bucket**

Slightly unwind the net so that it fits inside the bucket. With a smaller bucket or a spray bottle, wash the contents of the kick-net into the bucket. It will take several minutes and several washes to knock loose most of the BMIs. Between each attempt, remove the net and check for BMIs that have not been dislodged. Often these hardy clingers are found near the edges of the kick-net along the bottom-side and in the seams of the net. Be sure to check the opposite side for BMIs that may have crawled to escape. You must be very careful not to overfill the bucket. If the bucket begins to fill with stream water more than about two-thirds its heights, remove some of the water by seining it through the kick-net (hold the net tightly on the bucket and pour off the water) so that the water is poured off and the BMIs remain in the bucket. The process is complete when you are satisfied that the kick-net has been thoroughly washed and most of the BMIs are now in the bucket.

6. **Remove the captured BMIs from the bucket and begin sorting**

The goal of this step is to remove all captured BMIs so that they can be observed, identified, and counted. WV Save Our Streams recommends that you use several shallow white trays. The best way to start is by trapping the BMIs as they are poured from the bucket. Before starting the steps below, remove all larger materials that may have been collected with your sample from the bucket. Make sure to check these for BMIs before they are discarded. At certain times of the year leaves and other debris are very plentiful in the stream and this material must be sorted. (It is common to find many kinds of BMIs in leaf-packs; this material is one of their favorite places to live.) The best way to deal with the leaves is to remove as many as possible, place them in smaller bucket or container and wash them to remove the BMIs. Pay close attention to the leaves that appear chewed and have begun to decay. Newly fallen leaves are less likely to have many BMIs.

Removing (seining) can be completed by using a second bucket with your kick-net on top, and then pouring the captured organisms over the net so that they are trapped. The pouring is stopped periodically so that the BMIs can be removed from the net and placed into the collection trays. Small forceps are the best tool for this job; however, the BMIs can also be removed by hand. Another method is to use a sieve bucket (wash bucket) or EZ-strainer. The EZ-strainer is recommended and is available in limited-quantity from the WV Save Our Streams Program. The EZ-strainer comes in a variety of mesh sizes (some even finer than 500-microns) and fits nicely inside a 3 ½ or 5-gallon bucket. The bucket used to capture your collections can easily be poured into the second bucket and the macroinvertebrates are removed from the EZ-strainer.

The collection procedures are repeated three or more times, one for each sample collected. Volunteers may choose to sort each sample separately or combine all three samples and sort them at one-time. The latter is highly recommended since the bioassessment procedure is based on a composite sample. In certain (rare) circumstances samples may need to be counted, sorted, and identified separately to compare different portions of the reach. These comparisons are done only when there is a suspected insult to the macroinvertebrates such as a habitat alteration or a suspected chemical that may not be affecting the entire reach. Collection, sorting, counting, and identification are the most intensive tasks of the survey procedures.

Note: If your organization decides to complete independent surveys that include aquatic collections, you must apply for and receive a **Scientific Collection Permit** from the WVDNR. [§20-2-50]

BMI counting, identifying, and sorting

Sorting BMIs from survey samples (a procedure often referred to as "bug picking") is an extremely important step in the biological research. The quality of the work performed by the "picker" influences the quality of subsequent processes, such as identification and data analysis. A competent "picker" must be able to recognize the morphological diversity of aquatic organisms, as well as the various methods these organisms may use to hide themselves from predators. The outcome of the final study may be affected, even if only a few organisms are overlooked during the picking process. Table 5 provides a list of materials and supplies needed for this work.

Table 5 - Recommended supplies for bug picking and identification.

1. Pans (larval trays): contains sample during the sorting process.
2. Gridded tray: a white enamel or plastic tray used to separate family groups. The tray can be marked into equal size grids ranging in size from 1 x 1 to 3 x 3 inches. The grids help to estimate the numbers. Ice-cube trays and plastic craft organizers are also effective tools.
3. Forceps: fine tipped forceps are used to remove the organisms from the debris and to manipulating specimens during examinations to determine identification.
4. Magnifier: an optical aid to illuminate and magnify the sample during the picking process.
5. Various taxonomic keys (e.g. dichotomous keys, picture or illustrated keys, and other guides), which provide some family-level descriptions.

Once the collections are placed into larval pans you will need to sort and identify. At times this can be very difficult in the field so your group may want to consider using alternate procedures such as preservation and sub-sampling. This is a very important part of the survey procedure, and it requires a great deal of time and some expertise. The procedure can vary based upon the contents of your collection. **Use the steps below as a guide**.

1. Add a couple of inches of water to your main sorting tray and the others you will be using. Spread the sample out over the bottom of a white tray. Spend a little time watching the macroinvertebrates. See how they move and look at the different shapes and colors (the colors change when they are preserved).
2. Pick through your sample in the sorting tray. Use a pipette, tweezers, spoon, or brush to transfer your macro-invertebrates to the wells in the ice cube tray, craft organizer or smaller tray. Place animals belonging to the same group in the same portions of the tray. In some cases, it may be simpler to sort through one order at a time, especially if multiple kinds are probable. For example, **Ephemeroptera** (Mayflies), **Plecoptera** (Stoneflies) and **Trichoptera** (Caddisflies) can be very abundant in healthy streams and these orders as well as **Diptera** (True flies) are likely to have multiple families present.
3. For the first 10–20 minutes, transfer any animal that you see from the sorting tray into the other trays. For the last 10–20 minutes, look particularly for animals that are uncommon. Fast moving macro-invertebrates will be obvious but some will only start to move after 10 minutes or so. If after 30 minutes you find an invertebrate, you have not seen before, sort for another 10 minutes until you find no new families.
4. There are many key guides available to identify your macroinvertebrates. A 10x magnifying loupe, magni-cube or low power binocular microscope is useful for looking closely at the animals.
5. Estimate the abundance or count the number of each kind of animal in the tray sections. As you look for families and count or estimate abundance keep track of your tallies on the survey data sheet. Use a pencil so you can erase or scratch though your numbers when different families are encountered or your abundance changes. If you find a macroinvertebrate you cannot identify, record this on your result sheet, giving a brief description of what you found. When you finish, return your collections to the stream as close to the collection sites as possible.

Calculating your stream score

After the sorting and identifications is complete, the macroinvertebrates are assessed using three **METRICS**, which are converted into an overall stream score using a simple point system. First, transform your abundance rating into numbers: (**A** = **6**; **C** = **3**; **R** = **1**) then follow the instructions to complete all the necessary calculations.

Table 6. Level-one metric calculation example.

