Confluence Crew HANDBOOK

PALOUSE
CONSERVATION DISTRICT

The mission of the Confluence Crew is to empower citizens in our community
with the knowledge and tools necessary to protect our local water resources and
to contribute to citizen-based scientific research.

This program is administered by the Palouse Conservation District. The mission of Palouse Conservation District is to foster the voluntary conservation of natural resources by providing the tools, education, technical expertise, and financial assistance to support our local community.

This handbook is adapted from the University of Idaho Extension
IdaH2O Master Water Stewards Handbook.

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This publication was developed under
Assistance Agreement No. NE-01J82401 awarded by the U.S. Environmental Protection Agency (EPA) and Agreement No. PaloCD_00050 awarded by Washington State Department of Ecology (Ecology).
It has not been formally reviewed by EPA or Ecology.

Introduction & Policies

Thank you for your interest in becoming a member of the Confluence Crew! Water quality is a pressing concern on the Palouse. Changes in land-use practices over the last two centuries have dramatically altered the landscape and have had an effect on surface water and the beneficial uses it serves. A wide range of harmful pollutants enter our water bodies, threatening recreation, fisheries, and wildlife communities. Citizen-based water quality monitoring helps to identify pollution concerns and formulate local solutions.

Confluence Crew provides a platform for citizens throughout the Palouse Conservation District (PCD) who are interested in learning more about water quality monitoring and the status of their local water bodies. As a volunteer with the Confluence Crew, you will collect valuable water quality data and gain a personal stake in the health of our surface water resources.

The data that you collect will be published real-time so that all citizens in our community have an accurate and up-to-date understanding of the conditions within our watershed. This data will further help Palouse Conservation District and its partners identify areas requiring further study or the implementation of conservation projects, such as riparian buffers.

Pollution Sources

Waters of the Palouse are impacted by several forms of non-point source pollutants. Non-point source pollution occurs when runoff picks up pollutants from the surrounding landscape and deposits them into a water body. Because the source of the pollution is not easily identifiable, non-point source pollution presents a difficult challenge, and mitigation efforts require community-wide awareness and action. Examples of non-point source pollutants that we commonly see on the Palouse include pet waste, litter, fertilizer and pesticides, and other substances that are harmful to our aquatic ecosystems.

Water Quality on the Palouse

The Palouse River watershed has a rich agricultural history that developed on the foundation of fertile, wind-deposited loess soils. These soils contribute to the watershed's status as one of the leading wheat-producing regions in the US. In 2015, more than 240 million bushels of wheat were harvested in the region, worth an estimated $1.3 billion. An estimated 3.3 million acres of dryland wheat is planted each year within the watershed. Years of intensive land cultivation has led to severe problems with soil erosion by wind and water. It is estimated that before 1970, 0.75 tons of soil were lost for every bushel of wheat produced. Since the 1970's, advances in farming technology, including no-till drills, have reduced soil erosion to roughly 2.5 tons per acre per year. While this reduction is significant, there are still several tons of non-point source pollutants that move through the watershed each year.

The Palouse River has been listed by the State of Washington under Section 303(d) of the Clean Water Act for non-compliance with state water quality criteria for fecal coliform bacteria, pH, temperature, dissolved oxygen, and toxics. Multiple Total Maximum Daily Loads (TMDLs) have been developed by the Washington State Department of Ecology for the Palouse River for fecal coliform bacteria (Ecology, 2006), chlorinated pesticides (Ecology, 2007), temperature (Ecology, 2013), dissolved oxygen, and pH (Ecology, 2015). The Washington State Department of Ecology is currently working on completing a TMDL for pH, dissolved oxygen, and temperature on the South Fork Palouse River. The sources of pollution in each watershed originate from both point and non-point sources. Identified point sources in the watershed include the Moscow, Pullman, Albion, Palouse, Garfield, and Colfax municipal wastewater treatment plants. Other identified point sources entering the streams are located in the City of Pullman's stormwater system. The majority of the point sources within the watershed are permitted by the National Pollutant Discharge Elimination Systems (NPDS) through the Clean Water Act. The main focus of this citizen science project is to measure non-point source pollution associated with dryland agriculture, failing onsite sewage treatment systems, livestock operations, stormwater, urban activities, and wildlife.

What else does Palouse Conservation District do to conserve our local waters and the life within them?

Research & Monitoring: PCD has a robust water quality monitoring program. The data collected by the Research & Monitoring Program is used to assess effectiveness of conservation projects, identify water bodies that would benefit from the instillation of conservation projects, and educate the community.

In-Stream Habitat Restoration Projects: We assist with projects that install low-cost, woody debris structures called PALS (Post-Assisted Log Structures) and bioengineered soft streambank stabilization structures created with woody material. These projects provide spawning habitat for steelhead, protect actively eroding streambanks, and allow for increased summer base flows and floodplain reconnection.

Education & Outreach: We provide many opportunities throughout the year for our community to engage with water-focused programs, including:

- Public workshops focusing on local water resource concerns
- K-12 programming for area schools on topics including point- and non-point source pollution, groundwater, the water cycle, water conserving behaviors, and more
- Volunteer opportunities including stream planting events, maintenance of City of Pullman pet waste stations, and the Pullman Adopt-A-Stream program

Resource Conservation: Much of our work focuses on restoring riparian areas (the lands that occur along water bodies). These areas are vital to our overall water quality and to the wellbeing of all wildlife. We work with landowners to help them install forested riparian buffers, commodity buffers, livestock fencing, off-site livestock watering facilities, and other practices to protect and enhance aquatic habitat.

Getting Involved

1. **Determine** to what degree you would like to participate in this program. Would you like to do simple physical and observational monitoring, or do you want to receive training on all the measures of water quality, up to and including biological indicators? What are your goals for participating in this program? We are very supportive of volunteers engaging in whatever capacity they may wish to, and we will happily provide you training to the degree that you'd like.
2. **Fill out** the interest form located on our website at www.palousecd.org/confluence-crew.
3. **Watch** our training videos located on our website. Be sure to take the knowledge checks associated with each video.
4. **Sign up** for an in-person field practicum.
5. **Select** a monitoring site. Your site can be on private or public property. PCD will work with you to select a monitoring site if you need inspiration or guidance. Should you wish to monitor on another landowner's private property, please let us know and PCD can help facilitate that conversation.
6. **Find** a partner or group (or indicate on the registration form that you would like to be matched with another volunteer). PCD strongly recommends that monitors have at least one other person with them whenever they are entering the water.
7. **Read** this handbook in its entirety to make sure that you have all the information you may need as a volunteer.
8. **Go out there** and start monitoring!

Funding

This program is administered by the Palouse Conservation District. Funding for the development of this program was provided by United States Environmental Protection Agency and Washington State Department of Ecology.

Expectations

In-stream conditions can fluctuate rapidly from month to month due to seasonal changes in precipitation, temperature, agricultural activity, and a myriad of other conditions. Therefore, we ask that our monitors commit to a schedule of monitoring every month. While there is flexibility in this schedule due to weather, safety, and personal circumstances, attempting to adhere to a steady and regular sampling schedule ensures that the data collected will be robust and relevant to PCD's water monitoring goals.

Confluence Crew members will be provided with all the equipment necessary to conduct monitoring. PCD cannot reimburse volunteers for time or travel expenses.

As this data will be published on the PCD website and used to inform management decisions, we ask that our volunteers agree to collect high-quality data following data collection standards put forth by PCD. Don't worry! We'll be sure to train you in these processes, and our staff are always happy to answer any questions you may have along the way.

