Standard Operating Procedures

Field Manual

For

Water Quality Assessment Monitoring

Gallatin Stream Teams
Citizen Monitoring Program
Greater Gallatin Watershed Council
Gallatin Local Water Quality District

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1 Introduction

1.1 Goals and Objectives

The goal of the Gallatin Stream Team Program is to collect data of sufficient quality to be used for long-term trend analysis by local and state agencies. By meeting Montana Department of Environmental Quality (MDEQ) scientific credibility requirements, the data collected could be used by the county (Gallatin Local Water Quality District) and the state to assist in making water quality and land use decisions, as well as help identify specific problems that require further attention or study. GGWC will use the data to educate residents on the connections between land use and water quality.

1.2 The Protocols

The protocols contained in this document utilize the work of MDEQ Water Quality Protection Bureau's "*Water Quality Monitoring Field Procedures Manual*" (WQPBWQM-020 Version 3, 2012). Some of the protocols have been modified to fit the needs of trend monitoring for this program. The protocols used for macroinvertebrate (aquatic insect) and chlorophyll-*a* sampling are based on the U.S. EPA's "*Environmental Monitoring and Assessment Protocol*" (EMAP). MDEQ has incorporated these protocol methods into their standard operating procedures (WQPBWQM-009 for macroinvertebrates and WQPBWQM-011 for chlorophyll-*a*).

1.3 Field Crew and Time Estimates

The methods in the following protocols are designed to be completed by a four person field team. A very experienced field team can expect to complete the full suite of physical measurements and sampling protocols (including macroinvertebrate or chlorophyll-*a* collection) in approximately 3 hours for one site. Less experienced crews will probably take closer to 4 hours per site to complete the work depending on the complexity of the sampling reach. Note that estimates only include time spent at the site, not travel time or preparation time.

1.4 Quality Assurance & Quality Control Procedures

The guidelines and requirements for quality assurance and quality control for the GGWC Gallatin Stream Team Program monitoring procedures are outlined in the program's Quality Assurance Project Plan (QAPP). These include guidance covering: field team training requirements and qualifications, training and field audit procedures, procedures for chain of custody documentation, and requirements for measuring precision.

Meter calibration procedures are contained in Appendix A.

Stream Team members are strongly encouraged to contact one of the program's technical advisors anytime questions regarding field sampling and monitoring procedures are in question. Technical advisors are listed in Appendix B.

Field data forms are located in Appendix C.

1.5 Summary of Water Assessment Monitoring Event

Following is a summary of the sequence of monitoring activities to be conducted at each monitoring station.

- ☐ Identify stream reach(es) for monitoring. **NOTE**: This may have been pre-determined by GLWQD technical staff.
- ☐ Determine representative sampling site(s) within each reach. **NOTE**: This may have been pre-determined by GLWQD technical staff.
- ☐ Select and record initial EMAP "F" site. **NOTE:** This may have been pre-determined by GLWQD technical staff.
- ☐ Make sure proper landowner permission has been obtained to access site (This may have been completed by GGWC watershed coordinator in advance.) and a copy of the Landowner Property Access Permission Card is in your Stream Team binder.
- ☐ Sample monitoring stations from the upstream site to the downstream site (to avoid contaminating samples).
- ☐ Begin filling out all required field forms for each sampling event.

Sampling Sequence to be conducted at each monitoring station:

- ☐ **Set-up and Collect Water Chemistry Sampling (at the "F" Site)**
  - Record in-stream water chemistry parameters using YSI 556 meter.
  - Record information on all sample container labels using waterproof marker.
  - Collect grab samples for water chemistry (to be sent to Energy Labs for analysis).
  - Complete any required field preservation and/or filtration of samples and place in a Ziploc freezer bag, on ice, in the cooler.
- ☐ **Layout EMAP Transects**
  - Calculate mean wetted width
  - Calculate sampling reach length (40 x mean wetted width)
  - Calculate distance between transects (sample reach length/10)
  - Flag 11 transects (A-K), from downstream to upstream, with "F" site in center.
  - Set-up and collect biological samples (macroinvertebrates or chlorophyll *a* or both)
- ☐ **Macroinvertebrate Sampling**
  - Fill out the sample tags for both inside and outside the sample container(s).
  - Collect sample in the stream reach using the EMAP method.
  - Fill out EMAP Sample Collection Form.
  - Perform macroinvertebrate habitat assessment and complete the form.
  - Record biological samples on the Site Visit Form.
- ☐ **Chlorophyll *a* Sampling**
  - Determine relevant collection procedure(s) (hoop, core, template) and collect sample(s) according to EMAP protocol.
  - Fill out sample label(s).
  - Fill out Aquatic Tracking Form and Aquatic Visual Assessment Form.

- Record samples on the Site Visit Form.

☐ **Physical/Habitat Measurements**

- Conduct a site map drawing for the stream reach.
- Collect fine sediments for metals analysis.
- Conduct Wolman Pebble Count; complete the Substrate Composition Data Form.
- Measure channel cross-section and stream flow using velocity float method. Record data on the Cross Section and Stream Flow Form.
- Document site with digital photographs. Record photo descriptions on the Photo Survey Data Form.
- Identify sampling site with GPS, record latitude/longitude (NAD83) on Site Visit Form.

WRAP-UP

☐ Verify that all pertinent field forms are completed ***before leaving the site***.
☐ Make sure to leave the site "as you find it" (no trash, etc.)
☐ Record water chemistry samples collected on the chain-of-custody (COC) and site visit form ***before leaving the site***.
☐ Confirm sample bottles are tight closed, and Ziploc bags sealed including bags with ice.
☐ Keep chlorophyll *a* samples on ice, wrapped in foil, in the dark.
☐ Place macroinvertebrate samples in a cooler or other storage container **without** ice.
☐ Ship water and chlorophyll *a* samples with completed COC to Energy Laboratories via Fed Ex or UPS (except on Thursday, Friday, Saturday or Sunday). Samples must be kept cool until shipment (keep in cooler with Ziploc bags of fresh ice).
☐ Turn completed field data sheets and copy of COC form in to the Quality Assurance Officer (Tammy Crone, Water Quality Specialist, Gallatin Local Water Quality District, 215 W. Mendenhall, Suite 300, Bozeman, MT 59715 tammy.crone@gallatin.mt.gov Phone: 582-3145).
☐ Deliver macroinvertebrate samples (if collected) to Tammy Crone, Gallatin Local Water Quality District, 215 W. Mendenhall, Suite 300, Bozeman, for later shipment.
☐ Conduct post-sampling readings with YSI meter using the calibration standards and record in the meter calibration/maintenance log book.
☐ Put away all equipment, clean, into the GGWC equipment and supplies storage tub.
☐ Report any equipment breakage/failure and shortage of sampling supplies right away to the GGWC watershed coordinator.

1.6 Field Supply List

General	☐ GGWC Volunteer Monitoring Program QAPP and SOP Manual ☐ Field forms (photocopied on "Rite-in-the-Rain" paper) ☐ Clipboards (2), pens, pencils and waterproof markers ☐ Cell phone and phone numbers (for emergencies) ☐ Calculator ☐ First aid kit ☐ Sunscreen, insect repellent ☐ Hip boots/waders, rain gear ☐ Kim-wipes, paper towels, trash bags ☐ Ziploc freezer bags (gallon-size) for ice and sample bottles ☐ Nitrile, powderless (latex-free) gloves
Physical Attributes (cross section, stream discharge, pebble count, site photos)	☐ Cross Section and Stream Flow Data Form ☐ Photo Survey Data Form ☐ GPS unit ☐ Digital camera (with additional memory card and battery) ☐ YSI 556 meter o pH 7.00, pH 10.00, 447 µS calibration solutions & waste container o calibration log & instruction manual o extra batteries and Phillips screwdriver o tap water for probe storage ☐ 1 – small squirt bottle of deionized (DI) water to clean YSI meter probes ☐ 1 – gravelometer (for Wolman Pebble Count) ☐ 2 – tape measures (100 ft ea) for establishing bug reach, cross-sections & velocity float trials ☐ 4 – metal tent stakes and 1 hammer ☐ 6 – 2"x4" piece of wood cut to 6" in length for conducting velocity float trials ☐ 1 – roll of twine (plus pocket knife or scissors to cut twine) ☐ 1 – line level ☐ 1 – stopwatch **or** wristwatch w/ a second hand ☐ 1 –4 ft long, ½ in diameter PVC pipe labeled in 1/10 ft with a thick waterproof black marker
Water and Sediment Samples	☐ Site Visit Form ☐ 1 – Buchner funnel ☐ 2 – 12" x 12" squares of 63 micron nylon mesh ☐ 1 large plastic spoon ☐ Squeeze bottle with 5% nitric acid wash ☐ Deionized water (for field blank samples) ☐ Cooler containing: o plastic sample bottles & preservatives & ice (cubed and placed in Ziploc bags) o chain-of-custody form & pre-paid mailing label (Energy Labs)
Aquatic Insects (macroinverte-brates)	☐ Macroinvertebrate Habitat Assessment Form ☐ EMAP Sample Collection Form ☐ Pre-made macroinvertebrate sample labels (on "Rite-in-the-Rain" paper) ☐ 3 – 1000 ml (1 liter) wide-mouth plastic jar ☐ 1 – D-frame, conical-shaped kick net, 1.2 mm mesh ☐ 1 – sieve (#35 US Standard, 500 µm) ☐ 1 – 5-gallon bucket ☐ 95% ethanol (for preserving insects) ☐ 1 – spray bottle containing 95% ethanol

	☐ Tweezers & turkey baster ☐ Clear packing tape (for covering macroinvertebrate jar labels) ☐ Parafilm (to wrap around lid and container seal) ☐ Cooler with suitable absorbent material for transporting ethanol and samples
Chlorophyll *a*	☐ 1 – hoop: copper wire secured in circular hoop (internal surface area 710 cm^2) ☐ 1 – core: 60 cc syringe with tapered end cut off (internal surface area 5.6 cm^2) ☐ 1 – template: approximately ¾ inch long portion of PVC pipe (internal surface area 12.5 cm^2) ☐ Pall glass fiber filters (GF/F) (0.70 µm) ☐ 1 – Filtration unit (filter flask & funnel, o-rings) ☐ 1 – vacuum hand pump ☐ Large Ziploc bags – 1 gallon size ☐ Small Ziploc bags – sandwich size ☐ 50 ml centrifuge tubes ☐ 1 – roll aluminum foil ☐ ParaFilm wax ☐ 1 – pair of scissors ☐ 1 – toothbrush ☐ 1 – turkey baster ☐ 1 – centrifuge tube brush ☐ 1 – small plastic tray ☐ 1- pair metal forceps ☐ 1 – folding pocket knife

2 PROTOCOL: Laying Out Stream Reaches for Wadeable Streams

2.1 Concept

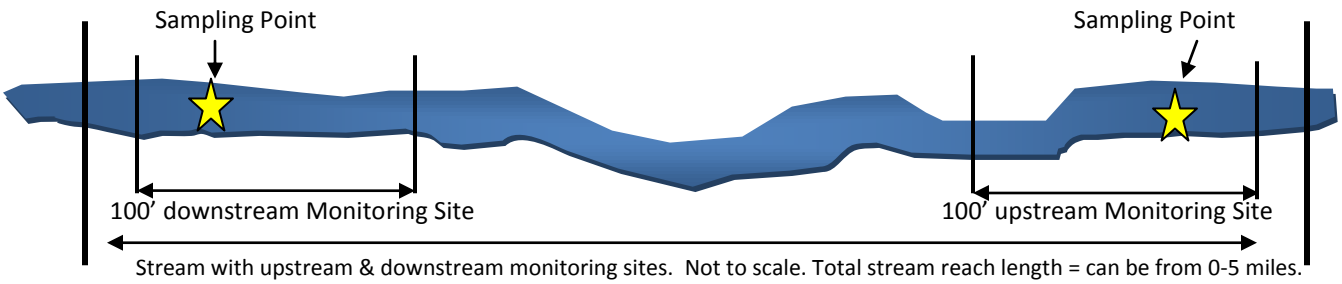
The concept of long-term trend analysis sampling is that randomly selected reaches located on a stream can be used to measure changes in the status and trends of habitat, water quality, and aquatic life (biota) over time if taken in a scientifically rigorous manner per specific protocols. We are applying the MDEQ and MT Watercourse Volunteer Monitoring sampling protocols for this volunteer monitoring program. Instead of randomly selected stream reaches, stream reaches where MDEQ or GLWQD have previously sampled will be monitored.

MDEQ uses a spatial hierarchy of "segment"," reach" and "monitoring site" to describe streams at incrementally smaller scales. GGWC VMP will focus on the reach and monitoring site scale.

- **Segment** is the stream as defined in the MDEQ assessment database. This is the smallest unit for which an impairment determination by MDEQ is made.
- **Reach** represents a homogeneous portion of the stream based on land use or physical land/habitat features (geomorphology). Reach scale measurements are used to document long-term ecological conditions for a reach. The stream reach should have the following characteristics:
  - 0-5 miles in length.
  - Relatively free from evident impacts/obstructions (roads, bridges, cattle, etc.)
  - Water depth greater than 6 inches.
  - Permission to access if located on private property.

  Reach breaks should be confirmed by visual observation of the changes in the stream through landforms, land uses, and the influence of major tributary streams, if any.

- **Monitoring Site** is a *100-foot straight section* located within the stream reach. Ideally, a stream reach will have two (2) monitoring sites, located at the *upstream* and *downstream* ends of the reach. <u>If this is not possible, the monitoring site will be located at the downstream end of the reach</u>.
  - The **sampling point** in the monitoring site should be representative of the stream reach. For example, if the reach is mostly "high gradient" (riffles), then a riffle should (generally) be selected as the representative sampling point.