Insect groups	Abundance	Tolerance Value	Tolerance Score	Taxa
Stoneflies	1	2	2	1
Mayflies	3	3	9	3
Case-building caddisflies		3		
Net-spinning caddisflies	1	4	4	2
Common netspinner	6	5	30	1
Free-living caddisfly		3		
Dragonflies		5		
Damselflies		8		
Riffle beetle	3	4	12	1
Water penny	3	3	9	1
Other beetles		6		
True bugs		8		
Hellgrammite (Fishfly)	1	4	3	1
Alderfly		6		
Non-biting midge	3	8	27	1
Black fly	3	6	18	1
Crane fly		4		
Watersnipe fly	1	2	3	1
Other true flies		7		
Non-insect groups	Abundance	Tolerance Value	Tolerance Score	Taxa
Water mite		6		
Crayfish	3	5	15	1
Sideswimmer (Scud)		5		
Aquatic sowbug		8		
Operculate snails	1	5	4	1
Non-operculate snails	1	8	7	1
Clams		6		
Mussel		4		
Aquatic worm	1	10	10	1
Leech		8		
Flatworm		7		
Other (describe)				
Totals	Total Abundance **31**		Total Tolerance **150**	Total Taxa **17**

See the example calculation (left). For additional information refer to the survey data sheet in Appendix C.

1. **Biotic Index -** Multiply the abundance number by the tolerance to calculate the tolerance score. Add the entire tolerance score column and the relative abundance column. Divide the total tolerance by the abundance total.
2. **Total Taxa -** Calculate the total number of kinds (taxa).
3. **EPT Taxa -** Calculate the total number of kinds (taxa) from the stoneflies, mayflies, and caddisflies.

WV Save Our Streams provides on-line spreadsheets for calculating these metrics. If a group prefers not to calculate the stream score, the coordinator will perform the calculations when the data is reviewed.

Tolerance values are numbers that represent the tolerance to pollution insults. The values often are variable within order and family groups so in some cases, a single number is not the best representation. However, SOS selected the most appropriate for this level of identification.

Metrics	Results	Points	**10**	**8**	**6**	**4**	**2**
Total Taxa	17	8	> 18	18 - 15	14 - 11	10 - 7	< 7
EPT Taxa	7	6	> 10	10 - 8	7 - 5	4 - 2	< 2
Biotic Index	4.84	6	< 3.5	3.5 – 4.3	4.4 – 5.6	5.7 – 6.5	> 6.5

Stream score	**20**	Integrity Rating			
		Optimal	Suboptimal	Marginal	Poor
		> 24	24 - 19	18 - 13	< 13

Measuring Velocity

The stream's velocity (commonly called flow) is modified by conditions along and around the stream, such as:

- Structures, such as dams and weirs, in the waterway.
- Removal (diversion) of water for use in irrigation, industry, and households.
- Rainfall, snow melt, and water releases from dams, power stations and industry.
- Entry of groundwater.
- Evaporation (evapotranspiration) and leakiness of the riverbed and banks.

The size of a waterway and its flow rate affect its water quality. For example, discharges containing contaminants will have less effect on large swiftly flowing rivers than on small slow streams. This is one reason for measuring flow - to work out the load of contaminants and sediment the waterway is carrying. Because discharge can have a significant effect on water quality, it is important that it is recorded at the time of sampling and, if possible, during the previous few days. It is particularly valuable to know if flows are at low, moderate, or high level and if the level is rising or falling. This is because the concentrations of nutrients, turbidity and contaminants tend to be higher when the stream level is rising than when it is falling. There are three ways to measure discharge. A simple method is to see how fast a floating object travels downstream over a chosen distance. This is called the float method. Secondly, flow data can be obtained from US Geological Service or the State Emergency Management Office, if your site is near a gauging station. Thirdly, the velocity head rod (VHR) method can be used.

The **float method** is easy to understand and something most of us have done as children. You simply float an object on the water and measure the time it takes to travel a set distance. The equipment you will need for this method includes:

- Foam golf ball (preferred), tennis ball, apple, or orange peel
- Net to catch the ball.
- Open-reel tape or survey rod
- Stopwatch

Procedure: Mark off a 20-foor length of the stream. Choose a section that is relatively straight and free of vegetation or obstacles. Avoid areas with a culvert or bridge because those structures will modify the true flow. If the flow is very slow, mark out a shorter distance. Position a person at each end of the section. Place the ball on the surface near the middle of the stream at least two feet or more upstream of the end of the tape so it has time to come up to water speed. When the ball is in line with the beginning of the tape, start the stopwatch. Stop the watch when the ball gets to the end of the section. Repeat the procedure at least three times at this site and average the results. To calculate the water velocity, divide the distance travelled in feet by the time taken in seconds. Then multiply by a correction factor to compensate for the variability in velocity with depth and across the channel, i.e., water will move slower at the edges than in the middle and at different speeds within the water-column.

See the example below for a rocky-bottom stream.

Distance travelled = 20 feet Average time = 18 seconds	Velocity = 20 ÷ 18 = 1.1 ft/sec	Depth = 0.6 ft; width = 10 ft Cross sectional area = 6.0 ft^2

Discharge = 1.1 x 0.8 x 6.0 = 5.3 ft^3/sec (cfs)

US EPA's Volunteer Manual recommends using a correction factor in the calculation based on stream type. The factor for rocky-bottom streams is **0.8** and the factor for sandy/muddy bottom streams is **0.9**.

The **velocity head rod** (VHR) is a fast and inexpensive method of measuring velocity in a stream. The rod can be a yardstick or meter stick, or it can be made using a 3 - 6 foot long, very thin, piece of wood. A 26-gauge copper sheet is sometimes fastened to the cutting edge to protect it from abuse. Mark a scale in ½ inch increments on the rod, starting with zero at the bottom of the rod and stopping at 18 inches. Steps to find the flow rate with a velocity head rod are as follows:

- Place rod in the water with sharp edge upstream. Measure stream depth on scale.
- Place rod sideways in the water. This will create turbulence and the water will "jump" or rise above its normal depth; velocity is proportional to this jump.
- Measure depth of turbulent water next to rod. Subtract stream depth from the turbulent depth reading to obtain the "jump height," or velocity head in inches.
- Find the stream velocity in feet per second from the table provided on the survey data sheet.
- Determine the stream velocity at intervals across the stream and average them to obtain the average stream velocity in feet per second.
- VHR Velocity = $8 \times \sqrt{R}$, where R is rise.

Cross sectional shape varies with position in the stream, and discharge. The deepest part of channel occurs where the stream velocity is the highest. Both width and depth increase downstream because discharge increases downstream. As discharge increases the cross-sectional shape will change, with the stream becoming deeper and wider. The measurement of the cross section is necessary to determine the total discharge, which is the volume and velocity of the water. Measuring the width and depth of the waterway, and multiplying these measurements together determine the cross section. The depth will vary across the stream and so the width and depth should be measured in small intervals and aggregated to determine the total area.

To determine an average discharge, WV Save Our Streams recommends measuring the depth in at least five positions across the stream, one of these positions being the deepest portion of the channel (thalweg). In most cases the velocity and cross-sectional area (width x depth) should be determined from a run. Each time these measurements are made they should be completed from the same section of the reach.

Additional Survey Procedures

Sketch the reach (the site map): In addition to the observations above, volunteer monitors are asked to sketch a site map of the reach. Draw the site map from direct observation. It should show the main features of the site and their relationship as accurately as possible. As fieldwork continues, modify the map with features such as important habitat conditions (i.e., eroding banks, bars etc.) and indicate the approximate location of water sample and macro-invertebrate sample collection locations. Scale the map to show the entire reach surveyed.

