WATER QUALITY MONITORING PROGRAM

FIELD SAMPLING PROTOCOL

FOR WATER QUALITY ASSESSMENT OF STREAMS AND RIVERS

Draft Copy

OKLAHOMA WATER RESOURCES BOARD
WATER QUALITY PROGRAMS DIVISION
3800 NORTH CLASSEN
OKLAHOMA CITY, OK. 73118

April 27, 2004

TABLE OF CONTENTS

STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF WATER QUALITY SAMPLES IN STREAMS

DRAFT—UNDER REVIEW FOR SECTION 2

1.0 General Information

Following is a detailed description of sampling procedures. Efficiency is the key, and finding a comfortable sequence of sampling is essential. This will vary from person to person and from sampling team to sampling team. Yet, employing consistent sampling patterns at every site will maximize the number of sites sampled per day and decrease the chance for introduction of sampling error. Sampling sequence is unimportant. Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadeable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites.

2.0 Definitions/Terms

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining “Traffic Safety Protocols”.

4.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO’s) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory.

4.1 Kinds of Samples

Samples are collected to test various DQO’s precision, accuracy, and representativeness. Following is a short description of each kind of sample. Samples are submitted to the analytical laboratory with other “trip” samples.

- **Lab Blank Sample** A laboratory blank sample is collected to ensure that laboratory cleaning methods are adequate and are not contaminating samples. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.
- **Field Blank Sample** A field blank sample is collected to ensure that field cleaning methods are adequate and are not cross-contaminating samples. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.
- **Analytical Blank Sample** An analytical blank sample is submitted to control the methods of the analytical laboratory. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.

- **Duplicate Sample** A duplicate sample is collected to control the sample splitting method. This sample ensures that composite samples are being collected appropriately. Submitted on a regular schedule.
- **Replicate Sample** A replicate sample is collected to control the general sampling methodology that is being employed. This sample ensures that a representative sample is being collected. Submitted on a regular schedule for some types of samples. Replicate samples may also be submitted to verify the accuracy of analytical results.
- **Spike Sample** A spike sample is a known stock solution diluted by environmental sample. - Submit as required.
- **Known Sample** A known sample is a known stock solution diluted in the laboratory with reagent grade water. - Submit as required.

The Oklahoma Department of Environmental Quality (ODEQ) can provide ampule stock solutions for spike or known samples, or under certain circumstances, these samples may be purchased through a laboratory supplier. Consult a supervisor to determine where to acquire stock solutions. When preparing QC spike and known samples, **record everything you do**! It is essential that all steps of the process be adequately documented.

4.2 Preparation of Samples

4.21 Inorganic Chemistry, Metals, Chlorophyll and Field QA/QC Samples

Analytical Blank Sample

- One sample is collected for each “sampling week”.
- The sample is collected from reagent grade water provided by the analytical laboratory.
- The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity).
- Label with a “31" in the QA code.

Laboratory Blank Sample

- One sample is collected for each “sampling week”.
- The sample is collected by running reagent grade water through all plasticware that will be used in the field during a particular sampling week.
- The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity).
- Label with a “32" in the QA code.

Field Blank Sample

- One sample is collected for each “sampling day” or in an arrangement otherwise made by the project manager.
- The sample is collected by running reagent grade water through any plasticware that is used at more than one station. Normally, this will only be the splitter churn. Water should be aliquotted in a manner that is consistent with normal sampling procedures.
- The sample will include 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity).
- Label with a “33" in the QA code.

Duplicate Sample

- At least one sample is collected for each “sampling trip”.
- The sample is collected by using a "churn splitter" to divide water from one sample site into two separate samples.
- The sample will include 2 sets of 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity).
- Label one sample set with an “11” (environmental sample) and the other sample set with a “21" (duplicate sample set) in the QA code.

Replicate Sample

- At least one sample is collected for each “sampling trip” when noted as needed by the project quality assurance plan.
- The sample is collected by repeating the exact sampling process collecting two independent sample sets.
- The sample will include 2 sets of 1-liter bottles for ice preservation, sulfuric acid preservation, metals, chlorophyll, and field parameters (turbidity, hardness, and alkalinity).
- Label one sample set with an “12” (environmental sample) and the other sample set with a “22" (replicate sample) in the QA code.

4.22 Organic Chemistry QA/QC Samples

Organic chemistry collections require all QA/QC samples described in 4.21 of this document with the exception of the field blank sample (qa code “33”). The field blank sample is not collected because no glass or plasticware is reused during the sampling process.

5.0 Personnel and Equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the collection of water quality samples requires only one field person. However, depending on the safety requirements of a particular station, additional crewmembers may be necessary to ensure a safe work zone. Equipment used to collect the chlorophyll-a sample are described in the document “Standard Operating Procedure for the Collection of Water Quality Samples”.

5.1 Depth Integrated Sampling Equipment

5.11 DH-81 Sampler

The DH-81 is used for wadable sampling and requires an ~ 4 inch MSD. The sampler is composed of 5 separate components—the DH-81A adapter, the D-77 cap, a 5/16 or 3/16 inch plastic nozzle, a 1-liter plastic bottle, and a 3 foot wading rod. The supervising F.T.E. will initially demonstrate the use of the insturment. Water should be poured into the churn-splitter by removing the nozzle attachment from the bottle. To assemble the unit, follow these steps:

- Snap the adapter over the D-77 cap,
- Determine the appropriate nozzle to use and attach it,
- Screw in the 1 liter bottle,
- Attach the wading rod. The rod should be maintained at a 90-degree angle to the surface of the water during sample collection.

5.12 DH-81hl Weighted Bottle Sampler

The DH-81hl is a hand line sampler that adapts the DH-81 sampler for bridge sampling. The sampler is composed of the following components—the DH-81 assembly (minus wading rod and adapter), the PVC main body adapter, a two piece plastic collar, 4-3/4 inch plastic thumb screws with nuts and washers, and 4 recessed hex screw caps. It is used as a weighted bottle sampler during minimal but unwadeable flows. Fins can be attached to the back of the sampler for use in flowing water. However, because the sampler does not take a truly integrated sample, it should only be used when depth-integrating equipment is not available or when true composite grab samples are adequate to meet DQO's. The supervising F.T.E. will initially demonstrate this process. Water should be poured into the churnsplitter by removing the nozzle attachment from the bottle. To assemble the sampler, follow these steps:

- Mount the plastic collar and screws onto the 1-liter sample bottle and insert into the core of the main body,
- Mount the collar on the main body with the 4-3/4 inch screws, nuts and washers (the other four recesses at the head of the main body should be capped with recessed hex cap screws),
- Attach the hand line cable and harness and lower the unit into the water.

5.13 DH-95

The DH-95 is a hand line sampler that adapts the DH-81 sampler for bridge sampling. The sampler is composed of the following components—the DH-81 assembly (minus wading rod and adapter), the bronze casted main body, and a rubber O-ring to hold the bottle assembly in place. Although the sampler is considered a handline sampler, it is bulky and can be quite heavy when lowered from a bridge. Therefore, it is normally lowered using a bridge crane. A full description for the proper use of the sampler can be found in ….. A supervising F.T.E. will initially demonstrate the use of the sampler.

5.14 D-95

The D-95 is a larger version of the DH-95 sampler. The sampler is composed of the following components—the DH-81 assembly (minus wading rod and adapter), the bronze casted main body, and a rubber O-ring to hold the bottle assembly in place. The sampler is of considerable weight and should only be used with the assistance of a bridge crane. A full description for the proper use of the sampler can be found in ….. A supervising F.T.E. will initially demonstrate the use of the sampler.

6.0 Collection of Water Quality Samples

6.1 General Sampling Methodology

A variety of sampling methods are available. These methods include depth-integrated composites (horizontal), composite grab, point grab, and near shore sampling. Depending on various factors, any of the

preceding methods can be employed. However, data quality objectives (DQO's) are the most important consideration. Representativeness and accuracy are effected by methodology. Table 1 outlines how each of the sampling methods effects these DQO's based. It is important to note, however, that site conditions may exclude methods with higher representativeness and accuracy, and conversely, may increase DQO level. Unless otherwise noted, all sampling programs will use depth-integrated composites.

Table 1. Relationship of sampling methodology to level of representativeness and accuracy. (* = denotes that level is dependent on site conditions)

Sampling Method	General Level of Representativeness	General Level of Accuracy
Depth-Integrated Composites	High	High
Composite Grab	Medium to High*	Medium to High*
Point Grab	Low to Medium*	Low to Medium*
Near Shore Sampling	Low	Low

Several factors determine what sampling method will be used. The method to use is not the same from month to month and will be affected by current site conditions. A flow chart is included at the end of this document to give quick reference to field personnel. The most obvious are the accessibility, depth, and flow of the stream. Depth-integrating samplers require a minimum sampling depth (MSD). The MSD is roughly defined as "the minimum depth at which the mouth of the nozzle can be fully immersed into the water column while remaining perpendicular to the flow of the water". Samplers used from bridges require an ~ 10 inch MSD to 8 inch MSD while wadeable samplers require an ~ 4 inch MSD. If a site does not meet the MSD for bridge sampling, it must be sampled by wading the stream. A site can be considered wadeable if the site is accessible by road or safely by foot and if the sampling personnel feels comfortable entering the stream. Therefore, if the site is not accessible for wading, a composite or point grab sample must be taken. During extreme flows, depth integration may be impossible. During these situations, a surface grab may be the only possible method. Conversely, during minimal flows depth-integration may impractical. Even though depths may meet the MSD for depth-integrating samplers, the samplers may stir up bottom sediments which would bias the sample. In these cases some form of grab sample is appropriate.

6.11 Depth Integrated Composite Sampling [Depth-Integration/Equal Width Increments (DI-EWI)]

NOTE: This method is time and equipment intensive, and may not be necessary to meet the data quality objectives of all programs.

Depth-integration (D-I) allows a flow weighted sediment sample to be collected by continuously collecting from the surface of the water through the water column. The Equal Width Increments (EWI) collects water at intervals, or verticals, over the cross-section of the entire river or stream. By coupling the methods and compositing the water collected at each vertical, a sample may be collected which represents both the horizontal and vertical profile of the waterbody.

Why is it necessary to go to so much trouble to collect a representative sample from both profiles? The method allows for a representative sample to be collected at all velocities and of all sediment sizes. Most chemicals (nutrients, minerals, toxicants, etc.) in streams and rivers may be attached to sediment. Unfortunately, sediment does not travel at a consistent rate because of two inherent properties—one related to sediment and the other related to the waterbody. The property inherent to sediment is weight. Because

sediment particles are not uniform in size and density, they will settle at varying rates in flowing water. Therefore, because a larger or denser particle may contain a larger amount of certain chemical, it is important to collect a representative sample of each partical size. The property inherent to the waterbody is velocity of flow. Streams and rivers do not flow through symmetrical concrete weirs and because of this do not have symmetrical velocities. They flow through channels that are uneven due to deposition and scouring, that meander and move, and have numerous physical obstructions. Therefore, if a stream is viewed at a single point, velocities differ through (vertically) and across (horizontally) the water column. This has a tremendous effect on how sediment flows. Therefore, because these varying velocities may contain differing amounts and types of sediments, it is important to collect a representative sample at all velocities. The entire method is described graphically in Figure 1. Please refer to the graphic throughout this subsection.

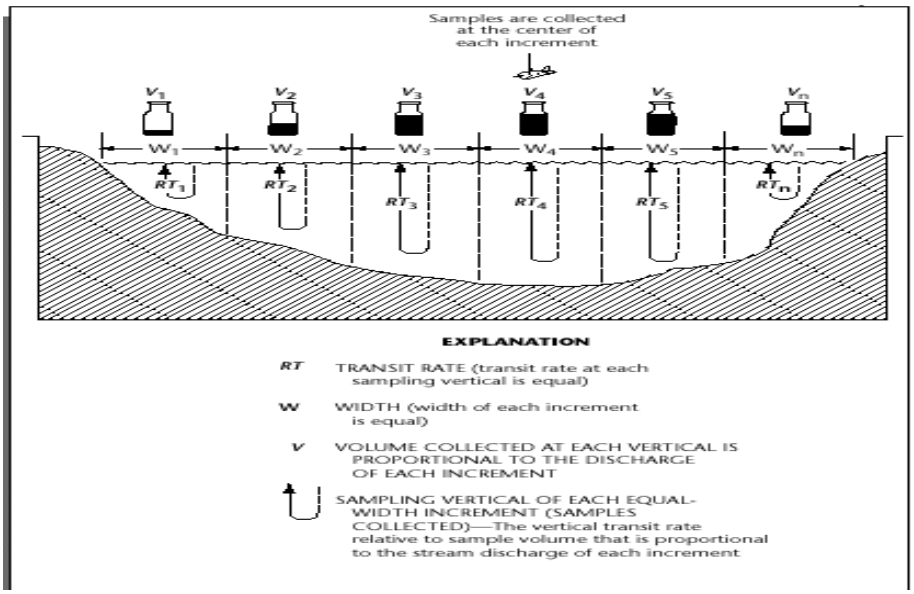


Figure 1. Graphical representation of DI-EWI.

6.11a Establishing EWI

Following is a detailed, step-by-step process of how to establish EWI.

1. **Determine the inaccessible and accessible portions of the cross-section**. Many things can make a portion of the cross-section inaccessible. These include:
    - Immovable upstream obstructions such as bridge piers (bridge sampling) and brush piles (bridge and wadeable sampling). Bridge piers are permanently marked on the bridge railing in this way " E| |P ".
    - Immovable instream obstructions such as brush piles (bridge and wadeable), rocks (bridge and wadeable), and illegally disposed of objects (bridge and wadeable).
    - Dangerous flow (bridge and wadeable). If bridge sampling is not feasible and 80 percent of the cross section can be safely waded, the sample can be taken in-stream. If this is done, make every reasonable attempt to collect a representative vertical in the area of high flow.
    - Minimal flow (bridge and wadeable). These areas only become a problem when sample collection can not be done without inadvertently collecting substrate that is suspended by the act of sampling.

- Unwadeable depth (wadeable). If bridge sampling is not feasible and 80 percent of the cross section can be safely waded, the sample can be taken in-stream. If this is done, make every reasonable attempt to collect a representative vertical in the area of unwadeable depth.
- Minimal MSD not met (bridge and wadeable). Refer to previous section on sampling equipment.
- **Exposed substrate is always excluded.**

2. **Determine the width of the of the accessible portion of the cross-section.** Because EWI involves taking measurements at incremental points along the cross-section, a tagline is used to accommodate measurements. On bridges, the tagline is painted hashmarks along the bridge wingwall, and in certain instances, along the bridge decking. The areas of the bridge railing that are outside of the normal banks but are in the bank full area of the river are not delineated to 5 and/or 10 feet but only have the 100 and 50 foot marks. A calibrated tagline or tape may also be laid on the bridge deck. All bridges should be marked with the following hashmarks (all OWRB hashes are marked in blue):

   100-foot line—full, triple mark with value beside it (e.g., 1 = 100, 2 = 200, etc.);
   50-foot line—full, double mark;
   10-foot line—full, single mark;
   5-foot line—half, single mark (not done on all bridges);
   2-foot line—half, single mark (not done on all bridges).

   In stream, a calibrated tagline is stretched across the water. Many things can be used as a tagline including measuring tape and calibrated twine. However, because Oklahoma is windy , it can be extremely difficult to set some things, and because measuring tapes and string can stretch over time, taglines may go out of calibration. Therefore, the OWRB uses 1/16 or 3/16 inch coated Kevlar. The taglines are extremely durable, stretch very little over time, and hold steady under most winds. The tagline is calibrated as follows:

   100-foot line—double, red mark;
   50-foot line—single, green mark;
   10-foot line—single, red mark;
   5-foot line—single, black mark (not done on all bridges).

   Under certain conditions, increments can be established without using a tagline. These include extremely wide cross-sections, inaccessible banks or substrates, and unmarked bridges. Increments can be established by pacing cross-section or using consistently spaced objects along the wingwall of the bridge (e.g., vertical I-beams on trestle bridges). Remember, in each situation, care should be taken to use consistent increments of measurement.

3. **Establish the points of collection for each vertical.** The number of verticals needed may vary depending on site conditions. In general, follow this rule of thumb for number to determine verticals needed;

   - Use 5 verticals when accessible cross-section is >1 but < 30 meters wide.
   - Use 10 verticals when accessible cross-section is > 30 meters wide.
   - Grab samples should be collected when accessible cross-section is < 1 meter wide.

NOTE: Site conditions that may change the preceding rule of thumb could be multiple channels, backwater flows, eddies, etc.

To establish the points do the following:

- Beginning at the near end of the accessible cross-section, mark the inaccessible portions while measuring the width of the accessible of the cross-section. (Two widths should be noted on the field sheet: 'total bank to bank width/sampled width'.)
- Divide the width of the accessible cross-section by 6 (5 increments) or 11 (10 increments) to determine the width of each increment. This excludes both near shore areas from the sampling cross-section.
- Starting at the far end of the accessible cross-section, measure out one full increment and place a mark to establish the first vertical.
- Establish each vertical in the same way until the near end of the accessible cross-section is reached (remember to exclude the inaccessible portions).

6.11b Depth-Integration

To use EWI D-I, follow these steps:

1. **Approximate the velocity (none, minimal, light, moderate, heavy, or storm water) at each vertical.** This can be done by visually assessing the displacement of the sampler or wading before sampling. Make notes on amount of weight and/or nozzle size to be used at each vertical.
2. **Approximate the transit rate to be used.** Collect water for the native rinse at the vertical with the greatest estimated flow (highest velocity and deepest depth). Establish the transit rate as the "time it takes to obtain approximately 1-liter of water at the thalweg." This will ensure that an adequate amount of water is collected.
3. **Choose appropriate sized sampler and attach appropriate nozzle.** Remember to maintain an equal rate of transit throughout the water column. Detach the nozzle cap before pouring sample into churn splitter. The general rule of thumb for nozzle size is:

    - No nozzle in minimal velocities (will be using a weighted bottle sampler anyway);
    - 5/16 nozzle for low to medium (narrower) velocities;
    - ¼ nozzle for medium to high (narrower) velocity;
    - 3/16 nozzle for high (wider) to storm water velocities.

4. **At the approximated transit rate, lower and raise the unit through the water column.**
5. **Repeat steps 4 until cross-section is completed.** When sampling only 5 verticals it may be necessary to sample each vertical more than once so that enough water is collected. **If this is necessary, each vertical must be sampled the same number of times**.
6. **By using a churn or cone splitter, split the composite sample into the appropriate number of sampling bottles.**

NOTE: Inevitably, there will be occasions when the velocity cannot be compensated for and a representative sample cannot be collected. On such occasions, collect as far into the water column a possible, and note that "sampling through the water column was not possible due to..." on the 'sampler's comments' field sheet.

NOTE: When samplers are hand-lined, it is difficult to maintain a consistent transit rate. To be as consistent as possible, establish a count for each overhand pass of the hand-line and always use the same hand-line motion during the entire sampling event.

6.12 Composite Grab

A composite grab is made under several circumstances:

1. **The MSD for the wadeable or bridge sampler is not met.** As was stated before, samplers require a 4-10 inch MSD to work. At certain times of the year, this can't be met at any point across the stream. Occasionally, in sandy-bottomed waters, a space can be dug out to allow the MSD to be met. However, care should be taken not disturb bottom sediments into the sampler.
2. **The waterbody is at minimal flows.** When a stream or river is at minimal flow, attempting to take a depth-integrated sample may disturb bottom sediments, which would potentially bias the sample.
3. **The waterbody is at extreme flows.** When a stream or river is at extreme storm water flow, it may be impossible to lower the sampler through the water column. In these cases, by continuing to use the sampler, a grab sample can be taken. It is a grab sample because it does not sample completely through the vertical profile.
4. **The waterbody is a series of disconnected pools.** In these cases, take a representative grab sample from several of the pools and add to the composite.

To take a composite grab, follow these steps:

1. **Using EWI, establish verticals through the cross-section (refer to above).**
2. **When wading the waterbody, use a wide-mouthed bottle to collect water at each vertical and add to the composite.**
3. **When sampling from a bridge, use a weighted-bottle sampler to collect at each vertical and add to the composite.**
4. **Note the use of the composite grab technique on the field sheet.**

6.13 Point Grab

A point grab is made under several circumstances:

1. **The stream is less than one meter wide.**
2. **The stream is less than three meters wide and is at minimal flow.**
3. **The waterbody is one large pool surrounded by dry streambed.** Take a point grab at the center of the pool.

To take a point grab, follow these steps:

1. **Establish the thalweg (deepest, fastest moving part) or center of the waterbody.**
2. **When wading the waterbody, use a wide-mouthed bottle to collect water at the point and fill the necessary amount of sample bottles.**
3. **When sampling from a bridge, use a weighted-bottle sampler to collect water at the point and fill the necessary amount of sample bottles.**
4. **Note the use of the point grab technique on the field sheet.**

6.14 Near Shore Sampling

When a stream or river is inaccessible by bridge, boat, or wading, it may be necessary to collect a near shore sample. Extended samplers are made and should be used to extend the point of sampling as far away from

the shoreline as possible. If an extended sampler is unavailable, every effort should be made to extend as far as possible away from the shore.

To take a point grab, follow these steps:

1. **Use a wide-mouthed bottle to collect water at the point and fill the necessary amount of sample bottles.**
2. **Note the use of the point grab technique on the field sheet.**

6.2 Methods for Splitting Composite Samples

6.21 Splitter Churn

A splitter churn is used to aliquot a composite sample into various bottles for further analytical analysis. It can be made of polyethylene or teflon and is composed of the following parts—the bucket with a spline used for guiding the churn and a spigot for dispensing the sample, a churn, a hose, and a top cap. The following guidelines must be followed when using a splitter churn:

- The churn should always mate properly to the spline when inserted into the bucket. By doing this, the vertical lip of the churn is centered over the spigot. This orientation allows for the churned composite to be properly dispensed.
- Churning of the sample should always been done at a slow, consistent pace. Churning the sample at a high rate of speed can agitate the sample and bias it.
- The spigot should always be kept free of obstructions so that a continuous even flow exits the bucket into the sample containers.
- A hose should be attached to the spigot when dispensing the sample to avoid cross contamination of the sample.
- Flow through the hose.should be maintained in a continuous stream when aliquotting the sample.
- The churn cap should always be in place during both sample collecting and dispensing.
- The churn should be kept in a clean plastic bag during both sample collecting and dispensing.

6.22 Sample Inversion

Sample inversion is used to aliquot a composite sample into various bottles for further analytical analysis. The method is normally used when a plastic churn can not be used or a teflon churn is not available. The method involves collection of the composite sample to a larger collection bottle usually made of glass. The sample is alliquotted by inverting the collection bottle until adequately mixed and dispensing the mixed composite to the sample bottles. The following guidelines must be followed when using the sample inversion method:

- The collection bottle should always be capped between verticals.
- To adequately mix the composite, the collection bottle should be inverted at least ten times.
- To avoid sample aeration or over agitation, the inversions of the bottle should be done at a slow, consistent pace.
- Only one sample bottle should be filled for each inversion cycle. If two bottles are required for a complete sample, the collection bottle should go through an inversion cycle for each bottle.