Stream with upstream & downstream monitoring sites. Not to scale. Total stream reach length = can be from 0-5 miles.

2.2 Equipment and Supplies

- Handheld GPS Unit
- Site Visit Form

2.3 Procedure – Recording Site Location

1. Begin filling out the **Site Visit Form** (date, volunteers, Site ID, Location, etc.)
2. Use a handheld GPS unit to obtain the latitude and longitude reading.
    - Set the map datum to NAD83
    - Set the coordinate system to decimal degrees.
3. Record the lat/long on the Site Visit Form and note which GPS datum was used to take the reading (NAD83).

Note: If the GPS unit does not display decimal degrees (only degrees, minutes and seconds), then write down the reading and then use the computer online conversion program for latitude and longitude at:
http://www.geology.enr.state.nc.us/gis/latlon.html or
http://www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html

3 PROTOCOL: Field Instrument Calibration and Measurements

3.1 Concept

Field instrument measurements include water temperature, pH, specific conductivity (SC), dissolved oxygen (DO) in milligrams per liter (mg/L) and percent saturation (% sat), and total dissolved solids (TDS). These parameters are "single point in time" measurements and only relate to the sampling point (water column) at the instant the reading is taken. The Gallatin Stream Team uses the YSI 556 multiprobe meter with internal barometer to obtain these measurements.

3.2 Equipment and Supplies

- YSI 556 meter
- Callibration standards (pH 7.00, pH 10.00, Conductivity 447 µS)
- Calibration log
- DI water
- Tap water (for sensor probe storage)
- Kim-wipes
- Waste container (cup, etc.)
- Site Visit Form

3.3 YSI 556 Meter Calibration & Maintenance

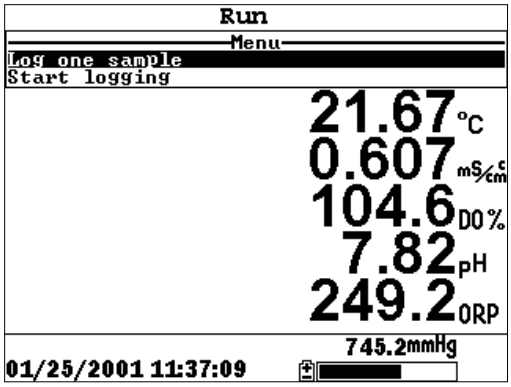
The YSI 556 meter must undergo annual inspection and maintenance prior to the monitoring field season according to the manufacturer's specifications. This must occur within a time-frame that allows for any needed parts to be ordered and installed prior to use, so plan ahead.

NOTE: Step-by-step calibration procedures are located in the back of this SOP in Appendix A. Calibration must be performed prior to taking measurements at sampling sites.

For a detailed review of calibration and maintenance procedures, go to the YSI 556 meter instruction manual. The instruction manual must remain with the meter at all times for quick reference. Calibration logs for recording calibration activities must remain with the meter. Training for use of the meter will be given at the annual volunteer monitoring training/refresher workshop.

3.4 YSI 556 Meter Field Measurements Procedure

1. Do not proceed with this step until you have performed calibration for all parameters.
2. Keep probe attached to the meter after calibrating.
3. Install probe sensor guard in place of the calibration/transport cup.
4. Press the **On/Off** key and select **Run** from the Main Menu to display the run screen.



Example of what the display looks like on the YSI meter.

5. Carefully enter the stream moving out as close to the center of the stream as is safely possible.
6. While facing upstream, place probe in the water. Completely immerse all the sensors.
7. Standing in place, gently yet rapidly move probe through the stream (provides fresh sample to DO sensor).
8. When the readings on the display stabilize, record them on the Site Visit Form.
9. Turn off meter, rinse probe with DI water and dry. Place tap water (**do not use DI water)** in the calibration/transport cup. Replace sensor guard with the calibration/transport cup containing 1/8 inch of **tap water**. **(Do not store the probe sensors in DI water!)**. Remove probe cord from meter and place both into carrying case.

4 PROTOCOL: Grab Sampling for Water Chemistry

4.1 Concept

Water grab samples are "single point in time" measurements. They only relate to the sampling point (water column) at the instant the sample is taken. Water samples have the shortest temporal (time) and spatial (area/location) coverage of all measurements taken by GGWC VMP.

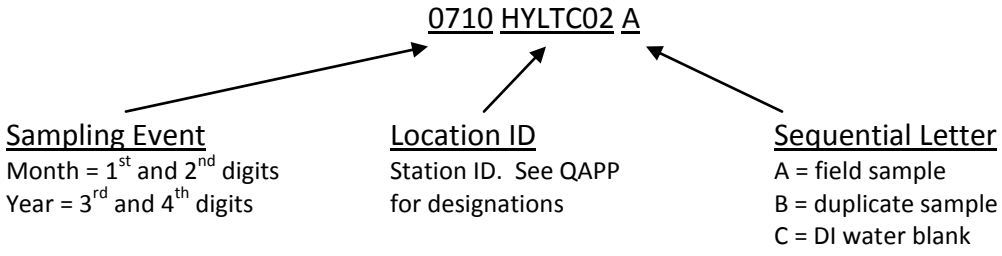
Water samples are collected for total suspended solids (TSS), nutrients (total persulfate nitrogen, nitrate-nitrite as nitrogen, total ammonia as nitrogen, total phosphorus), total recoverable metals (copper, iron, lead, mercury, zinc), and hardness as calcium carbonate. All sample bottles and preservatives are provided by Energy Laboratories in Billings which provides analytical services.

4.2 Equipment and Supplies

- ☐ Cooler, bottles, preservatives, chain-of-custody form, prepaid shipping label from Energy Labs
- ☐ Ziploc freezer bags
- ☐ Ice
- ☐ Site Visit Form, pen, waterproof marker

4.3 Sample Identification

1. Each sample must have a unique identifier. An example of a sample ID is as follows:



4.4 Sampling Procedure

1. Fill out the sample bottle labels using a waterproof marker (Client, Project, Sample ID, Collection Date & Time and check box for filtered or non-filtered sample).

A completed bottle label for the downstream monitoring station on Bozeman Creek for a field sample collected in August 2011. Note the Sample ID corresponds to the nomenclature referenced in Section 4.3 above.

2. Stand facing upstream in the center of the stream (or as close as safely possible).
3. Rinse sample bottles 3 times with the stream water: partially fill the bottle, placing the lid over the bottle, shake several times, then pour out the water downstream.
4. After the triple rinse, fill the bottles with stream water (collected upstream from *any previous disturbances* to avoid contaminating the sample) by completely submerging the sample bottle into the water. Recap the bottle while it is still underwater.

Collecting a water grab sample.

5. Add the appropriate preservative to each sample type (color-coded lids and preservatives), affix lid securely and mix the sample well by gently inverting 3-5 times.
    - Nitric Acid (HNO_3) for metals = RED cap
    - Sulfuric acid (H_2SO_4) for nutrients = YELLOW cap
    - **NO** preservative for total suspended solids (TSS) = WHITE cap

Labeled sample bottles for collecting grab water samples at one sampling station. The color-coded caps correspond to the appropriate preservative. Only samples collected on Bozeman Creek and Mandeville Creek utilize all three bottles. Bridger Creek and Hyalite Creek use the yellow-cap and white-cap bottles.

6. Be sure lids are tight and that no leaking will occur.
7. Place sample bottles in a 1-gallon Ziploc freezer bag and keep samples in a cooler on ice. The ice should also be stored in 1-gallon Ziploc freezer bags.
8. Record the water chemistry sampling event on the Site Visit Form.
9. Complete the Energy Labs chain-of-custody form.

4.5 Field Replicate Samples for Quality Control

To assess precision and representativeness of the sampling technique, volunteers will collect replicate grab samples for all chemical measurements during July and September sampling events. July replicate stream sample will be collected at the **upstream** sampling station. In September, the replicate stream sample will be collected at the **downstream** sampling station. Results of replicate samples will verify that volunteers are collecting samples consistently.

4.5.1 Sample Collection Procedure

1. Collect replicate samples (sets) following EXACTLY Steps 1-9 in Section 4.4 beginning on page 13. This will result in two sets of stream samples being collected at one site.
2. Replicate samples should be labeled using the following: "MMYYSampleID-A and MMYYSampleID-B" An example would be: 0711BOZMC01-A and 0711BOZMC01-B
3. Note: Replicates must be handled identically (temperature, preservation, etc.).
4. Include a remark in the comment section of the Site Visit Form that a replicate was collected at this site and include the Sample ID for the replicate as a reference (i.e., 0711BOZMC01-B = duplicate/replicate stream sample).
5. Include field replicates on chain-of-custody form; ship with samples to the laboratory.

4.6 Field Blank Samples for Quality Control

To assess the potential for false positive results due to site contamination, volunteer s will collect field blanks during each sampling event in July and September. In July, the field blank sample will be collected at the **upstream** sampling station. In September, the field blank sample will be collected at the **downstream** sampling station. The results of the field blanks will verify that false positive results are not obtained either from the site conditions or through cross-contamination during transport.

4.6.1 Sample Collection Procedure

1. Transport DI water to the sampling site and peep in a location where it does not become exposed to excessive dust, mud, or come in contact with other equipment.
2. At the sampling site, fill a set of the same bottles used for the grab samples with the DI water. Preserve them with the appropriate preservative, if needed.
3. Bottles are sealed and labeled exactly the same as the grab samples and replicate samples along with a unique Sample ID (i.e., 0711BOZMC02-C).
4. Record the field blank Sample ID in the comments section of the Site Visit Form (i.e., 0710BOZMC01-C = DI water blank).
5. Include field blanks on chain-of-custody form and ship with samples to the laboratory.

5 PROTOCOL: Sediment Samples for Metals Parameters

5.1 Concept

Sediment samples are collected for total recoverable metals analysis to evaluate the potential for heavy metals to become suspended in the stream during high flows.

5.2 Equipment and Supplies

- 1 Buchner funnel
- 2 – 12" x 12" squares of 63 micron nylon mesh
- 1 – large plastic spoon
- squeeze bottle of dilute 5% nitric acid wash
- Ziploc freezer bags
- Ice
- Site Visit Form, pen, waterproof marker

5.3 Sampling Procedure

1. Identify at least 5 wadeable deposition zones of VERY fine bed sediment that are representative of the stream reach; identify additional zones as necessary.
2. Place the Teflon 60-micron mesh sieve between the two pieces of the Buchner funnel. Place the end of the funnel in the 2 liter sample bottle.
3. Scoop sediment from the streambed with a non-metallic spoon or turkey baster and place it on the sieve in the funnel. Scoop enough sediment so the sieve is completely covered.
4. Use the spoon or turkey baster to add **minimal** amounts of stream water over the sediment in the funnel. Stir the water and sediment in the funnel, being very gentle not to damage the mesh, to create fine sediment slurry. Allow the slurry to filter into the bottle.
5. Once the first zone is completed, pour the excess sediment out of the sieve. Rinse all equipment with ambient stream water between each depositional zone. Move to the next depositional zone and repeat the sample collection steps above. **Use the same sample bottle at each zone to collect a composite sample**.

IMPORTANT: Fill bottle **no more than 1/5 full (or approximately 1 cm deep in a 2 liter wide-mouth sample bottle)**. Be aware while sampling to collect only enough sample volume at each of ≥5 depositional zones without exceeding the maximum composite sample volume. Use a minimal amount of water. Affix to each bottle a label containing the following information and cover it with clear tape:

- Stream name
- Sample ID
- Sample Type *(this would be "sediment")*
- Collection date
- Collector's name

Ensure lids are tight and will not leak. Store samples completely surrounded with ice in a cooler until delivery to the laboratory for analysis. Between sampling sites/events, thoroughly rinse the Buchner funnel, mesh, and spoon and/or turkey baster with dilute nitric acid (5%). Rinse equipment again with distilled water after acid wash is complete.

6 PROTOCOL: Collecting Benthic Chlorophyll *a* Samples in Wadeable Waters Using the EMAP Reach-Wide Method

6.1 Concept

Chlorophyll *a* is measured as a means of estimating algae (periphyton) biomass in a body of water. Heavy growths of algae generally indicate inferior water quality. These sampling methods are designed to produce a quantitative measure of algae growth by relating the total mass of chlorophyll *a* pigment to a known area or volume. Three benthic chlorophyll *a* collection methods are presented below. Dry ice is the preferred cooling medium for chlorophyll *a* samples. However, due to the nature of the volunteer monitoring program and the lack of access to dry ice, regular ice is the acceptable alternative. **It is important that the samples not come into direct contact with the ice water and great care must be taken by double-bagging the ice and the samples.**

IMPORTANT: Since chlorophyll *a* breaks down readily in sunlight, **avoid exposing all chlorophyll *a* samples to direct sunlight at all times!**

6.2 Equipment and Supplies

- ☐ 1 – hoop: copper wire secured in circular hoop (internal surface area 710 cm^2)
- ☐ 1 – core: 60 cc syringe with tapered end cut off (internal surface area 5.6 cm^2)
- ☐ 1 – template: approximately ¾ inch long portion of PVC pipe (internal surface area 12.5 cm^2)
- ☐ Pall glass fiber filters (GF/F) (0.70 µm)
- ☐ 1 – Filtration unit (filter flask & funnel, o-rings)
- ☐ 1 – vacuum hand pump
- ☐ Large Ziploc bags – 1 gallon size
- ☐ Small Ziploc bags – sandwich size
- ☐ 50 ml centrifuge tubes
- ☐ 1 – roll aluminum foil
- ☐ ParaFilm wax
- ☐ 1 – pair of scissors
- ☐ 1 – toothbrush
- ☐ 1 – turkey baster
- ☐ 1 – centrifuge tube brush
- ☐ 1 – small plastic tray
- ☐ pair metal forceps
- ☐ 1 – folding pocket knife

6.3 Sampling Procedure

The environmental monitoring and assessment protocol (EMAP) is a rigorous sampling technique for wadeable streams. It is used to evaluate the biological integrity of a stream for the purpose of detecting stresses on the benthic macroinvertebrate community structure and assessing the relative severity of those stresses. The protocol takes several hours to complete.