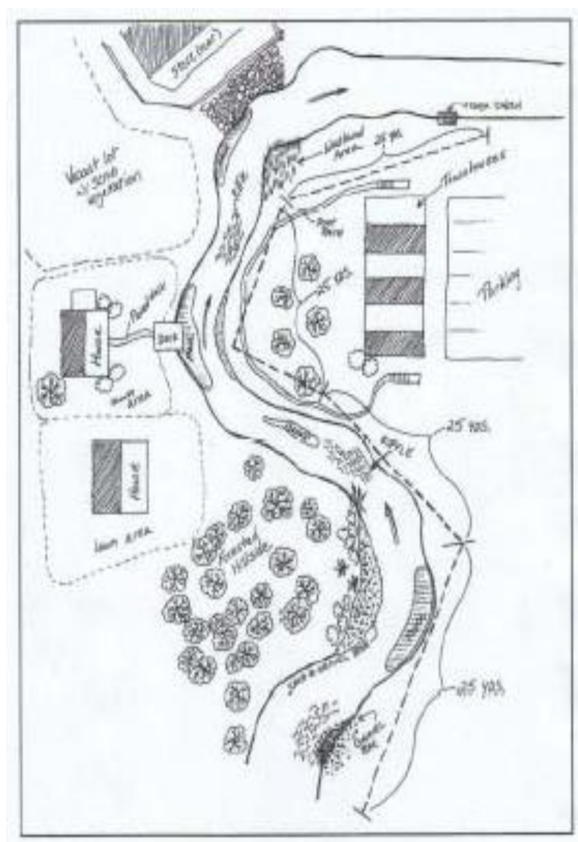


Photo documentation: Photographs provide a qualitative and potentially semi-quantitative record of conditions in a watershed, or within a stream reach. Photographs can be used to document general conditions, pollution events or other impacts, and document temporal progress for restoration efforts or other projects designed to benefit water quality. Use the same camera to the extent possible for each photo throughout the life of the station. From the inception of any photo documentation until it is completed, always take each photo from the same position (photo point), and at the same bearing and vertical angle. For general reach photo documentation, take at least two photos that show the entire reach. More specific photos can be taken if needed. Try to include landscape features that are unlikely to change over several years (i.e., rocky outcrops, cliffs, large trees, buildings, or other permanent structure), so that repeat photos will be easy to position. It is often important to include a ruler, stadia rod or person to convey the scale of the image. Often an overhead or elevated shot from a bridge, cliff, peak, tree, etc. will be important in conveying the full dimensions.

Land use assessment: The purpose of this portion of the survey is to get an overall picture of the land surrounding and draining the stream reach. A basic assessment will help you better understand what problems to expect and where to look for those problems. The first step is to review your topographic map and aerial photographs that include your stream stations. Prior to or after completing a stream survey, drive or walk portions of the watershed upstream from your stations to locate any possible activity that may threaten your stream reach. Keep in mind that this rating is simply your judgments of the level of impacts; it is not an actual assessment of the real impacts. The only way to assess a specific impact or activity is to set-up an impact assessment study.

All surveys are mailed to the coordinator so that a proper quality assurance review can occur. After the review is complete the surveys are returned to the volunteer group along with a summary and other comments, questions, or recommendations from the coordinator. The data is then entered into the **Volunteer Assessment Database**.

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WV Save Our Streams Program: *http://go.wv.gov/sos*

WV Save Our Streams does not require signatures on or provide any type of liability or hold-harmless waiver forms for volunteer monitors. The primary objectives of the program are to provide education; training and resources volunteers need to carry out a water monitoring survey. The safety at the site is the responsibility of the volunteer monitoring group. If the volunteer group fills the need for such forms, they should seek the advice of a trusted legal advisor. However, the program strongly recommends that volunteers develop specific safety preparedness plans and attend safety and outdoor first-aid training on an annual basis. At least one of the persons present during the survey should have up-to-date safety and first-aid training.

1. **Develop a safety plan**: Find out the location and telephone number of the nearest telephone and write it down. Locate the nearest medical center and write down directions on how to get between the center and your site(s) so that you can direct emergency personnel. Have each member of the sampling team complete a medical form that includes emergency contacts, insurance information, and pertinent health information such as allergies, diabetes, epilepsy etc.
2. **Never drink the water in a stream**: Assume it is unsafe to drink and bring your own water from home. After monitoring, wash your hands with antibacterial soap.
3. **Always monitor with partner**(s): Use a minimum of 2 persons; teams of 3-4 or more people are best; always let someone else know where you are, when you intend to return and what to do if you don't return at the appropriate time.
4. **Have first aid kits handy**: Know any important medical conditions of team members (e.g., heart conditions or allergic reactions to bee stings). It is best if at least one team member has first-aid and CPR certification.
5. **Listen to weather reports**: Never go sampling if severe weather is predicted or if a storm occurs while at the site.
6. **Never wade high water**: Do not monitor if the stream is very swift or at flood stage; adult volunteers should not enter swift-flowing water above waist-deep, unless absolutely necessary, and young volunteers should not enter swift-flowing water just above knee-deep.
7. **Park in a safe location**: If you drive, be sure your car doesn't pose a hazard to other drivers and that you don't block traffic.
8. **Put your wallet and keys in a safe place**: Use a watertight bag you keep in a pouch strapped to your waist. Without proper precautions, wallet and keys might end up downstream.
9. **Never cross private property without the permission of the landowner**: Better yet, sample only at public access points such as bridge or road crossings or public parks. Take along a card identifying you as a volunteer monitor.
10. **Confirm your location**: Prior to visiting your site(s) check maps, and make sure all volunteers are aware using site descriptions and specific directions.
11. **Know what to do if you get bitten or stung**: Watch for irate dogs, wildlife (particularly snakes), and insects such as ticks, hornets, and wasps.
12. **Watch for vegetation in your area that can cause rashes and irritation**: Learn to identify (in all seasons) poison ivy, poison oak, sumac and other plants that may cause irritation; be aware of briers and thorny plants as well.
13. **Do not monitor if the stream is posted as unsafe:** Do not monitor if the water appears to be severely polluted. No matter what the water conditions are; always remove wet shoes and clothes as soon as possible after leaving the stream; use anti-bacterial soap and shower soon after the stream survey is completed.
14. **Do not walk on unstable stream banks**: Disturbing these banks can accelerate erosion and might prove dangerous if a bank collapse. Disturb streamside vegetation as little as possible.
15. **Be very careful when walking in the stream itself**: Rocky-bottom streams can be very slippery and can contain deep pools; muddy-bottom streams might also prove treacherous in areas where mud, silt, or sand has accumulated. If you must cross the stream, use a walking stick to steady yourself and to probe for deep water or muck. Your partner(s) should wait on dry land ready to assist you if you fall. Do not attempt to cross a stream that is swift.
16. **Come prepared for outside work**: Wear clothes such as a hat, loose fitting clothes (especially during warmer weather), closed toed shoes such as sneakers, boots, or waders. Felt glued to the bottom of the shoe will improve your traction for walking in the stream. The outside conditions should determine your overall manner of dress. You should also have plenty of drinking water, sunscreen, and insect repellent.