6.3 Types of Water Quality Samples

6.31 Inorganic Panel

The inorganic panel is proceessed through an analytical laboratory for a nitrogen series, phosphorus series, and certain minerals. A solids series may also be included in this panel. These samples are almost always split using a splitter churn. Unless otherwise described in a project quality assurance plan, these samples are

collected by splitting the composite to two 1-liter polyethylene sample bottles. Completed samples should be void of air. One sample bottle is preserved on ice at 4°C, and the other sample bottle is preserved on with concentrated sulfuric acid on ice at 4°C. Because these samples are normally processed for both a nitrogen and phosphorus series, they normally have a 48 hour hold time and must be returned to the laboratory within that holding time.

6.32 Field Panel

The field panel is proceessed by field staff for turbidity, hardness, and alkalinity. These samples are almost always split using a splitter churn. Unless otherwise described in a project quality assurance plan, these samples are collected and processed at the site but may be split a small polyethylene sample bottle or the 1 liter collection bottle used during sampling. Completed samples should be void of air. If samples are collected for processing at a later time, the sample is preserved on ice at 4°C. Because alkalinity and turbidity have a 24 hour hold time, samples must be processed within a 24 hour time period and must be brought to ambient temperature before analyzed. Processing of these samples is described in other SOP's which are referenced in Section 9.0 of this document.

6.33 Metals Panel

The metals panel is proceessed through an analytical laboratory for metals included in the Oklahoma Water Quality Standards (OWQS) and various other minerals depending on the project. These samples are almost always split using a splitter churn. Unless otherwise described in a project quality assurance plan, these samples are collected by splitting the composite to one 1-liter polyethylene sample bottle. Completed samples should be void of air. The sample is preserved with concentrated nitric acid on ice at 4°C. When cadmium, copper, lead, and silver are collected In areas with a hardness of less than 150 ppm, a second sample bottle is split and preserved in the same fashion. So that lower reporting limits may be obtained, the analytical laboratory processes this sample using a more sensitive methodology.

6.34 Organics Panel

The organics panel is proceessed through an analytical laboratory for various organics listed in the OWQS. Depending on the organics of interest, the analytical methods may include 515.3, 608, 614, 8260, and 8270. These samples are almost always split using the bottle inversion method. Unless otherwise described in a project quality assurance plan, these samples are collected by splitting the composite from a 1 gallon glass jar to various quart or pint glass containers. Completed samples should be void of air. Bottles are preserved on ice at 4°C.

7.0 Forms

7.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

7.2 Laboratory Log-in Sheets

Log-in sheets are documents turned into the analytical laboratory for each sample collected. These forms are used to denote the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time of sample collection and be legible and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper

procedure to complete the log-in sheets, refer to your supervisor and or FTE. Log-in sheets can be found at S:\Monitoring\STREAMS\forms\.

7.3 Chains of Custody

Chains of custody are documents turned into the analytical laboratory for each group of samples collected. These forms are used for several purposes. They act as a legal document to show proper delivery of samples occurred and they make a general list of the parameters that should be analyzed. Chains of custody are available for inorganic, metals, and organics panels. They are a data sheet and should be treated as such. Therefore, they should include the date and time for each sample collected and be legible and complete. They should also be signed and dated by field and laboratory receiving personnel at the time of delivery. To avoid confusion and loss of data, a new chain of custody should be used for each group of samples. For guidance on proper procedure to complete the chains of custody, refer to your supervisor and or FTE. Chains of custody can be found at S:\Monitoring\STREAMS\forms\.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

American Public Health Association, et. al. Standard Methods for the Examination of Water and Wastewater (18th ed.). Port City Press, Baltimore, MD., 1992.

National Field Manual for the Collection of Water Quality Data, by F.D. Wilde and D.F. Radtke: USGS—TWRI Book 9, 1997.

STANDARD OPERATING PROCEDURE FOR THE MEASUREMENT OF HARDNESS AND ALKALINITY IN STREAMS

DRAFT—UNDER REVIEW FOR SECTION 2 and 9

1.0 General Information

Hardness and Alkalinity data are collected to assist in understanding the mineral content/conductivity of the waterbody. Furthermore, hardness is used in the establishment of hardness-dependent toxicant criteria. Following is a detailed description of sample processing using Hach Field Analysis Kits. Any kit may be purchased and used.

2.0 Definitions/Terms

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining "Traffic Safety Protocols".

4.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO's) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory. The QA/QC protocols for hardness and alkalinity can be found in the document "Standard Operating Procedure for the Collection of Water Quality Samples".

5.0 Personnel and Equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the collection of water qulaity samples requires only one field person. However, depending on the safety requirements of a particular station, additional crew members may be necessary to ensure a safe work zone. Equipment used to collect the hardness and alklainity samples are described in the document "Standard Operating Procedure for the Collection of Water Quality Samples".

5.1 Hach© Hardness and Alkalinity Kits.

5.11 Maintenance

When not in use, the kits should be kept in their blue field case. The glassware, titrators, and chemicals should be kept dry and clean both inside and out. The glassware should be kept free of inner abrasions. After each measurement, all glassware and titrator tubes should be rinsed twice with deinonized water. Instruments should never be stored in temperatures below freezing in extremely hot temperatures.

5.12 Calibration of Titrators

Titrators do not require specific calibration and should maintain calibration throughout their life. However, a known sample should be run periodically to ensure that titrators have maintained calibration.

6.0 Measurement

6.1 Alkalinity Sample Collection and Analysis.

Alkalinity is collected using mehtods described in the document "Standard Operating Procedure for the Collection of Water Quality Samples". Alkalinity should be measured at the site. On occasion, this may not be possible, so it must be read within 24 hours of collection. If analysis will be done later, water is collected using a clean plastic bottle. Prime the bottle with native water from the churn splitter and, while churning, completely fill bottle ensuring that the bottle is not aerated. Place on ice until analysis is made. Samples should be brought to ambient temperature before analysis. Do not aerate the sample before testing. Both "phenolphthalein alkalinity" and "total alkalinity" will be measured and recorded.

To perform the test, follow these steps:

1) Select the sample volume and sulfuric acid titration cartridge responding to the expected alkalinity concentration (this chart is in the Hach© "Digital Titrator Manual" on page 33). The expected concentration can be ascertained from trip notebook.
2) Insert a clean delivery tube into the titration cartridge. Attach the cartridge to the titrator body.
3) Turn the delivery knob to eject a few drops of titrant. Reset the counter to zero and wipe the tip.
4) Use a graduated cylinder to measure the sample volume from table 1 on page 33 in the manual. Dilute with deionized water to the 100-ml mark if necessary. Transfer the sample to a clean 250-ml Erlenmeyer flask. Make sure that all glassware has been rinsed with deionized water and primed with native water before analysis begins.
5) Add the contents of one phenolphthalein indicator powder pillow and swirl to mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
6) If the solution turns pink, titrate to a colorless end point. Place the delivery tube tip into the solution and swirl the flask while titrating with sulfuric acid. Record the number or digits required to reach end point.
7) Calculate: Digits required X digit multiplier = mg/L CaCO3 P- Alkalinity.
8) Add the contents of one bromocresol green-methyl red indicator powder pillow to the flask and mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
9) Continue the titration with sulfuric acid to a light pink (pH 4.5) color. Record the number of digits required.
10) Calculate: total digits required X digit multiplier = mg/L as CaCO3 Total Alkalinity
11) Report both alkalinity values on the field notes for the station.

6.2 Hardness Sample Collection and Analysis.

Alkalinity is collected using mehtods described in the document "Standard Operating Procedure for the Collection of Water Quality Samples". Hardness should be measured at the site; however, on occasion this may not be possible, so it must be read within 48 hours of collection. If analysis will be done later, water is collected using a clean plastic bottle. Prime the bottle with native water from the churn splitter and, while churning, completely fill bottle ensuring that the bottle is not aerated. Place on ice until analysis is made. Samples should be brought to ambient temperature before analysis. Do not aerate the sample before testing. "Total hardness" will be measured and recorded.

To perform the test, follow these steps:

1) Select the sample volume and EDTA titration cartridge responding to the expected hardness concentration (this chart is in the Hach© "Digital Titrator Manual" on page 108). The expected concentration can be ascertained from trip notebook.
2) Insert a clean delivery tube into the titration cartridge. Attach the cartridge to the titrator body.
3) Turn the delivery knob to eject a few drops of titrant. Reset the counter to zero and wipe the tip.
4) Use a graduated cylinder to measure the sample volume from table 1 on page 108 in the manual. Dilute with deionized water to the 100-ml mark if necessary. Transfer the sample to a clean 250-ml Erlenmeyer flask. Make sure that all glassware has been rinsed with deionized water and primed with native water before analysis begins.
5) Add 2 ml's of Hardness 1 Bufer Solution and swirl to mix well.
6) Add the contents of one Man Ver 2 Hardness Indicator powder pillow to the flask and mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
7) Titrate with appropriate EDTA titrant from red to a pure blue color. Record the number of digits required.
8) Calculate: total digits required X digit multiplier = mg/L as CaCO3 Total Hardness.
9) Report total hardness on the field data collection sheet. One duplicate, blank and known sample should be collected for each sampling trip.

7.0 Forms

Hardness and alkalinity data are maintained on the station field form. They are data and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

Hach Company. Digital Titrator Model 16900-01 Manual. Loveland, CO., 1988.

STANDARD OPERATING PROCEDURE FOR THE MEASUREMENT OF TURBIDITY IN STREAMS

DRAFT—UNDER REVIEW FOR SECTION 2 and 9

1.0 General Information

Water for use in turbidity analysis is collected using one of the vials in the turbidometer kit (for immediate analysis) or a clean one pint plastic bottle (for later analysis). Prime the vial or bottle with native water from the churn splitter and, while churning, fill the vial above the white line or fill the pint bottle to the top ensuring that the bottle is not aerated. If collecting for later analysis, place the bottle on ice until analysis is made (water must be brought to ambient temperature for an accurate reading to be determined). Analysis must be made in 24 hours, but immediate analysis is preferable. Turbidity is measured using the Hach© 2100P portable Turbidometer. Remember that dirty glassware and the presence of air bubbles may give false results. Be sure to record all calibration information in the log notebook found in each Turbidometer case.

2.0 Definitions/Terms

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining “Traffic Safety Protocols”.

4.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO’s) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory. The QA/QC protocols for turbidity can be found in the document “Standard Operating Procedure for the Collection of Water Quality Samples”.

5.0 Personnel and Equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the collection of water qulaity samples requires only one field person. However, depending on the safety requirements of a particular station, additional crew members may be necessary to ensure a safe work zone. Equipment used to collect the turbidity sample are described in the document “Standard Operating Procedure for the Collection of Water Quality Samples”.

5.1 Hach© 2100P PORTABLE Turbidometer.

5.11 Maintenance

When not in use, the turbidometer and vials should be in kept their blue field case. The instrument should be kept dry and clean both inside and out. The vials should be kept clean and free of abrasions. After each measurement, the vial and lid should be rinsed twice with deinonized water and stored filled with deionized water. Vials should never be stored inside the instrument. Instruments should never be stored in temperatures below freezing in extremely hot temperatures.

5.12 Calibration

There are 2 types of calibration for the Hach© 2100P - primary and secondary calibration. Primary calibration must be completed at least every three months. Primary calibration should also be completed every time batteries are changed, every 3 months, or if secondary calibration values are significantly different from the last primary calibration values. A secondary calibration must be completed at the beginning of each sampling day. Secondary calibration uses the gelex secondary standards stored in each Turbidometer case. Once secondary calibration is complete and the results are satisfactory, you are ready to read the turbidity of actual samples.

To perform a primary calibration:

1) Place a drop of silicone on the Stabl Cal <0.1 NTU ampule (blank) and spread evenly with a chemwipe. Place the ampule in the cell compartment and align the orientation arrow with the orientation mark on the front of the cell compartment. Close the lid. Turn the Hach 2100P on by pressing **I/O**.
2) Press **CAL** and the "S0" icons will be displayed. The "0" will flash. The 4-digit display will show the value of the SO standard for the previous calibration. If the blank value was forced to 0.0 the display will be blank. Press to get a numerical display.
3) Press **READ**. The instrument will count from 60 to 0 (67 to 0 if the signal average is on), read the blank. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
4) The display will show the "S1" (with the 1 flashing) and the "20 NTU" or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the key until the number that needs editing flashes. Use the key to scroll to the correct number. After editing, insert the 20 NTU Stabl Cal ampule (coated with silicone) into cell compartment, align orientation marks, close lid and press **READ**. The instrument will count from 60 to 0, measure turbidity, and store value. Remove ampule.
5) The display will show the "S2" and the "100 NTU" or the value of the S2 standard for the previous calibration. If the value is incorrect, edit using previously described procedure. Insert the silicone coated 100 NTU Stabl Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then automatically increment to the next standard. Remove the sample ampule from the cell compartment.
6) The display will show the "S3" and "800 NTU". If the numeric value is incorrect edit as described above. Insert the silicone coated 800 NTU Stabl Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then automatically increment back to the S0 display. Remove the sample ampule from the cell compartment.
7) Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
8) In the calibration log book, Record the date, your initials, and primary calibration completed.
9) Next, perform a secondary calibration as described below.

To perform a secondary calibration:

1) Turn the Hach© 2100P on by pressing **I/O**.
2) Select automatic range mode using the **RANGE** key. This setting should always be set to whole numbers unless changed by the project manager.
3) Thoroughly clean the outside of the gelex vials and apply a thin coating of silicone oil using a **chemwipe (abrasive material will scratch the vial)**.
4) Place the 0-10 NTU Gelex standard in the cell compartment and align orientation marks. Close the lid and press **READ**. Record the value on the calibration log.

5) Repeat steps 3 and 4 for the 10-100 NTU and 100-1000 NTU Gelex standards. If this is the first measurement of Gelex values following primary calibration, these values will be what future readings are compared to for accuracy. If this is not the first measurement following primary calibration, compare to the values collected immediately following primary calibration. If the two sets of values are significantly different, primary calibration is necessary.

6.0 Measurement of Turbidity

6.1 General Guidelines for Measuring Turbidity

1) **Turbidity should be measured at the site**, but on occasion this may not be possible, so it must be read within 24 hours of collection.
2) **Sample should always be well mixed.** Sample vial must be well mixed immediately before reading. If the sample is to be read later, bottles must be well mixed to dislodge any particles that may have settled.
3) **Attempt to use the same sample cell when measuring turbidity.** The glass in each cell is slightly different and therefore reflects light differently. Using separate cells for each sample could introduce additional error to the method and bias results.
4) **It is imperative to clean and prime the glass before each use.** Scratches, fingerprints, and water droplets on the inside of the turbidity tube or inside the light chamber can cause stray light interference, leading to inaccurate results.
5) **Do not let the glass fog while reading the sample.** As stated before, it is important to read samples at the ambient temperature, but this may not be possible if the temperature of the water is too cold. In this case, collect the sample in the vial and allow it to warm before taking the reading. If samples were stored on ice, the sample must be allowed to warm before reading.
6) **Make three turbidity readings per sample.** Record the cumulative total and the average (rounded to the nearest whole number) on the field data sheet (e.g., 2 readings of 30 and 1 reading of 31 would be recorded as "3/91 = 30").

6.2 Measurement with Hach© 2100P unit.

To measure turbidity, follow these steps:

1) Clean vial with deionized water ensuring that all residue is gone,
2) Prime vial with sample water,
3) While churning, fill vial to the white line (miniscus should sit on the white line),
4) Clean vial with silicone oil by adding a single dropping and spreading with a chemwipe (do not use an abrasive cloth),
5) Invert vial several times and visually ensure that all sample particles have been dislodged,
6) Place vial in cell compartment, align orientation marks, and press **READ** (samples should be read with no decimal),
7) Record reading and visually ensure that the sample did not fog,
8) Repeat steps 4-7 two times (for a total of 3 readings). It will not be necessary to add a drop of silicone oil after each reading. The vial can be cleaned with only the previously used chemwipe.
9) Turn unit off after each use.

7.0 Forms

Turbidity data are maintained on the station field form. They are data and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database. Each sample should be maintained electronically in the database under a unique sample number.

10.0 References

STANDARD OPERATING PROCEDURE FOR THE RECORDING OF PHYSICAL / CHEMICAL PARAMETERS USING A MULTIPARAMETER INSTRUMENT IN STREAMS

DRAFT—UNDER REVIEW FOR SECTION 2 and 9

1.0 General Information

A Hydrolab® or Y.S.I. ® sonde is used to collect and store information for some of the physical/chemical parameters of the stream being studied. Parameters measured by these sondes include water temperature, dissolved oxygen (D.O.), dissolved oxygen % saturation, pH, specific conductivity, salinity, depth, oxidation-reduction potential (redox),and total dissolved solids. There are many similarities in operating both types of sondes. Some instructions on operating the Hydrolab® are provided in this document but specific training on the operation of each sonde will be provided by the supervising F.T.E. The important thing to remember is to always use the same type of sonde (even the same serial number sonde, when possible) throughout a particular study so that data collected is comparable.

2.0 Definitions/Terms

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining “Traffic Safety Protocols”.

4.0 Quality of the Measurement

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO's) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Known standards for each parameter should be routinely measured. Protocols for these calibrations are listed in Section 5.12 of this document

5.0 Personnel and Equipment

In most instances, the collection of water qulaity samples requires only one field person. However, depending on the safety requirements of a particular station, additional crew members may be necessary to ensure a safe work zone. Equipment used to collect the turbidity sample are described in the document "Standard Operating Procedure for the Collection of Water Quality Samples".

5.11 Hydrolab© Datasonde, Minisonde, and Surveyors

Check calibration and maintenance logs before leaving office to ensure that the pre-trip calibration has occurred. If calibration has not occurred, perform the pre-trip calibrations (a supervising F.T.E. will demonstrate calibration techniques and the unit's operations manual can be consulted for calibration techniques). **ALL CALIBRATIONS AND MAINTENANCE MUST BE RECORDED IN THE UNIT'S LOGBOOK.**

5.12 Maintenance

When not in use, the hydrolab units should be in kept in their carrying case. The instrument should be kept dry and clean both inside and out. After each measurement, the probes should be rinsed twice with tap water and stored in the storage cap in tap water. Instruments should never be stored in temperatures below freezing in extremely hot temperatures. Surveyor stored data should be recorded and deleted on a weekly schedule. Failure to do so may result in shortening the life of the internal lithium battery and/or the loss of valuable field data.

Speicific pre-trip and in field maintenance should occur for the sonde as follows

- **Sonde casing.** Check the sonde casing periodically for crackes or looseness of connections. Connections may need to be tightened or re-siliconed periodically (only after the approval of a supervisor or senior staff member).
- **Bulkhead.** Periodically check the bulkhead connection for bent pins or looseness.
- **Dissolved Oxygen Probe.** Check the probe membrane for any cracks, bubbles, or other abnormalities, and change membrane if necessary.
- **PH Probe.** Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only after the approval of a supervisor or senior staff member). Clean with warm soapy water and Q-tip.
- **Specific Conductance(SpC) Probe.** Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only after the approval of a supervisor or senior staff member). Clean with warm soapy water and Q-tip.
- **Stirrer.** Periodically take the stirrer end off and clean out embedded sediment.

5.13 Pre-trip Calibration

Speicific weekly pre-trip calibrations should occur for each probe as follows:

- **Dissolved Oxygen Percent Saturation.** Perform an "air" calibration with tap water using the barometric pressure (BP) of the laboratory. The lab and field barometers give BP in units of "inHg", and the unit can only accept BP in units of "mmHg". A conversion chart is provided in the laboratory and in each field notebook (the conversion is 'inHg x 25.4 = mmHg').

- **PH Probe.** Determine the expected range of pH by consulting the station data, and perform a two-point calibration based on the pH values. For example, if the ranges on the trip are from 7.5 to 8.1, perform a 7-10 pH calibration, or if the ranges are from 6.6 to 7.1, perform a 7-4 pH calibration. If values vary from station to station, always calibrate to the first station on the trip.
- **Specific Conductance(SpC) Probe.** Determine the expected range of SpC by consulting the station data, and perform a two-point calibration based on the SpC values. For example, if the ranges on the trip are low range (< 700), perform a 0-500 SpC calibration, or if the ranges are high range (> 700), perform a 0-1413 SpC calibration. If values vary from station to station, always calibrate to the first station on the trip.
- **Oxidation/Reduction Potential (ORP):** Should be performed once per month. Consult unit logbook to determine if needed.

5.14 Site Specific Calibrations or Checks

The following in-field calibrations and checks should occur as follows:

- **Depth:** Depth (meters) should be calibrated to 0.1 at each station.
- **Dissolved Oxygen Percent Saturation (D.O.):** At each station, check the probe membrane for any cracks, bubbles, or other abnormalities, and change membrane if necessary. Dissolved oxygen percent saturation should also be calibrated when BP change is greater than 0.5 inHg in comparison to the previous calibration, when the reading is below the screening, or when the reading is outside the norm for a particular station (refer to the description of lab calibration). Local BP can be obtained from the SHERPA® weather watch or a comparable instrument (an FTE will demonstrate appropriate use and calibration of the watch). Also, the tap water used for calibrating should be changed each time calibration is done. Fresh tap water should be collected in the morning and at least once during the day and should always be kept in the cab of the truck to avoid freezing or over-heating.
- **pH:** At each station, check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of pH by consulting the station data. Refer to the description of lab calibration. If the initial reading at a site is outside the range of current calibration, the instrument needs to be calibrated to the correct two point calibration. If the reading is outside the OWQS standard of 6.5 to 9.0 s.u.'s, then the instrument needs to be calibrated at the appropriate range to ensure that the reading is accurate.
- **Specific Conductance(SpC):** Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of SpC by consulting the station data. Refer to the description of lab calibration. If the initial reading at a site is outside the range of current calibration, the instrument needs to be calibrated to the correct two point calibration.
- **Oxidation/Reduction Potential (ORP):** Do not perform in field.

5.15 Post-Trip Checks

All units should undergo a post-trip check. After each trip (normally before pre-trip calibration for the following week), the unit should be checked against known standards to ensure that probes are reading correctly. If a probe is not reading correctly, the information should be recorded in the log book and on the field sheet of comments of the previous trip.