6.3.1 Established Sampling Reach

1. See table 5.3.1. If the stream you are monitoring is listed in the table along with the corresponding Station ID that you will be sampling from, then use the established Reach Length and Transect Intervals indicated in the table and **Proceed to Step 3 in Section 6.3.2**. **IF NOT, see Step 2 below:**

Table 6.3.1. Reach Length, Transect Intervals and "F Site" for Established Monitoring Stations

Stream	Station ID *(Description)*	"F Site" GPS location		Reach Length (ft)	Transect Interval (ft)
		Latitude	Longitude		
Bozeman Creek	BOZMC01 *(City Hall)*	45.6810	-111.0324	760	76
	BOZMC02 *(E Lincoln St)*	45.6641	-111.0304	750	75
	BOZMC02a *(Bogert Park)*	45.6747	-111.0330		
	BOZMCO3 *(Goldenstein Ln)*	45.6366	-111.0319		
Bridger Creek	BRIDC01 *(Golf Course)*	45.7087	-111.0235	800	80
	BRIDC02 *(Bridger Canyon)*	45.7486	-110.8916	400	40
Hyalite Creek	HYLTC01 *(Pierce)*	45.7875	-111.1292	820	82
	HYLTC02 *(gage station)*	45.5013	-110.9856	500	50
Mandeville Creek	MANVC01 *(Red Wing Dr)*	45.7111	-111.0562	500	50
	MANVC02 *(College St)*	45.6713	-111.0530	350	35
	MANVC03 (MSU @ 12th Ave)	45.6674	-111.0540		

2. If you are establishing a new monitoring station then proceed to **Section 6.3.2** and follow the steps to determine the sampling reach and sampling points. Once those have been determined, proceed to **Section 6.3.3** to conduct chlorophyll-*a* sample collections.

6.3.2 New Sampling Reach: Determining Sampling Reach and Sampling Points

1. Each sampling location will consists of a reach of a stream. This stream reach must be **40 times** the wetted width of the stream or a minimum of 150 meters (500 feet), whichever is larger.

   Note 1: *If the stream average wetted width is >10 meters (30 feet), then use a reach length of 250 meters (820 feet). Your reach length will then be divided into 11 equally-spaced intervals (82 feet).*
   Note 2: *The reach length can be shorter than 150-meters (~500 ft) if upstream and/or downstream barriers preclude a 150-meter (~500 ft) reach length.*

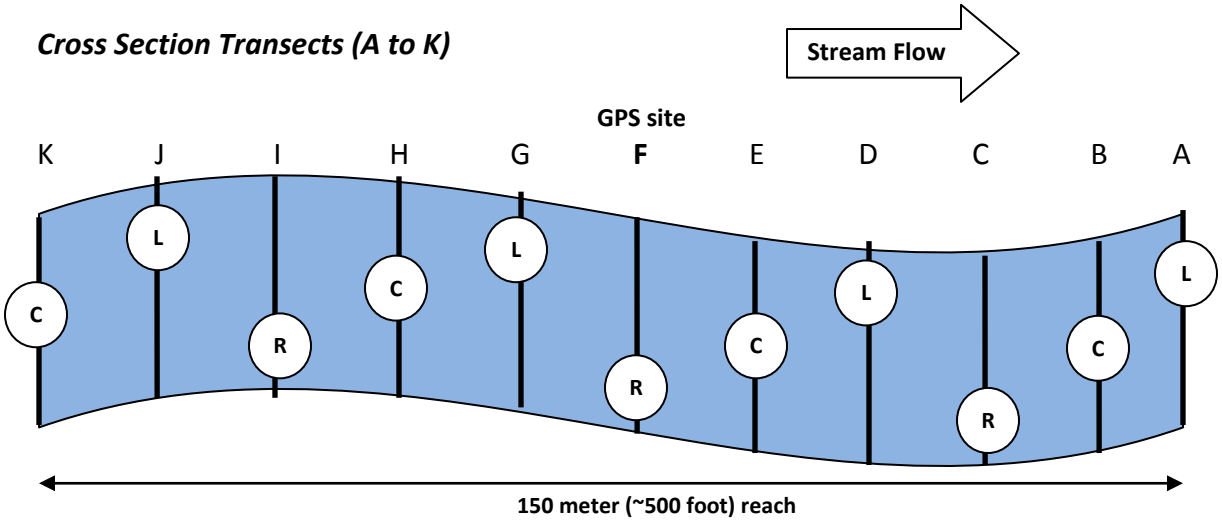
   Note 3: *When the exact reach location is not restricted by the sampling design, attempt to position reaches upstream of bridges and other barriers to avoid this influence.*

2. Measure the wetted width at 5 random places from the "F" site (central GPS located sampling site)…2 upstream, 2 downstream and 1 at the "F" site. Calculate average wetted width and round to the nearest foot (example):
   - 15, 14, 14.8, 15.2, 15 = 74 ÷ 5 = 14.8 feet average wetted width

- Multiply the average wetted width by 40: 15 x 40 = 600 ft sampling reach
- Divide by 10 to determine the width of spacing between sampling transects: 600 ÷ 10 = 60-foot transect intervals

3. Measure out the 11 equally-spaced intervals, equally, up and downstream from the GPS "F-site". These transects are designated "A" through "K". The downstream end of the reach should be flagged as transect "A". Refer to the diagram on page below:

Cross Section Transects (A to K)



4. Proceed upstream from Transect A with the tape measure and flag the position of 10 additional transects (labeled "B" through "K" as you move upstream) at intervals equal to 1/10 of the reach length. **Enter channel <u>only</u> when necessary to avoid disturbing the stream prior to sampling.**

5. At Transect F, determine the geographic coordinates using a hand-held GPS receiver (decimal degrees using NAD83 datum setting). Record this information on data sheet.

6. Each transect (A-K) needs to be sampled at one of three points: Left (L), Center (C), or Right (R). To randomly select the first sampling point, use a digital wristwatch and note the last digit on the watch.

   Digit 1 – 3: Left sampling point
   Digit 4 – 6: Center sampling point
   Digit 7 – 9: Right sampling point

   Subsequent sampling points beginning with Transect B are sampled following the sequence Left, Center, Right, etc. For example, if the sampling point assigned to Transect A was "Center", then Transect B is assigned "Right", Transect C is "Left", Transect D is "Center", etc.

6.3.3 Sample Collection: Reach-wide Method

- Using the 11 transects identified above, a single sample will be collected at each transect and each is considered a single collection (you will have 11 total). The substrate and conditions encountered at each transect locale determine the collection technique to be used: (1)

template method, (2) hoop method, or (3) core method and should represent conditions prevalent in approximately a 1 m^2 area around the transect. For example, if the sample is to be collected from Transect D, Left (see diagram above), the sampler should observe the algae conditions that prevail from the left wetted edge to 1 meter out along and 0.5 meter up and down of the transect line. The sampler then selects the appropriate sampling method and samples the most representative point. For Center samples, observe 0.5 meter on four sides of the channel transect centerpoint (upstream, downstream, right and left) and then sample the most representative point.

- Once collected, place all individual foil-wrapped benthic chlorophyll-*a* samples, one from each of 11 transects, into one (or more as needed) large Ziploc bag for organization an storage in the cooler. Label these Ziploc bag(s) with the Sample ID, Date, Stream Name, and Collector Name.

- Complete the Aquatic Plant Tracking Form ***and*** the Aquatic Plant Visual Assessment Form while collecting the chlorophyll-*a* samples at ***each*** transect A through K.

- Always take at least one digital photograph per transect (A through K) at the channel position (R, L, C) where each sample was collected. These photos should represent a close-up aerial view fo the channel substrate in the representative area that was sampled using either the hoop, core or template method to accompany the Aquatic Plant Visual Assessment Form. Record the photo information and description on the Photo Survey Form.

Template Method – *For sampling transect with substrate dominated by small boulders, cobble, and gravel without heavy filamentous growth. Equipment = cut-off PVC pipe.*

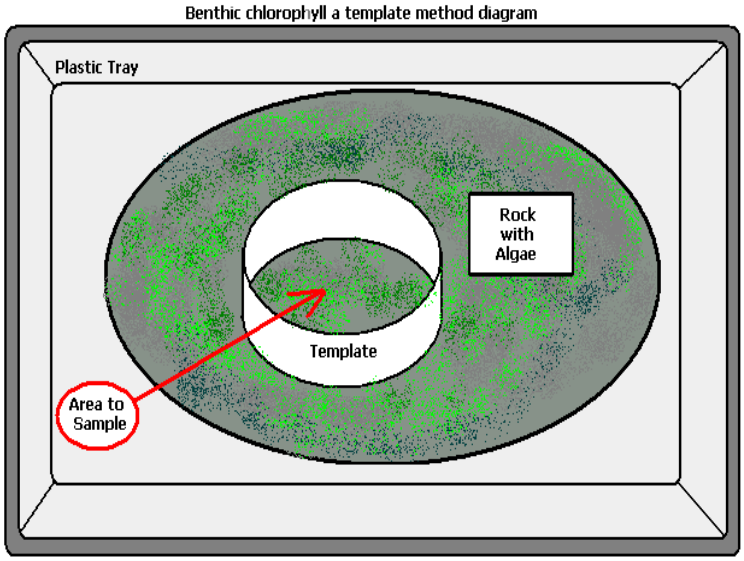
Template Appropriate Conditions

1. Locate a representative point at the sample locale (R, L or C) on the transect line. Observe the algae density in a roughly 1 m^2 area centered on the sampling point and select a representative rock therein.

2. Lift the rock slowly out of the water to minimize disturbance of the algal film and place it in a shallow pan. Place the template over the upper (light-facing) surface of the rock.

3. Use a sharp point (knife) to score the algal film around the inner circumference of the template. Use a pocket knife to scrape all of the growing material within the template into the pan. In certain cases the volume of algal material on the rock surface is small, therefore, it is better to scrub the rock surface with a toothbrush and then rinse the rock surface and toothbrush into the pan with a small volume of **tap water** (DO NOT USE DEIONIZED WATER).

Template method diagram



4. In cases where rocks are smaller than the template diameter but too large for core sampling, place several representative rocks inside the template diameter, and follow the process as described in the paragraphs above, scrubbing the light-facing surfaces.

5. Set-up the filtration unit and use clean forceps to place a glass fiber filter on the filter holder. Use a small amount of tap water from a wash bottle to settle the filter. Rinse the sides of the filter funnel and filter with a small volume of tap water. Attach the filter funnel and connect the plastic tubing and vacuum pump.

IMPORTANT: Filtration **MUST** be performed in the field!!

6. Pour all rinse water/algae material from the pan into the filter unit, rinsing as necessary to capture all material in the funnel. Minimize rinse water use to assure that all water will move through the filter. Draw the sample through the filter using the vacuum hand pump. Note: to avoid rupture of fragile algal cells, **do not exceed 9 inches Hg** on the vacuum gage.

7. After filtration is complete, use clean forceps to remove the filter, fold it in half with the colored side folded in on itself, and place it in a 50 ml centrifuge tube.

8. If algae density from a single template is so high that the filter clogs prior to all water passing through, the remaining algal material/water in the upper half of the Nalgene unit may be returned to the clean pan. Load a second filter on the filter unit, filter the remaining

water/algae material, and place both filters in the centrifuge tube together. Record the number of filters associated with the single template on the Aquatic Plant Tracking Form.

9. If attached algae levels are so low that scrapings from a single template will result in very little material on the filter, little or no color will be observed on the filter after filtration. To better assure thathte sample is sufficient to achieve detectable levels, a maximum of 3 templates from the same rock (or from other representative rocks in the sampling locale) can be collected and all the scraped material is then captured on the same filter. Record the number of templates aggregated on the single filter on the Aquatic Plant Tracking Form.

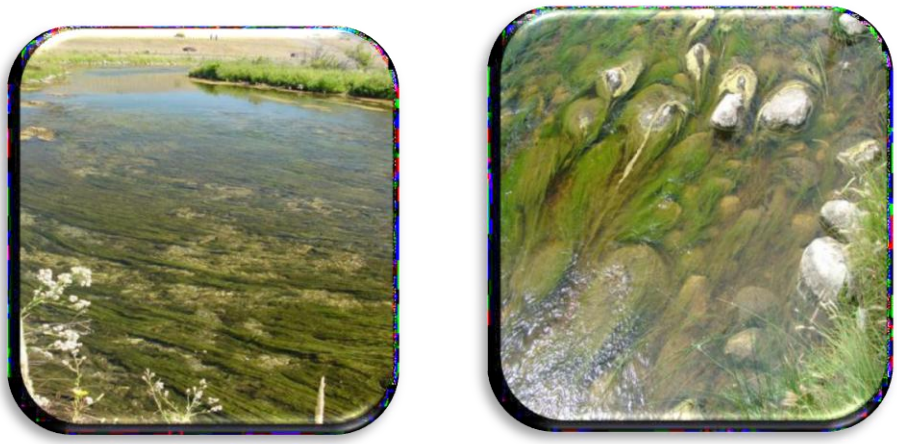
10. Fill out a label with the following information:
    - Sample method ("T" for template)
    - Sample ID with medium code "C"
    - Stream name
    - Transect letter (A-K)
    - Collection Date
    - Collector's Name

11. Affix the label to the centrifuge tube and cover the label with clear tape. Wrap the tube completely with aluminum foil, leaving no space for light to enter. Write the Sample ID on the foil with a black ink Sharpie.