A well-equipped first aid kit should suffice for most of your medical situations. At a minimum your kit should contain the following items:

1. Telephone numbers of emergency personnel such as the police and ambulance (Know the location of the nearest medical facility and the nearest cell-phone signal.)
2. Several different size Band-Aids for minor cuts.
3. Antibacterial and/or alcohol wipes.
4. First-aid crème or ointments.

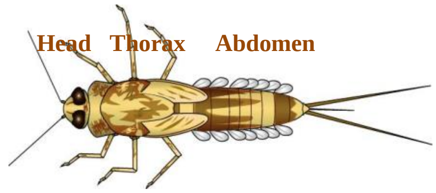
5. Triangular bandages and several gauze-pads 3-4 inches square for deeper cuts.
6. Acetaminophen for minor pain relief.
7. A needle and tweezers for removing splinters.
8. Small scissors or a single-edge razor blade for cutting tape to size.
9. A two-inch roll of gauze for large cuts (tunicates).
10. A large compress bandage to hold dressings in place.
11. A three-inch wide elastic bandage for sprains and to aid in applying pressure, when necessary, to slow bleeding.
12. If participants are allergic to bee stings, include a doctor prescribed antihistamine; make sure all volunteers have their necessary allergy medications prescribed for their specific condition.
13. Always have emergency telephone numbers, contact person(s) and medical information for all participants in case of emergency.

Appendix B - Equipment list

In many cases not all of the equipment listed is necessary for each monitoring session; however, you should carefully plan your fieldwork and make a checklist of equipment and other items needed prior to your excursions to the stream.

1. Appropriate clothes and footwear (i.e., hats, loose-fitting clothes for warm weather, layered clothes for cooler weather; raingear for wet-weather; waders, boots, close-toed shoes)
2. Carrying case (i.e., backpacks, plastic containers etc.)
3. Chemical kits and meters (pH meters or kits, dissolved oxygen kit and other chemical monitoring kits as needed)
4. Collection bottles for water samples and vials for macroinvertebrate preservation
5. Collection Nets (usually a two-pole or single-pole kick-net)
6. First aid kit
7. Flow meter or equipment that can be adapted to measure flow such as, an aluminum straight-rod or a float
8. Forceps (tweezers)
9. Gloves (non-allergenic latex or rubber)
10. Open-reel tape measure (100 and 300 feet)
11. Plastic (flexible) mm ruler or gravelometer for pebble counts
12. Preservatives (i.e., alcohol or formalin)
13. Sample size delineator and embeddedness survey ring (optional)
14. Scrub brush (for rock rubbing)
15. Several sizes of buckets: (1) 2 to 3 ½ gallon and at least (1) 5-gallon
16. Sieve such as a wash bucket or 400-micron EZ-strainer, to aid in sorting, counting and separating
17. Small folding table and chairs
18. Sorting trays (white bottom and durable; divided plastic inserts; ice cube trays and plastic craft organizers also work well)
19. Survey instruments (stadia rod etc.) for measuring channel profiles.
20. Submersible thermometer
21. Various types of magnifying lenses (box magnifiers, 10^x hand-lens (loupes), etc.)
22. Wash bottles

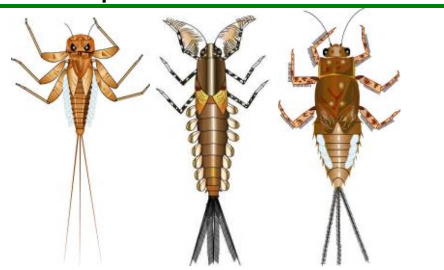
Appendix C – BMI ID-guide and the stream survey data sheet



Small minnow mayfly

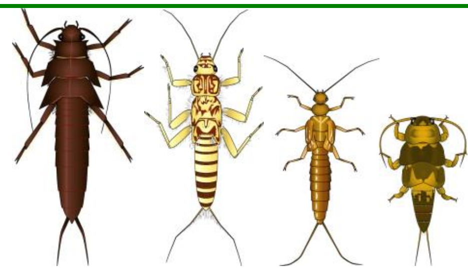
What is an insect? An insect is an invertebrate (an animal with no spine) that has three-pairs of legs (except Diptera) and three body divisions; the head is the location of the mouth, antenna, and eyes; the thorax is the attachment site for the legs and wing pads; and the abdomen, which often has a variety of structures attached including filaments gills and tails. Gills are usually leaf-like, plate-like, or thin filaments. Tails can be long and thin, hairy, webbed or paddle-like. Most of the **BMIs** you will encounter during stream surveys are aquatic larva or nymphs of insects. Most adult stages are not aquatic, but the beetles are the exception.

Insect Groups



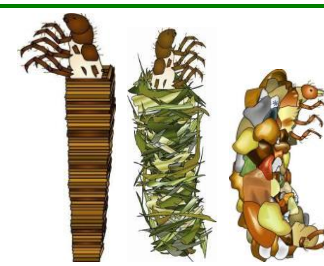
Mayflies

(Order **Ephemeroptera**): Three-pairs of legs with a single hook at the end; three sometimes two tail filaments; gills attached to the abdomen, which may sometimes be covered and difficult to see. Mayflies exhibit several types of movements (or habits); swimmers, clingers, crawlers and burrowers. (**VS-M**) (**M**)



Stoneflies

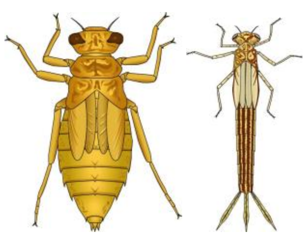
(Order **Plecoptera**): Three-pairs of legs with two-hooks at the end; two tail filaments; no gills attached to the abdomen but some kinds may have gills near the top of the abdomen; gills if visible, mostly on the legs and thorax. (**S-VL**) (**M**)



Case-building caddisflies

(Order **Trichoptera**): Grub-like soft body and a hard head; Three-pairs of legs located on the upper third of the body; tail is small and usually forked, sometimes fringed with hairs; gills are scattered on the underside of the abdomen. The case (retreat) is a relatively solid structure made of a variety of stream-bed materials held together by silk. (**VS-L**) (**M**)

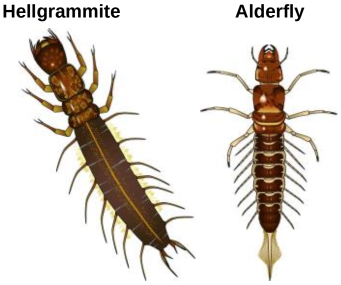
Dragonfly **Damselfly**



Dragonflies and **Damselflies**

(Order **Odonata**): Three-pairs of legs; large eyes; long spoon-like jaws; no tails on the abdomen. Dragonflies have a broad shaped abdomen, while the Damselfly abdomen is much narrower. Damselfly gills are attached to the end of the abdomen, they look like tails. (**M-VL**) (**M**)

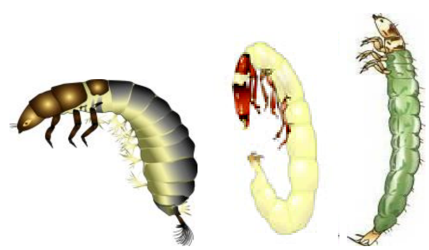
Hellgrammite **Alderfly**



Fishflies and **Alderflies**

(Order **Megaloptera**): Three-pairs of legs; large pinching jaws; eight-pairs of filaments attached to the sides of the abdomen. Fishflies also called **hellgrammites** have a two-hooked tail, whereas Alderflies have a single tapered tail and are usually much smaller and lighter in color. (**M-VL**)