6.0 Measurement of *in-situ* Parameters Using Multiparameter Instruments

No matter which sonde is used, similar techniques are used to collect data. At each site, data is collected at the thalweg (the major channel). The collection method will be different for bridge sites and wadeable sites. For bridge sites, the sonde unit will be connected to the data logger using the 150-foot cable. It is important to ensure that sonde unit is in the water, and depending upon flow, different sized weights may be necessary. If the flow is so high that an accurate reading can not be obtained, the reading may be taken outside of the thalweg in an area of lesser flow (note in the "sampler's comments" portion of the laboratory log-in sheet). After lowering the sonde into the water, allow the unit to equilibrate. Equilibration should take no more than 1 to 2 minutes. The key is to allow all the parameter readings to

stabilize before storing the information. Because streams and rivers have a constant mixing zone, the sonde readings can be taken from just below the surface of the water to the midpoint of the water column (sampling near the stream bed may bias certain parameters). The supervising F.T.E. will instruct you on how to operate and store data in the logger unit and also how to extract data from the surveyor unit for recording on the field sheet. Use a 5-meter cord for wadeable streams.

6.1 Hydrolab

6.11 Creation of Manual File

Each trip requires a different manual file be created. Only needs to be done at the beginning of the trip. Create the file by doing the following:

- sequence: I/O ➔ File ➔ Create ➔ Enter file name ➔ Done ➔ select parameters to be measured ➔ Done.
- File names should be written in the following sequence: trip number, trip type, month, year. For example, permanent station trip number 7 taken during November of the year 2000 would be written as "07AT1100".
- Parameters to be measured should already be entered and be in the correct order. If they need to be entered, do so in the following order: "date(MMDDYY)/time(HHMMSS)", "depth(meters)", "water temp(°C)", "dissolved oxygen(mg/L)", "dissolved oxygen(%sat.)", pH(units)", "specific conductivity(æS/cm)", "salinity(ppt)", oxidation/reduction potential(mV)", "total dissolved solids(g/L)", "circulator(status)", "IB volts(volts)", "IB percentage(%left)".

6.12 Connecting the Sonde to the Surveyor

- The surveyor is connected to the cable at the serial port on the back of the unit. Ensure that pins are fully aligned before tightening screws. Do not force or over-tighten screws.
- The sonde is connected to the cable at the bulkhead. Ensure that the sonde pins are aligned with the bulkhead by matching the raised knot on the bulkhead to the large pin on the sonde. Snap the two ends together and screw the sleeve tight. (**NOTE**: If pins are bent and do not completely connect, the unit will not work properly.
- Use 150-meter cable when working from bridge and 5-meter cable when wading.
- **BEFORE PROCEEDING, ENSURE THAT ALL CONNECTIONS BETWEEN SONDE /CABLE/SURVEYOR ARE SECURED.**

6.13 Measuring and Recording Readings

- Each site will be measured at or near the thalweg at a depth of 0.1 to 0.5 meters.
- Lower the sonde unit to the desired depth and wait for the Hydrolab to equilibrate (especially D.O., temp., and specific conductivity readings) before selecting the STORE key to save the displayed information.
- When the readings are stabilized, press **Store**. Now the reading for that site is stored into the manual file of the Hydrolab and is safe from human error. **Before pressing store be sure to read the file that you are storing to. The surveyor unit may bring up another file that is in the unit.**
- After storing the information, data will need to be recorded to the multiprobe field data sheet. This can be accomplished by using the **Review** option under the **File** menu for the surveyor 4. It is best to record data on site.

7.0 Forms

Multiparameter data are maintained on the station field form. They are data and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. Both sonde and surveyor serial numbers should be recorded on the field notes. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

STANDARD OPERATING PROCEDURE FOR THE MEASUREMENT OF STREAM DISCHARGE

DRAFT—UNDER REVIEW FOR ARRANGEMENT OF SOP (NEEDING SEVERAL SECTIONS ON SAFETY, PERSONNEL, ETC.); METHODOLOGY IS APPROVED

1.0 General Information.

This SOP will provide general information for the collection of discharge information as well as the establishment of stage-discharge relationships. The obtainment of accurate flow measurements is more a matter of physical technique than it is of instrument operation. Each stream will present you with a unique physical situation; therefore, it is not possible to describe to you what to do under any situation. The following instructions are presented as guidelines but you will have to exercise considerable judgement in the field to obtain good results.

2.0 Site Selection

2.1 Controls. Following is a brief description of controls. These will be explained more fully in the field. An excellent resource is the USGS "Techniques of Water Resources Investigations Reports" which can be found on the USGS website.

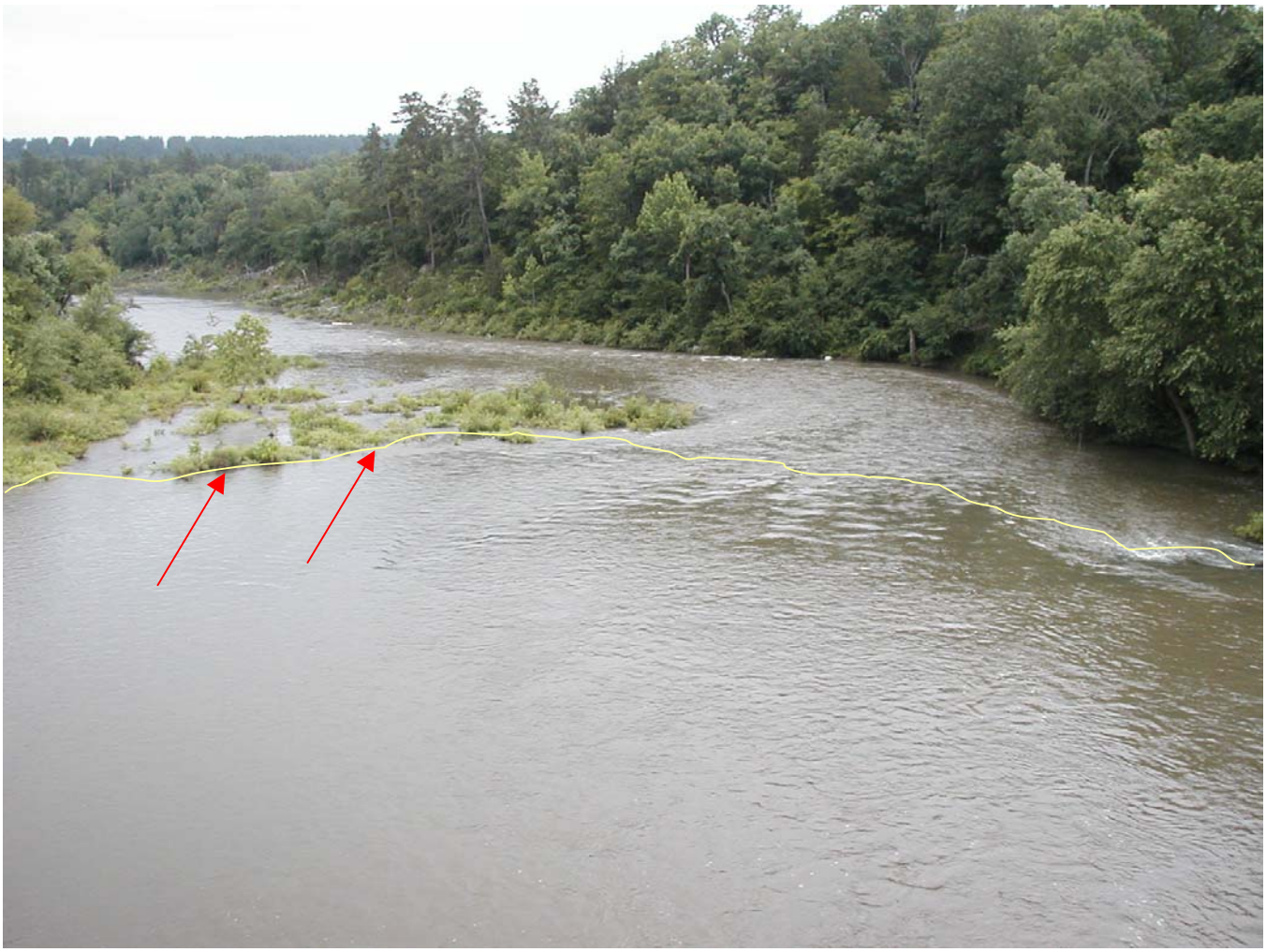
Low Water Controls. An LWC governs the stage discharge relationship at low water. Figure 1 is an example of a rock dam controlling the upstream pool elevation.

Figure 1. Low Water Control

Medium Water Controls. An MWC governs the stage discharge relationship at medium water. Figure 2 is an example of an MWC. As the photo shows, stage is being controlled by the U-shaped channel and not the LWC.

High Water Controls. The HWC governs the stage discharge relationship when the water extends past the MWC. The actual HWC is the floodplain of the waterbody.

Figure 2. Medium Water Control



2.2 Measurement Location

For wadeable measurements, the portion of the stream where flow is to be measured should be as uniform as possible. Avoid stagnant areas or those with irregular bottoms, turbulent flow, standing waves, or strongly sloping bottoms. For small streams, the narrowest portions are generally best as velocities will be higher and fewer measurements will be required. Consult the location descriptions and/or supervising FTE to assist in the determining optimal location to measure flow.

3.0 Collecting discharge Measurements

Accurately measuring discharge requires that real differences in both the vertical and horizontal profile of the stream be adequately characterized. By following the general rules of this section, stream discharge should reach the level of needed accuracy. Following is a description of the various activities involved in taking stream measurements. These are general rules and each stream during varying conditions may need to be approached in a different manner. This experience comes through time, observation, and direction from experienced technicians.

3.1 Establishment of Measurement Verticals

Before measurements begin, the stream should be divided into a number of measurement verticals (intervals). The more segments, the more accurate the results. The ideal setup divides the stream so that each segment accounts for 5% of the flow, but under some circumstances, each measurement may unavoidably account for no more than 10% of the flow. Using this method establishes more accurate readings in two ways. First of all, if one measure is inaccurate, it will not significantly affect the results. Secondly, by dividing the stream into a number of segments, the chance of missing an area of significantly higher or lower flow decreases. The following is a general rule of thumb to be used when establishing measurement verticals:

- **ALWAYS ESTABLISH THE GENERAL TREND OF VERTICAL WIDTHS BEFORE BEGINNING MEASUREMENTS.**
- **Minimum vertical width is 3 inches.**
- **In streams greater than 5 feet wide, at least 20 and no greater than 35 verticals should be established.**
- **Vertical width should lessen as depth increases and widen as depth decreases.** Generally, an increase of 25% in depth, should cause a 50% decrease in vertical width, and vice-versa.
- **Vertical width should lessen as velocity increases and widen as velocity decreases.** Generally, an increase of 25% in velocity, should cause a 50% decrease in vertical width, and vice-versa.

3.2 Edges of Water

In many streams, the first foot or so of stream from the bank is very shallow and stagnant. These areas are known as the left edge of water (LEW) and the right edge of water (REW). Edge of water is determined by looking downstream with the right bank being the REW and the left bank being the LEW. There are two approaches to dealing with this problem. The first is to ignore the shallow portion while the second involves averaging the depth and velocity between the bank and the first sample point. The best approach is to take the first measurement at the closest point where depth and flow are adequate. Any stream area closer to the shore than one-half the segment width from this point is not measured for velocity.

3.3 Placement of tag line

A tag line is Kevlar line that has been marked in graduated intervals to assist in accurate determination of width and interval locations. The graduations are in 1 (blue), 5 (single red), 10 (double red), 50 (single green), and 100ft (double green) increments.

Process of tag line placement:

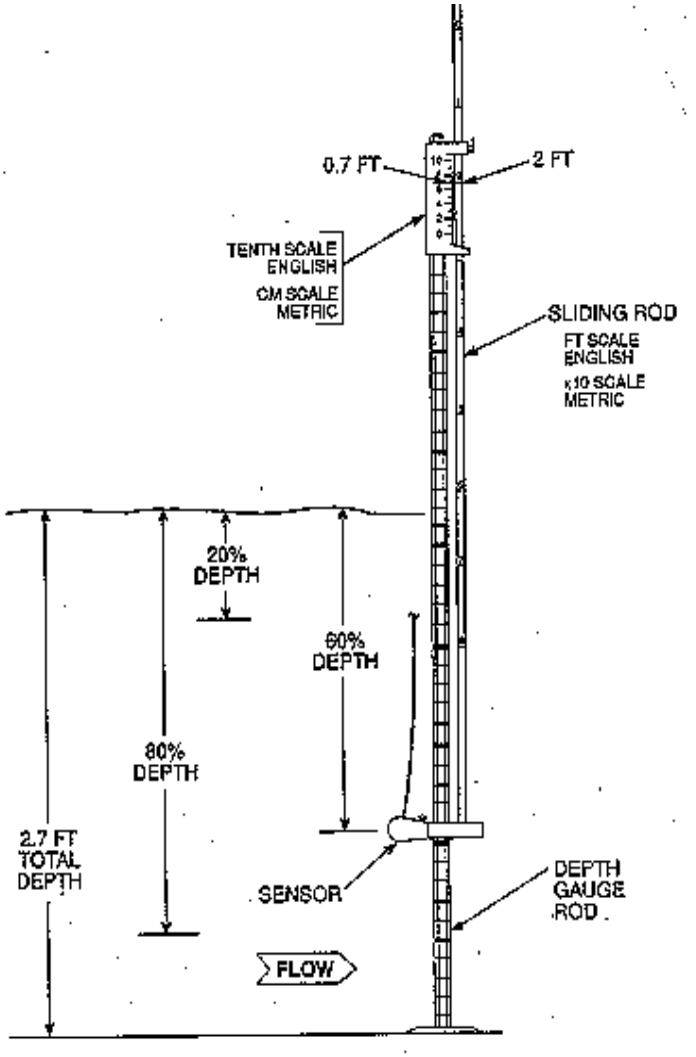
1) The beginning of the tag line is normally started at the Left Edge of Water (LEW).
2) Stretch a graduated line from LEW to REW at the cross section to be sampled. The tagline should be strung perpendicular to the direction of the majority of stream flow. This decreases the likelihood of needing to use horizontal angle coefficients in the measurement.
3) Anchor line and reel firmly to both banks ensuring that the line is taut.
4) Determine the measurement interval from both the width and the variable depths/velocities across the section (refer to 3.1).
5) Establish point of LEW. Preferably this point should be “0”. However, this is often not the case and should be the actual measured distance on the tagline.
6) Point the head of the instrument directly into the current and hold steady. Stand to the side and away from the wading rod.
7) Observe the depth and flow and if sufficient, this is your first point of measurement.
8) Measure your distance from LEW to this point. For example, if LEW is at 10 and the first measurement vertical is 5 feet past 10, then the distance for vertical 1 is 15 feet. Record the distance on the flow sheet in the *Distance from initial point* column.
9) Using the segment interval, move to the next measure point. Continue to measure adjusting the distance between measurement verticals as needed. (refer to 3.1)

10) Continue this procedure until you reach the area of insufficient depth or flow at the REW, and record the distance from the last point of measurement to REW.

3.4 Wading Rod

The wading rod is a top-adjusting model divided into feet and tenths of feet (not inches). The rod not only suspends the meter when wading but also is used to provide vertical depth and set the sensor in the correct location for measurement. The vertical depth is read on the main rod at the point where the velocity head is. Velocity should be measured at different depths, dependent upon the depth of the water column. The wading rod is designed to facilitate the placement of the meter at the correct sensor depth. See figure and explanation below.

Figure 3. Wading Rod



3.41 Use of wading rod

The rod should always be maintained in an even upright position. Depending on the depth of flow, the meter will be set at 0.2, 0.6, or 0.8 of water depth. To set the meter at these depths, do the following:

1) 0.6 of depth
   a. Determine depth of segment to be measured using the gradations on the wading rod (e.g. 2.7 ft)
   b. Slide smaller rod up until the "2" on the small rod lines up with the “7” on the rod handle.

2) 0.2 of depth
    a. Determine depth of segment to be measured (e.g. 2.7 feet)
    b. Multiply depth by 2 = 5.4 feet
    c. Slide small rod until "5" on the rod lines up with the 4 on the rod handle
3) 0.8 of depth
    a. Determine depth of segment to be measured (e.g. 2.7 feet)
    b. Divide depth by 2 = 1.35.
    c. Slide small rod until "1" on the rod lines up with the 3.5 on the rod handle.

3.5 Use of Pygmy and Price-Type AA meters.

For most studies, the OWRB uses mechanical velocity meters. The mechanical principle is as the flow makes revolutions of the bucket wheel, a tiny piece of carbide/tungsten known as a cat whisker is tripped. As this is tripped, an electrical current is sent to a set of headphones or a flow computer and is recorded as a tic, or revolution. These revolutions are counted for at least 40 seconds until a multiple of 5 tics is reached. The time and number of tics is then compared to a rating table to determine velocity. Use and maintenance of these meters will be demonstrated. Refer to the operations manual for a more complete understanding of operation and maintenance. The OWRB also uses magnetic head meters, which operate under the same principle as described above. The only differences are changes to the contact chamber and shaft. Magnetic head meters should be used in slower moving waters or areas of higher conductivity. Follow these general rules when choosing a meter to use:

- Depths from 0.3-1.5 feet use pygmy
- Depths greater than 2.5 feet use AA
- For depths from 1.5-2.5 feet use meter needed for the majority of the cross-section
- Do not change meter in middle of a measurement
- When suspending from a bridge cable, always use the AA

Meter connection of pigtail

White-ground/rod

Red-meter (AA or Pygmy)

RCA Jack connect to Sutron or headphones

3.51 Recording Data Using Headphones and Stopwatch.

The classic way of collecting the revolutions and time is use of headphones and stopwatch. Follow this procedure to collect data:

1) Before beginning, perform a spin test ensure that headphones are recording revolutions. This can be done by holding meter into the wind or starting revolutions with hand.
2) Place meter into water at appropriate depth and establish sound. The tics may be more or less audible depending on the conductivity of the water.
3) Reset stopwatch to "0", and simultaneously begin counts and stopwatch.
4) Continue counting tics until stopwatch passes 40 seconds. Because counts must be in increments of "5" to use the rating table, the stopwatch may go past 40 seconds.
5) Record the seconds and revolutions in the appropriate boxes on the Discharge Notes. Refer to rating table to establish velocity.

3.52 Recording Data Using Sutron DMXpert.

The flow computer operates on the same principle as the stopwatch and headphones, but eliminates the need for making counts. Furthermore, the computer calculates Q, performs a QA/QC analysis, and provides the total discharge notes in a download. A supervisor will fully demonstrate the use of the Sutron DMXpert SOP and a Sutron DMXpert instruction manual is available with each kit to assist with usage.

3.6 Measurement of Velocity

As was stated before, accurately measuring discharge requires that real differences in both the vertical and horizontal profile of the stream be adequately characterized. Accurately measuring the vertical profile involves adequately characterizing the mean velocity of each vertical. Several factors make this difficult including stream depth, upstream obstructions (e.g., rocks), upstream sandbars, surging flows, etc. To counteract these problems, several methods have been developed to measure velocity including several one point methods, a two point method, and a three point method.

3.61 Six-tenths Depth Method

When using this method, a single measurement is made at 0.6 depth and is considered to be the mean velocity for the vertical. This method should be used under the following conditions

- Depths between 0.3 and 2.5 feet for both the pygmy and AA meters
- When any 2-point method is circumvented because of stream conditions (e.g., ice) or equipment (e.g., can not extend meter to 0.8 depth due to sounding weight size)
- When conditions require that a measurement be made quickly (e.g., rapidly increasing or decreasing discharge)

3.62 Two-tenths Depth Method

When using this method, a single measurement is made at 0.2 depth and, after a coefficient is applied, is considered to be the mean velocity for the vertical. This method should only be used under the following conditions:

- Velocities are too great to extend to 0.6 depth. This requires a depth profile so that the 0.2 depth can be calculated without extending into the water column.

- When sounding weight can not reach to 0.6 depth in shallowest verticals, but a measurement is still required.

3.63 Two Point Method

When using this method, measurements are made at 0.2 and 0.8 depths. These two measurements are averaged to obtain the mean velocity of the vertical. This method should always be used when depths exceed 2.5 feet unless stream conditions do not allow. It should never be used under 2.5 feet because of the proximity of the meter to the streambed.

3.64 Three Point Method

When using this method, measurements are made at 0.2, 0.6 and 0.8 depths. The mean velocity is obtained by one of two ways. All three measurements may be averaged to obtain the mean velocity when more weight is desired for the upper and lower depths. Conversely, when equal weight is desired between the upper/lower and the middle, the 0.2 and 0.8 measurements are averaged and that mean is then averaged with the 0.6 measurement to acquire the mean vertical velocity. This method should be used under the following conditions:

- When the velocities are abnormally distributed. Normally, the upper measurement should be more than the lower measurement in a two point method. However, occasionally this may flip and measuring the 0.6 depth will be useful.

- When the lower depth is seriously affected by the friction or turbulence along the streambed (e.g., sandbars).

4.0 Completion of Discharge Measurement Notes

4.1 Front Section

The front section of the Form is broken into five main sections. Many data items are self explanatory, such as date and site name, but others require some thought to further investigation to determine. It is very important that each section be completed. When using the Sutron, many of the items are contained in the different fields of the instrument. A supervising FTE will demonstrate how to gather the information. When using the Sutron, all of this information may be entered in the various menus.

The first section contains biographical information specific to the site and the measurement including station name and ID, and measurement number, date, and time. The second section contains biographical information about the meter including type and number as well as calibration information. The third section describes the measurement location.

The fourth section is the data and QA section. This section should be completed at the station if time and conditions permit. Most of the items are self-explanatory, but several do need further review. The percent difference from rating is used only when the station has an updated rating curve. This difference may demonstrate that an inadequate measurement has been made or that the station needs an updated survey. Rating a measurement is somewhat subjective. Based on the information gathered in the field, the technician should attempt to rate the measurement, but the data manager may change this measurement when reviewing the data. It is important that the technician be explicit in this section and includes all required information. If another sheet is necessary, please attach.

The fifth section contains information about the gages at the station. It is important that all necessary gages be read during each visit both before and after the discharge measurement. It is equally as important that the point of zero flow (PZF) be measured when accessible. The PZF is described in the station plan.

4.2 Recording and Completion of Data on Discharge Measurement Notes

When manually recording data, the following steps should be followed to fill in the discharge notes. A supervising FTE will demonstrate all steps.

1) In the first row, mark LEW (Left edge of water) in the width square. When circumstances require starting from the right edge of water, REW should be written. Also, write the starting point on the tagline in the "distance from initial point". This may be a number other than zero.
2) On the following line, your distance from initial point is the first reading of measurable flow. Exclude areas that are too shallow for a measurement.
3) Write down the corresponding total depth and velocity on the line.
4) Mark your observation depth (0.2, 06, or 8.0) according to your percentage of depth.
5) Proceed by measuring depth and flow as you have been until you have recorded your last measurement that falls on a whole distance interval.
6) Record the depth and velocity of the REW.
7) Average any multiple depth measurements and record in the average velocity on the 0.2 line.
8) For width, the first section width is equal to ½ the distance between the first observation point and the second observation point. The width of the second section is equal to ½ the distance between the preceding observation point and the succeeding observation point. For example, if the preceding observation point is 7, and the succeeding observation point is 4, then the width for observation point is (7-4) / 2 = 1.5. Final section width is the ½ of the difference between the last observation point distance and the preceding observation point distance. In the figure below. This will be demonstrated by a supervising FTE.
9) Sum all widths along the bottom row of the discharge notes and record on the front. This measurement should equal the distance between LEW and REW.
10) Area for each vertical is determined by multiplying the width by the total depth. Sum all areas on the last row of the notes for the total area of the measurement. Record sum on the front page of the notes.
11) Discharge for each vertical is determined by multiplying the area by the mean velocity of that segment. Sum all discharges on the last row of the notes for the total discharge of the measurement. This is the total discharge. Record sum on the front page of the notes.