Equipment/Supplies

You will be provided with the equipment needed to conduct monitoring as long as you are a Confluence Crew member. If you cease monitoring activities, you will be required to return your equipment and supplies to PCD.

We are happy to resupply you with any replacement items you may need throughout your time as a volunteer provided you have been conducting regular monitoring and have been reporting your data within a sufficient timeframe from the date of data collection. Simply fill out the resupply request form on our website and a PCD staff member will get in contact with you.

Please store all testing equipment at room temperature away from direct sunlight when not in use.

Each monitor will be equipped with:

- Turbidity Tube
- Nitrile gloves
- Pencils
- Rite-in-the-Rain data sheets
- Laminated data, identification, and protocol sheets
- Thermometer
- Safety vest
- Clipboard
- Sandwich bags to hold waste

Additional equipment for Tier II:

- LaMotte Nitrate Nitrogen Test Kit #3354-01
- LaMotte Precision pH Test Kit #5858-01
- CHEMets Dissolved Oxygen Visual Kit #K-7512
- 1 L sampling bottle
- Tap water wash bottle
- Plastic waste bottle
- Stopwatch
- Coffee filters

Additional equipment for Tier III:

- Sieve
- Aquatic net
- Ice cube tray
- Magnifying glass or loupe
- Forceps
- Dichotomous key
- Wash bin

Additional equipment for Tier IV:

- Laminated vegetation ID field guide
- Plant identification book

Once-yearly habitat assessment and nutrient testing equipment:

- Measuring tape
- Yard stick
- Rubber or tennis ball
- Sampling bottles

Optional equipment:

- Waders: Available to monitors who wish to borrow them; deposit required.
- Sampling pole (if you will be sampling out of the water)

We recommend you wear water shoes, boots, or waders during monitoring. Felt-soled waders are not permitted, as they are a known transmission vector for invasive species. If you do not have access to rubber-booted waders, PCD will be happy to provide them to you. We require that you furnish a check or cash deposit to cover the cost of the waders should they become damaged or lost. You will receive the deposit back once your volunteer service has ended.

Code of Ethics

As a Confluence Crew member, we ask that you agree to:

- Be responsible for your own safety while monitoring
- Use proper scientific methodology and follow data collection standards
- Fully document technical observations
- Accept the responsibility to report data
- Do your best to "leave no trace"; avoid walking on unstable banks to minimize erosion and try to minimize your disturbance to riparian vegetation
- Be mindful that water shoes and waders are often methods of transport for invasive species. If your site has invasive species present, then dedicate one pair of shoes or waders for your site only to avoid the spread of these invasives. It is best practice to remove all visible vertebrates, invertebrates, plants, algae, or sediment with a scrub brush and clean water on site. For more information on aquatic invasive species in Washington State, visit our website.

If working on your own private lands:

- You will have the option to keep the exact location of data collection private. If you mark the location private, the data will be published alongside a generalized location.
- Collect all data that is relevant to the tier you are measuring (i.e., do not pick and choose the data within a tier, but commit to collecting all measurements on the data sheet as you are able)

If working on someone else's private lands:

- Notify PCD that your chosen sampling site is on or requires access to private property
- Allow PCD to facilitate the discussion and agreement between you and the landowner
- Establish a sampling schedule with landowner agreement, or notify the landowner at least two days in advance of sampling session
- Do not harm private property
- Take complete responsibility for personal safety while on private property
- Share sampling data with landowner after data has been reviewed by PCD staff

Safety

The safety of our volunteers is our utmost concern. You should NEVER place collecting data above your own well-being.

- Always monitor with a buddy
- Always notify someone where you are going and when you will be back
- Use caution when entering water
- Do not attempt to enter water if stream flow is too high; in general, any water that is higher than your knees should not be entered
- Always collect data during daylight hours
- Wear appropriate footwear. Do not wear felt-soled waders, as those can easily spread invasive species from one site to another.
- Be aware of possible dangers, such as poisonous plants, wildlife, broken glass, unstable banks, swift water after rain or snow melt, and livestock
- Dress appropriately for the weather and be sure to monitor your own temperature
- Stop collecting data immediately if a storm is nearby. Remember that lightning can strike up to 12 miles away from a thunderstorm; if you hear the thunder, then you are likely within range of being struck
- Do not monitor if the site has warnings posted about being unsafe for humans
- Bring drinking water and a first aid kit
- Wash thoroughly with hot water and soap once home

Water Quality Metrics

An ecosystem includes both biotic (living) and abiotic (non-living) components. These biotic and abiotic factors interact constantly. It is important to study both the biotic and abiotic conditions in a water body in order to understand its current condition.

The three types of monitoring that scientists typically conduct are physical, chemical, and biological. Physical monitoring includes metrics like temperature and water clarity. Chemical monitoring includes measurements of pH, electrical conductivity, nitrates, and other chemical properties. Both physical and chemical monitoring can tell you about the real-time conditions of the water body. Biological monitoring includes identifying the presence and abundance of macroinvertebrates, fish, bacteria, and other organisms in the aquatic environment. Biological monitoring is unique in that it shows how the biotic (living) population in the stream is responding to conditions in the water over a longer period of time. Altogether, data collected from the three monitoring types can provide a holistic understanding of the condition of the water body.

Suspended Sediment

The Palouse has historically had some of the highest levels of soil erosion from cropland in the nation. Erosion is a natural process that carries fine particles of soil, called sediment, to our streams during runoff events (heavy rains or spring snow melts). Sediment can also enter streams from eroding streambanks. Sediment is carried by water until it settles to the bottom of a stream, lake, or other area (sedimentation). A small amount of sedimentation is natural; however, too much sediment is harmful to our lakes and streams. As it settles out of the water column, sediment covers up stream and lake bottoms and harms the aquatic communities that live there. In these conditions, many animals cannot feed and reproduce successfully because excess sediment clogs their gills, smothers their eggs, and destroys their food supplies and habitat. Suspended sediment also reduces light penetration, thereby reducing photosynthesis and slowing the growth of aquatic plants -- meaning less food and oxygen are available for aquatic life. Finally, sediment pollution can also change the type of habitat available in the stream. As it builds up and fills in pools, riffles, and runs, the shape of the streambed changes and gets shallower. This results in a wider, warmer, and slower stream, leading to lower dissolved oxygen levels and further streambank erosion.

Streams on the Palouse naturally meander and tend to have riparian vegetation alongside them. This riparian vegetation helps filter runoff originating from agricultural fields, thereby reducing the amount of sediment in the water. The roots of the vegetation help to stabilize the streambank, reducing the amount of sediment that is eroded by the water as it flows through the stream. Many riparian areas on the Palouse have been degraded or removed completely. Removing this vegetation can lead to increases in soil erosion and surface runoff entering streams, which in turn contributes to higher levels of sediment and water velocities. Coupling the increased speed of the water with the removal of riparian vegetation, the streambed can erode even more.

Nutrients

Nutrients such as nitrogen and phosphorus are essential to plant growth. On agricultural fields, they are necessary elements for crop production. In our waters, however, excess nutrients contribute to overproduction of algae, which can give the water a greenish hue and a foul odor, and can make waters unsafe for humans and animals. Runoff of sediment, nutrients, and other non-point source pollutants can be reduced by installing riparian buffers between agricultural fields and streams.