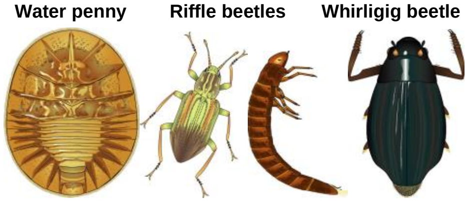
Common netspinner **Finger-net** **Free-living**



Net-spinning caddisflies

(Order **Trichoptera**): Similar characteristics as above but the abdomen usually has more abundant gills, especially the **common netspinner** (family **Hydropsychidae**). The net-spinner's retreat is also made of a variety of streambed materials, which are held together more loosely by fine strands of silk. The **free-living caddisfly** (right) does not build a case or net. (**S-L**) (**M**)

Water penny **Riffle beetles** **Whirligig beetle**

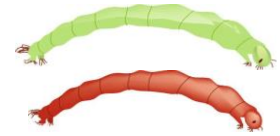


Beetles

(Order **Coleoptera**): Three-pairs of legs; body usually covered by a hard exoskeleton. The Most common kinds collected are the **water penny** and **riffle beetles** (left-right), but other kinds are also found. (**VS-L**) (**M**)

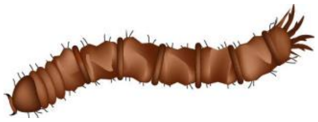
True flies

(Order **Diptera**): Usually the body is segmented with some type of visible features either along the body, or at the head or tail regions (i.e. head, tails, prolegs, whelps etc.). This order is the only aquatic insect without fully developed legs in the larval stages. Dipterans are very diverse order with many aquatic varieties. Several common kinds are described here. (**M**)



Non-biting midge

(Order **Diptera**; family **Chironomidae**): Segmented body with a visible head; two leg-like projections at the front and rear. Sometimes they are bright **red** in color. (**VS-M**)



Crane fly

(Order **Diptera**; family **Tipulidae**): No legs, no visible head; plump body with lobes along the segments; may have structures that look like tentacles, lobes or one bulb at the end of the body. (**S**-**VL**)

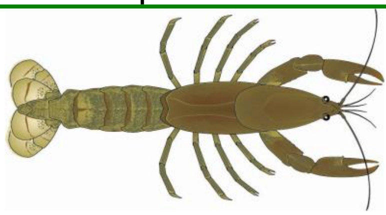
Black fly

(Order **Diptera**; family **Simuliidae**): Body has a bowling-pen shape (lower is wider than the upper); there are multiple brushes/fans on the head and a ring of hooks on the abdomen. (**VS**-**M**)

Watersnipe fly

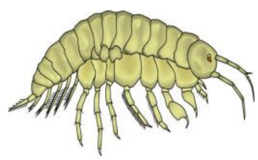
(Order **Diptera**; family **Athericidae**): Plump body, looks very much likes a caterpillar; on the underside there are structures that look similar to legs but are not segmented; the tail is forked and fringed with hairs. (**S**-**L**)

Non-Insect Groups



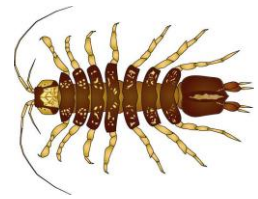
Crayfish

(Class **Crustacea**; order **Decapoda**): Five pairs of legs, the first two usually have large claws; large flipper-like structure at the end of the abdomen. (**M**-**VL**)



Scud/Sideswimmer

(Class **Crustacea;** order **Amphipoda**): Seven pairs of legs, the first two may be claw-like; body is somewhat higher than it is wide. Usually swims with a sideways motion. (**S**-**M**)



Aquatic sowbug

(Class **Crustacea;** order **Isopoda**): Seven pairs of legs, the first two may be claw-like; very long antenna; body is wider than it is high, giving the animal a fairly flattened appearance. (**S**-**M**)

Mussel

Clams

Clams and **Mussels**

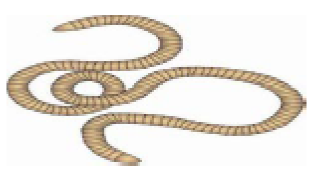
(Class **Bivalvia**): Fleshy body enclosed between two-hinged shells; the shape and ridge spacing of the shells can determine different kinds. **Mussels** are usually larger than clams and have dark colored oblong shells. (**VS**-**VL**) (**M**)

Operculate snails

(Class **Gastropoda**; sub-class **Prosobranchia**): Fleshy body enclosed by a single shell, which is usually coiled in an upward spiral. The opening of the shell is covered by an operculum (door). (**VS**-**L**) (**M**)

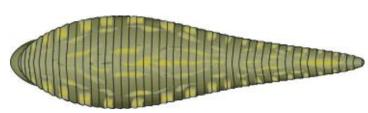
Non-operculate snails

(Class **Gastropoda**; sub-class **Pulmonata**): Fleshy body enclosed by a single shell, which is sometimes coiled upward but also may lie flat or have a conical shape. The opening of the shell is not covered by an operculum. (**VS**-**L**) (**M**)



Aquatic worms

(Phylum **Annelida**; class **Oligochaeta**): Body is long with numerous segments along its entire length; has no visible head or tail. (**VS**-**VL**)



Leeches

(Phylum **Annelida**; class **Hirudinea**): Body is long and thin or slightly widened; 34–segments along its length, but there appears to be many more. (**S**-**VL**)

Flatworms

(Class **Turbellaria**): Soft elongate body without segment; head triangular shaped with eyes on top, which give the animal a cross-eyed appearance. (**VS**-**L**)

WVDEP WATERSHED IMPROVEMENT BRANCH
SAVE OUR STREAMS

Instructions: Identification is easier when the organism is viewed in the same orientation as its illustration. Illustrations are drawn mostly in top and side views; the water penny is shown in underside view. The (**M**) symbol indicates that multiple kinds may be collected from the group (Order or Class). Use morphological features as your basis for identification; the size and color are often variable and influenced by environmental factors. Only a few of the many kinds possible are illustrated. **Sizes illustrated not proportional.**

Size categories (mm): > 50 Very large (**VL**); 50 - 30 Large (**L**); 29 -10 Medium (**M**); 10 - 5 Small (**S**); < 5 Very small (**VS**)

https://go.wv.gov/sos

Illustration's courtesy of the Cacapon Institute; Jennifer Gillies, artist.

(1) Determine the stream-reach boundary. (2) Near the lower end of the reach (in the deepest portion of the run), collect water samples and analyze using the chemical tests you have available. You may use your collection container to observe watercolor and clarity and to determine water odors. (3) Measure the width-depth, discharge and estimate the water level. (4) Using a **kick-net**, collect a minimum of three benthic macroinvertebrate (BMI) samples from the best riffles or runs within your stream reach. Use the tally sheet on page four to record information about your collections. (5) Evaluate the physical and habitat conditions, and record information about known land use activities. (6) Sketch your reach or submit photographs with the survey and add any other comments that you feel are important. Note: A **Scientific Collection Permit** from WVDNR is required for all benthic surveys.