NOTE: The sum of the widths should equal your measured width of stream and the sum of the area and discharge should be computed individually for their respective columns.

5.0 Data Storage

All paper copies of Discharge Measurement Notes should be maintained with the station data set. The data from the notes should be quality assured and entered into the Water Quality Database.

6.0 References

Discharge measurements at gaging stations, by T.J. Buchanan and W.P. Somers: USGS—TWRI Book 3, Chapter A8. 1969.

Calibration and maintenance of vertical-axis type current meters, by G.F. Smoot and C.E. Novak: USGS—TWRI Book 8, Chapter B2. 1968.

Measurement and computation of streamflow Volume 1. Measurement of stage and discharge Volume 2. Computation of discharge, By S. E. Rantz, et al.: USGS—Water Supply Paper 2175.

STANDARD OPERATING PROCEDURE FOR USE OF FLOATS TO DETERMINE STREAM DISCHARGE

DRAFT-UNDER REVIEW FOR LACK OF SECTION 7 BUT METHODOLOGY APPROVED

1.0 Introduction

A float can be used where the velocity is too low and the depth is insufficient to obtain reliable measurements with a Pygmy current meter. They are also used where flood measurements are needed and the measuring structure has been destroyed or it is impossible to use a meter.

2.0 Definitions/ Terms

Floats- any object that will float unrestricted along a stream reach.

LEW- Left edge of water, determined by looking downstream, with left side being the LEW.
Reach- A section of stream that displays uniform properties and is representative of that particular stream.

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadeable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining “Traffic Safety Protocols”.

4.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO’s) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory.

For float measurements quality assurance will be measured in three ways. The primary measure of QA is the adherence to the SOP. A second measure is internal duplication of measurements. This involves releasing the float at the same point on the upstream tagline at several locations and comparing measurements. A third measure is site replication. Staff members should periodically replicate a float measurement by both side by side measurements with another staff member and replication of a particular site. Float measurements can be made with accuracy fewer than 10 percent but only under good conditions and when a certain amount of care

is exercised. If a poor reach is selected and not enough float runs are made, the results can be as much as 25 percent in error.

5.0 Personnel and Equipment

5.1 Personnel

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the float measurements should be done by two staff members—one upstream and one downstream. However, more one person may only be available. In these instances attempt to not disturb the water when moving between taglines.

5.2 Measurement Equipment

There are two main types of floats that are used, a surface float and a rod float. Surface floats may be almost anything that floats, such as wooden disks, partially filled bottles, or orange peels. Floating debris or ice cakes may also serve as natural floats. A surface float should have sufficient weight to prevent wind currents from moving the float. Rod floats are wooden rods weighted on one end so they will float upright in the stream. (Fig 1) Rod floats must not touch the streambed because this will interrupt the progression of the float.

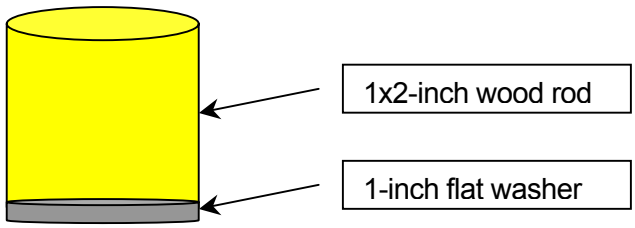


Figure 1. Rod Float

6.0 Discharge Measurements

6.1 General Procedure

The procedure for a float measurement is to distribute a float at a specific interval across the stream width. Two cross sections are selected along a reach of straight channel for a float measurement. The cross sections should be far enough apart so that the time the float takes to pass from one cross section to the other can be measured accurately. The distance between the two cross sections should be at least 10 feet, with 20 feet or longer preferable. The reach should have uniform features and be free of pools, debris piles and overhanging

vegetation. (Fig 2) At the lower cross section, a tagline should be used to divide the stream width into 20-30 segments. At each segment, release the float upstream of the first cross section, allowing the float to settle and reach a consistent velocity. As the float passes the first cross section, start the stopwatch. When the float passes the second cross section, note the time and distance from LEW. Where the float crosses the 2nd cross section, a depth measurement is made. A travel time of at least 20 seconds is recommended, but a shorter time can be used on small streams with high velocities, where it is impossible to select an adequate length of straight channel. Care must be taken when measuring low velocities, so that the floats are not being affected by wind.

Fig 2

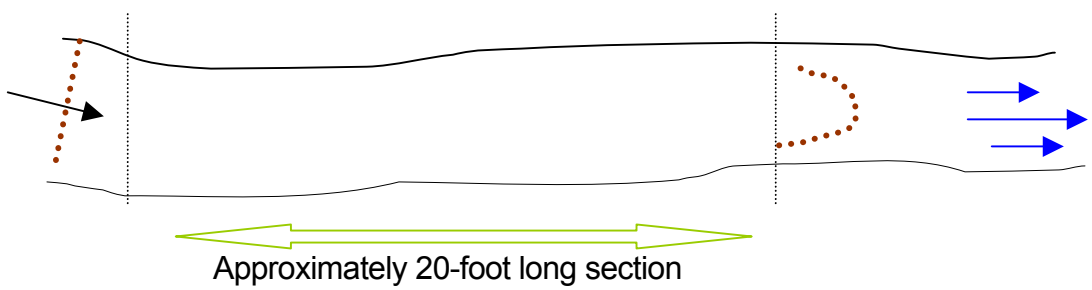


Figure 2. General setup for measuring discharge using floats

6.2 Determining Stream Velocity Using Floats

The velocity of the float is equal to the distance between the cross sections divided by the time of travel. The mean velocity of flow in the vertical is equal to the float velocity multiplied by a coefficient, which is based on the shape of the vertical-velocity profile and relative depth of immersion of the float. A coefficient of about 0.85 is commonly used to convert surface velocity to mean velocity. The coefficient for rod floats varies from 0.85 to 1 .00 depending on the shape of the cross section and the velocity distribution. The discharge in each partial section is computed by multiplying the average area of the partial section by the mean velocity in the vertical for that partial section. The total discharge is the sum of the discharges for all the partial sections.

7.0 Data Storage

All paper copies of Discharge Measurement Notes should be maintained with the station data set. The data from the notes should be quality assured and entered into the Water Quality Database.

8.0 References

Discharge measurements at gaging stations, by T.J. Buchanan and W.P. Somers: USGS—TWRI Book 3, Chapter A8. 1969.

Measurement and computation of streamflow Volume 1. Measurement of stage and discharge Volume 2. Computation of discharge, By S. E. Rantz, et al.: USGS—Water Supply Paper 2175.

STANDARD OPERATING PROCEDURE FOR THE INSTALLATION OF NONRECORDING GAGES AND MEASUREMENT OF STAGE IN STREAMS

DRAFT-UNDER REVIEW FOR SECTION 2

9.0 Introduction

Continuous measurements of stream stage are used in determining records of stream discharge. In stream gaging, gage heights are used as the independent variable in a stage discharge relation to derive discharges. The stage of a stream is the height of the water surface above an established datum plane while the gage height is a water-surface elevation referenced from an arbitrary point to the gage datum. Reliability of the discharge record is therefore dependent on the reliability of the gage height record as well as the stage-discharge relation. Gage height records may be obtained through various means. They may include a water-stage recorder, by systematic observation of a non-recording gage, or by noting only peak stages with a crest-stage gage. This SOP describes the installation and operation of Nonrecording gages commonly used in obtaining a record of stream stage.

10.0 Definitions/ Terms (UNDER CONSTRUCTION)

Datum plane
Stage Height
Reference Mark
Reference point

11.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining "Traffic Safety Protocols".

12.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO's) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory.

For all measurements of stage, quality assurance is measured through several means. First of all, all surveys to set datums should be periodically checked. Secondly, replicate measurements should be taken from outside reference gages when available. Lastly, duplicate stage measurements should be made under extreme hydrological or meteorological conditions and periodically (1 in 10) for each measurement taken.

13.0 Personnel and Equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality

and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the collection of water quality samples requires only one field person. However, depending on the safety requirements of a particular station, additional crewmembers may be necessary to ensure a safe work zone. Equipment used to collect the chlorophyll-a sample are described in the document "Standard Operating Procedure for the Collection of Water Quality Samples".

14.0 Installation of Gages and Collection of Stage Data

14.1 Gage Datum

The gage datum is the level surface that is at the zero elevation of all the gages at a gaging station. This point can be tied to mean sea level or can be an arbitrary datum plane. Arbitrary datums are often established so that numbers are more manageable. A permanent datum must be maintained so that only one datum for the gage-height record is used for the life of the station. Though a benchmark is preferable, each gaging station requires at least two to four reference marks that are independent of the gage structure in order to maintain a permanent datum. The gage height is then established from the change in elevation between the gage datum and the gage. All gages are periodically checked under the procedures required and outlined by the Surveying Gaging Stations SOP. An individual Station Plan will outline in detail the frequency of surveys, the survey circuit, and the maintenance required to protect the gage datum.

14.2 Non Recording Gages

The types of non-recording gages generally used are staff, wire-weight, and manual tapedown. Staff gages are read directly whereas the other two types are read by measurement to the water surface from a fixed point. For the OWRB, nonrecording gages serve several purposes including:

1. A reference gage at nonrecording water quality stations
2. Useful when a recording gage is not practical or feasible
3. Outside reference gage at recording water quality stations
4. Inexpensive screening tool to determine best location for recording gages in watershed or aquifer specific studies.

14.2.1 Accuracy of Measurements at Nonrecording Gages

The level of measurement accuracy needed depends on the use of the data. In general, gages maintained to 0.01-0.05 foot have a high level of accuracy, and the stage-discharge rating that is developed may be used for all purposes. Accuracies maintained in a range of 0.05-0.20 foot may have limited utility but are still appropriate for certain purposes. Except in rare cases when data is used only as a screening tool, accuracy should never exceed 0.20 foot.

The most important parts of maintaining accuracy are attention to detail and consistency of effort. A long-term schedule for surveying should be made when the station is installed and adhered to over the period of record. Station characteristics should be noted when making discharge measurements. For example, comparison of inside and outside gage readings or comparison of flood marks with recorded peak gage heights should be made at every opportunity.

The management decisions outlined in workplans and individual Station Plans are the final guide on accuracy to be maintained. In addition, the OWRB's "Levels and Gaging Stations SOP" Section 6.3 makes general suggestions for the

frequency of levels. However, rules of thumb concerning management decisions may be followed to assist in the determination of what level of accuracy is needed.

1. When minimal shifts in stage can dramatically influence management decisions, high levels of measurement accuracy are required. Examples include decisions made at the lower end of the rating curve (e.g., characterizing surface-ground water interactions), a small stream with relatively small medium to peak discharges, or a rating maintained to determine surface water yield.
2. When minimal shifts in stage will not dramatically influence management decisions, moderate levels of measurement accuracy are acceptable. For example, ratings used to assist in the calculation of surface water loadings because the great majority of constituent loading occurs during medium to peak discharges. Another example is when data are used to assist in trend analysis or comparison of a standard to a concentration.
3. If relative stage height is the only data need, a low level of accuracy may be sufficient. This is usually the case when using stage as a screening. However, it should be kept in mind that the data gathered during the screen may be of limited utility once a station is put in place.

14.3 Manual Tapedown Gages

14.3.1 Accuracy and Use of Manual Tapedown Gages

Manual tapedown gages are the easiest and least expensive gages to install, measure, and maintain. The gage is placed directly in wing wall or a pier and usually consists of a chiseled mark or a pin. Accuracy and precision are normally low and are adversely effected by several things including: 1) difficult to accurately read and repeat reading of steel tape to a hundredth because of placement, 2) tape often not vertical due to winds and/or the lip of the bridge deck, and 3) susceptibility of marks and pins to movement and vandalism. By using a graduated engineer's tape, tapedowns can be accurate to 0.005 foot under perfect conditions. However, perfect conditions do not exist, and actual accuracy may be 0.01-0.10 foot. Therefore, they have limited utility. In certain instances (e.g., screening or starting a gage when limited funds are available), they can be used as the sole reference gage at a non-recording station. Tapedown stations are normally used in conjunction with another nonrecording gage as an index reference point. They should not be used as the outside reference gage for a recording station.

14.3.2 Installation and Maintenance of Manual Tapedown Gages

The chiseled arrow is simply a reference point that has been etched into the bridge wingwall or deck on the downstream side over the main channel. It is the most cost effective but least accurate method of stage measurement. The marks should be elevated if possible as well as labeled and painted. Tapedown should be free of any obstructions below the mark and in an area readily accessible by personnel. When placing marks in concrete, avoid scaling concrete. Because of the solid surface of angle or tubular iron, these often work best in steel bridges

Steel pins can also be installed as a reference point for tapedown gages. These are the more advanced cousin of the chiseled arrow because they have a more defined surface from which to measure and allow for a vertical measurement. However, they still yield low accuracy. Pins are installed by placing an anchor, bolt or nail into the bridge wingwall or pier on the downstream side over the main channel. They should be of sufficient length and set deeply enough to remain firmly fixed in place. Tapedown should be free of any obstructions below the pin and in an area readily accessible by personnel.

The marks should be consistently inspected for damage and, at a minimum, be surveyed annually to account for movement and loss of accuracy. If the gage is serving as a reference point for another type of nonrecording gage, it may be surveyed on the same schedule. Because they are inexpensive and easy to install, several should be installed at each station above all possible channels and labeled as primary (RP-1), secondary (RP-2), etc.

14.3.3 Measurement of Stage at Tapedown Gages

Stage is measured by taping down from the gage to surface of the water using a weighted, calibrated steel tape graduated in tenths and hundredths. The weight, known as a Louisiana ding-wop, is made of 2 inch tubular brass with a turned I-bolt sunk in the top and secured to the tape with plastic zip ties. The length of the dingwop can be changed by

tightening the I-bolt and should be measured to one foot, or another known length. This length should be checked periodically using the steel tape. With the dingwop barely touching the surface of the water (look for slight ripples immediately around the weight or have a spotter), the steel tap is read at the pointed end of the chiseled arrow or the top of steel pin. After adding in the length of the ding-wop, stage is recorded to the nearest thousandth. If wind is affecting the measurement, attempt to measure stage between gusts, but if wind is constant, note the affect of wind in the discharge notes. Steel tapes are easily deformed and should be straightened before measurement.

14.4 Staff Gages

14.4.1 Accuracy and Use of Staff Gages

Vertical staff gages (Figure 1) are used as a stand-alone outside gage, an outside gage at a recording station, or a reference gage to another nonrecording device. Vertical gages are available in a variety of lengths, widths, and increments in both U.S. and metric scales. However, because of the necessary accuracy, comparability, and ruggedness, gages should be a Style A gage, which is made of porcelain enameled iron sections measuring 3 1/3' by 4" and graduated at every foot, tenth, and 0.02 foot. They are accurate only to 0.02 foot and can be damaged or lost due to high flows or ice. They have a tendency to drift if not consistently kept free of debris. Accuracies to 0.01 foot may be obtained if needed by reading the gage with a point gage.

Because of their uniqueness to each station, inclined gages are normally not available commercially for stream gaging. They are used in situations where placement of another type of outside gage is not possible. They can be used as stand-alone outside gages or as an outside gage at a recording station. Inclined gages have a low level of accuracy of up to 0.10 foot. Because of issues with installation, maintenance, and accuracy, inclined staff gages should be used only when other options are not feasible.

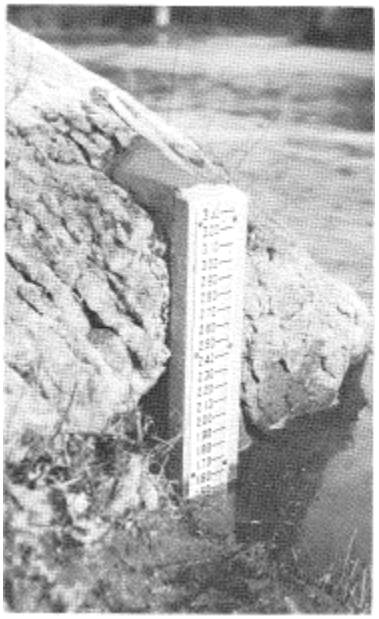


Figure 1. Vertical staff gage

14.4.2 Installation and Maintenance of Staff Gages

A vertical gage is mounted to permanently placed structure such as a piers or beam sunk to bedrock. If mounted in a stable location, a number of plates may be mounted one on top of the other. When mounting, find the high water bench and atempt to place the top of gage above that mark. Vertical height of gages should be kept to one plate and may

require the installation of two or more to account for the vertical height of banks and potential high water level. When mounting to a pier, special equipment may be needed. The gage should be kept free of obstructions and be in an area readily accessible by personnel. A reference point should be placed on the backing of the gage plates and tied into the level circuit, and an RP reading should be noted by measuring against the steel plate using a steel tape. During subsequent surveys, new RP readings should be made and compared to the elevation for that RP. If these are different, a correction should be made to the gage datum. If a series of gages are used, each should be tied to the level circuit with a separate RP.

Inclined staff gages are usually made of a graduated heavy timber securely attached to a permanent foundation and are built flush with the stream bank The position of installation should be that the gage might be observed from a safe place during floods and high water conditions. To tie the gage into the level circuit, place an RP near the gage, and from the RP, make several side shots to foot marks throughout the range of the gage. Corrections should be made only if errors exceed 0.10 foot.

14.4.3 Measurement of Stage at Staff Gages

The measure is rather straightforward. The water level is read by a three step method. As an example, 20.64 is used as a measurement. The foot mark, 20.0, is noted. The next mark (6) is the inch mark. The next step is to locate the hundredth mark and count the marks backward from the next highest inch mark. Using the example, the water level is at 0.64, and to determine the hundredth mark (0.04), the technician would count back from 0.7 to the water level. In this instance, the count was 0.06. By subtracting 0.06 from the inch mark, the hundredth mark (0.04) is obtained.

14.5 Wire Weight Gages

14.5.1 Accuracy and Use of Wire Weight Gages

The type A wire weight gage (Figure 2) consists of a drum wound with a single layer of cable, a bronze weight attached to the end of the cable, a graduated disc, and a Veeder counter, all within a cast-aluminum box. It is used as a stand-alone outside gage or an outside gage at a recording station. A full description of the gage is made in Section 4.4.3 of this document. The gage has a high level of accuracy ranging from 0.005 to 0.01 foot depending upon use. Several sources of error are associated with the use of the gage. The elevation of the gage may vary considerably due to placement along a bridge span. As top surface temperatures rise above bottom surface temperatures (hotter months), the bridge will arch upwards and vice-versa when bottom surface temperatures are higher (cooler months). To avoid this potential source of error, every attempt should be made to place the gage near the end of a long span. Also, variations in the drum or cable diameter may lead to errors of up to 0.10 foot over 60 feet of spooled out cable.

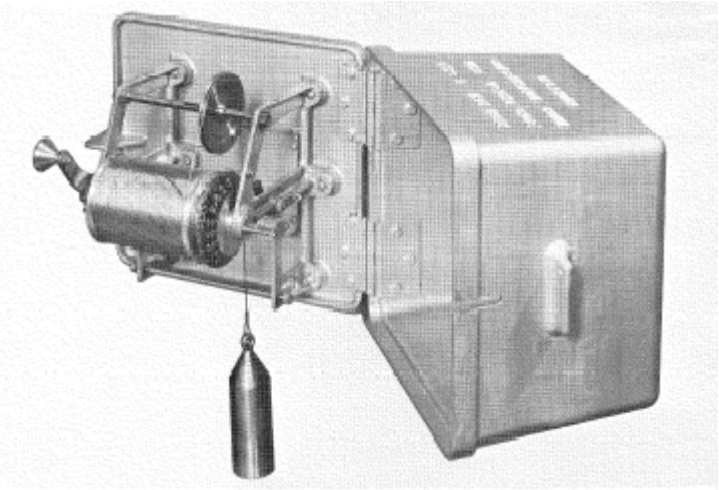


Figure 2. Type A wire weigh gage

14.5.2 Installation and Maintenance of Wire Weight Gages

A wire weight gage should be placed on the bridge wing wall directly above the deepest portion of the main channel. However, the area should be free of disturbance from piers, obstructions, and bridge supports so that the wire weight may be lowered freely without interference from the bridge and associated objects. Debris piles around piers can drastically reduce the accuracy of the measurement. Therefore, moving the weight away from the immediate vicinity of a pier is preferable. To ensure the gage can rotate freely to the water's surface, tapedown with a steel tape at an appropriate horizontal distance from the wing wall. The gage can be affixed to the wing wall through a variety of means. However, the horizontal check bar must be parallel to the water surface and level, and metal shims, brackets, and/or washers may be required.

Levels should be run at several points when installing a wire weight gage. At a minimum, the wire weight should be leveled at the check bar in its outer position, and the gage datum should be leveled to the stream bottom. This requires two level circuits, but both begin at the same starting point allowing the wire weight to be tied to the gage datum. When possible, a reference gage (see tapedown measurements) should be established beside the wire weight. By tying the two marks together, changes in gage height may be more easily detected during normal measurements. An electric tape gage can also be mounted as the reference gage. Furthermore, if a gage is mounted near the center of long bridge span, placing reference points on both ends of the span may assist in determining the change of the gage datum that can be attributed to arching and sagging of the bridge. When possible, a reference point should also be established near the gage datum in a bridge pier or other permanent structure.

So that the gage height may be read, the dial is set to zero at the gage datum, and as the reel is brought back to the bridge, the gage height will gradually increase until it reaches the check bar reading. For streams with unstable substrates, the gage datum is often set above zero to allow for scour. When surveying, the gage height is calibrated and adjusted if needed. Follow these steps (an example in Table 1):

1. Survey the elevation of the check bar and the reference gage.
2. Tapedown to the water surface from the reference gage and correct gage height if necessary. A spotter should always be used and should not be done during windy conditions.
3. Read the check bar to the nearest thousandth.
4. Using a steel tape, tape to the water's surface from the check bar.
5. Using a steel tape, tape to the water's surface from the reference point.
6. Survey the elevation of the water surface.
7. Take a gage reading.
8. Adjust the check bar reading up or down so that the gage reading and the water surface elevation are equivalent to at least the hundredths.