12. Place the foil-wrapped sample into the large Ziplock bag for storage. Immediately store the sample on ice; samples should be frozen upon delivery to the lab. The samples should be sent to the laboratory as soon as possible for analysis.

Hoop Method – *For transects dominated by the presence of filamentous algae, regardless of stream substrate.*

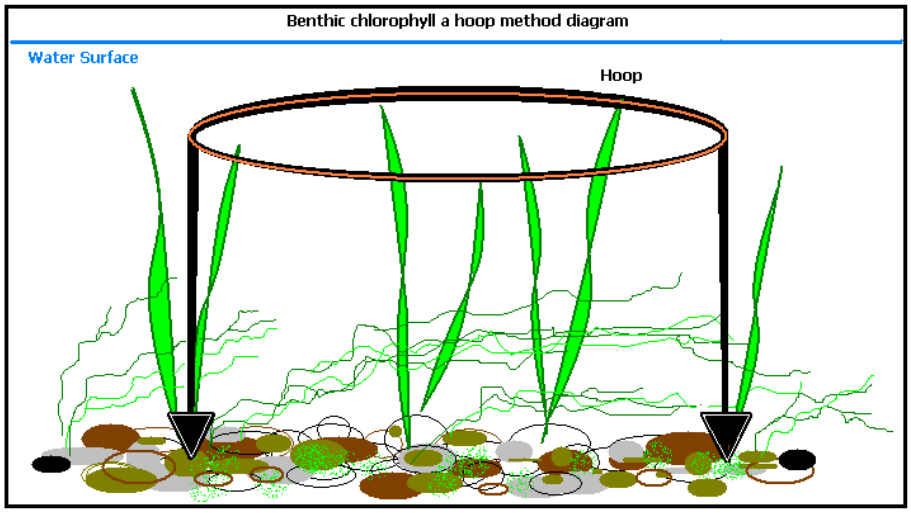
Example of Hoop Appropriate Conditions



1. The hoop can be made by wrapping a stiff wire around the bottom of a 5-gallon bucket. Measure the hoop diameter and calculate the area of a circle (Area = 3.14 x (diameter/2)2) and adjust as necessary to arrive at an area of 710 cm^2. The diameter o the hoop is approximately 30 cm.

2. Locate a representative area within approximately 1 m2 at the sampling locale (R, L or C) on the transect line. Place the metal hoop over the collection site and lower it from the water surface to the substrate, *capturing all algae within the hoop from the water surface to the substrate*.

Hoop method diagram



3. Collect all algal material (i.e. filamentous and non-filamentous) within the hoop, using scissors or a knife to detach the filamentous algae from their substrate, and place it in a shallow pan. **Note:** Filaments originating inside the hoop that are streaming beyond it in the downstream direction, or originating upstream of the hoop which are streaming down into the hoop, are to be cut off along the edge of the hoop and only the parts within the hoop are retained. Scrape algae attached to rocks within the hoop into the Ziploc bag. Minimize the amount of water submitted by decantation (do not decant floating algae); gently squeezing the water out of filaments works well.

4. Manually separate the filamentous algae from macrophytes. Retain both portions only if *both* algae and macrophyte ash free dry weight is being analyzed; *otherwise, retain only the algae portion*. IF ≤5% by area macrophytes are present, separate them from the algae at the time of collection; if >5% macrophytes are present, place the sample into a small plastic pan and separate them from the algae on the bank or other stable surface. Record the relative proportion of algae to macrophytes on the Aquatic Plant Tracking Form. **Note:** If the sample contains 100% macrophytes (no algae), discard all and record "N" for "no sample" on the Site Visit Form and indicate "no sample" and 100% macrophytes on the Aquatic Plant Tracking Form for that transect.

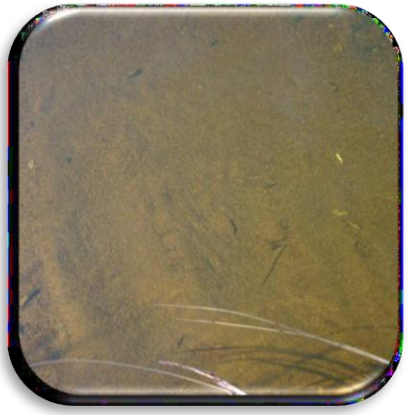
5. Place all algae collected at a site in a single Ziploc bag. Fill out a label with the following information, attach it to the Ziploc bag containing the sample, and cover it with clear tape:
   - Sample method ("H" for hoop)
   - Sample ID w/medium code "C"
   - Stream name
   - Transect letter (A-K)
   - Collection Date
   - Collector's Name

6. Wrap the sample bag completely in aluminum foil, leaving no space for light to enter. Write the Sample ID on the foil with a black in Sharpie.

7. Place the foil-wrapped sample into the large Ziploc bag for storage. Immediately store the sample on ice; samples should be frozen upon delivery to the lab. The samples should be sent to the laboratory as soon as possible for analysis.

Core Method: - *For transects dominated by silt-clay substrate without heavy filamentous algae growth; these substrate types are often dominated by varying thicknesses of microalgae mats.*

Example of Core Appropriate Conditions



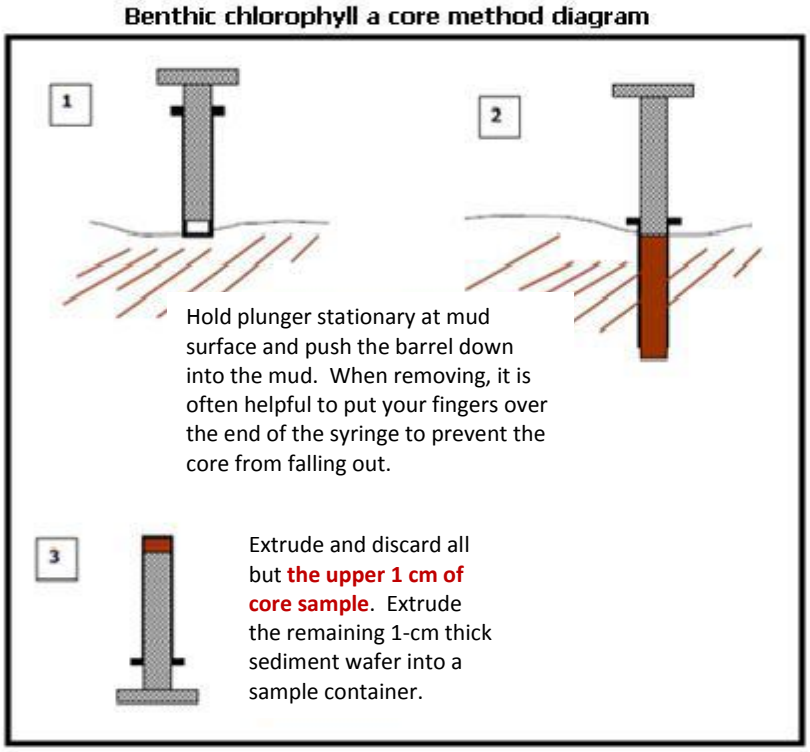
The corer is a 60 cc plastic syringe with the end cut off. To extend your reach in deeper water, a long pole (broom handle) can be duct-taped to the syringe.

1. Locate a representative area within approximately 1 m^2 at the sampling locale (R, L, or C) on the transect line. Drive the 60 cc syringe vertically into the substrate to a depth 5-10 cm. The syringe plunger may have to be drawn up as the body of the syringe sinks into the substrate to accommodate the core sample "plug" (the plunger may have too much friction within the barrel to rise on its own as the body of the syringe is punched into the sediment).

2. The plug may be comprised of loose sediment that will fall out of the syringe as it is lifted out of the substrate water column. To minimize loss, the sampler should place fingers over the end of

the syringe until the core is out of the substrate and water. Immediately invert the syringe to prevent the plug from sliding out of the barrel.

3. Extrude the core so **only the upper 1 cm** of the core remains in the syringe. Slice off and discard the lower portion. Place the upper 1 cm portion in a 60 ml centrifuge tube.



IMPORTANT: Assure that all the material adhering to the rubber surface of the plunger-end is carefully collected, as most of the chlorophyll-*a* is located there.

4. Fill out a label with the following information:
   - Sample method ("C" for core)
   - Sample ID w/medium code "C"
   - Stream name
   - Transect letter (A-K)
   - Collection Date
   - Collector's Name

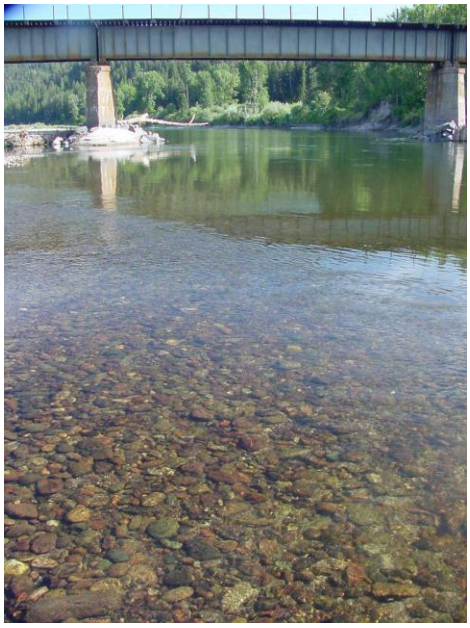
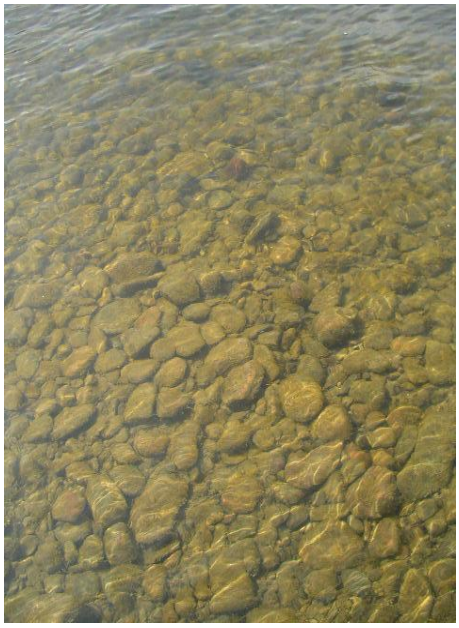
5. Affix the label to the centrifuge tube and cover the label with clear tape. Wrap the centrifuge tube completely in aluminum foil, leaving no space for light to enter. Write the Sample ID on the foil with a black ink Sharpie.

6. Place the foil-wrapped sample into the large Ziploc bag for storage. Immediately store the sample on ice; samples should be frozen upon delivery to the lab. Samples should be sent to the lab as soon as possible for analysis.

Visual Estimation – *For use in place of hoop/core/template sample collection methods when field personnel believe, based on visual estimation, that the entire sampling frame (11 transects) has universally low chlorophyll-a values <50 mg/m^2.*

1. Field personnel may decide that, based on visual assessment, benthic algal chlorophyll-*a* is low (<50 mg/m2) at all transects of a stream site. See photos below for what this level of algal growth looks like. If this is the case, then *only* photos are taken at all 11 transects to document that the chlorophyll-*a* is <50 mg/m2 at all 11 transects. **A mixture of photos (ie., no sample taken) and actual chlorophyll-*a* samples from a site is not permitted. It must be EITHER samples collected using the hoop/core/template method(s) OR photos.** If the sampler is not confident that algae levels at all transects are equal to or lower than what is shown in the example photos below, then proceed with collection of chlorophyll-*a* samples.

Example photos showing benthic algal chlorophyll-*a* at < 50 mg/m^2


2. If all transects appear to be <50 mg/m2, take at least one digital photo per transect (A-K). Each photo should represent a close-up aerial view of the channel substrate at the transect. Record the photo number and brief description on the Photo Survey Form. If conditions do not allow for substrate photos through the water column and the bottom is rocky, some representative rock samples should be taken to the bank and photographed for each transect.

7 PROTOCOL: Collecting Benthic Macroinvertebrates in Wadeable Waters Using the EMAP Reach-Wide Method

7.1 Concept

Macroinvertebrates (aquatic insects) are a direct measure of aquatic life use support and are excellent indicators of instream habitat health and water quality. Also, because many macroinvertebrates have relatively long life cycles of a year or more and are relatively immobile, macroinvertebrate community structure is a function of present or past conditions. By evaluating the diversity and abundance of aquatic insects, we can assess the environmental conditions which are present in the stream over a period of time. Diversity measures are based on the concept that certain high-quality streams support a greater diversity of organisms than poor-quality streams where insects that are sensitive to pollution cannot live. Typically, poor-quality streams will have low species diversity; dominated by organisms that are tolerant of pollution.

7.2 Equipment and Supplies

Kick-net for macroinvertebrate collection.