Stream name ______________________ Survey date __________
Watershed ______________________ County __________
Latitude __________ Longitude __________ Directions __________
______________________ Start/end times __________
Survey completed by ______________________ Station code __________
Affiliation ______________________ E-mail __________
Mailing address ______________________ Phone number __________
____

WATER CHEMISTRY: Use the boxes below to record the results of your water chemistry analysis; attach additional sheets if necessary.

	Result	units		Result	units		Result	units
Temperature (C/F)			Conductivity			Alkalinity		
Dissolved oxygen			Nitrates			Iron		
pH			Turbidity			Fecal/E-coli		

Additional tests (describe and record results) ______________________

____

PHYSICAL CONDITIONS: Use the check boxes below to describe the conditions that closely resemble those of your stream. The extra lines are provided to write in any additional comments. You may see more than one type of condition; if so, be sure to indicate these on your survey (check all that apply). If multiple conditions are observed, always indicate the most dominant condition. Note: If the condition you observe is not listed, describe it in the comment section.

Water clarity		Watercolor		Water/sediment odor	Water	Sediment	Surface foam	
Clear		None		None			None	
Murky		Brown		Fishy			Slight	
Milky		Black		Musky			Moderate	
Muddy		Orange/red		Rotten egg			High	
Other (describe)		Gray/White		Sewage				
		Green		Chemical				

Algae color		Algae abundance		Algae growth habit		Streambed color	
Light green		None		Even coating		Brown	
Dark green		Scattered		Hairy		Black	
Brown		Moderate		Matted		Green	
Other (describe)		Heavy		Floating		White/gray	
						Orange/red	

Physical condition comments: ______________________

____

____

Weather (today and past 48-hours) ______________________

____

Indicate the % of your reach that is shaded	> 80 Excellent	80 – 60 Good	60 – 40 Fair	< 40 Poor

Width and Depth Measurements: Record the wetted width and average depth from at least two of the channel's habitats (run, riffle or pool). Determine the average depth from a minimum of five measurements (one should always be from the deepest part of the channel). The width should be measured from the widest section of the feature.

1. Riffle Wetted Width (feet) ________ Depth (feet) __________
2. Run Wetted Width (feet) ________ Depth (feet) __________
3. Pool Wetted Width (feet) ________ Depth (feet) __________

Discharge: Determine the discharge by using a flow meter or other methods such as the **float** or the **velocity head rod** (VHR) method. The more measurements collected the more accurate your discharge results will be. However, you should collect a minimum of five measurements. Discharge should always be measured from a **run**. Stretch your tape measure across the run and select a minimum of five positions along the tape to measure discharge. One measurement should be from the deepest part of the channel and the others should be on either side. If you use the float method move 10-20 feet upstream from the tape and float at least five times back to the tape. The float distance must be timed in seconds.

Discharge method used **Water Level**

☐ Float ☐ VHR ☐ Flow meter ☐ Low ☐ Normal ☐ High ☐ Dry

Channel width ________________ feet

Tape positions (ft)	Depth (ft)	Velocity (ft/sec)	VHR (Rise-inches)	Float (sec)	Discharge (cfs)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Totals/Averages					

Cross Sectional Area (CSA) ________________ ft^2

(CSA = Average Depth x Width)

Discharge = CSA x Velocity

= __________________ x ___________________

= __________________ cfs (ft^3/sec)

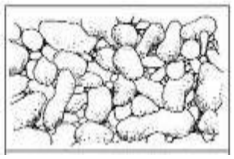
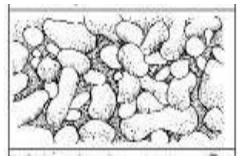
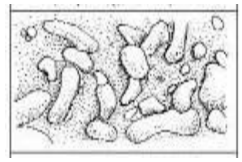
If you use a float record your distance below and the number of seconds, it took to travel the distance in the column indicated. **Float distance** (feet) ____________

VHR rises and velocities

Rise ®	Velocity	Rise ®	Velocity
¼	1.2	3 ¼	4.2
½	1.6	3 ½	4.3
¾	2.0	3 ¾	4.5
1	2.3	4	4.6
1 ¼	2.6	4 ¼	4.8
1 ½	2.8	4 ½	4.9
1 ¾	3.1	4 ¾	5.0
2	3.3	5	5.2
2 ¼	3.5	5 ¼	5.3
2 ½	3.7	5 ½	5.4
2 ¾	3.8	5 ¾	5.5
3	4.0	6	5.7

VHR Velocity = $8 \times \sqrt{R}$, where R is rise.

Habitat Conditions: Rate the habitat conditions by choosing the best description for the reach, and then choose a score from the range within the description. Make sure to travel your reach and make observations throughout. Your scores must reflect the entire reach conditions.

	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Embeddedness EVALUATED IN RIFFLES ☐	 Fine sediments surrounds <10% of the spaces between the gravel, cobble, and boulders. **O**ptimal	 Fine sediment surrounds 10-30% of the spaces between the gravel, cobble, and boulders. **S**uboptimal	 Fine sediment surrounds 30-60% of the spaces between the gravel, cobble, and boulders. **M**arginal	 Fine sediment surrounds > 60% of the spaces between the gravel, cobble, and boulders. **P**oor
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Sediment deposition ☐	Little or no formation of depositional features; < 20% of the reach affected. See below for examples **O**ptimal	Some increase in depositional features; 20-40% of the reach affected. **S**uboptimal	Moderate amounts of depositional features; 40-60% of the reach affected. **M**arginal	Heavy amounts of deposition; > 60% of the reach affected. **P**oor

The next two conditions are evaluated on both the left and the right sides of the stream. <u>Note</u>: The **LEFT** and **RIGHT** sides are determined by looking downstream.

	10 9 8	7 6	5 4 3	2 1
Bank stability Left ☐ Right ☐	Banks are stable; no evidence of erosion or bank failure; little or no potential for future problems; < 10% of the reach affected. **O**ptimal	Banks are moderately stable; infrequent areas of erosion occur, mostly shown by banks healed over or a few bare spots; 10-30 % of the reach affected. **S**uboptimal	Banks are moderately unstable; 30-50% of the reach has some areas of erosion; high potential for erosion during flooding events. **M**arginal	Banks are unstable; many have eroded areas (bare soils) along straight sections or bends; obvious bank collapse or failure; > 50% affected. **P**oor
	10 9 8	7 6	5 4 3	2 1
Riparian buffer width Left ☐ Right ☐	Mainly undisturbed vegetation > 60 ft; no evidence of human impacts such as parking lots, roadbeds, clear-cuts, mowed areas, crops, lawns etc. **O**ptimal	Zone of undisturbed vegetation 40-60 ft; some areas of disturbance evident. **S**uboptimal	Zone of undisturbed vegetation 20-40 ft; disturbed areas common throughout the reach. **M**arginal	Zone of undisturbed vegetation < 20 ft; disturbed areas common throughout the entire reach. **P**oor

Total points		> 70	70 – 55	54 – 40	< 40
		Optimal	Suboptimal	Marginal	Poor

Habitat comments: ____

____

____

____

____

____

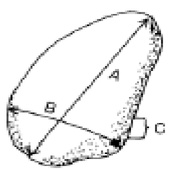
____

Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increase in size as the channel is diverted toward the outer bank) or shoals or result in the filling of runs and pools. Usually, deposition is evident in areas that are obstructed by natural or manmade debris and areas where the stream flow decreases, such as bends.