High nutrient loads (also called nutrient enrichment) ultimately change the types of plants and animals that can live in the stream. This process, called eutrophication, sets off a chain reaction of excess plant growth and algal blooms (an algal population explosion). When algae die, the bacteria that decompose them deplete the water of oxygen, causing a condition called hypoxia (low oxygen). These blooms and the resulting drop in dissolved oxygen levels (hypoxic conditions) can lead to mass die-offs of fish, invertebrates, and other aquatic animals as there is simply not enough oxygen for the animals to survive and they suffocate.

In urban areas, water runs off lawns, golf courses, streets, and parking lots. While many believe that this runoff water is treated in a sewage treatment plant before it rejoins our natural water bodies, the reality is that this runoff empties directly into our streams without undergoing any water treatment whatsoever. Overuse of fertilizers on urban lawns and gardens can substantially degrade water quality because those chemicals are deposited directly into a stream.

Temperature

Water temperatures naturally fluctuate with the seasons, but can also change due to human impact. For example, stormwater runoff may be warm from running over hot asphalt. Chemical reactions from agricultural fields may change runoff water temperatures as well, impacting stream temperature as the runoff enters the waterway. Impeded flow, shallow depths, and lack of vegetation cover from degraded riparian areas also expose water to external temperatures and sunlight in greater amounts, leading to increases in water temperature.

Temperature greatly affects dissolved oxygen (DO). Just like we breathe oxygen on land, aquatic animals breathe oxygen that is dissolved in the water. The warmer the water, the less oxygen is available for aquatic animals. Aquatic environments that are subjected to higher temperatures can be poor habitat for those animals.

There is a strong relationship between water temperature and biological activity. Each species that inhabits a body of water has a preferred temperature range. Water temperature is thought to influence the behavior of fish more than any other non-living variable. As the temperature deviates further from the range of preferred temperatures, the scarcity of the species increases. Some species are particularly vulnerable to temperature fluctuations. These include many of Washington's native cold-water fishes such as salmon and trout, as well as some amphibians. The effects of higher water temperatures can range from decreased spawning success to increased susceptibility to disease and toxins. High water temperatures can even spell death for these animals.

The most important tool we have to moderate temperature in a stream is riparian vegetation, as the shade provided can help keep water temperatures cool. This is why PCD and its partners emphasize restoring these streamside barriers.

Bacteria/Fecal Coliform

Fecal coliform are bacteria that originate in the waste of warm-blooded animals. The presence of these bacteria indicates that pathogens from these wastes may be reaching the body of water from inadequately treated sewage, improperly managed livestock waste, urban pet waste, aquatic birds or mammals, or failing septic systems.

Although some fecal coliform bacteria are naturally occurring, population spikes are often due to excess human and livestock waste flowing into the stream. Fecal coliform tests performed on the Palouse River demonstrate that a large amount of fecal coliform enters the water body in the city from livestock and urban pet waste.

Fecal coliform is a common metric that we use to decide whether or not water is "safe" to recreate in.

Macroinvertebrates

Macroinvertebrates (macro = visible to the naked eye; invertebrate = no backbone), such as caddisflies, mayflies, worms, and midge larvae, can be helpful indicators of the quality of a water body. These species are referred to as "indicator species" because their presence or absence in a stream can tell us about the quality of that aquatic habitat. For example, macroinvertebrates such as stoneflies, mayflies, and water pennies require high-quality habitat. They will not be found in highly polluted areas, so their presence can indicate a healthy aquatic environment. Other macroinvertebrates, such as aquatic worms or leeches, can be found flourishing in highly degraded environments. If you find only these pollution-tolerant animals in the water, it can be a good clue that the aquatic habitat is poor quality.

Macroinvertebrates are affected by the sediment load in a stream. The animals that prefer clean gravel beds tend to become scarce with higher sediment loads, while those that prefer fine sediment become more abundant. The decreased light infiltration from reduced water clarity can also increase predation risk, as species mistakenly travel downstream during the day when their predators are more prevalent.

Changes to the macroinvertebrate population in a stream can affect the fish and other animals that feed on them. Given the rapid and widespread decline of insects across the globe, and their importance as a food source for our fish, birds, and other animals, macroinvertebrate population monitoring is becoming increasingly important.

Watersheds

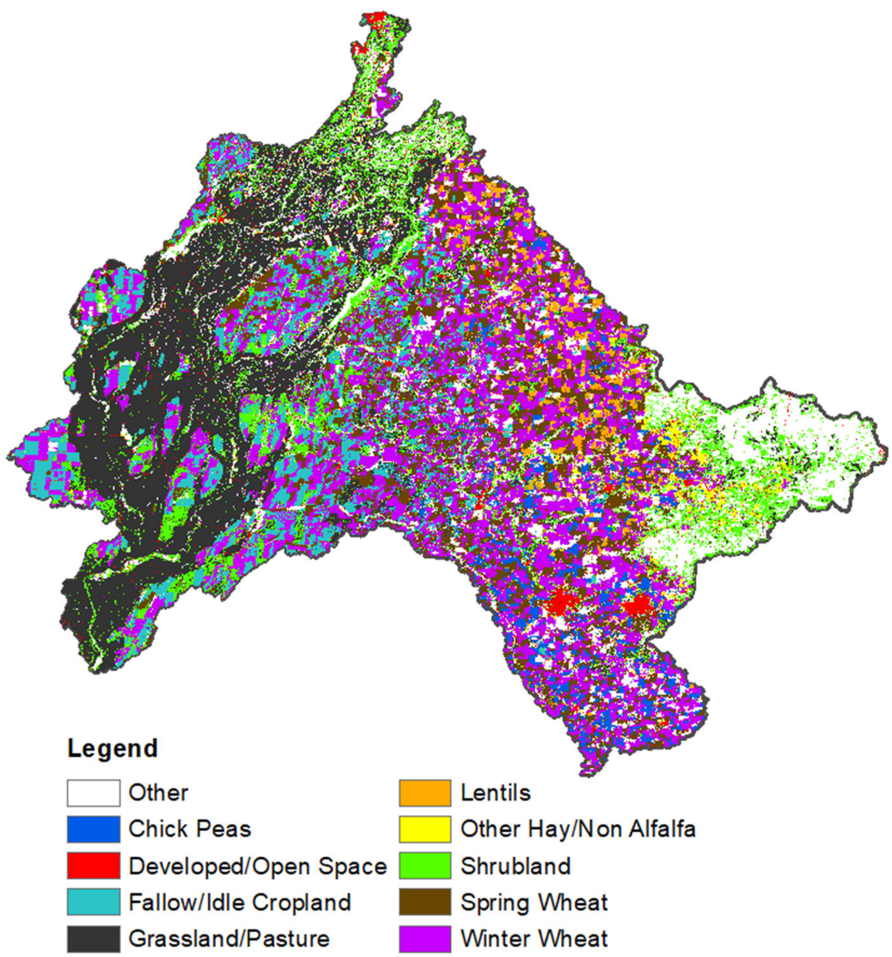
What is a watershed?

A watershed is an area of land where all the water (surface and groundwater) flows to the lowest point - usually a stream, lake, or river. Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. No matter where you are, you are in a watershed. In the continental US, there are 2,110 watersheds; with the addition of Hawaii, Alaska, and Puerto Rico, there are 2,267 watersheds.

We refer to watersheds by their proper name as well as by a grouping of numbers. This set of numbers is called the watershed's Hydrologic Unit Code (HUC). The HUC be anywhere from 2 to 16 digits long - more numbers mean it's the address of a smaller watershed. There are two HUC 8 watersheds within the Palouse Conservation District: HUC: 17060107- Lower Snake-Tucannon & HUC: 17060108-Palouse.