- Kick-net (1.2 mm mesh “D”-shape net)
- Watch with timer or second hand or a stopwatch
- Sieve (U.S. Standard #35, 500 micron)
- Turkey baster & tweezers
- 100-ft reel-type tape measure
- Flagging for marking off the transect cross-sections (labeled “A” – “K” with a sharpie)
- Plastic 5-gallon bucket
- 3 sample containers, 1-liter (plastic, wide-mouth)
- Spray bottle containing 95% ethanol
- 95% ethanol in a proper container for preserving insect samples
- Cooler (with suitable absorbent material) for transporting ethanol and samples
- Sample labels (2 per sample bottle) printed on Rite-in-the-Rain Paper, pencil
- Site Visit Form and Macroinvertebrate Habitat Assessment Form
- Parafilm and clear packing tape strips

7.3 Sampling Procedure –EMAP Reach-Wide Method

The environmental monitoring and assessment protocol (EMAP) is a rigorous sampling technique for wadeable streams. It is used to evaluate the biological integrity of a stream for the purpose of detecting stresses on the benthic macroinvertebrate community structure and assessing the relative severity of those stresses. The protocol takes several hours to complete.

7.3.1 Established Sampling Reach

1. See **Table 7.3.1**. If the stream you are monitoring is listed in the table along with the corresponding Station ID that you will be sampling from, then use the established Reach Length and Transect Intervals indicated in the table and **proceed to Step 3 in Section 7.3.2**.

Table 7.3.1. Reach Length, Transect Intervals and "F Site" for Established Monitoring Stations

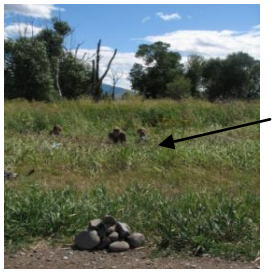
Stream	Station ID *(Description)*	"F Site" GPS location		Reach Length (ft)	Transect Interval (ft)
		Latitude	Longitude		
Bozeman Creek	BOZMC01 *(City Hall)*	45.6810	-111.0324	760	76
	BOZMC02 *(E Lincoln St)*	45.6641	-111.0304	750	75
	BOZMC02a *(Bogert Park)*	45.6747	-111.0330		
	BOZMCO3 *(Goldenstein Ln)*	45.6366	-111.0319		
Bridger Creek	BRIDC01 *(Golf Course)*	45.7087	-111.0235	800	80
	BRIDC02 *(Bridger Canyon)*	45.7486	-110.8916	400	40
Hyalite Creek	HYLTC01 *(Pierce)*	45.7875	-111.1292	820	82
	HYLTC02 *(gage station)*	45.5013	-110.9856	500	50
Mandeville Creek	MANVC01 *(Red Wing Dr)*	45.7111	-111.0562	500	50
	MANVC02 *(College St)*	45.6713	-111.0530	350	35
	MANVC03 (MSU @ 12th Ave)	45.6674	-111.0540		

BOZMC01 – City Hall - F Site looking west

BOZMC02 – East Lincoln St. - F Site looking west

BRIDC01 – Golf Course – F Site looking east

BRIDC02 – Bridger Canyon Rd – F Site looking west



HYLTC01 – Pierce – F Site looking east

HYLTC02 – DNRC Gage Station – F Site east

MANVC01 – Red Wing Dr – F Site looking north

MANVC02 – College St MSU – F Site looking south

2. If you are establishing a new monitoring station on one of the streams listed in the table or a new stream, then skip to **Section 7.3.2** and follow the steps to determine the sampling reach and sampling points. Once those have been determined, proceed to **Section 7.3.3** to conduct macroinvertebrate sample collections.

7.3.2 New Sampling Reach: Determining Sampling Reach and Sampling Points

1. Each sampling location will consists of a reach of a stream. This stream reach must be **40 times** the wetted width of the stream or a minimum of 150 meters (500 feet), whichever is larger.

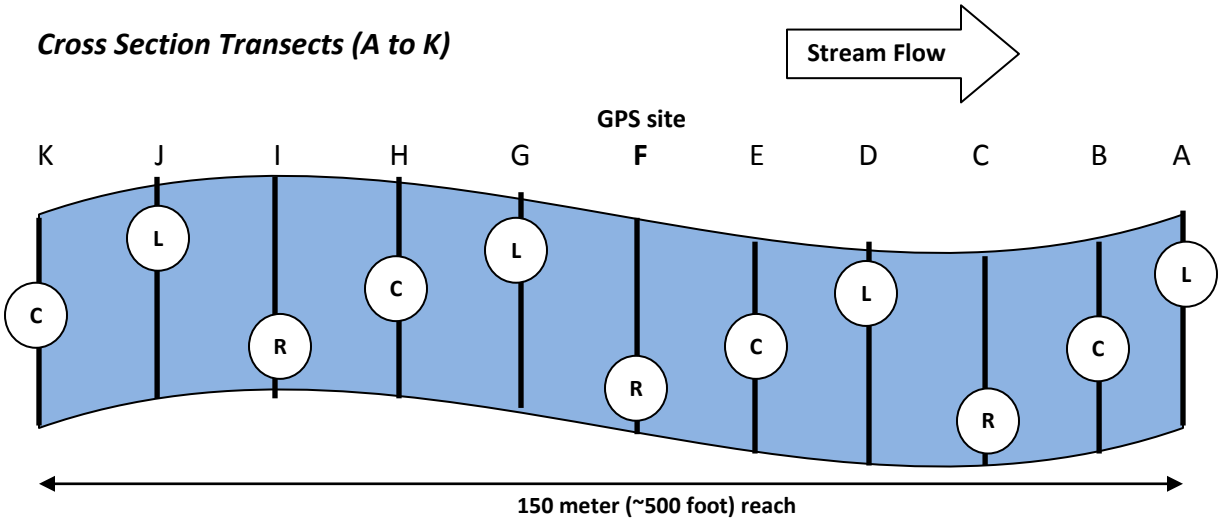
   Note 1: *If the stream average wetted width is >10 meters (30 feet), then use a reach length of 250 meters (820 feet). Your reach length will then be divided into 11 equally-spaced intervals (82 feet).*
   Note 2: *The reach length can be shorter than 150-meters (~500 ft) if upstream and/or downstream barriers preclude a 150-meter (~500 ft) reach length.*

   Note 3: *When the exact reach location is not restricted by the sampling design, attempt to position reaches upstream of bridges and other barriers to avoid this influence.*

2. Measure the wetted width at 5 random places from the "F" site (central GPS located sampling site)…2 upstream, 2 downstream and 1 at the "F" site. Calculate average wetted width and round to the nearest foot (example):
   - 15, 14, 14.8, 15.2, 15 = 74 ÷ 5 = 14.8 feet average wetted width
   - Multiply the average wetted width by 40: 15 x 40 = 600 ft sampling reach
   - Divide by 10 to determine the width of spacing between sampling transects: 600 ÷ 10 = 60-foot transect intervals

3. Measure out the 11 equally-spaced intervals, equally, up and downstream from the GPS "F-site". These transects are designated "A" through "K". The downstream end of the reach should be flagged as transect "A". Refer to the diagram on page below:

Cross Section Transects (A to K)



4. Proceed upstream from Transect A with the tape measure and flag the position of 10 additional transects (labeled "B" through "K" as you move upstream) at intervals equal to 1/10 of the reach length. **Enter channel <u>only</u> when necessary to avoid disturbing the stream prior to sampling.**

5. At Transect F, determine the geographic coordinates using a hand-held GPS receiver (decimal degrees using NAD83 datum setting). Record this information on data sheet.

6. Each transect (A-K) needs to be sampled at one of three points: Left (L), Center (C), or Right (R). To randomly select the first sampling point, use a digital wristwatch and note the last digit on the watch.
   Digit 1 – 3: Left sampling point
   Digit 4 – 6: Center sampling point
   Digit 7 – 9: Right sampling point
   Subsequent sampling points beginning with Transect B are sampled following the sequence Left, Center, Right, etc. For example, if the sampling point assigned to Transect A was "Center", then Transect B is assigned "Right", Transect C is "Left", Transect D is "Center", etc.

7.3.3 Sample Collection: Reach-Wide Composite

1. A kick net sample is to be collected from each transect cross-section beginning with Transect A at the assigned sampling points (Left, Center or Right) for a total of 11 samples.
   - ***NOTE:*** *At transects assigned a "Center" sampling point* where the stream width is between one and two net widths wide, pick either the "Left" or "Right" sampling point instead. If the stream is only one net wide at a transect, place the net across the entire stream width and consider the sampling point to be "Center". If a sampling point is located in water that is too deep or otherwise unsafe to wade, select an alternate sampling point on the transect at random.

2. If there is sufficient current in the area at the sampling point to fully extend the kick net, classify the habitat "riffle/run" and proceed to Step 3. If not, classify the habitat as "pool/glide" and proceed to step 3.
   - ***Note:*** *If there is too little water to collect the sample with the kick net, spend 30 seconds hand-picking a sample from about 1 ft^2 of substrate at the sampling point. Place the contents into the "REACH-WIDE" bucket. Go to Step 5.3.3 "Filling and Labeling Macroinvertebrate Jars".*

Riffle/Run Habitats:

3. With the net opening facing upstream, position it securely on the stream bottom to eliminate gaps under the frame. Visually identify a stream sampling quadrant one net width wide and one net width long (1 ft^2) directly in front of the net opening.

4. Sample the 1 ft^2 area in front of the net by holding the bottom of the kick net against the substrate. Pick up any loose rocks (golf-ball sized or larger) or other larger substrate particles (sticks, etc.) within the sampling quadrant. Use your hands to dislodge organisms so that they are washed into the net. Large rocks that are less than halfway into the sampling area are pushed aside. After scrubbing the rocks, set them aside, outside of the sampling quadrant.

5. Keep holding the net securely in position. Start at the upstream end of the quadrant and vigorously kick the remaining finer substrate for 30 seconds (use a watch).

6. Let the water run clear, then pull the net out of the water with a quick upstream motion to wash the organisms to the bottom of the net.

7. Invert the net into the bucket, which is about ½ full of water, and rinse organisms out of the net using the spray bottle containing 95% ethanol. Inspect the net for clinging organisms. Remove any organisms from the net and place them in the bucket using the 95% ethanol spray bottle, turkey baster, and tweezers. Carefully inspect any large objects (rocks, sticks, leaves) in the bucket and wash any organisms found off of the objects into the bucket before discarding the object. Remove as much detritus as possible without losing any organisms.

8. Have your partner place an "X" in the appropriate channel-type box ("riffle/run", "pool/glide") and substrate-type box for the transect on the Sample Collection Form:
    - Fine/sand: not gritty to gritty, up to ladybug size.
    - Gravel: fine to coarse gravel (ladybug to tennis ball sized)
    - Coarse: Cobble to boulder (tennis ball to car sized)
    - Other: bedrock (larger than car sized); hardpan (firm, consolidated substrate), wood of any size, aquatic vegetation, etc. Note the type of "other" substrate in comments on the field form.

9. Proceed upstream to the next transect and repeat steps 1-8 above.
10. Combine all kick net samples ("riffle/run" and "pool/glide" habitats) into the bucket.

Pool/Glide Habitats: If there is insufficient current in the area at the sampling point to fully extend the net, classify the habitat as "pool/glide".

- ***Note:*** *If the pool is too deep (> about 1m) to sample safely at the designated spot, move downstream until a safe sampling spot is found.*

- ***Note:*** *If there is too little water to collect the sample with the kick net, stir up the substrate with your gloved hands and use the sieve to collect the organisms from the water in the same way the net is used in larger pools.*

11. Follow Steps 2-10 above.

7.3.4 Filling and Labeling Macroinvertebrate Jars

1. Pour entire contents of the bucket through the sieve. Remove large objects and wash off clinging organisms back into the sieve before discarding.

2. Using a turkey baster and stream water, rinse all the organisms from the bucket into the sieve. This is the composite sample for that habitat for that site.

3. Estimate the total volume of the sample in the sieve. The sample material should not exceed ½ of the total container volume to ensure adequate preservation of the sample. You may need to use more than one jar for the samples.

4. Wash the contents of the sieve to one side by gently agitating the sieve in the water. Wash the sample into a jar using as little stream water as possible. Use the turkey baster if necessary. Carefully examine the sieve for any remaining organisms and use the turkey baster or tweezers to place them into the sample jar.

5. Add 95% ethanol to fully fill the sample jar. Gently agitate the jar to ensure thorough mixing of alcohol and sample. ***Note:*** Prepared composite samples can be transported back to the vehicle before adding ethanol if necessary.

6. Place a label written on **waterproof** paper, using a pencil, inside the jar and one label written in pencil on the outside of the jar (secured with clear packing tape) with the following information:

Sample label for macroinvertebrate jar

Stream Name: _____ Sample ID: _____
Date: _____ Time: _____
Sampler Name(s): _____
Sampling Method: EMAP Reach-Wide
Client: GGWC Volunteer Monitoring Program

- ***Note:*** If a second jar is needed, add the following information to the labels: "container 1 of 2" and "container 2 of 2".

7. Tightly replace the cap on the jar. Seal the jar with parafilm.

7.3.5 Sample Storage and Shipping

1. Store labeled composite samples in a cooler with absorbent material that is suitable for use with 95% ethanol until transport or shipment to the laboratory.

2. Deliver sample jars and completed field forms to Tammy Crone, Gallatin Local Water Quality District, 215 W. Mendenhall, Suite 300, Bozeman. 582-3145.

3. Long-term storage: Check samples regularly for alcohol loss and sample degradation.
   i. One week after sample collection: replace alcohol with new. Conduct a second and final replacement of alcohol on the samples three weeks after sample collection. Samples can then be stored up to one year. Inspect alcohol level in samples every three months and refill as necessary.