Streambed Composition: You should always collect information about the composition of your reach. You can either estimate the proportions or you use a pebble count for a more accurate measure of composition. At a minimum you should estimate composition of the riffles within your reach. The size categories are determined by the (B) axis measured in millimeters. Use the table to record your data. **Did you estimate** ☐ **or count?** ☐

Silt/clay < 0.06	Sand 0.06 – 2	Gravel 2 - 24 25 - 64	Cobble 65 - 255	Boulder 256 - 1096	Bedrock > 1096	Woody debris
Very small; having a smooth slick feel	Very small; having a grainy feel	Pea to tennis ball	Tennis ball to basketball	Basketball to car size	Usually larger than a car; solid surface	Includes sticks, leaves etc.
		Fine Coarse				

Riffle only ☐ Entire reach ☐ Estimates should be made from riffles only



(A) Long axis (**Length**)
(B) Intermediate axis (**Width**)
(C) Short axis (**Height**)

Pebble counts require two people, one in the stream and one on shore. The person in the stream walks upstream from bank to bank using a zigzag pattern. After each step the person reaches down without looking, picks up the first particle touched, and measures the intermediate axis with a ruler. The on-shore partner records the measurement. The process continues until **100** pebbles have been measured or the reach has been walked. For a quick estimate, the coordinator recommends that **50** be collected from the entire reach and **20** if collecting from riffles only. You should divide the gravel category into fine and coarse to get a more accurate measure. Note: Pebble counts are not required; they are optional and should only be completed once each year or less frequently.

Land Use: Indicate the land uses that you believe may be having an impact on your stream station. Use (**S**) streamside, (**M**) within ¼ mile and (**W**) somewhere in the watershed, to indicate the approximate location of the disturbance and (**1**) slight, (**2**) moderate or (**3**) high, to represent the level of disturbance.

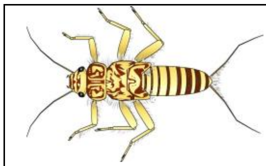
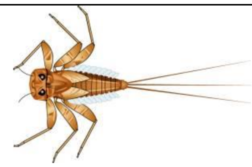
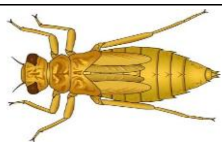
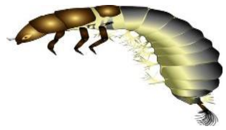
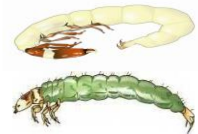
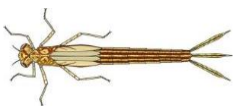
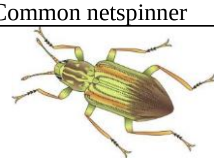
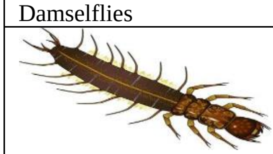
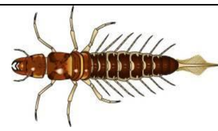
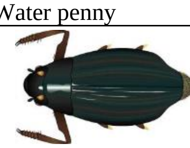
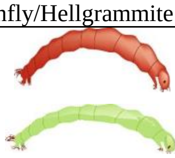
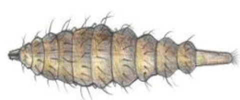
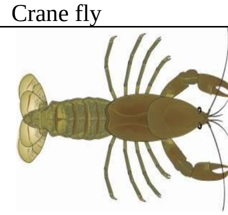
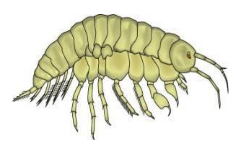
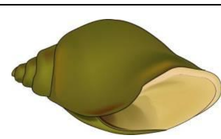
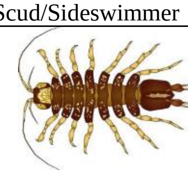
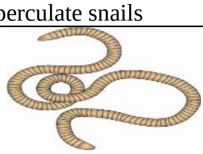
Active construction			Pastureland			Single-family residences		
Mountaintop mining			Cropland			Sub-urban developments		
Deep mining			Intensive feedlots			Parking lots, strip-malls etc.		
Abandoned mining			Unpaved Roads			Paved Roads		
Logging			Trash dumps			Bridges		
Oil and gas wells			Landfills			Other (describe)		
Recreation (parks, trails etc.)			Industrial areas					

Pipes? Yes No

Describe the types of pipes observed and indicate if there is any discharge from the pipes. Also describe the colors and. odors of the discharge, and provide any other land-use comments ______________________

Photograph AND **Sketch the Study Reach**: Use the space below to draw a **bird's eye view** your study reach. Indicate the direction of flow, sample locations and important features of the reach. Select two-points from which to take your photos and submit these with your survey data sheet.

BMIs: Use the table below to record information about your collections. Record their abundance using these codes: (**A**) > **50**, (**C**) **5 – 50** and (**R**) < **5** and record the number of different kinds. The shaded # of kind's box indicates groups in which multiple kinds (*FAMILIES*) are possible. Note: Do not forget to record the **# of kinds**.

 Stoneflies		 Mayflies		 Caddisflies	Case-builders
 Dragonflies		 Common netspinner		 Caddisflies	Net-spinners / Free-living
 Damselflies		 Riffle beetle		 Water penny	
 Fishfly/Hellgrammite		 Alderfly		 Other Beetles/Bugs	Beetles / True bugs
 Midges		 Black fly		 Crane fly	
 Watersnipe fly		 Other True flies		 Crayfish	
 Clams		 Mussel		 Scud/Sideswimmer	
 Operculate snails		 Non-operculate snails		 Aquatic sowbug	
 Aquatic worm		 Leech		 Flatworm	

Illustration's courtesy of the Cacapon Institute; Jennifer Gillies, artist.

Other aquatic life observed or collected: ______________________________

Stream Score

After the sorting and identifications is complete, the BMIs are assessed using three metrics. First, transform your abundance rating into numbers using this code (**A** = **6; C** = **3**; **R** = **1**) and follow the instructions below to complete all calculations. Note: The **shading** indicates that multiple kinds are possible within the group.

1. **Biotic Index**: Multiply the abundance number by the tolerance value to calculate the tolerance score. Add the entire tolerance score column and the abundance column. Divide the tolerance total by the abundance total.
2. **Total Taxa**: Calculate the total number of kinds.
3. **EPT Taxa**: Calculate the total number of kinds from the stoneflies, mayflies, and all caddisflies.

The final step is to determine a **point value** for each metric. These points are added together to determine your overall **stream score** and integrity rating. Note: **Do not forget to record the number of kinds**.