Map sources: USGS National Hydrography Dataset (NHD), Census Bureau 2018 Urban Areas

Map sources: USGS National Hydrography Dataset (NHD)



Map sources: USDA NASS CDL 2020, USGS NLCD 2019

Getting Started

Selection of Monitoring Site

An important first step of any monitoring project is to identify your monitoring site. Ideal monitoring sites are close to your home and easy to access. You may want to choose a location that has personal meaning to you. You will be monitoring at this same site throughout the length of your monitoring project, so try to pick a spot that you will enjoy returning to throughout the year. Once you have selected a site, be sure pick out a landmark so that you are always sampling from the same part of the stream. PCD will supply you with rebar and orange caps to mark your monitoring location, if you'd like.

The goal of this program is to gain a better understanding of water quality in the streams and rivers across the Palouse. Therefore, we support monitoring efforts on both public and private property. If you have a specific site in mind that you would like to monitor, such as on your property or at a public park, that is wonderful! If you need help identifying a public or private monitoring site, we can help. Just let us know and we can facilitate finding the perfect monitoring site for you.

Once you have a monitoring site identified, please submit the coordinates to PCD. This helps us track data spatially.

You will also be given a site name. Please remember this name and record it at the top of all data sheets.

Some other things to keep in mind:

- Try to establish your site away from manmade structures like bridges, which provide 100% canopy cover all of the time and are not representative of the stream. However, if you are restricted to the right-of-way, then monitoring at a bridge is adequate.
- If you do monitor at a bridge crossing, try to sample upstream from the bridge, unless safety or landowner considerations prevent you from doing so.
- Always monitor from the stream, if possible. If safety, weather, stream discharge, accessibility issues, time constraints, or other such conditions prevent you from obtaining water samples directly from the stream itself, then you may collect water samples without physically entering the stream. You may check out a sampling pole from PCD if you are unable to enter the stream.
- Perennial streams may dry up in low rainfall years, leaving little to no water or flow and in some cases only pools of water. Intermittent streams may dry up every year, yet retain enough water to maintain perennially pooled conditions. If your monitoring location is stagnant or dry, simply take a photograph and make note of the conditions on your report. You are not required to perform any further monitoring activities in this case.

Frequency

We encourage you to monitor every month, as weather, stream conditions, and personal circumstances allow. Best practice dictates that you monitor at the same time each day, preferably midday.

You are welcome to limit your monitoring to the warmer months (April – October) or monitor year-round. The conditions and location of your monitoring site will likely dictate your decision.

Selecting a Monitoring Tier

We want to ensure that this monitoring program fits in with your schedule and interests. We have developed a tiered system of data collection so that you can decide "cafeteria-style" what level of commitment you would like to make. Please be sure that you collect all data within the tier you select, unless streamside conditions prevent you from doing so.

We require that all Confluence Crew volunteers collect Tier I data at a minimum. However, whether you choose to collect any additional data is up to you. As the extent of knowledge and training required increases with each tier, there is no obligation to collect data beyond Tier I. We will happily provide you with the training necessary to successfully and accurately monitor all parameters.

Tier I Data Collection (Confluence Crew Members): We require that all volunteers collect monthly Tier I data. This data includes:

- Visual observations
- Photo of site
- Water temperature
- Air temperature
- Turbidity

Tier II Data Collection (Confluence Crew-saders): Tier II data collection focuses on chemical testing and should be collected every month:

- Dissolved oxygen
- Nitrate
- pH

Tier III Data Collection (Confluence Crew Captains): Tier III data collection involves biological monitoring and should be conducted twice a year (in the spring and fall):

- Macroinvertebrate identification
- Presence of fish

Tier IV Data Collection (Confluence Crew Commanders): Tier IV data collection involves vegetation monitoring and should be conducted once a year in the summer:

- Aquatic vegetation
- Riparian vegetation

Once-Yearly Data Collection:

In addition to the parameters listed above, we encourage all volunteers to complete additional seasonal site assessments. While these tests are not mandatory, they help us gain a stronger understanding of your monitoring site and how various factors may affect or contribute to the results that you collect year-round. These additional assessments include:

Visual habitat assessment (conducted in July or August):

- Epifaunal substrate: Structures on the streambed that provide surfaces on which animals can live.
- Embeddedness: The extent to which rocks are surrounded by, covered, or sunken into the silt, sand, or mud of the stream bottom.
- Riffles/Runs/Pools: Pools are deep with slow water. Riffles are shallow with fast, turbulent water running over rocks. Runs are deep with fast water and little to no turbulence.
- Sediment Deposition: When suspended particles settle down to the bottom of the stream. Often occurs when water flow slows down or stops, and the flow of water can no longer support the heavy particles.
- Channel Flow Status: A measure of how much water is present in the stream.
- Channel Alteration: The degree to which humans have altered the streambank.
- Channel Sinuosity: Bends and curves.
- Bank Stability: The ability of a streambank, including its soils and vegetation, to resist erosion from water flows and gravity.
- Riparian Zone Width: The width of the riparian zone as compared to the width of the stream.

In-stream flow calculation and laboratory testing of Nitrate, Suspended Sediment Concentration (SSC), and Fecal Coliform levels (conducted in September or October):

- You will receive an email in the fall to schedule a time to pick up these additional testing materials. As we have a limited number of these kits, we ask that volunteers complete this additional testing within a reasonable timeframe so that materials can be returned to PCD and checked out to the next volunteer.
- Chemical laboratory testing is available to all volunteers who complete fall flow testing. The required materials will be distributed in the flow kit. Site-specific results will be shared with each monitor who chooses to take advantage of this lab testing.

How to Sample

First Sampling Session:

Land Use

The land use adjacent to the stream and riparian zone is important to document. Cropland, pastures, wastewater treatment facilities, or city storm sewers can be sources of nutrients entering nearby waters. Other important influences include golf courses, roadways, parking lots, construction zones, airports, and state or federally protected natural areas.

It is important to document any land use that might influence the water quality of your stream. Documenting evidence of human use can help illustrate our physical connections to our aquatic resources. Please note if there are any changes to land use near your site as your monitoring progresses.

Sampling: Tier I Data

Tier I Data should be collected each month. Much of this data includes visual observations, which can provide vital indicators of a water body's status.

Visual observations: Please limit visual observations to what you see within a 50-foot radius of your site.

Weather

It is important to note the current weather conditions when you are monitoring. Weather strongly influences the physical characteristics of water. For example, cloudy weather may result in lower dissolved oxygen levels because of reduced plant photosynthesis. Recent rains may dilute point source pollution or increase non-point source pollution through surface runoff and pollutant transport.

If applicable, note the amount of rain (in inches) that the area has received in the past 24 hours. You can check this information by referring to wunderground.com.

Stream Flow

Stream flow (discharge) is the volume of water flowing over a given point in a fixed period of time. Stream flow is important to note, as it can change greatly from season to season. It is impacted by precipitation/surface runoff, snow melt, and natural springs.

To measure flow, observe your stream and indicate on the data form whether the flow is dry, stagnant/still, low, normal, high, or flood.

Color

The water's color can provide you immediate clues as to a stream's condition:

Clear: Clear water doesn't necessarily mean clean water, but it could indicate low levels of suspended sediment.

Brown: Brown water is usually due to heavy sediment loads.

Green: Green water is usually the result of excessive algae growth.

Oily sheen: Oily sheens can be caused by petroleum or chemical pollution, or they may be natural by-products of decomposition. To tell the difference between petroleum spills and natural oil sheens, poke the sheen with a stick. If the sheen swirls back together immediately, it's petroleum. If the sheen breaks apart and does not flow back together, it is from bacteria or organismal decomposition.