4. Store in a cool dry place at less than or equal to 25°C until shipped to the laboratory. Step 5 & 6 below will be performed by the Gallatin Local Water Quality District.

5. Place each container into a 1-gallon Ziploc freezer bag. Put the containers into a cooler. Use absorbent and packing material to prevent container movement during shipping.

6. In a Ziploc bag, place a copy of Habitat Assessment Form and Macroinvertebrate Collection Form with letter to Rhithron Associates requesting analysis. The letter should include: a request that samples be analyzed using the MDEQ updated macroinvertebrate metrics (WQPBWQM-009 Rev2), billing and shipping information for cooler return and final analysis report to GGWC and GLWQD. Ship samples to:
   Rhithron Associates, Inc., 29 Forth Missoula Road, Missoula, MT 59804

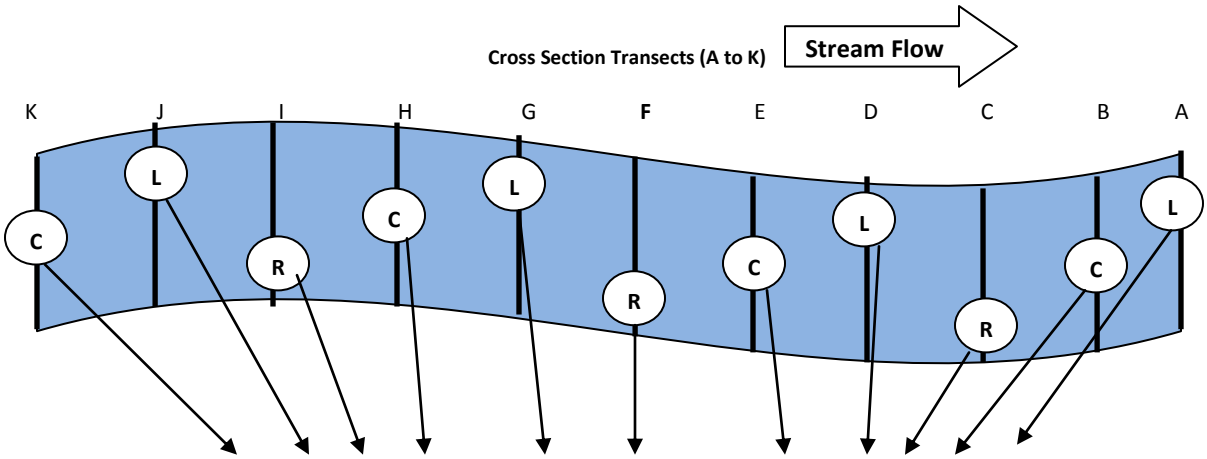
7.3.6 Macroinvertebrate Habitat Assessment

1. Complete the EMAP Macroinvertebrate Habitat Assessment Data Sheet only if you have collected a macroinvertebrate sample at the site. Only team members who conducted the biological sampling should complete the form, since they have observed the entire sampling reach. Perform the assessment on the reach length from which the biological sampling is conducted. Some parameters require an observation of a broader section of the catchment than just the sampling reach; as a rule of thumb, use 2 lengths of the sampling reach to assess these parameters.

2. For each of the habitat parameters based on the stream type you collected macroinvertebrates from (high gradient stream or low gradient stream), carefully read each of the options, and select a numeric score that best represents the conditions where the samples were collected for 2 lengths of the sampling reach used.

3. Send a copy of this data sheet to the laboratory with the samples.

EMAP Reach-Wide Sampling Design for Benthic Macroinvertebrates



Transect Samples (1 per transect)
Sampling point of each transect (L, C, R) selected systematically after random start

- Kick net (500 micron mesh)
- 1 ft^2 quadrant sampled for 30 seconds

Combine all kick net samples collected from riffles and runs and from pools and glides

COMPOSITE REACHWIDE SAMPLE

SIEVING

- 500 micron mesh
- Remove as much debris, fine sediment as possible

COMPOSITE INDEX SAMPLE

- 1-liter container(s)
- Fill no more than 50% full with sample
- Preserve with 95% ethanol (to final concentration of 70%)

8 Protocol: Measuring Channel Cross Section Profile

PROCEDURE NOTE: *The GGWC Gallatin Stream Team will conduct channel cross section profiles* ***annually*** *to ensure that bankfull indicators are accurate. This will be done during the* ***July sampling event only****.*

8.1 Concept

The shape of a stream's cross-section profile is a reflection of current and recent flow conditions. These conditions influence the streambed shape. Regular monitoring of a stream's cross-section profile allows for documentation of changes in stream condition. Two measurements are taken when conducting a cross-section profile: "bankfull depth" and "water depth". Bankfull depth is also known as "high-water mark" or "flood stage". Bankfull is the level at which water completely fills the active stream channel and begins to overflow onto the adjacent floodplain. Sometimes, identifying the bankfull depth is tricky. In this case, it can be identified by the following features:

- Change in vegetation
- Change in slope along the stream bank
- Change in particle size of bank material (i.e., boundary between gravels and silt/clay)
- Color change, stain lines on the lower limit of lichens on streamside boulders

Note: *If a stream channel is degraded, then it may not be accessing its floodplain.*

8.2 Equipment and Supplies

- ☐ 100-ft reel-type tape measure
- ☐ 2 tent stakes & hammer
- ☐ Stadia rod (made from PVC pipe) with markings in 1/10-feet
- ☐ Twine & line level
- ☐ Cross-Section Field Form (**NOTE**: Only use the form with columns for bankfull depth)

8.3 Procedure

1. Identify a riffle cross-section in the stream reach, which is representative of the form of the stream. Select a fairly straight section where the channel is somewhat constricted, where you can avoid large boulders and big deadfalls, which alter the form and lateral (side-to-side) movement of the channel. Ideally, this will be your "F" site from the macroinvertebrate collection protocol.

2. Install stakes at the bankfull elevation of each side of the channel and attach twine to the stakes at bankfull height, keeping the twine tight. Attach a line level to the twine and adjust twine to make sure you have a uniform horizontal plane to measure to.

3. Using the tape measure, determine the stream width from <u>bankfull to bankfull</u>. Record on the field form. Next, measure the stream width from <u>wetted edge to wetted edge</u> and record on the field form.

4. Use this wetted edge to wetted edge measurement to determine the distance needed between measurement intervals. Twenty (20) interval measurements are needed (These will include the wetted edge readings of zero):
   - **Stream WE-WE < 20 feet wide:** Measure depth at 20 equal intervals.
   - **Stream WE-WE = 20 feet wide:** Measure depth at every foot.
   - **Stream WE-WE > 20 feet wide:** Measure depth at 20 equal intervals.

   To calculate distance between measurement intervals, divide the stream wetted edge-wetted edge into 20 equal intervals. (example: stream width WE to WE equals 28 feet, 28 ÷ 20 = 1.4 foot intervals). **NOTE:** *Use this same measurement interval for measuring the bankfull depth to the wetted edge depth.*

5. At the left bank (facing downstream), attach the tape measure to the stake. Pull tight and attach the other end to the right bank stake.

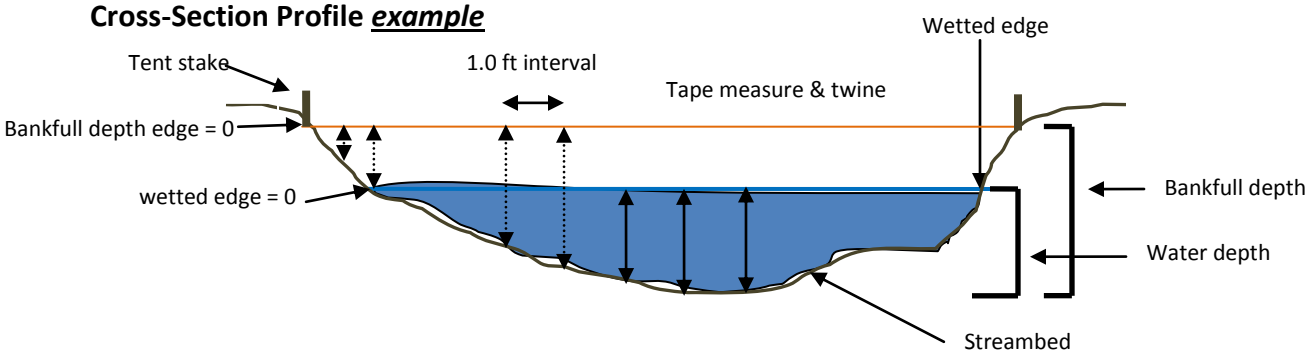
6. Starting at the left bank, use the stadia rod to take bankfull and water depth readings at the appropriate measurement intervals. Record the vertical distance from the streambed to the string level (the "bankfull depth") and also the water level surface distance from the streambed (the "water depth"). Record these measurements in the table on the field form.
   - ***Note:*** *The "wetted edge" is where the water comes in contact with the streambank. The water level reading here will be zero.* ***From bankfull to wetted edge, there may be more than one zero reading for the water depth. That is okay. Just make sure when you get to the Wetted Edge, that you record the letters "WE" in the table next to that zero reading for the water depth. See EXAMPLE:***

Tape Meas. Reading	Interval #	Bankfull Depth	Water Depth	Tape Meas. Reading	Interval #	Bankfull Depth	Water Depth
#	1 (Left Bank)	0	0	#	22	1.1	0.2
#	2	0.4	0	#	23	0.7	0 **WE**
#	3	0.9	0 **WE**	#	24	0.2	0
#	4	1.0	0.3	#	25 (Right Bank)	0	0

7. Call out the measurements to your team partner who will record the information on the data sheet. Record on the Site Visit Form that a channel cross-section has been done.

8. Do not remove this cross-section if you plan to measure stream velocity.

Cross-Section Profile *example*



9 Protocol: Measuring Stream Velocity for Calculating Stream Discharge Using the Float Method

9.1 Concept

Stream flow (discharge) is the rate at which a volume of water passes through a cross section per unit of time. This is expressed as "cfs" (cubic feet per second – ft^3/sec). Discharge is an important component of an aquatic environment because it helps determine riparian and streambed habitats, temperature, the interaction between surface water and ground water, aquatic species diversity, and the concentration of various chemical substances in the water. Velocity is the speed of water moving past a given point. To calculate discharge, you must first measure velocity.

Stream staff gages will be installed for the GGWC VMP at each of the sampling sites. Volunteers will then measure cross-sectional area and stream velocity a minimum of 3 times (3 site visits) using the ***float method*** to develop a rating curve for the staff gage. This rating curve will then be used to chart future staff gage readings for determining stream discharge (flow).

The float method is a semi-quantitative method for determining stream flow. It is important to note this method tends to underestimate the flow due to slower velocity near the surface, but it is more accurate than a visual estimate.

9.2 Equipment and Supplies

- 100' reel-type tape measure
- 4 tent stakes & twine
- hammer (optional if needed)
- Stream Flow Field Form
- 6 wood blocks (2" x 4" cut 6" in length) or oranges
- Stopwatch, timer, or watch with second hand

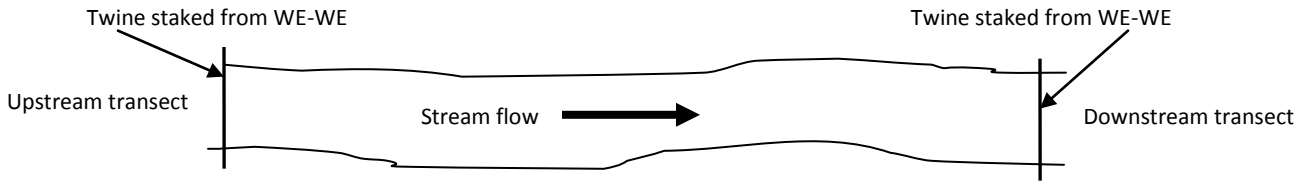
9.3 Procedure

1. If you have just performed a cross –section profile (Protocol #6), use that stream cross-section as your upstream starting point for conducting the float trials (ideally the "F" site from macroinvertebrate sampling). Identify a length of stream from this point that is straight, as well as uniform in width and depth.

2. Using the tape measure, mark off 100-feet of stream length from your first cross-section and mark the downstream end with stakes on each stream bank. Record on the data sheet. ***Note:*** *If a 100-ft straight length of stream is not available, use a shorter length that meets the above criteria in Step 1 and is as close to 100 feet in length as possible.*

3. Stretch a length of twine across the downstream bank and attach to stakes.

4. Determine average width of the stream (from wetted edge) by taking measurements at the upstream transect, the downstream transect and a random transect in between. Record on the data sheet. *See drawing:*



5. Station one person just above the upstream cross section with the wood block; a second person at the downstream cross section with the stopwatch; and a third person (if available) across from the upstream line.

6. The upstream person should gently release the wood block into the water just slightly above the cross-section twine.

7. The third person calls out the time as the wood block crosses the upstream line. (If only two volunteers the person who releases the block must call the start time).

8. The downstream person records the time as the wood block crosses the line. Capture the wood block and record the time on the data sheet.

9. Repeat Steps 5-9 at least five times. Perform calculations as indicated on the data form and record stream flow in cfs.

10. Record staff gage reading on data sheet.

11. Once rating curve is developed, volunteers only need to perform a staff gage reading, then use the rating curve graph to record the stream discharge on the data sheet.

NOTE: If branches, rocks, eddies, etc. obstruct the wood block movement, repeat the trial.