The wire weight gauge should kept closed from the elements. The cable assembly should be periodically checked for kinks, twists and fraying. The drum assembly should be periodically lubricated to ensure smooth operation.

14.5.3 Measurement of Stage at Wire Weight Gages

A wire weight gage is simply a cabled drum attached to a counter. The diameter of the drum of the reel is such that each complete turn represents a 1-foot movement of the weight. The disc attached to the drum is graduated in tenths and hundredths of a foot and is permanently connected to the counter and to the shaft of the drum. The reel is equipped with a pawl and ratchet for holding the weight at any desired elevation. A horizontal checking bar is mounted at the lower edge of the instrument so that when it is moved to the forward position the bottom of the weight will rest on it.

A wire weight gage is rather simple to use. Before lowering the weight, ensure that the cable is fed through the wheel guide above the drum. The check bar located beneath the weight should be moved to the rear of the bracket. On the side of the drum, there is pawl with toothed gear. Holding the drum handle, ease the pawl away from the gear. The weight is now free to be lowered slowly to the water's surface. **DO NOT FREEWHEEL THE DRUM**. Upon contact with the water, the measurement can be made by looking at two counters. The the Veeder counter, located on top of the instrument, represents the foot mark. The tenths and hundredths foot marks are located on the disc attached to the drum. The arrow

or pointer going from the drum to the disc represents the tenth mark. The hundredth mark is read going down from the tenth mark. Rewind the drum to the top and place the weight on the forward placed check bar. Lock the weight in place by locking the pawl. **LOCK THE COVER WHEN MEASUREMENT IS COMPLETED**.

14.6 Crest Gages

The crest-stage gage is a device for obtaining the elevation of the flood crest of streams. The gage is receiving widespread use because it is simple, economical, reliable, and easily installed. The one found most satisfactory is a vertical piece of " 2-inch galvanized pipe containing a wood or aluminum staff held in a fixed position with relation to a datum reference. Crest gages should be cleaned and reset after periodic floods. The crest gage should also be inspected for damage and level errors.

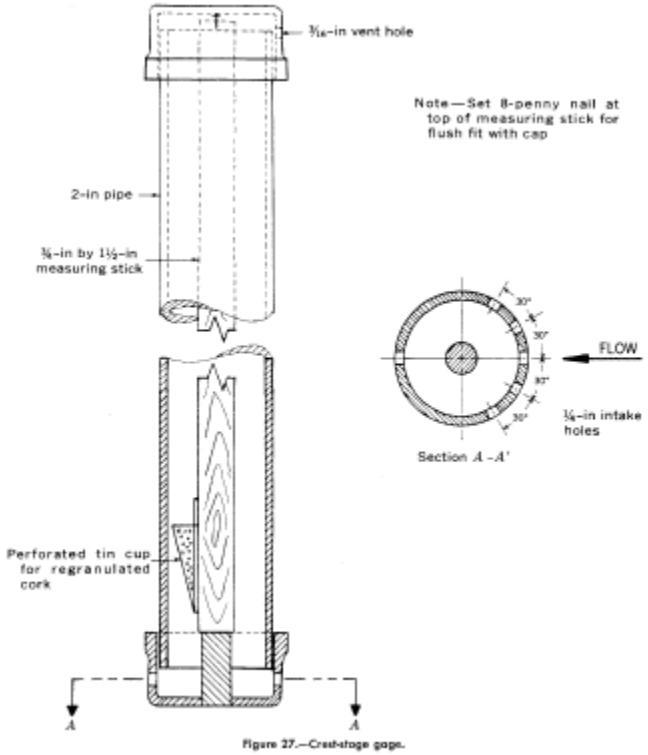


Figure 3. Crest gage

The bottom cap has six intake holes located so as to keep the non-hydrostatic draw down or super elevation inside the pipe to a minimum. Tests have shown this arrangement of intake holes to be effective with velocities up to 10 feet per second, and at angles up to 30 degrees with the direction of flow. The top cap contains - one small vent hole. The bottom cap or a perforated tin cup or copper screening in cup shape attached to the lower end of the staff contains regranulated cork. As the water rises inside the pipe the cork floats on its surface. When the water reaches its peak and starts to recede the cork adheres to the staff inside the pipe, thereby retaining the crest stage of the flood. The gage height of a peak is obtained by measuring the interval on the staff between the reference point and the flood mark. Scaling can be simplified by graduating the staff.

A Crest gage should placed in location that allows personnel to readily access the gage and reset the cork. Locations usually are along the bridge abutments, downstream in a protected location, or suspended from the bridge. If suspending from a bridge, the scale inside should be built to allow the scale to be removed and reset

15.0 Forms

15.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

16.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database or other approved electronic format. Each sample should be maintained electronically in the database under a unique sample number.

17.0 References

Stage measurement at gaging stations, by T.J. Buchanan and W.P. Somers: USGS–TWRI Book 3, Chapter A7. 1968.

Measurement and computation of streamflow Volume 1. Measurement of stage and discharge Volume 2. Computation of discharge, By S. E. Rantz, et al.: USGS—Water Supply Paper 2175.

STANDARD OPERATING PROCEDURE FOR SURVEYING GAGING STATIONS

DRAFT – ADOPTED JANUARY 2004

1.0 Introduction

This SOP describes the use of leveling to set a reference point in order to establish a gage height. The gage height is a critical component for establishing the stage to discharge relationship and can be measured through a variety of accepted means. It is used to establish the river gage, or height of water to a known fixed point. This known fixed point is referenced or leveled to a Reference mark or Benchmark. These marks are assigned either an arbitrary elevation or known elevation that is tied to a national elevation network. Thus over time, with periodic leveling, the reference points can be measured for movement. Because any movement of these points will affect the stage-discharge rating, it is critical that periodic measurements be conducted so that the gage heights remain leveled with the stage datum.

This document is meant to be a guide only. An FTE will demonstrate and explain fully how to operate all equipment and complete all notes. Different types of equipment have different installation requirements, and an SOP will be provided for more detailed guidance. Furthermore, each station will have unique requirements that cannot be covered in a generic SOP. To facilitate the installation and surveying process, a station project plan should be completed prior to work beginning.

2.0 Definitions/Terms

1) Backsight (BS) The reading on a leveling rod held on a point of known elevation. Used to establish Height of Instrument.
2) Benchmark (BM) A permanent marker whose description and elevation are referenced and tied to the National Geodetic Vertical Datum or a state wide equivalent.
3) Collimation Agreement of a level's line of site with its horizontal axis.
4) Collimation Error Factor (c) The inclination of a level's line of sight in ft/100ft.
5) Differential Leveling The determination of difference of elevation of two points by use of an engineers level and a leveling rod.
6) Elevation A measurement established for each station in the survey circuit. Established by subtracting the foresight from the last known height of instrument.
7) Error of Closure The difference between the starting and ending elevation of the starting point of the circuit.
8) Foresight (FS) The reading on a level rod held on a point to whose elevation is to be determined. Used to establish new elevations.
9) Gage Datum The datum whose surface is at the zero elevation of all the gages at a gaging station
10) Height of Instrument The elevation of the horizontal line of sight from the engineer's level. Established by adding the backsight to the last established elevation.
11) Leveling Rod A slender bar with graduated marks on one face starting from the bottom. Used to measure the height of a line of sight above a point on the ground.
12) Parallax The relative movement of the image of the leveling rod with respect to the crosshairs as the surveyor's eye moves. Is caused by improper focusing of the objective lens.
13) Peg Test A test to ensure that the level's line of sight is truly horizontal.
14) Reference Mark (RM) A semi-permanent marker established at the time of survey. Mark is used to consistently tie updated surveys together so that an established datum is not lost. Should be established in an area of little change (e.g., a bridge abutment).
15) Reference Point (RP) A marker established at the time of survey. Mark is tied into the datum and is used to provide a consistent point from which to measure stage.
16) Turning Point (TP) A temporary point of reference used in the leveling process. Always used at the midpoint of basic level circuits.

3.0 Safety

Leveling is carried out around and in water and from bridges. Ensure that all applicable safety procedures outlined in the OWRB Safety manual are followed. Any bridges that have vehicular traffic should be scouted initially to determine traffic control and conditions and personnel required. Each station should have a Station Plan on file that outlines any particular hazards and concerns. **Never survey in electrical storms. Be aware of all power lines when handling the rod. If digging is required, ensure that local utilities are properly marked**. Any questions or situations that involve safety or hazardous conditions, notify your supervisory FTE immediately.

4.0 Quality of the Measurement

The quality of the leveling measurement can be affected by a multitude of factors. The majority of these factors are associated either with equipment malfunction/ calibration issues or improper survey techniques.

4.1 Precision

Leveling precision is mostly affected by the quality of the instrument used but can be affected by measurement decisions. The automatic level has a precision of 0.001 foot up to 125 feet. This precision can also be affected by the quality of the rod being used. Furthermore, precision may be affected by personnel decisions. It is always important to read at distances within the maximum and minimum shot length that the instrument allows. It is also important to read at the same point on the crosshairs when completing a measurement.

4.2 Accuracy

Accuracy is determined by a comparison of the error of closure (C_E) of the measurement to the allowable closure (C_A) (Table 1). The C_E is the difference between the starting elevation of the circuit and the final foresight (or determination of elevation) to that same point. For example, the starting elevation is 10.000 feet at RM1, and the close of the circuit is 9.997 at RM1, so the C_E is –0.003 feet. The C_A is then determined in one of two ways. In general, the C_A has two components—a factor based on precision multiplied by the square root of a property of the measurement. For long line levels (e.g., levels tying a reference mark or benchmark back to sea level), C_A is determined by multiplying a factor of the level precision (e.g., 0.05 foot based on a precision of 0.01 foot) times the square root of the length of the line (M), which is expressed in miles. For short line levels (e.g., gaging station levels), C_A is determined by multiplying a factor of the level precision (e.g., 0.003 foot based on a precision of 0.001 foot at short distances) times the square root of the number of instrument setups (n). Depending on station conditions, the factor can be changed and can range from 0.003-0.005 foot. For factors above 0.003, proper documentation must accompany the level notes to demonstrate the need for a higher factor of level precision.

Table 1. Illustration of the determination of C_E and C_A.

Station	**B.S.**	**Ht. Inst.**	**F.S.**	**Elev.**
RM-1	**2.678**	**12.678**		**10.000**
RP-1	**2.590**	**12.726**	**2.542**	**10.136**
RP-2	**2.712**	**12.650**	**2.788**	**9.938**
RP-1	**2.602**	**12.74**	**2.512**	**10.138**
RM-1			**2.743**	**9.997**
The C_E is the difference between RM-1 at start and close—CE = 9.997-10.000 = -0.003				
The C_A is the factor of precision (0.003) times the square root of the number of setups (sqrt4)—CA = 0.003(sqrt4) = 0.006				

4.3 Elevation Adjustment

Because acceptable errors may occur throughout a leveling circuit, elevations at the same mark may be inconsistent throughout a circuit. Therefore, the elevation for each mark, other than the starting point, needs to be adjusted to account for the error. This adjustment is relatively simple and is illustrated in Table 2. The table is part of the Survey Notes. Starting with the beginning elevation, the differences between the two elevations calculated at adjacent points is calculated and added throughout the circuit. These are the final elevations and are recorded on the front sheet of the Survey notes.

Table 2. Illustration of elevation adjustments.

ELEVATION ADJUSTMENTS				
MARK	1ST DIFF.	2ND DIFF.	AVE. DIFF.	ELEVATION
RM-1				10.000
	0.136	0.141	0.139	
RP-1				10.139
	0.198	0.200	- 0.199	
RP-2				9.940

5.0 Personnel and equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

Leveling requires a minimum of two persons. A third person may be required to assist when the conditions and environmental factors require them. The survey party is made up of a level operator and a rod man. The level operator is the individual who will be conducting the survey, with the rod man following instructions. The level operator has the final authority and responsibility for determining needed accuracy as well as the recording and completion of all data. The rod man's responsibility is to ensure that the placement of the rod is plumb and in accordance with the survey plan. This survey plan may include locations of all known benchmarks, reference marks, reference points, turning points, and any equipment that is used to develop and read the gage height. Because it is often difficult to hear on site, the surveyor may develop a unique set of signals to convey instructions to the rod man. These signals should be thoroughly reviewed before the beginning of measurements.

5.1 Automatic Engineer's Level

An automatic, or self-leveling, engineer's level will be used for all surveying. After being manually leveled with the circular, or bull's eye, level before each use, the instrument self compensates as the leveling circuit is run. Each time the instrument is brought out of "bubble", it must be manually leveled again.

Because the level is delicate and can be brought out of calibration easily, each operator must handle with care during use and travel. The level is to be kept in its protective case when not in actual use. The level is to be stored securely in the cab of the vehicle. Eyecups should be placed over the lenses at all times when not in use. The leveling pegs should be screwed or run up into the level housing to protect against damage. When in transport at a survey site, the level should either remain in the case or firmly attached to the tripod. The tripod should be carried with two hands when moving a mounted level. The tripod can be carried over the shoulder only on relatively even surfaces (e.g., blacktop) and in areas with no immediate obstructions (e.g., bridge decks). Ensure that the tripod is anchored to the ground by firmly pushing the feet of the tripod against the ground. Care should be taken when moving the tripod and level through standing brush or narrow confines. If at any time the surveyor is crossing a fence, guardrail or other obstruction, the level is to be placed on the ground and retrieved after crossing. The tripod and level should never be left unattended at a survey site. An FTE will demonstrate appropriate methods to be used during travel and use.

5.1.1 Level Log Book

The logbook provides a means to record all calibration tests, survey operations, maintenance record and general information. This notebook is to be kept with the level in both storage and use. The surveyor has the responsibility to ensure that the logbook is updated when the level is in use, and properly stored when not in use. An FTE will demonstrate how to properly fill out the book.

5.1.2 Parallax

The presence of parallax should be routinely monitored when leveling. Parallax is present if the rod seems to move with movement of the head, while the instrument is in focus and the crosshair is sharpest. If it occurs, the rod is in focus in front of or behind the crosshairs instead of on the crosshairs. Can be tested for by moving head slightly while sighting an in-focus rod. Can be eliminated by adjusting the objective focus or in the worst case finding the best combination of the eyepiece and objective foci. If it persists over time and user, level may need servicing.

5.1.3 Compensator Sticking

Compensator sticking can seriously affect the accuracy of levels and should be tested for routinely. After level is in "bubble" and focused, turn the leveling screw nearest to the eyepiece slightly one way and then the other. If the crosshair return to same reading, the compensator is working, but if the readings are different, the compensator is sticking. If a light tap of the telescope before each reading causes agreement, then surveying can continue as long as the telescope is tapped lightly before each reading of the circuit. If the sticking is occurring, first check the circular level, and if that is "in bubble", the unit cannot be used until it is serviced.

5.1.4 Level Calibration Using a Peg Test

A peg test is a simple calibration test using elements of a survey. Record your readings in the logbook that accompanies the level. Record the time and date of the last peg test as well as the collimation error factor, "c", on the Survey notes. A peg test should be run at least once per week during surveying, or when there is

reason to believe the level may be out of calibration (e.g., large closure errors, sticking of the compensator, or suspicion based on level handling). To begin a peg test, place two stakes approximately 100-120 ft apart at a reasonably level site. Set up the level and tripod nearer to one stake (A). With the rod man holding the stadia rod plumb on center of stake A, take a backsight reading to the rod. The rod man will now move to the far stake (B), and the surveyor will take a foresight measure to the rod. As the rod man maintains position without moving the rod, the surveyor will break out of the tripod set and move nearer to stake B. The surveyor will then conduct a backsight to the stake B. The rod man will move to stake A and the surveyor will close the circuit by taking a foresight measurement to the rod. Upon completion of the circuit, a peg test closure error (CE) is calculated by taking the difference between both elevations of stake A (calculation of the closure error is included in Section 3.0 of this document).

The c is calculated by the following equation: $c = 100 \times \frac{(R1+R3) - (R2+R4-CR)}{(d2+d4) - (d1+d3)}$

CR (curvature and refraction) is calculated by (d2+d4)/2 with d2 and d4 being the long shots of the circuit. Compare to the following table to determine the CR to use. If c is greater than CR, adjust level according to manufacturer specifications.:

(d2+d4)/2	CR
0-110	0
110-190	0.001
190-245	0.002
245-290	0.003
290-350	0.004

5.2 Tripod

The engineer's level is mounted to a metal tripod with adjustable legs and stake-like feet. It is important that the tripod travels in a secure area and is set in a stable area for measurement. It is equally important that the leg tension of the tripod be maintained. To test, set up tripod, place legs about three feet apart, and lift tripod by the head. If tension is appropriate, the legs should fold in slightly. Adjust leg tension according to manufacturer's specifications.

5.3 Leveling Rod

The leveling rod commonly used is a 3-section fiberglass rod with gradations marked to the nearest tenth. Hundredths are denoted by black hashmarks with each black mark representing an odd number and the intervening white representing an even number. The rod should always travel in a carrying case and should never be left unattended in the field. It should never be carried over the shoulder with any section extended. Always check the booted end for cleanliness during measurements, and never drag the end along any surface. To ensure that the rod is in plumb, the rod man should always use a rod level. It is important that the rod be maintained in "bubble" throughout each measurement. The rod should be checked weekly or when the accuracy of the rod is in question. Use a calibrated steel tape to measure the sections. Record the measurements on the current station survey notes.

6.0 Conducting a Survey

Although all surveys have commonalities, they can be conducted differently depending on what the primary objective is. This section covers certain basics including survey points and pre-survey checks. Furthermore, a discussion of certain types of circuits is included.

Several rules of thumb should be followed when reading all levels:

1. All measurements should be made to the nearest thousandth.
2. Minimum shot distance is set by the manufacturer but should be no less than 15 feet.
3. Maximum shot distance is influenced by several factors including surveying experience, light (too much or too little), precipitation, air quality, traffic, wind, and change in elevation. It is better to establish an intermediate turning point than miss the needed precision on the closeout.
4. Consistently read to the top or the bottom of the crosshair in the viewer. Make a notation on the level sheet to assist in future levelings.
5. Attempt to avoid readings below 1 ft.
6. Attempt to avoid reading upper extensions of the rod during high winds.
7. During high winds, the rod should be rocked slightly forward and back to aid in reading the level.
8. A rod level should always be used.

6.1 Survey point

A benchmark (BM) or reference mark (RM) is used as the starting and end measuring point in the level measure. The difference between a BM and an RM is that BM's have usually been placed by a Federal, State or local organization and tied to a national or state wide geodetic datum. The United States Geological Survey (USGS), National Geodetic Survey (NGS), and the respective State Departments of Transportation have placed the most common BM's. These BM's are often located in a permanent structure or mounting that ensures that the marker has little to no movement in relation to the surrounding structure or area.

An RM is used in the absence of a known benchmark. The RM's will often consist of three types of marks. The first, with the lowest level of accuracy, is a chiseled square into a permanent concrete structure such as a wing wall or bridge abutment. To avoid improper rod placement, the chiseled square should be raised above the surrounding material and outlined with paint. The second is placement of an anchor or bolt into the structure. These pins often are common concrete anchor bolts or hex head steel bolts and are installed following the manufacturer's directions and/or common construction techniques. They should be in areas free of impact hazards to avoid damage and/or loss. They can be cut short and filed to a smooth surface to decrease the chance of damage. The third method involves placing a permanent marker during construction or in a permanent hardened location. The difficulty of placing an RM during construction is the cost, proper placement and scheduling of the placement. Therefore, installation of this type may cause an unnecessary increase in cost, materials, and manpower. The installation of a permanent RM is undertaken usually when a long-term commitment is required with a requirement that the RM be tied to a national or state survey system. All RM's should be labeled with paint.

Reference points (RP) are placed as a fixed point from which to measure stage. It is the point to which the datum is tied and from which the gage height is established. The RP is usually established as the check bar of a wire weight gage and/or a pin installed on the outer portion of a bridge. These pins are the same type as those used for RM's and placed and maintained accordingly. The RP's can also be established by placing a painted, chiseled arrow. All RP's should be labeled with paint.

Turning Points (TP) are used when the distance between the various points is too great to be accurately measured or at the midpoint of the basic level circuit. When running a basic level circuit, any firmly placed item can be used as a TP (e.g., a reflector mounted on a bridge or a quarter placed on an even surface). When running a complex level circuit, when possible, a semi-permanent or permanent mark should be placed along the bridge or in the ground. These can be concrete spikes with washers or pins as described above. The material or location should be free of debris and have a uniform thickness or flat surface. When a TP is established, that place should be marked with paint .

6.2 Pre-Survey Checks

Leveling should be scheduled for certain periods. Reliability of results as well as time spent at the station can be influenced by traffic, weather, water level, and time of day. Often traffic cannot be planned around but the other three can. Optimally, surveys should be conducted during periods of low water and favorable weather as well as after the initial light of day and before dusk. If inclement weather is adversely affecting measurements, the survey should be postponed. High winds, excessive cloud cover or haze, and precipitation can drastically alter results.

Before beginning, a series of checks should be conducted at appropriate intervals. These checks are fully described under Section 5 of this document. A consistent routine should always be used and a checklist maintained.

Before surveying begins, all BM's, RM's, RP's, and TP's should be located or established. If measuring from points established in historical surveys, the description of the point should be double checked by the survey leader and reaffirmed by a team member. If points are being established, a thorough description of the point should be made before surveying begins. After survey points have been established or located, a survey circuit should be laid out and reviewed thoroughly. When establishing the circuit, attempt to make all shots comparable in length. Take note of any shots that may be made difficult due to increases in elevation, station conditions, or length of shot, and ensure that conditions will not affect shot by doing informal reads of the level rod.

6.3 Frequency of levels

The frequency of levels should be established in the Station Plan, and this plan should be the ultimate guide for each station. However, there are several rules of thumb that can be followed.

1) New levels should be rerun at least 1 to 2 times in the first 3 years.
2) After the initial 3-year period, all levels should be run at least every 3 years.
3) Levels established at stations with transient channels (e.g., sand) should be run at the end of each rainy season.
4) Levels at stations with stable channels (e.g., bedrock or boulder) can be run every 3 years after the initial 3-year period.
5) Levels at stations with semi-stable channels (e.g., hardpan clay or gravel) should be checked diligently after the initial 3-year period and updated as needed.
6) Levels at stations located on wooden or wooden/steel bridges should be run annually throughout the life of the station.
7) Levels at stations located on new bridges should be checked diligently after the initial 3-year period for up to 10 years. They should be updated as needed.

6.4 Running a Basic Level Circuit

A basic level circuit (Table 3) is used when no permanent or semi-permanent installation (for example, a wire weight gage or a continuous gage) is made at the site. Also, it is used when the lower end of the discharge rating is relatively unimportant or when stage is used only as a screening measurement. A basic level circuit can be divided into seven main steps.

Table 3. Illustration of a basic leveling circuit.