Red: Reddish or orange colors are usually due to iron oxides.

Black: Blackish water is usually caused by natural processes of leaf decomposition. Pigments leached from decaying leaves can cause the water to appear murky. Excess leaf litter can result in increased phosphorus loads in the stream.

Milky: A milky appearance may be caused by salts in the water.

Surface Scum

Please note the presence of any surface scum, foam, or biofilm.

Surface foam is common and can be naturally occurring. Vegetation can produce surface-acting agents ("surfactants") which can cause surface foam. Human-induced surface foam may be an unnatural color (red, pink, blue, yellow, orange) and have a fragrant smell. This foam is most likely generated by household detergents and may be a sign of a failing septic drain field or discharge.

If the water has a pea soup-like appearance (see photo below), this can indicate the presence of cyanobacteria, also known as blue-green algae. Cyanobacteria are single-celled, aquatic bacteria that photosynthesize. In nutrient-rich water, the cyanobacteria population can explode, creating what is referred to as an "algal bloom." Certain varieties of cyanobacteria can create cyanotoxins. Unfortunately, it is not easy to visually determine whether or not an algal bloom is toxic without having advanced knowledge of the different species of cyanobacteria. The toxins can have a variety of negative effects on humans and animals. Symptoms of cyanotoxin poisoning may include vomiting, fatigue, convulsions, difficulty walking, and even death. If you see a blue-green algae bloom in your stream, please make note of the conditions but do NOT enter the water for your safety.


Image source: California Department of Fish and Wildlife on Flickr

Odor

Water odor can provide immediate clues about potential problems in a stream:

Sewage/Manure: These smells can be common in the air, but should not originate from our water. It is important to differentiate whether the odor is coming from the water or the air.

Rotten egg: This odor is caused by hydrogen sulfide gas, a by-product of anaerobic decomposition (rotting without oxygen). This is a natural process that occurs in areas that have large quantities of organic matter and low levels of dissolved oxygen. It may be caused by excessive organic pollution.

Petroleum: Any petroleum or chemical smells can indicate a serious pollution problem from a point source, such as a factory, or a non-point source like stormwater runoff.

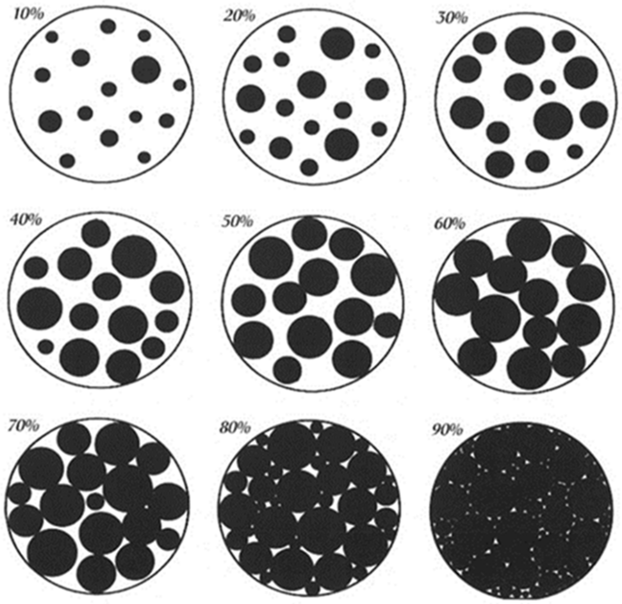
Trash Present

Is there any trash present at your site? Please indicate if you did a cleanup, or if your site requires an organized cleanup.

Canopy Cover

Canopy cover overhanging the stream is provided by the vegetation that exists in the riparian zone. Canopy cover is very important to the health of the stream because the shade keeps water temperatures cool. If the canopy of vegetation over a stream is reduced or eliminated, the health of the stream suffers. Elevated water temperatures resulting from solar heating may directly affect aquatic life. Warm water holds less dissolved oxygen than cold water, and thus less oxygen is available in warm water for fish and other aquatic life. Without adequate canopy cover, a stream's water temperature can fluctuate greatly and stress aquatic communities.

To measure canopy cover, estimate the percentage of the area above the stream that is covered by tree branches, leaves, and/or grasses. Make your best estimate of canopy cover in 10% increments (see next page for example).



How to estimate canopy cover

Photo of Site

Try to take at least one photo of the site each time you monitor. This can provide important visual cues about how your water body changes from season to season. Be sure to use landmarks to identify specific locations so you can compare images over time!

Air temperature

To sample air temperature, simply hang your thermometer off a branch in a shady area for at least 2 minutes to allow the reading to stabilize. Record the reading in Celsius. Then repeat the process and take another temperature reading. Record the average between the two readings.

Water Temperature

Many of the chemical, physical, and biological characteristics of a stream are directly affected by water temperature. Some species, such as trout, are quite sensitive to temperature changes. Water temperatures can fluctuate seasonally, daily, and even hourly.

Human activities can adversely raise stream temperatures in a variety of ways. Thermal pollution can be caused by:

- Warmed water entering a stream from industry discharges or runoff from paved surfaces
- Removal of riparian buffers, which increases solar heating
- Soil erosion, resulting in darker water, which absorbs more sunlight

Water temperature affects the following:

- The amount of oxygen dissolved in water. Cool water holds more oxygen than warm water
- The rate of photosynthesis by algae and aquatic plants, which increases with higher temperatures
- The metabolic rate of aquatic animals, which increases with higher temperatures
- The sensitivity of organisms to diseases, parasites, and toxins

Human impacts are most critical during the summer, when low flows and higher temperatures can cause greater stress on aquatic life.

To measure temperature, place your thermometer directly into the stream, holding it underwater in the main flow of the stream (not in a pool) for at least 2 minutes so the reading can stabilize. Be sure to measure in Celsius. Repeat the process and take another temperature reading. Record the average between the two readings.

Changes since last sampling session

There can be other changes you observe that may not be captured in the reporting metrics above. Please note any changes you see since you last sampled at this site.

Do you see any wildlife present?

Documenting the presence of wildlife helps us to understand long-term habitat use patterns.

Transparency

You will measure transparency using a turbidity tube. This tube has a small, high-contrast black and white disk (Secchi disk) at the base which helps you measure the transparency of the water (the ability of light to penetrate the water).

Step 1: Dip tube into the water and fill to the top. Sample flowing water. If you wade into the stream to collect the water, be sure to sample upstream from where you have walked to avoid collecting any disturbed sediment. Be sure not to let the tube touch the stream bottom.

Step 2: Measure in indirect sunlight to keep comparisons over time consistent. Cover the top of the tube with your hand and shake the tube to re-suspend sediment. Then look through the tube toward the Secchi disk at the bottom. If the disk is visible, record the water level in centimeters.

Step 3: If the disk isn't visible, slowly release water from the valve by pressing the bottom of the tube against the ground until the disk becomes visible. If this process takes some time, be sure to occasionally cover the top of the tube and re-suspend sediment. Once the disk is barely visible, observe the water level in NTUs.