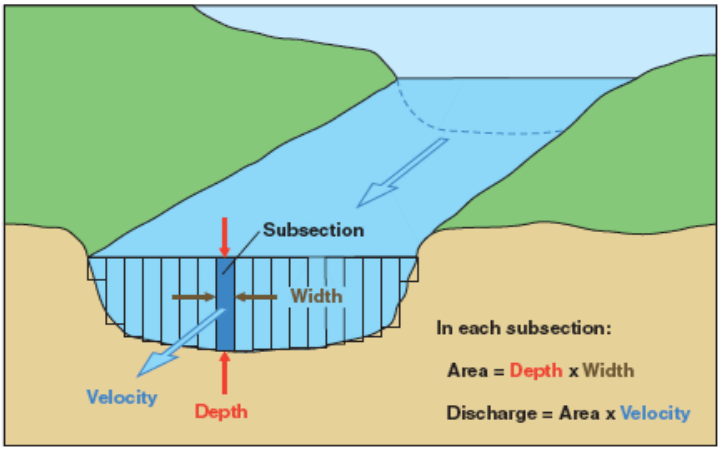
Staff gage on Bozeman Creek

10 Protocol: Measuring Stream Velocity for Calculating Stream Discharge Using the OTT Meter

10.1 Concept

Stream flow (discharge) is the rate at which a volume of water passes through a cross section per unit of time. This is expressed as "cfs" (cubic feet per second – ft^3/sec). Discharge is an important component of an aquatic environment because it helps determine riparian and streambed habitats, temperature, the interaction between surface water and ground water, aquatic species diversity, and the concentration of various chemical substances in the water. Velocity is the speed of water moving past a given point. To calculate discharge, you must first measure velocity.

If a staff gage is installed at a monitoring station, Volunteers will take a reading of the staff gage and record it on the site visit field form during each monitoring visit. By measuring stream discharge, a rating curve can be developed for that stream site using the staff gage. The rating curve can be used to chart future staff gage readings for determining stream discharge (flow).



Current-meter discharge measurements are made by determining the discharge in each subsection of a channel cross section and summing the subsection discharges to obtain a total discharge.

The OTT meter provides a very precise method of measuring stream velocity. The process consists of several (minimum 20) water depth and water velocity measurements which are used to calculate stream discharge. The GGWC Stream Team volunteers will measure depth and velocity and record this data on a stream discharge field form. Actual discharge will be calculated in the office by the Gallatin Local Water Quality District by entering the field data into a spreadsheet.

10.2 Equipment and Supplies

- ☐ 100' reel-type tape measure
- ☐ 2 tent stakes
- ☐ hammer (optional if needed)
- ☐ Stream Discharge Field Form
- ☐ Top-setting rod
- ☐ OTT meter (including black cordura case to transport meter)

10.3 Procedure

The OTT meter provides a very precise method of measuring stream velocity. The process consists of several water depth and water velocity measurements which are used to calculate stream discharge. The GGWC Stream Team volunteers will measure depth and velocity and record this data on a stream discharge field form. Actual discharge will be calculated in the office by the Gallatin Local Water Quality District by entering the field data into a spreadsheet.

Things to consider:

Select a good cross section of the stream for the following:

- A relatively straight portion of the channel (not on a bend)
- Waters is as smooth as possible (not turbulent or in a riffle)
- Water is moving downstream across the entire width (no backwater areas)
- Avoid undercut banks or section with obstacles like large rocks or debris, if possible

1. String the measuring tape across the stream at right angles to the flow with the zero end of the tape at the left bank (looking downstream). Secure the tape with stakes or objects on the bank. Make the tape tight enough so that it doesn't sag near the middle.
2. Record the measurement on the tape at the left and right edges of water (wetted edge). Measurements should be in tenths of a foot. Use these numbers to determine the wetted width of the stream channel. Leave the tape in place.

   Example:

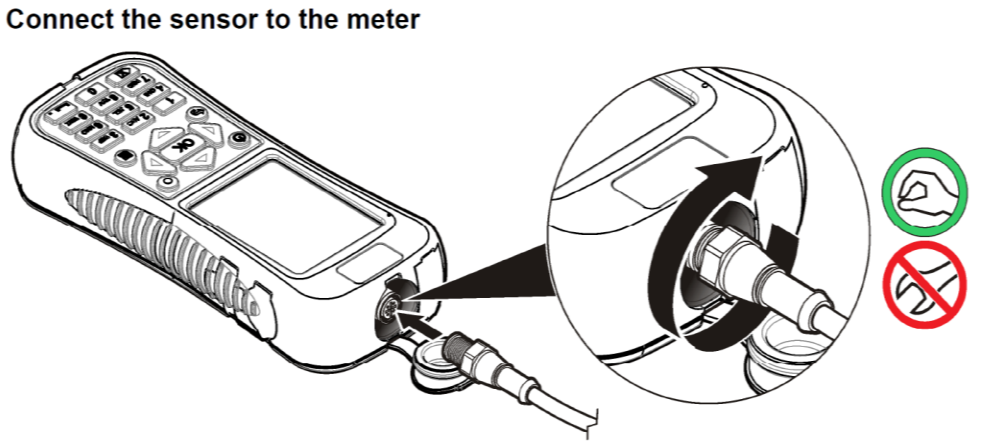
   left bank tape reads 0.5 ft. Right bank tape reads 10 ft. 10 – 0.5 = 9.5 ft wetted width).
3. Based on the wetted width of the channel, determine the distance between measuring points. You will need a minimum of 20 measurements.

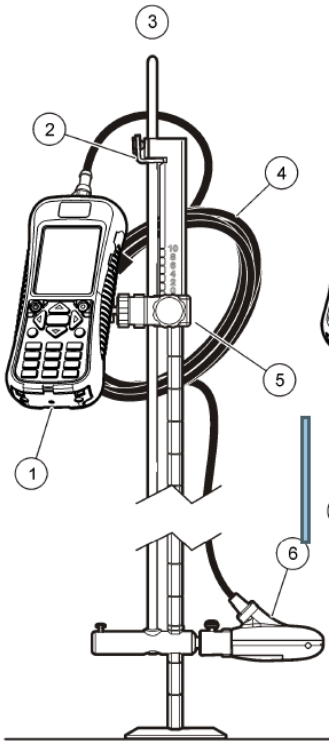
   Example:

   20 9.5 ft = 2.10 ft. Round down to 2. Take measurements every 2 ft.
4. Start at the wetted edge of the left bank and record the tape measurement at that location with a "zero" depth on the field sheet. Work your way across the stream to the right bank, recording tape distance ("Distance from Initial Point" column) and measuring water depth then velocity with the OTT meter at each interval. Record the water depth and velocity in the appropriate columns on the field form. You should finish on the right bank wetted edge with a zero measurement and should have at least 20 depth measurements. Instructions for specific use of the OTT meter are below:

10.4 Operating the OTT Meter

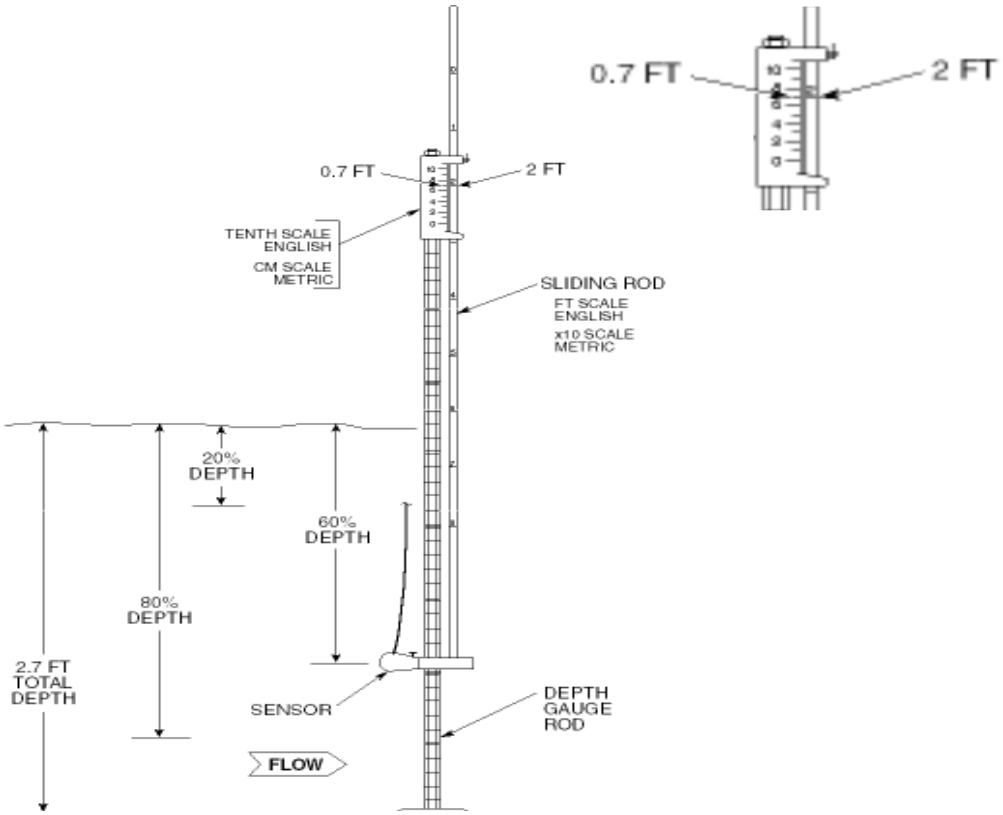
1. Attach the sensor to the top setting rod. Make sure the meter is parallel to the stream so that the cord comes out the top of the meter. Make sure the thumb nut that attaches the sensor to the top setting rod is very tight.



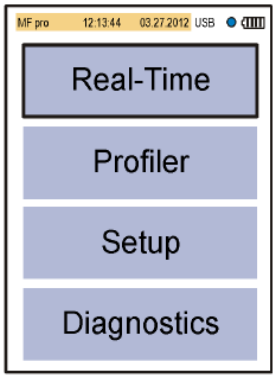


2. Push the **Meter Power** button (1) until an audible beep is heard. The meter does a self test and the display shows the results. If the meter fails the self-test, the display shows FAIL next to the failed parameter.
3. When the self test is complete, push **OK** to go to the Main Menu.
4. Set the rod at the first interval determined by the stream width measurement. Note the height of the water at the depth gage rod.
5. Each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot.

6. Line up the foot scale on the sliding rod with the tenth scale on the top of the depth gage rod. If, for example, the total depth of the water is 2.7 feet, then lip up the 2 on the foot scale with the 7 on the tenth scale. This will set the sensor at 60% of the stream depth.



7. Push **OK** when **Real Time** is highlighted. A screen will appear which shows a graph of velocity. The graph will record the velocity for 20 seconds. At the end of 20 seconds, the velocity will be displayed in ft/sec on the screen. That is the number that is entered into the stream discharge field form in the "Velocity" column.



8. When the last station is complete, press (1) the **Power Meter** button once then **Right Arrow**, **yes**, **OK** to turn off the meter.
9. Remove the sensor from the top setting rod (make sure the thumb screw is snug tight on the sensor, unplug the meter and place both the meter and sensor into the carrying bag.

STREAM DISCHARGE FORM

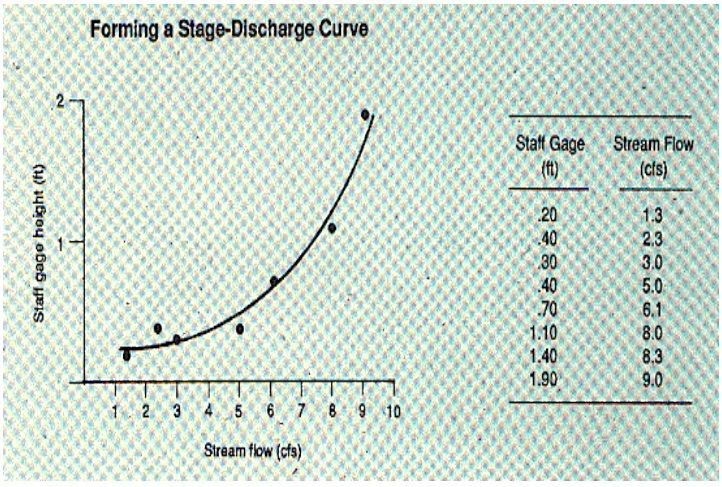
Meter: Hach OTT Meter						
Stream Name: Example Creek					**Station ID:**	
Station Description:					**Date:** SAMPLE DATE	
Team Members: GGWC VOLUNTEERS						
Stream Width (wetted edge to wetted edge):					**Stream Width (Bankfull):** 11.7	
Section #	**Tape Reading**	****Distance from initial point**	**Bankfull Depth (ft)**	**Water Depth (ft)**	**Velocity (at point) (ft/s)**	**Notes**
1		1.0		—	—	Left Bank
2		1.5		.32	0.51	
3		2		.71	0.62	
4		2.3		.80	0.71	
5		2.8		.45	1.21	
6		3.7		.57	1.07	
7		4.1		.41	1.13	
8		4.4		.63	0.81	
9		4.8		.57	0.72	
10		5.1		.60	0.64	
11		5.8		.55	0.73	
12		6.3		.72	0.51	
13		6.7		.81	0.83	
14		6.9		.77	0.94	
15		7.3		.73	0.97	
16		7.6		.74	1.01	
17		7.9		.52	0.81	
18		8.5		.41	0.72	
19		8.8		.32	.43	
20		9.1		.29	.27	
21		9.3		—	—	Right Bank
22						
23						
24						
25						
26						
27						
28						
29						
30						

NOTE:
First blank is used to mark the bank.
Begin measurements from the left bank (determine left bank while looking downstream).
Initial point is often the tape reading of the waterline (the wetted edge) & has no depth or velocity to measure.
At points where there is stagnant water or backflow effects, begin and end measurements at the edge of where positive flow can be measured.
Read depths on wading rod ignoring the "pile-up" effect of water on the rod.
Velocity is measured at six tenths depth from the water surface by moving the probe support so that the foot indicator

10.5 Rating Curve (Forming a Stage-Discharge Relationship)

Each time you take a flow measurement, you should take a staff gage reading, if a gage is located at the monitoring site. This should be recorded on the Site Visit Form in the Comments section. On a sheet of paper or in a computer file, keep a record of each flow measurement you take and the corresponding staff gage reading. Once you have enough data, simply plot these two variables on a graph and draw or compute the resulting curve.