Station	B.S.	Ht. Inst.	F.S.	Elev.
RM-1	**2.678**	**12.678**		**10.000**
RP-1			**2.542**	**10.136**
RP-2	**2.678**	**11.694**	**1.120**	**9.016**
RP-1			**1.556**	**10.138**
RM-1			**1.697**	**9.997**
The C_E is the difference between RM-1 at start and close— CE = 9.997-10.000 = -0.003				
The C_A is the factor of precision (0.003) times the square root of the number of setups (sqrt of 2) — CA = 0.003(sqrt2) = 0.004				

6.4.1 Step 1—Establishing the Initial Elevation

The initial elevation can be set in one of two ways. If a BM is used, the known elevation of the BM is to be used and is the initial elevation of the survey. If an RM is used, an arbitrary elevation of at least 10 feet is set and is adjusted after the datum is established. This initial elevation is set at 10 feet to avoid negative numbers.

6.4.2 Step 2—Establishing the Initial Height of Instrument

The initial H.I. is established by adding the initial elevation to the initial backsight, which is the first measurement taken. As long as the instrument remains set, this H.I. will be used to establish elevations at all points.

6.4.3 Step 3—Establishing elevations of all remaining points

As long as the instrument remains stable (does not move due to site conditions or length of shot), sideshots may be used to establish the elevations of all remaining survey points. Station RP-1 in Table 3 is an example of a sideshot. To obtain the elevation, the foresight measured during each sideshot is subtracted from the initial H.I. However, because not all measurements may be taken from the same position, intermediate H.I.'s may need to be determined. The intermediate H.I.'s are determined by establishing the elevation at a set TP, moving and releveling the instrument, and reestablishing the H.I. by taking an intermediate backsight back to the same TP. When intermediate H.I.'s are used, the elevations of the following points are set from the new H.I.

6.4.4 Step 4—Establishing a Closeout H.I. for the Remainder of the Circuit

All basic survey circuits will have at least one TP and a change in the H.I. This change occurs at the beginning of the closeout of the circuit and is also known as the breakup or shakeup. By doing this, the initial placement of the instrument can be eliminated as a factor in biasing elevations. When doing the breakup, the instrument tripod must be completely lifted off of the ground and be taken out of level. The instrument is then releveled and the closeout H.I. is established.

6.4.5 Step 5—Circuit Closeout

After the closeout H.I. has been set, the circuit is closed out by establishing elevations at the same points but in opposite order. The method for setting elevations is the same and all intermediate TP's used in the first half of the circuit should be used again.

6.4.6 Step 6—Elevation Adjustment

As each of the closeout points are measured, the closeout elevation readings should be compared to the elevations calculated during the first half of the circuit. An example of elevation adjustment is in Table 2. Before finalizing the survey, an elevation adjustment sheet must be completed and attached.

6.4.7 Step 7—Surveying the Datum

In a basic level circuit, a rough tapedown, using a weighted steel tape, is made to the streambed directly below RP-1 and sometimes RP-2. Depending on the substrate, a half to 3 feet may be added to the measurement to account for bed shift. This measurement is the datum and should be checked after all major events. Record both the initial and the adjusted measurement on the level notes.

6.5 Running a Complex Level Circuit

A complex circuit (Table 4) is used when a permanent or semi-permanent installation (for example, a wire weight gage or a continuous gage) is present or to be installed at the site. In general, these installations occur when one or more of the following attributes apply: 1) a discharge rating will be established, 2) the station is a long-term monitoring station, 3) data are used for making loading estimates, 4) data are used to determine ground/surface water interactions, or 5) when any mechanical (e.g., a wire weight gage) or continuous (e.g., a radar gage) stage measurement device is installed. For the most part, the same basic concepts used in a basic level circuit apply to complex circuits.

Table 4. Illustration of a complex leveling circuit.

Station	B.S.	Ht. Inst.	F.S.	Elev.
RM-1	2.678	12.678		10.000
RM-2	2.610	12.613	2.675	10.003
TP-1	2.720	12.779	2.554	10.059
RP-1	2.540	13.017	2.302	10.477
CH. BAR	2.993	13.000	3.010	10.007
RP-2	2.568	13.244	2.324	10.676

RM-3	**2.115**	**13.360**	**1.999**	**11.245**
RM-4	**2.355**	**13.575**	**2.140**	**11.220**
RM-3	**2.256**	**13.503**	**2.328**	**11.247**
RP-2	**2.953**	**13.625**	**2.831**	**10.672**
CH. BAR	**3.779**	**13.789**	**3.615**	**10.010**
RP-1	**2.999**	**13.474**	**3.314**	**10.475**
TP-1	**2.895**	**12.959**	**3.410**	**10.064**
RM-2	**2.795**	**12.794**	**2.960**	**9.999**
RM-1			**2.800**	**9.994**
The C_E is the difference between RM-1 at start and close— CE = 9.994-10.000 = -0.006				
The C_A is the factor of precision (0.003) times the square root of the number of setups (sqrt14) — CA = 0.003(sqrt14) = 0.011				

6.5.1 Step 1—Establishing the Initial Elevation

The only difference in this step is the need to use a benchmark when making long-term installations. Most bridge construction requires that a benchmark be established. If these preestablished marks are not readily found, they can usually be obtained by contacting the entity that owns or maintains the bridge. For short-term installations (1 to 3 years), a benchmark is preferred, but because the station may be used in the future, a well-placed reference mark must be used. The RM should be low profile and permanently placed in the bedrock. For example, a concrete bolt with a flat head or a brass cap can be placed along a more stable portion of a bridge pier. If a permanent structure must be formed for RM placement, it should grounded in bedrock.

6.5.2 Step 2—Establishing Elevations of Remaining Points

Sideshots should be avoided when running a complex level circuit. Therefore a new H.I. is established for each station. Turning points can be used when points are at a distance too far to read. The calculations for H.I.'s and elevations are the same as before. Several new points will be established when installing permanent or semi-permanent stage measurement devices. These new points and the survey circuit are fully described in SOP's pertaining to each of the different types of instruments. These SOP's are referenced in Section 7 of this document. Figure 4 illustrates the installation of a wire weight gage. Note that the check bar of the gage is included as a point along the circuit.

6.5.3 Step 3—Circuit Closeout

After the closeout H.I. has been set, the circuit is closed out by establishing elevations at the same points but in opposite order. The method for setting elevations is the same and all TP's used in the first half of the circuit should be used again.

6.5.4 Step 4—Elevation Adjustment

As each of the closeout points are measured, the closeout elevation readings should be compared to the elevations calculated during the first half of the circuit. An example of elevation adjustment is in Table 5. Before finalizing the survey, an elevation adjustment sheet must be completed and attached.

Table 5. Illustration of elevation adjustments for the circuit in Table 4.

Station	1st Difference From Prev. Sta.	2nd Difference From Prev. Sta.	Average Difference	Elev.
RM-1	**N/A**	**N/A**	**N/A**	**10.000**
RM-2	**0.003**	**0.005**	**0.004**	**10.004**
TP-1	**0.056**	**0.065**	**0.061**	**10.065**
RP-2	**0.418**	**0.411**	**0.415**	**10.479**
CH. BAR	**0.470**	**0.465**	**-0.468**	**10.012**
RP-3	**0.669**	**0.662**	**0.666**	**10.677**
RM-3	**0.569**	**0.575**	**0.572**	**11.249**
RM-4	**0.025**	**0.027**	**-0.026**	**11.223**

6.5.5 Step 5—Surveying the Datum

In a complex level circuit, a second, and sometimes third, circuit of levels is made to establish the datum. Repeating steps 1-4 runs this circuit. The only exception is for step where the remaining points run to the streambed. If available, an RM should be established on the underside of the bridge or on a bridge pier. The reference point is referenced to the permanent installation at the streambed as part of the circuit. This step is not fully discussed or illustrated in this document but is in the SOP's for the different types of instruments. These SOP's are referenced in Section 7 of this document.

7.0 Survey Notes

Survey notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper procedure to complete the survey notes, refer to your supervisor and or FTE. The cited references will also provide examples and details on level notes. Survey notes can be found at S:\Monitoring\STREAMS\technical documents\Survey Notes.doc

8.0 Data Storage

All paper copies of Survey Notes should be maintained with the Station Plan. The data from the Survey Notes should be entered into the Water Quality Database and station levels updated electronically as new surveys are made.

9.0 References

Levels at streamflow gaging stations, by E.J. Kennedy: USGS—TWRI Book 3, Chapter A19. 1990.

STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF BENTHIC AND SESTONIC CHLOROPHYLL-a SAMPLES IN STREAMS

DRAFT—UNDER REVIEW FOR SECTION 2

1.0 Introduction

The purpose of this document is to provide a simplified, step-by-step outline of the field and laboratory procedures used by the Water Quality Programs Division of the Oklahoma Water Resources Board (OWRB) for the collection of benthic and sestonic chlorophyll-*a* in wadeable rivers and streams. The basic sampling procedures that will be discussed in this document involve water quality sampling, methods and equipment. All documents needed for, including chain of custody forms and laboratory login sheets for both the OWRB and the Oklahoma Department of Environmental Quality (ODEQ), field data sheets, and checklists can be found at the end of this document.

2.0 Definitions/Terms

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadeable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites. When regulating the flow of traffic is necessary, please refer to the portion of the safety manual outlining “Traffic Safety Protocols”.

4.0 Quality of the Measurement

When sampling for all programs, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO’s) that are outlined in the controlling Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that field personnel are properly cleaning the plastics and glassware used in field sampling. Duplicate samples are collected to ensure that composite samples are properly processed. Replicate samples may be collected to ensure that the sampling methodology employed is collecting a representative sample. Spike or known samples may be submitted to test the efficacy of the analytical laboratory. The QA/QC protocols for sestonic chlorophyll-a can be found in the document “Standard Operating Procedure for the Collection of Water Quality Samples”. The QA/QC samples for benthic chlorophyll-a are the same. However, since both collection and filtration equipment are both used more than once in the field, two code “33” samples should be taken—one for collection equipment and one for filtration equipment.

5.0 Personnel and Equipment

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training

of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs.

In most instances, the collection of water quality samples requires only one field person. However, depending on the safety requirements of a particular station, additional crewmembers may be necessary to ensure a safe work zone. Equipment used to collect the chlorophyll-a sample are described in the document "Standard Operating Procedure for the Collection of Water Quality Samples".

5.1 Collection Equipment

For sestonic samples, the collection equipment is described in "Standard Operating Procedures for the Collection of Water Quality Samples". When collecting sestonic samples, an additional clean 1-L sample bottle labeled for chlorophyll-a should be included. The sestonic sample is merely collected from the splitter churn as an additional composite sample. To ensure cross-contamination has not occurred, a field blank (QA code 33) should be processed when sestonic chlorophyll-a samples are collected.

For benthic samples, the field collection unit should accompany the field crew. This unit includes a 1 or 2 gallon calibrated wide mouth jug, a large funnel, hard and soft substrate delimiters, coarse scrubbing brush, knife, spatula, rinse bottle, hip chain (extra string and stake), camera, and calculator. All parts should be cleaned thoroughly before leaving the office and while in the field. To ensure cleanliness, both laboratory (code 32) and field (code 33) blanks should be collected using all equipment coming into contact with the sample.

5.2 Filtration Equipment

A field filtration unit should accompany a field crew when benthic and sestonic chlorophyll-a collections are being made. The unit should be cleaned thoroughly after each use. This unit is composed of a filtration apparatus, glass fiber or membrane filters (0.45μm porosity, 47-mm diameter), rinse bottle, foil, marker, forceps, 250-mL plastic graduated cylinder, and zip-lock baggies. The filtration apparatus should include a glass filter funnel and base, a plastic or glass vacuum beaker (1000 mL), vacuum tubing, and hand pump. All glass and plastic parts should be thoroughly cleaned before leaving for the field. To ensure cleanliness, a laboratory blank (QA code 32) should be filtered and processed. Vacuum tubing should be checked regularly for cracks, and the hand pump should be regularly checked to ensure that proper pressure can be regulated.

5.3 Extraction Equipment

For benthic samples, only chemical extraction is used. A clean and labeled 100 mL polyethylene sample bottle should be included for each sample. Before leaving for the field, each bottle should be filled with 25 mL of reagent grade ethanol, tightly capped, and marked along the fill line. Before use in extraction, the line should be checked to ensure that no ethanol has spilled or evaporated.

For sestonic samples, both chemical and mechanical extraction are used. For chemical extractions, a sufficient quantity of buffered acetone should be kept in supply. After chemical extractant is added, the sample is mechanically extracted either by manual use of a glass mortar and pestle or with an automated grinder. Extracted samples are placed in 13 mL screw cap vials. All extraction equipment should be cleaned thoroughly before and after each use, a laboratory blank (code 32) should be collected when samples are processed.

6.0 Collection of Chlorophyll-a Samples

6.1 Benthic Sampling

Following is a detailed description of sampling procedures. Because sampling sequence is important, please follow the protocol as outlined. The general methodology underpinning periphyton sampling involves collecting and compositing samples taken at equidistant transects along a representative reach. Within this reach, samples will be collected in several representative habitats—erosional and depositional. Erosional habitats include riffles and runs. Depositional habitats are slack water and are mostly contained within pooling areas. In order to collect a representative sample within each stream reach, each type of habitat should be sampled. The sampling sequence will include the following generalized steps:

1. Establishment of reach and transects
2. Collection of samples
3. Extraction of samples

6.11 Establishment of reach and transects

The stream reach is defined as 20 times the wetted width of the widest section. Along this reach, 11 equidistant transects are sampled in an effort to sample all represented habitats. To establish, follow these steps:

a. To establish the sampled stream reach, measure the widest wetted width in meters and multiply by 20 (e.g., widest wetted width = 11 meters; stream reach = 20 x 11 meters = 220 meters).
b. To establish 11 equidistant transects (A-K), divide the total stream reach by 10 (e.g., stream reach = 220 meters; transect width = 220 meters/10 = 22 meters). Using the previous example, transect A will be at the head of the stream reach (0 meters), transects B-J will be at 22 meter intervals, and transect K will be at the bottom of the stream reach (220 meters).

6.12 Collection of Samples

At each transect, the sample will be collected at left (L), right (R), or center (C). The type of substrate—soft or hard, will determine the method used to collect the sample. Soft substrates include sand, silt and gravel. Hard substrates are all materials larger than gravel including hardpan and bedrock. **Please keep composited sample out of sunlight.** To collect, follow these steps:

a. The sampling point for each transect is established randomly at the first transect. Several methods may be used to randomize the first point, but the most available method involves the second hand on a watch. By looking at the second hand, “L” is represented by 1-20, “C” by 21-40, and “R” by 41-60. Each following sampling point is established by going from left bank to right bank, back to the left bank and on to the right bank. Repeat this process until all transects are assigned a sampling point.
b. Sampling moving upstream, determine the most representative habitat type at each transect and sample that habitat. Sampling technique will be dependent upon substrate type. Always pick an accessible collection area along transect. Collection area should be as close to the center of the sampling point as possible. Do not sample depths deeper than mid-bicep. Composite samples from each point into 1or 2-gallon wide mouth jar.
c. Sampling Soft Substrates
    - Place capped delimiter over substrate, pressing in until pressure is felt on cap.

- Slide spatula underneath delimiter and lift sample from water ensuring that none of the sample is lost.
- Pour sample into 1-gallon jar using small funnel. Using native water, rinse the delimiter, spatula and funnel.

d. Sampling Removable Hard Substrates (e.g., cobble)
- Remove rock(s) from stream and place open delimiter over substrate to define sampling area. Outline sampling area with a sharp edge.
- Place rock(s) into large funnel and scrub delimited area with a medium coarse wire brush. Periodically wash scrubbed area into jar and continue scrubbing until all periphyton has been removed from rock.

e. Sampling Unremoveable Hard Substrates (e.g., hardpan)
- Place capped delimiter over substrate, pressing in until pressure is felt on cap.
- Slide spatula underneath delimiter and lift sample from water ensuring that none of the sample is lost.
- Pour sample into 1-gallon jar using small funnel. Using native water, rinse the delimiter, spatula and funnel.

6.13 Extraction of Samples

Extraction method is 48 hours in ethanol at ambient temperature. Mechanical extraction is not used. The following steps are used to extract the subsample.

- A subsample of 25 mL from a completely mixed composite is measured using a graduated cylinder.
- The subsample is filtered using a glass or fiber filter (0.45μm porosity, 47-mm diameter). Filtration should not occur above 20 psi.
- When entire subsample is filtered, the filter is removed from the unit and placed in 25 mL of ethanol. The ethanol should be in a wrapped 100 mL polyethylene bottle.
- Sample is transported in the cab of the truck and should be delivered to the laboratory within 48 hours.

6.2 Sestonic Samples

Sestonic chlorophyll sampling and post-processing for streams is described in the lakes portion of the monitoring SOP. For streams, the only sampling difference will be the collection of a composited, depth-integrated sample from the splitter churn. This will be done while general chemistry samples are being aliquoted. Water collected for chlorophyll-a analysis has a 24 hour holding time and should be processed immediately in the field. Light and heat degrade chlorophyll, so it is imperative to minimize exposure to heat and sunlight and artificial light (i.e. don't process outside in direct sunlight, keep ice chest lids closed tightly). Chlorophyll-a must be filtered immediately after exposure to light to avoid degradation. Chlorophyll-a filtrates must be wrapped in foil, labeled, bagged and frozen on ice immediately upon processing. These filtrates may be kept frozen for up to 30 days before extraction occurs. Extracts must also be frozen immediately after preparation and should be submitted to the lab for analysis within one month of being processed.

6.3 Photo Documentation

7.0 Forms

7.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To

avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\Field Notes.doc.

7.2 Laboratory Log-in Sheets

Log-in sheets are documents turned into the analytical laboratory for each sample collected. These forms are used to denote the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time of sample collection and be legible and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper procedure to complete the log-in sheets, refer to your supervisor and or FTE. Log-in sheets can be found at S:\Monitoring\STREAMS\forms\.

7.3 Chains of Custody

Chains of custody are documents turned into the analytical laboratory for each group of samples collected. These forms are used for several purposes. They act as a legal document to show proper delivery of samples occurred and they make a general list of the parameters that should be analyzed. Chains of custody are available for inorganic, metals, and organics panels. They are a data sheet and should be treated as such. Therefore, they should include the date and time for each sample collected and be legible and complete. They should also be signed and dated by field and laboratory receiving personnel at the time of delivery. To avoid confusion and loss of data, a new chain of custody should be used for each group of samples. For guidance on proper procedure to complete the chains of custody, refer to your supervisor and or FTE. Chains of custody can be found at S:\Monitoring\STREAMS\forms\.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

Hill, B. H., "Periphyton", EMAP Western Pilot Study Field Operations Manual for Wadeable Streams, 156-158 (2001).

STANDARD OPERATING PROCEDURE FOR THE COLLECTION OF FISH IN STREAMS

ADOPTED APRIL 2004

1.0 General Information

Fish assemblage monitoring is an integral component of the Oklahoma Water Resources Board (OWRB) Water Quality programs. Assessment of the fish assemblage measures the structure and function of the ichthyofaunal community to evaluate the integrity of a stream. Following is a detailed description of sampling procedures. Efficiency is the key, and finding a comfortable sequence of sampling is essential. This will vary

from person to person and from sampling team to sampling team. Yet, employing consistent sampling patterns at every site will maximize the number of sites sampled per day and decrease the chance for introduction of sampling error.

2.0 Definitions/Terms

- Team Leader—crew member of fish collection team who provides support, expertise, and opinions; gives instruction and has final say on how work will be done; must score a 95% on critical fish identification
- Team Member—crew member of fish collection team who provides support, expertise, and opinions; follows the instructions of the team leader
- Formalin—fixative used in fish collections; is a carcinogen and can also cause permanent damage to mucous membranes and eyes.
- Electrofishing—use of an electrical field in the water to stun fish for collection; selective for areas of instream cover as well as larger fish with more surface area
- Seining—wide and deep net dragged through water to collect fish; selective for runs and pools as well as smaller fish with less surface area

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. Please refer to the OWRB safety manual for instructions. During most fish collections a backpack electrofisher or 2.5 GPP pram/boat electrofisher will be used. Because electrofishers send an electrical current through the water, not following safety procedures may result in serious injury or death. General safety guidelines include:

- Primary responsibility for safety while electroshocking rests with the team leader.
- **DO NOT CHASE FISH!!**
- All crewmembers should receive training in First Aid and CPR. Electro-fishing units have a high voltage output and may deliver dangerous electrical shock. Electric shock can cause heart fibrillations and/or death.
- While electrofishing, avoid contact with water unless sufficiently insulated against electric shock. Use chest waders with non-slip soles and watertight rubber gloves that cover to the elbow. If they become wet inside, stop fishing until thoroughly dry.
- Avoid contact with anode at all times. <u>At no time while electrofishing should a crewmember reach into the water for any reason.</u>
- The backpack electrofishing equipment provided is equipped with a 45-degree tilt switch, which interrupts the current. Do not make any modifications to the electrofishing unit, which would make it impossible to turn off the electricity.
- The pram/boat electrofishing equipment provided is equipped with an emergency shutoff switch. Do not make any modifications to the electrofishing unit, which would make it impossible to turn off the electricity.
- General safety guidelines should be observed. If waders or gloves develop leaks, leave the water immediately. Avoid operating electrofishing equipment near people, pets or livestock. Discontinue any activity in streams during thunderstorms or heavy rain. Rest if crew becomes fatigued.
- Gasoline is extremely volatile and flammable. Its vapors readily ignite on contact with heat, spark or flame. Never attempt to refill the generator while it is running. <u>Always allow the generator to cool before</u>

refilling. Keep gasoline out of direct sunlight to reduce volatilization and vapor release. Always wear gloves and safety glasses when handling gasoline. Keep gasoline only in approved containers.

- Decision to use electrofishing equipment will depend on size of site, flow, conductivity and turbidity. If the specific conductivity is below 10 uS or > 1000μs; if the flow is too high; if the site is too deep; if the water is too turbid to assure safe footing or locate stunned fish, the crew may consider using the seine only or determine that site cannot be sampled. This is a safety decision.
- Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. Proper precautions should be taken when handling formalin.
    - o Protective gloves and eyewear should be worn
    - o Avoid inhalation of vapors
- FAILURE TO OBSERVE SAFETY PROCEDURES WILL RESULT IN DISCIPLINARY ACTIONS INCLUDING PROBATION AND DISMISSAL.

4.0 Quality of the Measurement

4.1 Training

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs. Prior to collecting fish, all staff should familiarize themselves with Fisheries Techniques (edited by L.A. Nielsen and D.L. Johnson and published by the American Fisheries Society 1983), this SOP, and OWRB Technical Report 99-3 Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development.

Investigators are tested for identification abilities with a statewide assemblage of fish fauna before fish collections begin. These fish are comprised of species that are typically found in Oklahoma stream systems. The majority of the test specimens include fish with larger body sizes that are typically field identified and/or found in large numbers. Species of special concern such as the Arkansas River Shiner are also utilized during the testing procedure to insure endangered or threatened species may be correctly identified and released. A test score on critical species of 95% or better must be achieved before the investigator will be a field crew leader. Investigators that score under 95% will not collect without direct supervision of the crew leader.