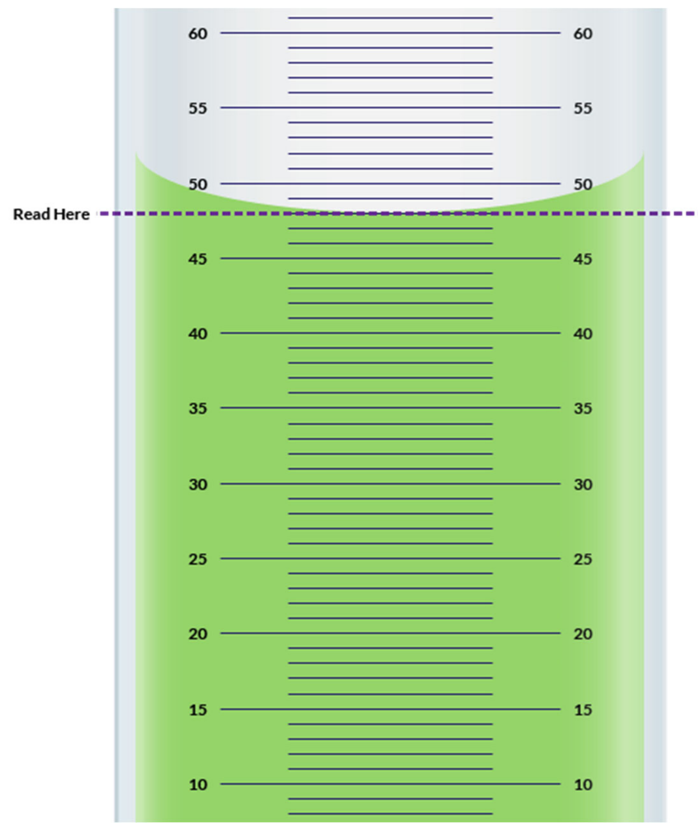
Step 4: Record the measurement in NTUs on your datasheet.

Sampling: Tier II Data

Tier II data should be collected each month, at the same time as you sample Tier I data. Tier II sampling focuses on chemical testing. As these chemical tests rely on identifying colors against a color scale, we recommend sampling midday or at a time where there is ample sunlight at your site. Color identification is also easier with another person – another reason we recommend sampling with a partner!

Be sure to rinse test tubes with tap water and allow to dry after use! Failure to rinse the test tubes can lead to inaccurate results the next time you use the kit. Liquid waste can be toxic and hazardous, and the liquid waste bottle may contain broken glass fragments from the dissolved oxygen test; be sure to pour the waste through a coffee filter as you dispose of it down a drain.

When measuring liquids in a test tube, you should always be aware of and account for the meniscus. The meniscus is the curve formed on the upper surface of a liquid inside a container. This is formed by the surface tension between the liquid and the container. To account for the meniscus, you should read the water level at the lowest level of the curve. When filling a test tube with water, fill to the meniscus for the most accurate results.



Example of where to read in a meniscus. (credit: sciencenotes.org)

Dissolved Oxygen (DO)

Dissolved oxygen is necessary for nearly all aquatic life to survive. Oxygen is added to water from the atmosphere through mixing in turbulent areas (rapids). Aquatic plants also contribute oxygen through photosynthesis. Both decomposition and respiration require oxygen, thus lowering the DO concentration in a stream. Remember that cold water holds more oxygen than warm water. Depending upon the time of day a measurement is taken, DO levels can fluctuate greatly – decreasing steadily at night to a low just before photosynthesis resumes at dawn. In summer, as streams and tributaries have less water or dry up, heat exposure increases the water temperature while turbulence decreases, thus limiting the amount of DO in these waterways.

Runoff water tends to have low DO, and typically transports chemical or biological pollutants. These pollutants require oxygen to decompose and end up lowering the waterway's DO levels further.

Survival of aquatic life requires a minimum amount of DO, meaning that while oxygen may be present in a stream, it could still be below the concentration required to sustain life.

Materials: CHEMetrics Dissolved Oxygen Kit K-7512

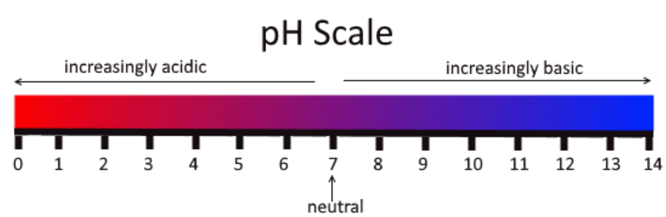
Step 1: Fill the sample cup to the 25 mL mark with stream water.
Step 2: Place the ampoule, tip first, into the sample cup. Snap the tip. This will take some pressure! The ampoule will fill, leaving a bubble for mixing. Take care to avoid the broken glass in the sample cup or at the tip of the ampoule.
Step 3: To mix the ampoule, invert it several times, allowing the bubble to travel from end to end.
Step 4: Dry the ampoule. Wait two minutes.
Step 5: Obtain a test result by placing the ampoule between the color standards until the best color match is found. If your sample lies in between two measurements on the scale, record the average of the two. Record in mg/L.
Step 6: Pour the water in the sample cup into your liquid disposal bottle. Place the used ampoule into a waste bag. Fill the sample cup with tap water from the tap water bottle, then pour it into the liquid disposal bottle. Do this twice. Note that the broken ampoule tip often gets stuck in the bottom of the sample cup – you may need to remove this once you are out of the field.

Nitrate

Nitrate is a form of nitrogen that is easily transported by runoff and commonly found in streams. Nitrate can come from soil organic matter, animal waste, plant decomposition, sewage, and fertilizer associated with runoff. Nitrate is the form of nitrogen that we measure in water.

Materials: LaMotte Nitrate Nitrogen Tablet Kit #3354-01

Step 1: Insert Nitrate-Nitrogen Octa-Slide 2 Bar into slide viewer.
Step 2: Fill a test tube to the 5 mL line with sample water. Add one **Nitrate #1** tablet. *There are two types of tablets in your kit – be sure you pay attention to which are #1 and which are #2 before proceeding!* Cap and mix until tablet disintegrates.
Step 3: Add one **Nitrate #2** CTA Tablet. Immediately slide the test tube into the protective sleeve. Cap and mix for two minutes to disintegrate the tablet.
Step 4: Wait 5 minutes. Then remove the tube from the protective sleeve and insert into the slide viewer.
Step 5: Match sample color to a color standard. If your sample lies between two measurements on the scale, note the average of the two.
Step 6: Multiply your result by 4.4 and record as mg/L.
Step 7: Pour the sample water into the liquid disposal bottle. Fill the test tube with tap water from the tap water bottle, then pour it into the liquid disposal bottle. Do this twice.



pH

pH is a measure of how acidic or basic a substance is. It is measured in pH units on a scale of 0 to 14. A pH of 7 is neutral (distilled water), while a pH greater than 7 is basic/alkaline and a pH less than 7 is acidic. The pH scale is logarithmic, meaning each unit change on the scale is actually a ten-fold difference in pH.

The pH of stream water is influenced by the concentration of acids in rain and the types of soils and bedrock in the watershed. The typical rainfall in the US is slightly acidic, with a pH ranging from 5.0 to 5.6. As rainwater falls, carbon dioxide from the atmosphere dissolves into it, forming a weak carbonic acid and lowering the pH of the precipitation.

Low pH levels (acidic water) can have harmful impacts on the health of aquatic communities. Heavy metals tend to be more toxic at lower pH levels due to increased solubility and bioavailability. Most aquatic organisms require habitats with a pH of 6.5 to 9.0.

Materials: LaMotte Precision pH Test Kit #5858-01

Step 1: Insert Wide Range pH Octa-Slide 2 Bar into the Slide Viewer.
Step 2: Fill a test tube to the 10 mL line with sample water.
Step 3: Add 10 drops of Wide Range pH indicator. Cap and mix.
Step 4: Insert test tube into slide viewer and match sample color to a color standard. If your sample lies between two measurements on the scale, record the average of the two.
Step 5: Pour the sample water into your liquid disposal bottle. Fill the sample bottle with tap water from the tap water bottle and then pour it into the liquid disposal bottle. Do this twice.