1. Draw a graph with an x-axis and y-axis. The x-axis, the horizontal line, will be the streamflow measurement. The y-axis, the vertical line, will be the staff gage reading.
2. Place a dot on the graph where each streamflow and corresponding staff gage measurement intersect.
3. Draw a smooth, curved line between the points. Now you have a stage-discharge relationship. From now on you can simply take the gage reading and estimate the stream flow from your prediction curve.



Staff Gage (ft)	Stream Flow (cfs)
.20	1.3
.40	2.3
.30	3.0
.40	5.0
.70	6.1
1.10	8.0
1.40	8.3
1.90	9.0

As convenient as a stage-discharge relationship is, it still needs to be supported by real data. The more data points you use to develop your graph, the better.

> ***Note:*** *The graph is accurate only for the stream flows that fall within the data range you used to create the graph*. **Example:** If all your measurements were taken during July – September when stream flows were low, the graph could not be used to predict high flows in December.

Be sure to collect data during a wide range of conditions (taking personal safety into account also). In general, if you have about four data sets from low-flow period and four from the high-flow period, you can comfortably prepare the rating curve graph. For long-term monitoring, make periodic checks of the discharge curve, especially after periods of flooding. Recalibrate the curve if the periodic checks indicate the relationship has changed. Eventually, natural changes in the stream bottom will result in a change in the relationship between flow and gage height.

11 Protocol: Performing the Wolman Pebble Count for Substrate Composition

11.1 Concept

The bed and bank material of a stream are key elements in the formation and maintenance of channel morphology. These materials influence channel stability and provide resistance to scour during high flow events. The frequency of bed load transport can be critically important to fish spawning and other aquatic organisms that use the substrate for cover. The Wolman pebble count procedure requires taking measurements of substrate on an increment within the bankfull channel and is used to determine particle size distribution in the stream channel.

11.2 Equipment and Supplies

- Gravelometer
- Substrate Composition (Pebble Count) form

11.3 Procedure

1. The sampling points are determined by paced transects across the channel from bankfull to bankfull using the "zig-zag" method (including the top, middle and bottom of the riffle). A minimum of 100 particles must be observed and recorded.

2. Start at one end of the downstream cross-section. Without looking directly at the substrate, step forward (by walking heel-to-toe). Reach down and pick-up the first particle at the end of your foot touched by your finger. DO NOT LOOK while you are selecting the substrate to ensure a random sample is collected.

3. Measure the intermediate diameter of the particle by inserting it through the first opening in the gravelometer the particle will fit through (known as the "Pass/No Pass Method"). Call out this measurement to your team partner.

4. Tally this sample measurement by the size categories outlined on the data form. Use the Dot/Slash system to record pebble counts. 10 = 

5. Repeat Steps 1-4 until *a minimum of* 100 particles have been observed and recorded. **If you reach 100 particles while in the middle of transect, continue collecting particles until you reach the end of the transect at the opposite bank**.

6. Calculate the cumulative percent total for each class size. This can be done after you leave the field site, but before the data sheet is turned in to your Field Team Leader.

12 Protocol: Photo Survey of Riparian Habitat and Instream Algae

12.1 Concept

Completing a photographic record of your sampling station can provide valuable information for the future. A photo will be able to provide a clear representation of how the stream site has changed over time. It will also provide objective data that will be an important supplement to other water quality data. Documentation of instream aquatic vegetation (algae) can be useful for providing general qualitative information on the extent of nutrient impacts to a stream. This does not, however, substitute for chlorophyll-a sampling and analysis (which is beyond the scope of work for GGWC at this time).

12.2 Equipment and Supplies

- ☐ Digital camera
- ☐ Photo Survey Data Sheet
- ☐ GPS unit

12.3 Procedure

1. Pick a specific location that can be used every time. Use an existing man-made structure or a distinctive tree to help mark your site. GPS this location and record it on the data sheet.
    - ***Note:*** *If these markers do not exist, mark the site with stakes or flags.*

2. From this location, take a North, East, South and West, plus an upstream and downstream photo. Record these photos on the data sheet.

3. To document periphyton (algae – aquatic plants) growth in the stream, take instream photos representative of the algae growth present in your stream reach. Also remove several rocks from the stream that are representative of algae growth, place on a surface with a pen or other item for "scale" and take a photo. Record these photos on the data sheet.

4. Include all of the following in the photo survey:
    - Direction of photograph (upstream, downstream, facing North, East, South, West, etc.)
    - Date
    - Time of day
    - Time of year
    - Focal length of lens

5. Repeat the photo survey at your sample site every time you sample so you can document the current conditions.

Literature Cited – Protocols Adapted From:

- *A Citizen's Guide to Understanding and Monitoring Lakes and Streams*, Michaud, Joy P., Envirovision – Environmental Consulting Service, Olympia, WA (1991). (Illustration by Sandra Noel).
- *EMAP-Western Pilot Study Field Operations Manual for Wadeable Streams, Section 11 (Benthic Macroinvertebrates)*, Revision 2, Peck, David V., Lazorchak, J. M., and Klemm, D. J. (April 2001).
- Montana Department of Environmental Quality. 2012. Water Qualtiy Planning Bureau *Field Procedures Manual for Water Quality Assessment Monitoring* Version 3.0. (WQPBWQM-020), Helena, MT.
- *Volunteer Water Monitoring Guidebook*, Montana Watercourse (2007).

APPENDICES

APPENDIX A – YSI 556 Multiprobe Meter Calibration Procedures

A.1 CALIBRATION TIPS & HINTS

- The transport/calibration cup that comes with the probe serves as a calibration chamber for all calibrations and minimizes the volume of calibration solutions required.
- Ensure all sensors are immersed in the calibration solution. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.
- Make sure to loosen the seal of the transport/calibration cup prior to the DO calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe. You may wish to shave old calibration standards for this purpose.
- Put some deionized (DI) water at ambient temperature to rinse the probe between calibration solutions.
- Have several clean, absorbent paper towels or Kim-wipes available to dry the probe between rinses and calibration solutions. Shake excess rinse water off the probe. Dry off the outside of the probe and sensor guard. (Making sure the probe module is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.

A.2 PROBE INSPECTION

- Ensure the o-ring is installed in the o-ring groove of the transport/calibration cup and that the bottom cap is securely tightened. **NOTE:** Do not overtighten!
- Remove the probe sensor guard, if installed.
- Remove the o-ring, if installed, from the probe and inspect for defects. Replace with extra o-ring if defects found.

THE STEPS TO CALIBRATING THE YSI METER ARE ON THE NEXT PAGE.

A.3 CALIBRATION LOG BOOK

1. Fill out the calibration log sheet for each time the YSI meter is calibrated.
2. The YSI meter must be calibrated prior to use.
3. The log book is to remain with the YSI meter at all times.

A.4 TO ENTER CALIBRATION MODE on YSI

1. Press the **On/Off** key to display the **Run** screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight **Calibrate**.
4. Press **Enter** key. **Calibrate** screen is displayed.

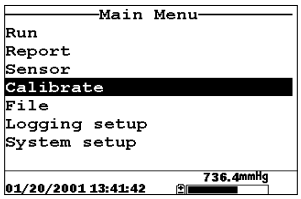


Figure 1. Main Menu Screen (Step 2 & 3)

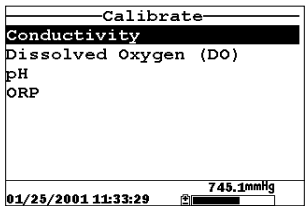


Figure 2. Calibrate Menu Screen (Step 3)

A.5 CONDUCTIVITY CALIBRATION

1. On the **Calibrate screen** select **Conductivity** and press **Enter**.
2. Select **Specific Conductance** and press **Enter.**
3. Place 55 ml (fill to the black line on the calibration cup) of the 447 µS/cm conductivity solution in the clean, dry calibration cup and immerse the sensors in the solution. Make sure the vent hole is completely covered.
4. Gently rotate/move probe up and down to remove air bubbles, if needed, and tighten the calibration cup onto the probe module.
5. At the **Enter Cond Screen mS/cm** , use the keypad to enter the calibration value: **0.447**

> ***NOTE:*** *The YSI 556 is set-up for "temperature compensation". Always use the value for the calibration standard at* ***25 C****.*

6. Press **Enter**. Allow **1 minute** for the **temperature** to stabilize.
7. Once the temperature is stable, **record** the **actual specific conductivity** reading in the calibration log book. Then…
8. When the **Specific Conductivity** reading is stable for **30 seconds**, press **Enter**.
9. **Record** the **calibrated specific conductivity** in the calibration log book.
10. Press **Enter** again to accept the calibration.
11. Press **Escape** to return to the **Calibrate** screen.
12. Rinse the sensors and calibration cup with **DI water** and dry with a Kim-wipe.

A.6 DISSOLVED OXYGEN CALIBRATION in % SATURATION

1. On the **Calibrate** screen, select **Dissolved Oxygen (DO)** and press **Enter**.
2. Select **DO%** and press **Enter**.
3. Place **1/8 inch** tap water in calibration cup, and place the probe module into it, make sure the DO and temperature sensors are NOT immersed in the water. Secure by tightening only 1 or 2 threads so the DO sensor is vented to the atmosphere.
4. Use the keypad to enter the local barometric pressure (BP) and press **Enter**. This can be found on the lower right corner of the display screen above the battery level indicator.
   NOTE: This YSI meter has an internal barometer pre-calibrated for local altitude.
5. Allow **10 minutes** for air in cup to become water-saturated and **temperature** to equilibrate; **Record** the **actual DO%** in the calibration log book.
6. After the 10 minutes, when the **DO%** reading shows no significant change for 30 seconds, press **Enter** and **record** the **calibrated DO%** in the calibration log book.
   NOTE: The reading will not display 100% saturation.
7. Press **Enter** again to accept the calibration.
8. Press **Escape** to return to the **Calibrate** menu.
9. Discard the water and dry out the calibration cup.

A.7 pH CALIBRATION

1. On the **Calibrate** screen, select **pH** and press **Enter**.
2. Select **2-point** calibration option.
3. Place **30 ml** of **pH 7 buffer** in the clean, dry calibration cup; immerse sensors in solution.
   NOTE**:** Always calibrate in **7 buffer** first.
4. Rotate/move the probe module up/down to remove bubbles from the pH sensor, if necessary. Make sure the sensor is completely immersed and tighten.
5. Enter the calibration value of the **pH 7 buffer.**
   NOTE: The YSI 556 is set-up for "temperature compensation" which means you will always use the value for your calibration standard at **25 C**.
6. Press **Enter** and allow **1 minute** for the **temperature** to stabilize.
7. **Record** the **actual pH** reading in the calibration log book.
8. When the **pH** reading is stable for **30 seconds**, press **Enter**.
9. **Record** the **calibrated pH** and the **pH mV** in the calibration log book.
10. Press **Enter** again to accept the calibration.
11. Press **Enter** to return to the **pH calibration screen**.
12. Rinse the probe module, calibration cup, and sensors with DI water and dry.
13. Repeat **Steps 3 through 10** for the **pH 10 buffer**.
14. Press **Escape** to return to the **Calibrate** menu.
15. Press **Escape** again to return to the **Main** menu.
16. Discard buffer, rinse probe module, calibration cup and sensors with DI water and dry.
17. Place **1/8 inch** of **tap water** in the calibration cup to store the probe module in.

A8. Post Calibration

1. From the **Main** menu, use arrow key to select **File** and press **Enter**.
2. Use arrow key to select **View File** and press **Enter.**
3. Press **Enter** to view the **.glp** file.
4. Read the values for **Conductivity cell constant** and **DO gain** for the day's calibration and **record** on the calibration log book.
5. Press **Escape 3 times** to return to the **data logging** menu.
6. Press the **on/off** button.
7. Leave the probe module attached to the hand-held display and place in the carrying case for transport to field site.

A9. TDS (Total Dissolved Solids)

1. There is no calibration procedure for TDS. TDS is calculated internally based on the specific conductivity reading (in mS/cm) and a TDS constant (between 0.3 and 1.00) which has been preset to default to 0.65 on the YSI 556 meter.

Instructions excerpt from:
YSI 556 MPS MultiProbe System Operations Manual, YSI Environmental Inc. May 2002.

Appendix B – Stream Team Technical Advisors

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Appendix C – Field Data Forms

- ☐ Site Visit Form
- ☐ EMAP Macroinvertebrate Habitat Assessment Form
- ☐ EMAP Macroinvertebrate Sample Collection Form
- ☐ Aquatic Plant Tracking Form (chlorophyll-a)
- ☐ Aquatic Plant Visual Assessment Form (chlorophyll-a)
- ☐ Cross Section and Stream Discharge Form
- ☐ Wolman Pebble Count (Substrate Composition) Form
- ☐ Photo Survey Documentation Form
- ☐ YSI 556 Multiprobe Calibration Log & Maintenance Forms