4.2 Kinds of Quality Assurance Samples

4.2.1 Replicate Collections

Replicate samples will be collected during each biological season. The scope and number of replicates will be determined by the project Quality Assurance Project Plan. They may include replicates for various habitat or stream order.

4.2.2 Vouchers and Photodocumentation

The OWRB has adopted a list of critical species (developed by the Oklahoma Conservation Commission) that will be released in the field. This list includes large fish (>100 gms or 0.25 lbs), fish easily identified (e.g., Longnose Gar), and fishes of special concern (e.g., Leopard Darter). However, proper procedures must be taken before fish may be released. Please follow these guidelines:

1. If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely. **The crew leader does have the final say on releases**.
2. All released fish must be documented on the Fish Collection sheet. Included with this documentation should be the common name (species if known) and characteristics noted to make a positive identification. Fish not recorded, must be brought to the laboratory for identification.
3. All large fish (e.g., smallmouth buffalo) or fish easily mistaken for another (e.g., river carpsucker) must be photographed. Background data in the photo should include the common name of the fish, the date and time (24h), station name or number, and county. Characteristics used to make the identification should be prominently displayed in the photo (e.g., later line scales of a redhorse). Photos should be managed digitally in the OWRB network and printed as needed.
4. When feasible, a voucher specimen should be kept of all released species. This may not be possible with large fish such as suckers or gar. Vouchers should also be kept when a juvenile member of the species is released (e.g., largemouth or spotted bass).

5.0 Personnel and Equipment

5.1 Personnel

Fish collection crews will consist of two to three people. In some instances, a fourth crewmember may be added on larger streams where a pram or boat shocker is used. The team will consist of a team leader and one to three team members. The team leader is someone with one or more seasons of collection experience who has scored above a 98% on critical species identification. Collection experience in other programs may be substituted for that with the OWRB. In certain instances, a team leader may have test scores below 98%. In this case, tests will be reviewed and species that were commonly missed in the scoring will be excluded from releasing. The team leader will have the final say on all crew activities. A team member is someone trained on fish sampling protocols. Team members will be expected to participate in the decision-making and follow the team leaders direction.

5.2 Equipment and Supplies

5.2.1 Backpack Electrofisher

A Smith-Root Backpack Electrofisher model 15 with a Honda model EX-350 generator will be used for collecting fish. Always use this equipment in accordance with manufacturer instructions. The team leader will provide a detailed explanation of how the shocker works as well as safety precautions. Each team member

before operating and/or assisting with the shocker should read and understand the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer. The shocking team must consist of at least two people—an operator and a netter. **This unit may be extremely dangerous if used inappropriately and without the proper safety equipment. Please refer to Section 2.0 for further details.**

The unit works to develop an electrical field, and everything within that field is subject to electric shock. The shocker consists of a trailing stainless steel cable electrode (cathode) and a ring electrode (anode) mounted on the end of a PVC pole. By pressing the anode button, the electrical field is created. The backpack electrofisher works effectively in specific conductance ranges from 40-1000 microsiemens (uS) with and optimal range of 150-650 uS.

The shocker selects for habitat and fish differently than does the seine. The electrofisher selects for fish with more surface area (i.e., larger or deep-bodied) such as bass or suckers. Also, the electrofisher is more effective in habitat where seining may be more difficult such as brush piles, root wads, undercut banks, bedrock ledges, cobble substrates, and shallow riffles. To effectively shock, the anode should be gradually passed back and forth over and in these areas as the team works upstream. As fish are stunned, they will usually roll over and become more visible, allowing the netters to see and capture them. Shocking may also be done in deep or shallow pools.

The unit should be maintained according to manufacturer specifications.

5.2.2 Pram or Boat Electrofisher

A pram or boat electrofisher may be used in waters with extremely low conductivity, conductivity greater than the backpack can handle (up to 1700 uS), and in deeper waters. A Smith-Root 2.5 GPP electrofisher with a Honda model 2500 generator will be on the pram or boat. Always use this equipment in accordance with manufacturer instructions. The team leader will provide a detailed explanation of how the shocker works as well as safety precautions. Each team member before operating and/or assisting with the shocker should read and understand the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer. The boat shocking team must consist of at least two people—an operator and a netter. The pram shocking team must consist of at least three people—an operator, a netter, and a pram guide. Because the guide must turn off the unit in case of accident, it is particularly important that this team member stay fully aware. **This unit may be extremely dangerous if used inappropriately and without the proper safety equipment. Please refer to Section 2.0 for further details.**

The unit works much like the backpack electrofisher, but certain distinctions do exist. The anode for the boat shocker is a set of arrays that are lowered into the water, and the anode for the pram is a wand but can be operated up to 100 feet from the shocking unit. The cathode for the both the pram and boat shockers is the either the boat if using an aluminum hull or a series of cathode arrays if using a fiberglass hull. When cathode arrays are used, they are mounted at the midpoint of starboard and port gunnels and the starboard and port corners of the bow.

The unit should be maintained according to manufacturer specifications.

5.2.3 Seine

Various sized seines may be used to collect fish. Recommended sizes vary from 3 to 6 foot seines in 10, 20, and 30-foot lengths. Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. This will allow the center of the net to form a bag behind the operators where the fish are more likely to stay in the net. However, it is important to remember that the longer the seine is, the more difficult it will be to control in stream currents. Therefore, rule of thumb for length may be discarded. When this occurs, extra time should be spent seining the missed habitats. In general, the OWRB uses 10X6 and 20X60. A seine 20X8 may be used in very deep and/or long pools. Seines should be a ¼ inch mesh to reduce fishing pressure on some young of the year.

The seine selects for habitat and fish differently than does the shocker. The seine selects for fish with less surface area (i.e., terete or smaller body plan) such as minnows or darters. Also, the seine is more effective in habitat where electrofishing may be more difficult pools or runs. Seining may also be done along banks and around instream cover. Seining technique is explained in the later methods section.

Seines should be stored dry and free of debris and other snags.

5.2.4 General Supplies

Clothing

Rubber Gloves	as many pairs as the shocking crew consists of
Waders	as many pairs as the shocking crew consists of, although everyone is responsible for their own waders
Goggles	for use in mixing formalin

Documentation

Dry erase board or white paper and clipboard for photodocumentation
Camera with at least 2 rolls of film or adequate digital memory
Tape measure to record lengths of released fish if desired

Chemicals

Gasoline/oil mix for generator
Extra two stroke oil
10% buffered formalin—always premix in lab and keep jugs stored in separate ice chest

Shocker Parts

Spare plug, Plug wrench, and screwdriver
Spare Anode

Nets

Fishing line or dental floss to repair nets
Dip nets to collect shocked fish

Containers

Wide mouth 1-gallon jars, at least 4 per site
Whirlpacs for putting special fish in

6.0 Collection of Fish

The collection of fish follows a modified version of the EPA Rapid Bioassessment Protocol V (EPA, 1989) supplemented by other documents. Specific techniques for, and relative advantages of seining and electrofishing vary considerably according to stream type and conductivity. The specifics are discussed in detail in Fisheries Techniques (edited by L.A. Nielsen and D.L. Johnson and published by the American Fisheries Society 1983).

The collection of fish involves the use of two collection methods, seining and electrofishing. The combination of methods was selected in order to produce a representative fish collection. Variations of habitat, type of fish, and water chemistry dictate the use of different collection techniques. Electrofishing selects for denser habitat (e.g., undercut banks, root wads, etc.) and very shallow riffles while seining selects for more open habitat such as runs or pools. Electrofishing selects for more surface area (e.g., larger or deep-bodied fish) while seining selects for smaller fish such as minnows darters. Backpack electrofishers are not effective in waters with specific conductance <40uS and >1000uS. The 2.5 GPP electrofisher is not effective in waters with specific conductance over 1700 uS.

Sequence when using both methods is determined by site characteristics. In general, seining should conducted before shocking since fish that utilize cover in the stream will generally not leave the area when disturbed. These fish are most efficiently collected by shocking and should remain when electroshocking commences. However, in very silty waters or waters with low flow and many suspended solids, electrofishing is done first. Stirring up waters while seining may decrease catch efficiency during electrofishing. Also, on extremely hot days, electrofishing early in the day may alleviate some safety concerns.

IN GENERAL, EACH STREAM IS SAMPLED FOR A DISTANCE OF 400 METERS. A REPRESENTATIVE STREAM REACH IS SELECTED AND MEASURED SUCH THAT PRIMARY PHYSICAL FEATURES ARE INCLUDED IN THE REACH (RIFFLES, RUNS, AND POOLS). VERY SMALL STREAMS MAY BE SAMPLED AT 200 METERS IF ALL REPRESENTATIVE HABITATS ARE REPRESENTED IN THAT REACH. LARGER RIVERS WITH LONG POOLS OR RUNS AND BRAIDED RIVERS MAY BE SAMPLED FOR UP TO 800 METERS. AGAIN, ENSURE THAT ALL REPRESENTATIVE HABITATS ARE REPRESENTED IN THAT REACH. THE REACH SHOULD BE LOCATED AWAY FROM THE INFLUENCES OF MAJOR TRIBUTARIES AND BRIDGE/ROAD CROSSINGS. RECORD REACH LENGTH ON THE FIELD NOTES.

In general, all fish are placed in 10% formalin immediately after capture. However, if larger fish (> 100 g) can be positively identified in the field, they are returned to the water in a location where recapture is unlikely. All large fish released are photographed on print film. A representative photograph or voucher specimen may be taken when large numbers of one fish species is collected and released. In all instances when fish are released, they should be recorded and the characteristics used to make the identification should be noted. Collected organisms are identified to species by an experienced taxonomist.

6.1 Seining

Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible, the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. The amount of obstructions in the stream will often preclude the use of longer seines however. When this situation occurs, the crew leader will decide on the most effective combination of seines. The OWRB uses 6 foot seines in 10 and 20 foot lengths on a regular basis. Deeper or wider seines are available to accommodate special cases.

To seine, two people drag the net through the water at a certain rate. This will allow the center of the net to form a bag behind the operators allowing the fish room to move within the net. Generally, the seine is hauled with the current because fish tend to orient towards the current. The leadline should be kept on the bottom, and in front of the float line. If there are many obstructions on the bottom, the leadline will become caught or bounce, and most fish will escape underneath the bottom of the net. If this happens use a smaller net that allows you to avoid obstructions, roll up the ends of the existing net to make it more manageable, use a trailer to move net over obstruction, or go to electroshocking. The brailles of the net should be used to disturb the area under any undercut banks, bedrock ledges, or beds of macrophytes near the edge in order to scare fish hiding in cover out towards the middle of the net.

Under ideal conditions the net should be pulled through the water in the manner described above for about 10 meters and dragged out of the water on a gradually sloping preselected beach. The person pulling the seine on the side of the stream opposite the beach should swing ahead of the other person so that the seine is pulled out on the beach stretched over the same distance it was stretched in the stream.

If the stream doesn't have gradually sloping banks, the dip method should be used. This method consists of sweeping around and through the area to be sampled, keeping a wide bag and moving the lead line as much under the undercut bank as possible. Use the brailles to probe repeatedly as far as possible into the undercut area working towards each other until the brailles overlap. The seine should then be swiftly stretched and lifted vertically from the water.

Other seining methods may be effective. All will not be discussed here, but may be demonstrated in the field. In certain instances moving with the current may not be possible. In these cases to keep from loosing fish, the bag should be deepened and the total reach seined should be shortened. Also, it is often not possible to reach a seine the width of a run while keeping an adequate bag. In these cases, seine perpendicular to the flow of the water towards the opposite shore. The downstream person should operate slightly ahead of upstream person forming a “J”.

RECORD THE TIME SPENT SEINING AND SEINE MESH SIZE ON THE FIELD DATA SHEETS.

6.2 Electrofishing

Before operating or assisting with the shocker, READ AND UNDERSTAND THE MANUALS for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not spelled out in this text. The manuals can be obtained from the equipment file in the main office.

The shocker consists of a trailing stainless steel cable electrode and either a ring or diamond electrode mounted on the end of a fiberglass pole. Under most conditions, both the ring and diamond electrodes can be used at the same time. In waters of extremely low conductivity (<40 uS), the ring should be used. In waters of

high conductivity (>500 uS), the diamond should be used. In very deep water where the ring seems to be ineffective the diamond electrode may offer better results.

The shocker is most useful where a seine cannot be used effectively in areas such as with dense instream cover, undercut banks, or riffles. In waters of high conductivity (>1000 µS/cm) backpack electroshocking is ineffective, due to the highly conductive nature of the water. Under these conditions, only seining is conducted.

In general, the following procedure should be followed:

- A minimum of two people is required for electrofishing. One carries and operates the shocker while the other(s) net stunned fish. With the pram shocker one person should act as the pram guide. This guide should stay fully aware so that the unit may be shut off in emergencies.
- Collection begins at a shallow riffle or other physical barrier at the downstream limit of the reach, and terminates at a similar barrier at the upstream end of the reach. In the absence of physical barriers, block nets may be set at the upstream and downstream ends of the reach prior to sampling.
- In general, fish collection procedures commence at the downstream barrier and proceeds in an upstream direction. Electrofishing is most effective when the team works upstream. Catch efficiency will decrease in turbid waters or waters with changing conductivity due to upturned mud, silt or sand. However, this is up to the discretion of the Crew Leader.
- The forward electrode should be gradually passed back and forth over the stream width, including brush piles and root wads. As fish are stunned, they will usually roll over and become more visible, allowing the netter(s) to see and capture them.
- In very dense brush or root cover, fish often sense the presence of the team before they are close enough to be stunned and then retreat so deeply into cover that it is impossible to net them when they are stunned. It is often better in situations such as these to insert the electrode into the brush before it is turned on, give the fish a minute or so to get used to the new situation and then turn the current on. Many fish will be much closer to the edge of brush pile when they are stunned in this manner.

RECORD THE TIME SPENT ELECTROFISHING ON THE FIELD DATA SHEETS.

6.3 Sample Handling & Preservation

CAUTION: Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. The fish should be put into the jar with the lid tilted open away from the operator so that the lid shields the face and body of the operator. Flood any skin exposed to formalin with plenty of water as soon as possible. If it gets in your eyes, flood the eyes with water immediately and go to the doctor immediately after that.

The following steps should be taken to handle and preserve fish:

- Fish collected by seining and electroshocking should be kept in separate jars and labeled with capture method. This will make the methods independent if desired for analysis.
- Label each jar. Using a pencil, write the date, WBID #, collection time, stream name, number of jars composing one sample, county, legal location, and crew leader's name on a piece of ~2 x 3

inch waterproof paper and place one label into every jar of fish from each site. Write the same information on the front of each jar using a wax pencil or an indelible marking pen.

- In general all fish should be placed in 10% formalin immediately after capture. There are a few exceptions made for larger fish (>100 gms or 0.25 lbs), which can be positively identified in the field.

- If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely.
- All released fish must be documented on the Fish Collection sheet. Included with this documentation should be the common name (species if known) and characteristics noted to make a positive identification. Fish not recorded, must be brought to the laboratory for identification.
- All large fish (e.g., smallmouth buffalo) or fish easily mistaken for another (e.g., river carpsucker) must be photographed. Background data in the photo should include the common name of the fish, the date and time (24h), station name or number, and county. Characteristics used to make the identification should be prominently displayed in the photo (e.g., later line scales of a redhorse). Photos should be managed digitally in the OWRB network and printed as needed.
- When feasible, a voucher specimen should be kept of all released species. This may not be possible with large fish such as suckers or gar. Vouchers should also be kept when a juvenile member of the species is released (e.g., largemouth or spotted bass).
- When preserving fish much larger than 0.3 to 5 kg (0.5 to 10 lbs), the fish should be sliced open along the lower rib in order to allow the formalin to penetrate the body cavity fast enough to prevent decay. A slit through the ribs is preferred to a belly slit to facilitate counting belly scales in the lab.
- Fill out a Chain of Custody Form.
- The Crew Leader is responsible for transferring the samples to the Fish Sample Taxonomist (currently the OU Museum of Natural History).

7.0 Forms

7.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\.

7.2 Laboratory Log-in Sheets

Log-in sheets are documents turned into the analytical laboratory for each sample collected. These forms are used to denote the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time of sample collection and be legible and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper procedure to complete the log-in sheets, refer to your supervisor and or FTE. Log-in sheets can be found at S:\Monitoring\STREAMS\forms\.

7.3 Chains of Custody

Chains of custody are documents turned into the analytical laboratory for each group of samples collected. These forms are used for several purposes. They act as a legal document to show proper delivery of samples occurred and they make a general list of the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time for each sample collected and be legible and complete. They should also be signed and dated by field and laboratory receiving personnel at the time of delivery. To avoid confusion and loss of data, a new chain of custody should be used for each group of samples. For guidance on proper procedure to complete the chains of custody, refer to your supervisor and or FTE. Chains of custody can be found at S:\Monitoring\STREAMS\forms\.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Biological Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

EPA, (1999) Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd Edition, EPA 841-B-99-002, Office of Water, Washington, D.C.

Oklahoma Water Resources Board (1999) Technical Report 99-3: Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development, Oklahoma City, OK.

Oklahoma Conservation Commission, Water Quality Division, (2000) Standard Operating Procedures for Fish Collection in Streams, Oklahoma City, OK.

Nielsen, L.A. and D.L. Johnson, (1983) Fisheries Techniques, American Fisheries Society.

1.0 General Information

Most free flowing water bodies, with acceptable water quality and habitat conditions, support diverse macroinvertebrate communities in which there are a reasonably balanced distribution of species among the total number of individuals present. Macroinvertebrate community responses to environmental perturbations are useful in assessing water quality and habitat impacts. The composition and density of macroinvertebrate communities in flowing water are reasonably stable from year to year. However, seasonal fluctuation associated with life-cycle dynamics of individual species may result in extreme variation at specific sites within any calendar year. Assessing the impact of pollution generally involves comparison of macroinvertebrate communities and their habitats at sites influenced by pollution with those collected from adjacent unaffected sites.

Macroinvertebrate collections, for purposes of stream assessment, are made from the community that requires or prefers flowing (lotic) water. Reasons why this community type is sampled rather than various lentic communities include:

1. The flowing water community is routinely exposed to the average water quality of the stream;
2. The metrics used to analyze the macroinvertebrate community of streams were designed for the flowing water community;
3. The database of pollution tolerance of macroinvertebrates found in Oklahoma is much larger for lotic communities; and
4. The organisms most sensitive to water quality degradation tend to live in flowing water.

Due to these factors, the flowing water community is more suitable for assessing the condition of a stream, than by looking at the pool community where more tolerant organisms are found regardless of the stream's water quality.

Lotic communities require a substrate of some type to attach to. The most common substrates of this type include rocky riffles, streamside root masses, and woody debris. Where possible, a rocky riffle should be sampled, but if it is not present, or is of dubious quality, if rocky riffles cannot be found at <u>all</u> streams of a given ecoregion, both of the other two alternate habitats should be sampled. The sampling methodology for the three habitat types is included in this SOP.

Invertebrate communities are constantly changing throughout the year as species emerge and new species hatch. Consequently, it is not possible to infer water quality from the invertebrate community of a stream by comparing it to a reference stream community that was collected at a different time of year. The springtime communities are especially unstable as many of the insects that over-winter as larvae begin to emerge. By summertime however, the insects that only have one generation per year have mostly emerged and the insects left are ones that hatch repeatedly throughout the summer. This means that collections made during different times of the summer tend to be the same in lieu of water quality differences. This period of the summer when collections from different streams can be compared to each other is termed the <u>Summer Index Period</u>.

2.0 Definitions/Terms

- Team Leader—crew member of fish collection team who provides support, expertise, and opinions; gives instruction and has final say on how work will be done; must score a 95% on critical fish identification
- Team Member—crew member of fish collection team who provides support, expertise, and opinions; follows the instructions of the team leader
- Riffle—any sudden downward change in the level of the streambed such that the surface of the water becomes disrupted by small waves. A riffle substrate must be composed of gravel, or cobble from 1" to 12" in the longest dimension; substrates of bedrock or tight clay are not considered suitable.
- Streamside Vegetation—any streamside vegetation that offers fine structure for invertebrates to dwell within or upon that receives suitable flow. Most habitats are located along undercut banks where fine roots of riparian vegetation are hanging in the water.
- Woody Debris—any dead wood with or without bark located in the stream with suitable current flowing over it.
- Summer Index Period—July 1 to September 15.
- Ethanol—preservative used in macroinvertebrate collections. Proper precautions should be taken when handling 100% ethanol. It is flammable, an intoxicant, and an eye irritant.

3.0 Safety

Upon reaching the sampling location, site safety determinations should be made before proceeding. Please refer to the OWRB safety manual for instructions. During most fish collections a backpack electrofisher or 2.5 GPP pram/boat electrofisher will be used. Because electrofishers send an electrical current through the water, not following safety procedures may result in serious injury or death. General safety guidelines include:

- Proper precautions should be taken when handling 100% ethanol. It is flammable, an intoxicant, and an eye irritant.
    - o Protective gloves and eyewear should be worn
    - o Avoid inhalation of vapors

4.0 Quality of the Measurement

4.1 Training

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements as well as habitat assessments and biological collections. In-house training will be conducted for the use of all meters and digital titrators used for water quality or quantity measurements. Investigators must be familiar with OWRB SOP document and all training will follow the methods outlined in that document. Extra training will be provided when new SOPs are developed. Training of field crews will be done through dry run exercises in the laboratory to familiarize field crews with sample collection, sample preservation, instrument operation, calibration, and maintenance. In addition, when new personnel are hired or new methods developed, qualified staff will train on sample collection, measurement, and field analysis methods through side-by-side field trips. These trips will familiarize staff with SOP requirements. When training is considered adequate, a qualified staff member will check field staff for adherence to SOPs. Prior to collecting macroinvertebrates, subsampling, and picking, all staff should familiarize themselves with this SOP and OWRB Technical Report 99-3 Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development.

4.2 Kinds of Quality Assurance Samples

4.2.1 Replicate Collections

Replicate collection samples and duplicate subsampling and pick samples will be collected during each biological season. The scope and number of replicates will be determined by the project Quality Assurance Project Plan. They may include replicates for various habitat or stream order.

4.2.2 Vouchers and Photodocumentation

All unique reaches and special or unusual circumstances should be photodocumented.

5.0 Personnel and Equipment

5.1 Personnel

Macroinvertebrate collection crews may consist of one to two people. The team will consist of a team leader and possibly one team members. The team leader is someone with one or more seasons of collection experience. Collection experience in other programs may be substituted for that with the OWRB. The team leader will have the final say on all crew activities. A team member is someone trained on macroinvertebrate collection, subsampling and picking protocols. Team members will be expected to participate in the decision-making and follow the team leaders direction.