Sampling: Tier III Data

Tier III data collection involves biological monitoring. Tier III Data should be collected twice a year (spring and fall).

Macroinvertebrate Identification

Aquatic macroinvertebrates can be very useful indicators of a stream's quality. An aquatic macroinvertebrate is a large macroinvertebrate that spends part or all of its life in water. Examples of aquatic macroinvertebrates include odonates like dragonfly and damselfly larvae, annelids like aquatic worms and leeches, and bivalves like clams and mussels.

The numbers and kinds of aquatic macroinvertebrates that you find in a stream are good indicators of the stream's health. High abundance and high biodiversity of these organisms in a stream is important.

Aquatic macroinvertebrates range in their ability to withstand substandard stream conditions. Some of these organisms are pollution tolerant, meaning they can handle high pollution loads, high sediment loads, and warm waters. Other organisms are pollution intolerant, meaning they require clean, cool, and/or clear waters. Remember that finding a pollution tolerant species does not necessarily mean the stream is polluted! Pollution tolerant organisms can live anywhere, meaning they are found in clean streams as well as polluted. If you find only pollution tolerant organisms, though, then maybe that is an indication the water is polluted.

Sampling for these organisms can also be helpful in identifying populations of invasive macroinvertebrates. Invasive macroinvertebrates can out-compete native species, upsetting the balance in the stream and threatening our insect populations. You've probably heard of the zebra mussel and the quagga mussel. While these species have not been found in Washington yet, they are found just a few states away. These species spread very easily and very rapidly, and they can smother native clams and mussels and eat much of the food available in an ecosystem. They have also been known to clog up infrastructure like pipes, causing damage costing millions of dollars. Please be sure you are familiar with these species. Should you find these organisms while sampling, make sure to report it immediately.

To sample for aquatic macroinvertebrates, you want to collect as many of these organisms as possible from your stream reach. They will be under rocks, hanging on grasses, floating on the surface, on woody debris, in leaf packs, and within gravel, sand, or silt. It is important to try to sample all of the microhabitats that might be within your reach.

You can collect macroinvertebrates by hand or using a net or sieve. Then deposit them into an ice cube tray or basin filled with water. Use the keys provided in your kit to identify and record what you have caught. Then fill out the equation on the Tier III datasheet to find an estimate of water quality.

Presence or identification of fish

Fish can be useful for assessing stream health, though collecting and identifying them can be difficult. Should you wish to record fish populations, simply note if you see any fish. Determine species and size if you are able, and take note of any spawning activity.

Sampling: Tier IV Data

Tier IV data collection involves vegetation monitoring. Tier IV data should be collected each summer. Collect observations within 50 feet of your sampling site (100' length total). When facing downstream, the right bank is located to your right. Note that the right bank will be on your left if you face upstream.

Aquatic Vegetation

Aquatic plants include all those that grow in the water. Aquatic vegetation is important as it provides habitat and stabilizes the stream bed. It also provides oxygen and removes contaminants from the environment. However, aquatic plants can also become overabundant, outcompete other species, and become invasive. Should you find invasive plants while sampling, be sure to make note of their presence and abundance, but be careful not to spread them to other sites!

To measure aquatic vegetation, estimate the percentage of the streambed covered with aquatic plants in increments of 25%. Identify any invasive species present.

Also make note if there is excessive algae growth or an algal bloom. Blooms can lead to anoxic conditions and mass die-offs of aquatic organisms. Some species of algae produce toxins that make the water unsafe for humans and animals to enter or drink.

Remember that if you see blue-green algae, this is actually a type of cyanobacteria. If blue-green algae is present you must not enter the water.

Riparian Vegetation

Riparian vegetation is the vegetation that is found along the riparian area (the area between the part of the land that is usually wet and the part that is usually dry). Riparian vegetation is important because it filters pollutants from runoff before it enters the stream. This vegetation also provides canopy cover, which is necessary to moderate water temperatures. To sample riparian vegetation, estimate the percentage of the streambank/riparian area covered with vegetation in increments of 25%. Be sure to make note if there are any invasive species present, as well as their abundance (some invasive species such as reed canary grass commonly forms monocultures and can quickly become the only species present in an area).

Additional Once-Yearly Assessments:

All volunteers are asked to complete additional once-yearly assessments to collect site information that is valuable in assessing overall site health. These assessments include a habitat assessment (to be conducted mid-summer), and stream flow and nutrient/bacterial tests (to be conducted each fall). The fall tests require additional materials that can be checked out by any monitors in good standing. As we have limited fall assessment kits available, we ask that you conduct your testing and return the kit in a timely manner so that others may also use the materials to conduct their testing.

Mid-summer Habitat Assessment: This assessment must be carried out in July or August. This is a visual assessment that aims to quantify the quality of the habitat for fish, macroinvertebrates, and other organisms. Simply follow along on the habitat assessment form, then record your calculated score.

Stream Flow: This should be done in September or October, once fall precipitation events start to occur and streams are carrying more water. Stream flow is the amount of water per unit of time flowing past a given point. You will calculate the water flow based on the area of your stream and the speed of a float as it travels along a stream segment. Please be sure to conduct the stream flow assessment *at the same time* as you conduct all your normal monitoring activities.

Step 1: Identify a relatively straight stretch of your stream that is at least 20 feet in length. Measure 20 feet with the measuring tape and mark the upper (Transect 1) and lower (Transect 2) stretch of your segment. (*Note: If your stream does not allow for 20 straight feet,* *you may use a shorter stretch. Be sure to make note of the length of your stretch in this case.*)

Step 2: To find the area of your stream, first measure the width of the stream at Transect 1 and record this. Then use the depth stick to record stream depth at regular intervals along the transect (aim for 7 depth measurements unless the stream is 4' or fewer in width). The first depth measurement starts at the water's edge and is recorded as 0. Once you have completed all depth measurements at Transect 1, calculate the average depth and record it on your data sheet. Then multiply the average depth by the width of Transect 1 and record this as the Cross-sectional Area for Transect 1.

Step 3: Repeat the process described in Step 2 for Transect 2. First measure the width of the transect. Then take regular depth measurements and calculate the average depth. Multiply the average depth by the width of Transect 2 to find the Cross-sectional Area for Transect 2.

Step 4: Use the cross-sectional areas for Transect 1 and 2 to find the Average Cross-sectional Area.

Step 5: To find the speed of the water, position one volunteer slightly upstream of Transect 1 and one volunteer slightly past Transect 2. The first volunteer will drop the ball into the swiftest part of the current, slightly upstream of Transect 1. Once the ball reaches Transect 1, the first volunteer will begin the timer on the stopwatch. Timing stops as soon as the ball floats past Transect 2. The second volunteer will catch the ball. Repeat this process three times and find the average time in seconds that the ball took to travel from Transect 1 to Transect 2. (*Note: If you are sampling alone, you may use an orange peel in place of the rubber ball, as this does not need to be retrieved.)*

Step 6: Assign a correction factor based on the type of stream bottom: 0.8 for rocky bottoms; 0.9 for muddy bottoms.

Step 7: To calculate flow, multiply the average cross-sectional area (ft^2) by the stream reach length (ft) and the correction factor, then divide by the average float time (sec) to get flow (ft^3/sec). Record this number.