COMMON BMI GROUPS	Abundance	Tolerance Value	Tolerance Score	Number of Kinds
Stoneflies (Order *Plecoptera*)		2		
Mayflies (Order *Ephemeroptera*)		3		
Case-building caddisflies (Order *Trichoptera*)		3		
Net-spinning caddisflies (Order *Trichoptera*)		4		
Common netspinner (Family *Hydropsychidae*)		5		
Free-living caddisfly (Family *Rhyacophilidae*)		3		
Dragonflies (Sub-order *Anisoptera*)		5		
Damselflies (Sub-order *Zygoptera*)		8		
Riffle beetle (Family *Elmidae*)		4		
Water penny (Family *Psephenidae*)		3		
Other Beetles (Order *Coleoptera*)		6		
True Bugs (Order *Hemiptera*)		8		
Hellgrammite (Family *Corydalidae*)		4		
Alderfly (Family *Sialidae*)		6		
Non-biting midge (Family *Chironomidae*)		9		
Black fly (Family *Simuliidae*)		6		
Crane fly (Family *Tipulidae*)		4		
Watersnipe fly (Family *Athericidae*)		3		
Other True flies (Order *Diptera*)		8		
Water mite (Order *Hydrachnida*)		6		
Crayfish (Family *Cambaridae*)		5		
Sideswimmer (Family *Gammaridae*)		5		
Aquatic sowbug (Family *Asellidae*)		8		
Operculate snails (Sub-class *Prosobranchia*)		5		
Non-operculate snails (Sub-class *Pulmonata*)		8		
Clams (Order *Veneroida*)		6		
Mussel (Family *Unionidae*)		4		
Aquatic worm (Class *Oligochaeta*)		10		
Leech (Class *Hirudinea*)		8		
Flatworm (Class *Turbellaria*)		7		
Other invertebrates (describe)	Total Abundance		Total Tolerance	Total Taxa (**# OF KINDS**)

Metrics	Results	**Points**	**10**	**8**	**6**	**4**	**2**
1. Total Taxa			> 18	18 - 15	14 - 11	10 - 7	< 7
2. EPT Taxa			> 10	10 - 8	7 - 5	4 - 2	< 2
3. Biotic Index			< 3.5	3.5 – 4.3	4.4 – 5.6	5.7 – 6.5	> 6.5

Integrity Rating Scale

STREAM SCORE		> 24	24 - 19	18 - 13	< 13
		Optimal	Suboptimal	Marginal	Poor

Submit your stream survey data sheet, notes, photos etc. by mail, or scan and email the data to: Saveourstreams@wv.gov.

Stream survey summary

LOCATION INFORMATION

Stream ______ RR miles ______ Date(s) ______
Monitor(s) ______
Directions ______ Start/end times | | |
County ______
Latitude ______ Longitude ______ Watershed ______

PHYSIOCHEMICAL CONDITIONS

	Result	Units		Result	Units		Result	Units
Temp. (°F or °C)			Alkalinity			Fecal coliform/E-coli		
pH			Nitrate/Nitrite			Iron		
Conductivity			Phosphates			Aluminum		
Dissolved O_2			Dissolved Solids			Manganese		
Acidity			Turbidity			Other (describe)		

Describe other conditions analyzed: ______

Water clarity ______ Algae color ______
Watercolor ______ Algae abundance ______
Water/Sediment odor ______ Algae texture ______
Streambed color ______ Surface foam ______
Comments ______

Riffle width ______ Run width ______ Pool width ______
Riffle depth ______ Run depth ______ Pool depth ______

Feet	Meters

Indicate units

PEBBLE COUNTS

Estimate | | Count | | Entire reach | | Riffles only | |

Silt/clay	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bedrock	Woody debris

Index | |

FLOW CONDITIONS

Discharge (cfs) ______

Water level	Low	Normal	High	No flow

Current/past weather conditions: ______

HABITAT CONDITIONS

Sediment deposition		Bank stability	
Embeddedness		Riparian buffer width	
Total Score		Channel shade	
Integrity Rating			

Comments ______

BIOLOGICAL CONDITIONS

Total Taxa		Biotic Index	
EPT Taxa		**Stream Score**	

Integrity Rating ______

Other aquatic organisms observed or collected (e.g., fish, salamanders etc.), or additional comments: ______

LAND USE IMPACTS

Indicate the types of land uses that affect your stream reach and their approximate location using the code: (**S**) streamside, (**M**) within ¼ mile, and (**W**) within the watershed. Also estimate the level of impact with the numeric codes (**1**) slight, (**2**) moderate, or (**3**) for high impacts.

	Impact	Location
Single family residences		
Sub-urban developments		
Urban areas		
Industrial areas		
Parking lots, malls etc.		
Bridges		
Paved roads		
Unpaved roads		
Active construction		
Parks, trails etc.		
Other recreation		
Landfills		

	Impact	Location
Trash dumps		
Intensive feedlots		
Pastureland		
Cropland		
Oil & gas wells		
Logging		
Mountaintop mining		
Abandoned mining		
Deep mining		
Quarries		
Other (describe)		

Comments: ______________________________

Pipes?		Yes		No
Discharge		Yes		No

BENTHIC MACROINVERTEBRATES: Record the total number or abundance estimate (#) and number of kinds (K) for the macroinvertebrates collected.

Low	#	K	Moderate	#	K	High	#	K
Mayflies ***Ephemeroptera***			Mayflies ***Ephemeroptera***			Damselflies ***Zygoptera***		
Stoneflies ***Plecoptera***			Common netspinner ***Hydropsychidae***			True bugs ***Hemiptera***		
Case-building caddisflies ***Trichoptera***			Dragonflies ***Anisoptera***			Other Beetles ***Coleoptera***		
Net-spinning caddisflies ***Trichoptera***			Riffle beetle ***Elmidae***			Non-biting midge ***Chironomidae***		
Free-living caddisfly ***Rhyacophilidae***			Other Beetles ***Coleoptera***			Other True flies ***Diptera***		
Water penny ***Psephenidae***			Alderfly ***Sialidae***			Aquatic sowbug ***Asellidae***		
Hellgrammite/Fishfly ***Corydalidae***			Black fly ***Simuliidae***			Non-operculate snails ***Pulmonata***		
Watersnipe fly ***Athericidae***			Crane fly ***Tipulidae***			Aquatic worms ***Oligochaeta***		
Mussel ***Unionidae***			Other True flies ***Diptera***			Leeches ***Hirudinea***		
Operculate snails ***Prosobranchia***			Water mite ***Hydrachnida***			Flatworms ***Turbellaria***		
Totals			Crayfish ***Cambaridae***			**Totals**		
			Scud/Sideswimmer ***Gammaridae***					
			Clams ***Veneroida***					
			Totals					

Abundance ratings: > 50 (**A**bundant) = **6**; 5-50 (**C**ommon) = **3**; < 5 (**R**are) = **1**

Total kinds	
Total number	

ADDITIONAL COMMENTS

VAD SURVEY CODE: ______________________

Website: https://go.wv.gov/sos
Questions? Email Saveourstreams@wv.gov

West Virginia Department of Environmental Protection

WV Department of Environmental Protection
Watershed Improvement Branch - Save Our Streams Program

https://go.wv.gov/sos

August 2023