If conditions make it unsafe to enter the water, please follow this alternative method for estimating stream flow from the bank (note that this process requires checking out a stadia rod from PCD):

Step 1: Identify a relatively straight stretch of your stream that is at least 20 feet in length. Measure 20 feet with the measuring tape and mark the upper (Transect 1) and lower (Transect 2) stretch of your segment. (*Note: If your stream does not allow for 20 straight feet, you may use a shorter stretch. Be sure to make note of the length of your stretch in this case.*)

Step 2: If you are unable to access the stream from both sides, find the width of your stream by using a stadia rod to measure to the mid-point of the stream and multiply by two. Note this width at both Transect 1 and 2. If you are able to access the stream from both banks and the channel is narrow enough, have another person on the opposite bank and extend the stadia rod to them. Mark where the water's edge is on both sides. Subtract the higher value from the lower one to get the width. Record the width in feet for both Transect 1 and 2.

Step 3: If you can only access the stream from one side, measure the depth of the stream by placing the stadia rod in the water. Record the depth in the center of the stream at Transect 1 and 2. If you can access both sides of the stream, record the depth of the stream in three sections – left bank, right bank, and center. Add these measurements up and divide by three to get average depth. Record this for both Transect 1 and 2.

Step 4: To find area of the stream, multiply the width recorded in Step 2 by the average depth recorded in Step 3. Take the areas calculated at both Transects and find the Average Cross-sectional Area of Stream Reach.

Step 5: To find the speed of the water, position one volunteer 20 feet upstream at Transect 1 (*or at whatever length is determined in Step 1*) and the other volunteer downstream at Transect 2. The volunteer upstream will drop a tennis ball (or orange peel) into the swiftest part of the current. The volunteer will start the stopwatch once the object crosses Transect 1. Timing stops as soon as the object reaches the Transect 2. (*If possible, catch the tennis ball with a net. If the flows are too high and it is unreasonable to catch the ball from the bank with a net, use orange peels instead. If you are alone, use orange peels*). Repeat this process three times and find the average time in seconds it takes the object to travel down the stretch of stream.

Step 6: Assign a correction factor based on the type of stream bottom: 0.8 for rocky bottoms; 0.9 for muddy bottoms.

Step 7: To calculate flow, multiply the area calculated in Step 4 (ft^2) by the stream reach length (ft) and the correction factor, then divide by the average float time (sec) to get flow (ft^3/sec). Record this number.

Nutrient and Bacteria Testing:

The fall kit that you check out will contain additional sampling bottles. Each bottle will have a label tag on it with blank spots for you to fill out the date and time the sample was collected.

At the stream, you will collect water in two 1 L bottles provided. Rinse each bottle three times with the water from the stream, then fill both bottles full of water from the stream.

One of the 1 L bottles will be used for the SSC (suspended sediment concentration) sample. The other bottle will be used to fill the 125 mL bottles for other nutrient and bacteria tests.

Fill the white bottle with a white sticker (labeled NO2/NO3/NH3), the white bottle with a pink sticker (labeled TP) and another 125 mL bottle provided with your site name printed on the outside (for fecal coliform) with water from the second 1 L bottle.

Reporting Your Results

As you sample, all data should first be recorded on a paper data sheet. Once you have completed sampling and filling out the paper form, then you will upload those results through Survey123. This is a free, user-friendly app. If your sampling location does not have phone service, you will have the option to log the data in the app and then submit the form once you are back within range of service.

Remember that all observations should first be recorded on paper before you report them via Survey123. Even though you are not submitting the paper data forms, please retain the forms for at least one month after monitoring. PCD will be checking data as it is submitted through Survey123. If we see data reported that falls outside of the expected parameters for your site, we may contact you to verify monitoring methods or to double-check what is recorded on your print data sheet.

It is best practice to report your results to Survey123 within 3 days of your sampling session.

Your reported results will auto-populate onto an embedded map on the PCD website that is accessible to anyone at any time. You have the option of making your results private; however, we ask that you only choose this option if you are sampling on private property and you do not wish for the location to be shared.

State Standards Chart

Use this chart to compare your data against the state standards.

Table 1: Applicable state water quality standards for the study area. *These criteria may differ from one site to the next since the Beneficial Uses of each body of water dictates water quality standards.

Parameter	Criteria	Confluence Crew Rule of Thumb
Fecal coliform (criteria expires 12/31/2020)	Fecal coliform organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL.	FC $\leq$ average of 100 CFU/100 mL
Dissolved Oxygen	Dissolved oxygen concentration will not fall below 8.0 mg/L more than once every ten years on average. When a water body's DO is lower than 8.0 mg/L (or within 0.2 mg/L) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L.	DO $\geq$ 8.0 mg/L
pH	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within above range of less than 0.5 units.	6.5 $\leq$ pH $\geq$ 8.5
Temperature (criteria for North Fork Palouse from confluence in Colfax to Idaho border)	Temperature shall not exceed a 1-day maximum temperature (1-DMax) of 20.0°C due to human activities. When natural conditions exceed a 1-DMax of 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C; nor shall such temperature increases, at any time, exceed t = 34/ (T + 9).	1-DMax $\leq$ 20.0°C
Temperature (all other streams in the study)	7-day average of the daily maximum temperature (7-DADMax) will not exceed 17.5°C more than once every ten years on average. When a water body's temperature is warmer than 17.5°C (or within 0.3°C) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.	
Turbidity	5 NTU over background when the background is 50 NTU or less; or A 10 percent increase in turbidity when the background turbidity is more than 50 NTU.	Turbidity < 10% increase of average turbidity

Glossary

Abiotic: The non-living elements in an ecosystem.

Algal bloom: A sudden increase in the abundance of suspended (planktonic) algae, especially at or near the water surface, producing a green appearance in the water. Excess nutrients can cause an algal bloom.

Alkaline: Having a pH greater than 7.

Aquatic Macroinvertebrate: An organism without a backbone that is visible to the naked eye and spends part or all of its life in water.

Biotic: The living elements in an ecosystem.

Discharge: A measure of how much water passes a given point in a given time.

Erosion: The wearing down and removal of soil, rock fragments, and bedrock through the action of running water, wind, moving ice, and gravitational creep.

Eutrophication: A gradual increase in the productivity of a lake ecosystem due to enrichment with plant nutrients, leading to changes in the biological community as well as physical and chemical changes. This is a natural process, but can be greatly accelerated by humans.

Fecal coliform: Fecal coliform bacteria is present in the gut or feces of warm-blooded organisms. The presence of fecal coliform in the water is an indication of pollution and potential human health risks.

Indicator species: Groups or types of organisms used to assess the environmental health of a waterbody.

Invasive species: An organism that causes harm to the environment in which it is found. Invasive species can cause economic harm and out-compete native species.

Load: The amount of a pollutant discharged into a water body during a period of time.

Non-point source pollutant: A pollutant whose source is not readily identifiable as any one particular point. Examples include pollution caused by runoff from streets, agricultural land, construction sites, and parking lots.

pH: A measure of acidity or alkalinity on a scale of 0 to 14. A pH of 7 is neutral, less than 7 is acidic, and greater than 7 is alkaline (basic).

Point source pollutant: A pollutant originating from an identifiable (“point”) source, such as a pipe, vent, or culvert.

Pollutant: A substance that harms the environment.

Runoff: Water from rain, snowmelt, or irrigation that flows over the ground surface and runs into a water body.

Sediment: Eroded soil, sand, and mineral particles transported by water.

Turbidity: The presence of sediment in water, making it unclear, murky, or opaque.

Watershed: A region or area of land that drains into a body of water such as a lake, river, or stream.