5.2 Equipment and Supplies

5.2.1 Kick Net

OWRB uses a 1 m^2 kick net with 500 micron mesh. The kick net is composed of the net, brailles inserted and tied to the net, and a bottom leadline. The team leader will provide a detailed explanation of how to use the net. The kick net is used in riffles and only in flowing water. Bugs are collected by disturbing a 1 m^2 area upstream of the net by overturning, scrubbing, and agitating all material within the area. The small mesh selects for all bugs within the habitat.

The net should be checked regularly for holes and should be stored dry and free of snags and debris.

5.2.2 Dip Net

OWRB uses a modified dip net (a.k.a. D-net) with 500 micron mesh. The net is composed of a net attached to a D-ring and a one to three foot handle. The net is shrouded to protect against snags and increase longevity. The team leader will provide a detailed explanation of how to use the net. The dip net is used in streamside vegetation and woody debris and is only used in flowing water. Bugs are collected by disturbing the underside of root wads, undercut banks, wood, etc. The small mesh selects for all bugs within the habitat.

The net should be checked regularly for holes and should be stored dry and free of snags and debris.

5.2.3 General Supplies

Chemicals

Ethanol

Nets

Fishing line or dental floss to repair nets
Spare net

Containers

Wide mouth 1-quart polyethylene bottles and lids
Large bucket for instream subsampling

6.0 Collection of Macroinvertebrates

Before beginning collection, determine if flow conditions are suitable for collection. Samples must be collected in flowing water no greater than 3 cm (~1 inch) above the seasonal base flow. After a high flow event, 5 – 7 days should lapse before a collection is made too allow the benthic organisms to return to the preferred substrate. Furthermore, collection should be delayed for two weeks after a stream has gone from no flow (interrupted, or dry conditions) to base flow conditions.

The collection of macroinvertebrates involves collection in three possible lotic habitats—riffles, streamside vegetation, and woody debris. The combination of methods was selected in order to produce a representative macroinvertebrate collection. Because Oklahoma streams vary widely in substrate, riffle habitats may not always be available.

In general, each stream is sampled for a distance of 400 meters. A representative stream reach is selected and measured such that all available habitats are sampled. The reach should also include representative microhabitats for streamside vegetation. Very small streams may be sampled at 200 meters if all representative habitats are in that reach. Larger rivers with long pools or runs and braided rivers may be sampled for up to 800 meters. Again, ensure that all representative habitats are in that reach. The reach should be located away from the influences of major tributaries and bridge/road crossings. Record reach length on the Field Notes.

Because streamside and woody habitats are timed collections and riffle kicks involve the use of three riffles, collections may be quite large. After exclusion of as much organic matter as possible, infield subsampling should be done to decrease the amount of each collection to no greater than 75% of a 1 quart sample bottle. This method is described is subsequent subsections. This sample is then subsampled and picked in the laboratory.

Sequence for collection is determined by site characteristics. In general, an appropriate riffle should be identified and sampled first. Subsequently, streamside vegetation can be sampled by going up the reach and woody debris sampled on the return trip.

6.1 Collection from Rocky Riffles

6.1.1 Suitable Substrate

A riffle is defined as any sudden downward change in the level of the streambed such that the surface of the water becomes disrupted by small waves. For this collection method the substrate of the riffle must be

composed of gravel, or cobble from 1" to 12" in the longest dimension. Riffles with substrates of bedrock or tight clay are not suitable.

6.1.2 Where to Sample the Riffle

Three 1 m^2 areas of the riffle must be sampled. They can be square, rectangular or trapezoidal so long as each area equals 1 m^2 in area. One should be in the fastest part of the riffle where the largest rocks and the smallest amount of interstitial sediment will generally be found. The second should be in the slowest part of the riffle, often near the edge of the stream where the smallest rocks and the greatest amount of interstitial sediment will be found. The third sample should be in an area intermediate between the first two.

6.1.3 Method of Collecting the Sample

Support a 1 m^2 kick net composed of a double layer of fiberglass window screen or a net of number 30 mesh in such a way that any organisms dislodged from the substrate will be carried into it by the current. The bottom of the net should be tight against the bottom of the stream and the current must be sufficient to insure that dense organisms such as small mollusks will be carried into the net from the sampling area. There is no definite cutoff for stream velocity in the sampling area, but if possible, riffles with average velocities of 1 foot/second or greater are preferred and should be chosen if possible.

By kicking the substrate, vigorously agitate the substrate of a 1 m^2 area of the bed of the riffle immediately upstream of the riffle until all rocks and sediment to a depth of at least five inches have been thoroughly scraped against each other. Organisms living between and upon the rocks will have been dislodged and carried into the net by the current. Any rocks too large to kick should be brushed by hand on all surfaces. This can be done using your hands or with the aid of a brush. If a brush is used, you must be very careful to clean it after each site to prevent contamination of the next sample with invertebrates from the previous site. Continue agitation and brushing until it can be seen that the area being sampled is producing no new detritus, organisms, or fine sediment.

At this point, rinse leaves, sticks and other large debris caught in the net in the current in a manner such that organisms on them are carried into the net. When the volume of the sample is reduced so that three 1 m^2 samples will loosely fill a 1 quart jar three fourths (3/4) full or less, remove all of the material from the net and place it in the jar. In no case should the jar be filled more than 3/4 full of loose sample. Add 100% ethanol to the jar until the sample is covered and there is free ethanol on top of the sample. There should always be enough room in the jar to have at least 5 cm (2 inches) of free ethanol over the sample. **Record the number of sample divisions that are made. This number will be used to calculate back to the number of individuals in the sample.**

Label the sample appropriately following the instructions presented in section 1.11 Sample Handling & Preservation.

6.2 Collection from Streamside Vegetation

6.2.1 Suitable Substrate

Any streamside vegetation in current that offers fine structure for invertebrates to dwell within or upon is suitable. The vegetation being sampled must be in the current so that it offers suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. This habitat will often be found

along the undercut banks of runs and bends where the fine roots of grasses, sedges, and trees, such as willow and sycamore, hang in the water.

6.2.2 Where to Sample the Riffle

This type of sample should be collected with a dip net made of #30 size mesh material. The net should be placed around or immediately downstream of the vegetation being sampled. The organisms can be dislodged from the roots either by vigorously shaking the net around the roots or by shaking the roots by hand while the roots are inside the net.

6.2.3 Method of Collecting the Sample

Sampling should continue for **3 minutes** of actual root shaking. Do not count the time that elapses between sampling areas. Be careful to only sample roots in current. Usually, only one or two sides of a given root mass are in current. Be careful not to sample the backside of a root mass that is in still water.

AT THIS POINT, RINSE LEAVES, STICKS AND OTHER LARGE DEBRIS CAUGHT IN THE NET SO THAT ORGANISMS ARE NOT LOST. WHEN THE VOLUME OF THE SAMPLE IS REDUCED SO THAT IT WILL LOOSELY FILL A 1 QUART JAR THREE FOURTHS (3/4) FULL OR LESS, REMOVE ALL OF THE MATERIAL FROM THE NET AND PLACE IT IN THE JAR. IN NO CASE SHOULD THE JAR BE FILLED MORE THAN 3/4 FULL OF LOOSE SAMPLE. ADD 100% ETHANOL TO THE JAR UNTIL THE SAMPLE IS COVERED AND THERE IS FREE ETHANOL ON TOP OF THE SAMPLE. THERE SHOULD ALWAYS BE ENOUGH ROOM IN THE JAR TO HAVE AT LEAST 5 CM (2 INCHES) OF FREE ETHANOL OVER THE SAMPLE. **RECORD THE NUMBER OF SAMPLE DIVISIONS THAT ARE MADE. THIS NUMBER WILL BE USED TO CALCULATE BACK TO THE NUMBER OF INDIVIDUALS IN THE SAMPLE.**

Label the sample appropriately following the instructions presented in section 1.11 Sample Handling & Preservation.

6.3 Collection from Woody Debris

6.3.1 Suitable Substrate

Any dead wood with or without bark in the stream is suitable as long as it is in current fast enough to offer suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. The final sample should consist of organisms collected from an even mixture of wood of all sizes and in all stages of decay.

6.3.2 Where to Sample the Riffle

This type of sample should be collected with a dip net made of #30 size mesh material. The net should be placed around or immediately downstream of the debris being sampled. The organisms can be dislodged from the debris either by vigorously shaking the net around the woody debris or by shaking the debris by hand while the debris is inside the net. Large logs that are too big to shake should be brushed or rubbed vigorously by hand while the net is held immediately downstream.

6.3.3 Method of Collecting the Sample

Sample for total of **5 minutes** counting only the time that debris is actually being agitated. Include as many types of debris in the sample as possible. These types often include wood that is very rotten and spongy with or without bark, wood that is fairly solid which has loose and rotten bark, wood that is solid with firmly attached bark and any combination of these states. They should range in size from 1/4" to about 8" in diameter.

After sampling, rinse leaves, sticks and other large debris caught in the net so that organisms are not lost. When the volume of the sample is reduced so that it will loosely fill a 1 quart jar three fourths (3/4) full or less, remove all of the material from the net and place it in the jar. In no case should the jar be filled more than 3/4 full of loose sample. Add 100% ethanol to the jar until the sample is covered and there is free ethanol on top of the sample. There should always be enough room in the jar to have at least 5 cm (2 inches) of free ethanol over the sample. **Record the number of sample divisions that are made. This number will be used to calculate back to the number of individuals in the sample.**

Label the sample appropriately following the instructions presented in section 1.11 Sample Handling & Preservation.

6.4 Sample Handling & Preservation

- **CAUTION: Proper precautions should be taken when handling 100% ethanol. It is flammable, an intoxicant, and an eye irritant. Protective gloves and eyewear should be worn. Avoid inhalation of vapors.**

1. **Pack the Jar Properly.** In no case should the jar be filled more than 3/4 full of loose sample. Add 100% ethanol to the jar until the sample is covered and there is free ethanol on top of the sample. There should always be enough room in the jar to have at least 5 cm (2 inches) of free ethanol over the sample.

2. **Label the Sample.** The jar should be labeled on the lid using a fine tip permanent ink marker (Sharpie) as described below. In addition, a small sheet of paper (approximately 2" x 2") should be filled out with the same information written in pencil and placed in the jar.

JAR LID & SAMPLE INSERT

DATE COLLECTED
Stream Name
Waterbody ID #
Site Time
Legal Description
County
Type of sample (riffle, woody, vegetation)
Sampler's Initials

3. **Complete the Chain of Custody.** Follow the instructions in the **Chain of Custody and Sample Labeling** SOP. A new COC should be completed for each collection episode. Each substrate collection (riffle, woody, vegetation) should occupy a separate line on the COC. There should be only one box of samples per COC, i.e., one box, one COC.

4. **Transfer samples to the Macroinvertebrate Sample Custodian.** Correctly labeled macroinvertebrate samples, along with a COC form, should be transferred to the Project Manager

for subsampling. The box should be conspicuously labeled with COC number. Once the samples have been received and the COC signed, the field sampler should make a photocopy of the COC for their records.

In some instances it may be necessary to drain the liquid from the sample and add fresh 100% ethanol. This is necessary when the sample contains a large amount of algae or other material with high water content or material that will rapidly become rancid. This will help preserve the morphological integrity of the invertebrates and greatly aid in taxonomic identification.

6.5 Subsampling and Picking of Macroinvertebrates from field Collected Samples

The waterbody assessment procedure utilized by OCC requires that a random sample of macroinvertebrates be collected, identified and enumerated, from the portion of the waterbody being assessed. In order to make this test cost effective it is not possible to identify more than about 150 organisms from each site. This procedure describes the procedure used to subsample a field-collected sample, which may contain 200-10,000 organisms.

1. **Obtain the Field Sample to be Subsampled.** The field collected macroinvertebrate samples and the original COC will be transferred to the individual(s) designated to complete the macroinvertebrate subsampling and picking. At this time a copy of the COC (signed by the subsampling designee) will be sent to the Data Manager or logged on the web page.

   The sample will come from the field in 1-quart jars preserved with 100% ethanol. Lids have a sealing compound that is not particularly resilient. Care must be taken so that the lids are not damaged when they are opened or resealed. If a lid is damaged it must be replaced with a new one. Keep a fresh supply of lids handy in case this happens. If you use a new lid, label it exactly the same as the one that was originally used.

   Samples will be subsampled/picked in the order assigned on the COC form.

2. **Decant Ethanol.** Without shaking or disturbing the contents, pour the liquid from the sample through a sieve made of #30 or finer screen. Save the ethanol to preserve the unused portion of the sample.

3. **Rinse Sample.** At this point, any silt, clay or fine sand in the sample should be GENTLY rinsed out of the sample. Be careful not to break off any of the delicate appendages that are used for identification of the animals. The sample will be easier to process if any large pieces of leaf, bark, stones, etc., are washed carefully and discarded.

4. **Prepare Sample for Picking.** Spread the sample out in a rectangular tray/pan that is divided into 28 sections of equal area. The size and shape of the divisions are not important so long as they are all equal in size. A pan with a white background may facilitate the collection since there will be a contrast between the organisms and the pan.

   A clear glass pan or baking dish can be effectively used by creating a grid system on the bottom of the pan using a permanent marker. Each square should be numbered (1-28), and a sheet of white paper

can be glued or taped over the outside bottom of the pan. If very many samples will be subsampled it will be worth your time to construct a divider for the tray similar in construction to an ice cube tray divider. This will not only demarcate the subsampling squares, but it will also prevent animals from drifting from one square to another during subsampling.

5. **Remove Large Pieces of Detritus and Sediment.** Large leaves and big pieces of wood and bark should be removed. Be VERY CAREFUL to pick all macroinvertebrates off of them before discarding. At this point, the material remaining in the dish should consist of a mixture of sand, fine gravel, small organic detritus, pieces of leaves < 1-2 cm wide, fine roots, algae and macroinvertebrates.

6. **Spread the Sample Out.** All detritus and sediment should be as uniformly distributed over the bottom of the dish as possible.

7. **Visual Estimate Invertebrate Density of the Sample.** Determine if the sample must be subdivided. The decision will be based on two requirements: (1) individual squares MUST have AT LEAST 3 animals in them (providing the entire sample has at least 84 animals total), and (2) each square can have absolutely NO MORE THAN 100 animals. Simulid (blackfly) larvae are not to be counted as individuals for this purpose. That is, the density estimate should be independent of any blackfly larvae present. The goal is to have roughly 10 TO 20 ANIMALS PER SQUARE. This is a compromise between the statistical ideal of very few organisms per square and ease of subsampling where the entire sample is picked from one square. If you estimate that there are less than 280 animals in the entire sample, you should process the entire sample.

   The purpose of this estimate is to make the sample statistically valid. Fewer than 80 animals does not provide a good representation of the population to draw conclusions from, and more than 130 animals biases the sample making it appear that that stream has more taxa, that it really does

8. **Subdivide the Sample.** If each square is estimated to have more than 50 animals, it is important to grossly subdivide the sample prior to picking. For instance, divide the sample in half or quarters depending on the animal density. Ideally, 10 to 20 animals per square is desirable.

   For dividing in fourths, cut the sample into top and bottom halves and then into right and left halves. After dividing the sample, the four portions should appear as equal as possible in terms of the amount of detritus and sediment present. Choose one quarter by random means. For instance, flip a coin to select either the top half or the bottom half, and then flipping the coin again to select either the right or left side of the first half selected. If the sample is not too dense, that is the selected quarter has a density of 10 to 20 animals per square, then no additional subdivision is necessary. If the number of invertebrates is still too dense, divide the remaining portion in half and select one half by flipping the coin again. Continue dividing the sample until the density appears to fall in the correct range. **Record the number of sample divisions that are made. This number will be used to calculate back to the number of individuals in the sample.**

9. **Return the Unselected Portion(s) to the Jar.** Return the unselected portion(s) of the sample to the original jar and add the reserved alcohol. Be very careful to remove the entire portion of unselected subsample. A proportionately high density of small macroinvertebrates can remain hidden in the sediment and detritus.

10. **Fill the Tray About 1 to 2 cm Deep With Water.** Add enough tap water to fill the tray to a depth of 1–2 cm (~0.5 to 0.75 inches). The water aids in the subsampling process. The organisms and individual pieces of detritus do not clump together as when they are dry. If the water is run into the tray very slowly, the remaining leaves and large pieces of detritus can be rinsed and discarded.

11. **Distribute the Sample Evenly.** Make sure that all materials in the tray are evenly distributed, especially the gravel and leaves. If a divider is to be used, place it in the tray now. Once the sample has been distributed, do not move the pan. Jostling can cause the organisms to move outside of their designated square. This could lead to a sampling bias.

12. **Fill Out the Subsampling/Picking Log Book.**
    Complete the Log Book information
    - **Picker's Name**. The name of the person doing the subsampling and picking should be printed legibly.
    - **Date Subsampled and Picked.** The date of subsampling and picking should be recorded (MM/DD/YY)
    - **Site Name.** The name of the site as it is written on the sample jar.
    - **WBID #** The waterbody identification number on the sample jar.
    - **Collection Date.** The date the sample was collected.
    - **Site Time.** The time recorded on the sample container
    - **Sample Type.** Type of sample "Woody", "Vegetation", or "Riffle"

13. **Fill Out Subsampling/Picking Form.**
    - **Picker's Name**. The name of the person doing the subsampling and picking should be printed legibly.
    - **Date Subsampled and Picked.** The date of subsampling and picking should be recorded (MM/DD/YY)
    - **Site Name.** The name of the site as it is written on the sample jar.
    - **Collection Date.** The date the sample was collected.
    - **County.** County the sample was collected
    - **Legal Description.** The legal location the sample was collected
    - **WBID #** The waterbody identification number on the sample jar
    - **Sample Type.** Type of sample "Woody", "Vegetation", or "Riffle"
    - **Estimate the Composition of the Sample.** Exclusive of invertebrates, estimate the composition of the sample according to the following list: silt and clay, sand, fine gravel (<2mm), course gravel (>2mm), woody debris (twigs, bark, roots, etc.), whole leaves, rotted pieces of leaves, filamentous algae, and unidentifiable organic material. Record the percentage of each fraction.
    - **Proportion Picked.** Record the fraction of the sample that was placed into the tray for sampling –e.g. 1/2, 1/4, or 1/8 of the original jar sample. This is important because the density calculations depend on this number.
    - **List Each of the Squares That Was Picked.** List the number of the square that was picked on the lab notebook along with the number of organisms that were picked from that square.
    - **List the Total Number of Animals Picked.** Record the sum total of all squares picked. This number is not used in the calculation of the IBI scores, but provides an estimate of the total number of organisms.

INFORMATION TO INCLUDE	SAMPLE NOTEBOOK PAGE
Subsampling Date	11/18/99
Sampling Date	07/16/99
Stream Name	Griever Creek
Site Time	13:30
Legal Description & County	E 9 T22N R15W, Major County
WBID #	OK620920-01-0130g
COC #	COC# 1772
Sampling Type	Riffle kick
Sample Description	40%fine gravel 10% film algae 30% well rotted leaves 10% whole leaves 5% woody debris 5% coarse gravel
Amount of Sample Picked	¼ of the original sample was prepared for picking
Squares Picked	Square # 1 12 3 23 28 10
# Of animals found in each square	# Picked 15 27 10 18 8 24
Subsampler's name	

14. **Randomly Select 6 of the 28 Squares.** Using some method to generate a series of random numbers (random number generator or number table), select at least 6. The random number generators found on most pocket calculators or the Excel spreadsheet function will give a series of three digit numbers—usually >0 but <1. Use only the last two numbers. Starting with the first random number generated, record all numbers between 01 and 28 until there are 6. These numbers represent the numbered squares to pick. Picking must follow the order in which the number were generated.

15. **Confine the Organisms to the Selected Square.** Place rectangles or squares constructed of clear plastic or other material that are the same or greater height as the water in each square. This will keep the organisms from drifting out of the squares during the picking process. If a large piece of detritus (leaves, roots, algae masses) crosses the boundary of two or more squares, it may be sliced along the edge of the square so it is contained with the boundary of the selected square.

16. If there are any organisms that cross square boundaries, do not cut them. Place them in the square in which their head is already lying.

17. **Pick <u>All</u> the Invertebrates Out of the First Square Selected.** Locate and collect all the organisms in the selected square. Keep track of the number of non-blackfly organisms picked. Place the organisms picked in a scintillation vial that is filled up to the neck with 70-100% ethanol. If any large organisms (that are too big to fit in the vial with the other organisms) are picked such as crayfish or hellgrammites, place them in a separate vial. If there is some question if something is an organism or if it is a simulid (blackfly), place it in the vial but <u>DO NOT COUNT</u> it as part of the total. Pickers should be trained to identify blackfly larval forms—if the picker cannot identify blackflies, they should not be subsampling without further training.

    When all of the organisms are picked out of the square, record the number of non-blackflies that were picked from that square under the number of that square in the lab book. See example page listed above.

18. **Continue to Pick Squares Until 100 Organisms Have Been Collected.** Using the random number list, continue to select squares until 100 (non-blackfly) animals have been collected. Once a square has been started, all of the animals must be collected from that square. A subsample will typically have 100-130 organisms / vial. If there are more than this, the sample was not properly subdivided. If the sample has more than 150 organisms in it, it must be mixed back in with the rest of the "unpicked sample" and re-picked. If the finished invertebrate sample has less than 80 organisms in it and there is unpicked sample available, another tray full of sample must be picked. The <u>ONLY</u> time that it is acceptable to have a sample with less than 80 organisms is when the entire jar of material has been picked. All other samples containing less than 80 invertebrates will be rejected as data with bad QA/QC.

19. **Label the Vial(s).** Using a fine point permanent ink marker label the vial. The top and side of the vial should both be labeled.

    The vial should be labeled with the following information:
    - o Stream name
    - o WBID #
    - o Date collected
    - o Site time
    - o Legal location and County
    - o Type of sample (riffle, woody, vegetation)
    - o Number of vials for this sample (e.g. 1 of x, where x = total number vials for one site (jar))

    The cap should be labeled with the following information:
    - o Stream name
    - o WBID
    - o Date collected
    - o Time
    - o Type of collection
    - o Number of vials for this sample

Scintillation Vial Scintillation Vial Cap

Figure 1 Example label for bug picking sample.

20. **Place Clear Tape Over the Label.** To protect the label from the ethanol, place clear tape (scotch tape) over the writing.

21. **Transfer Picked Samples to the Taxonomist**. Once macroinvertebrate samples have been picked and placed in a properly labeled scintillation vials, the vials and the original COC will be transferred to the laboratory for taxonomic identification. The original COC should be returned to the Data Manager with the signature of the taxonomist or laboratory custodian.

22. **Archive Remaining Sample.** The remainder of the field collected macroinvertebrate samples (un-picked) should be delivered to the Project Manager for archive purposes. The COC number should be conspicuously labeled on the end of the box.

7.0 Forms

7.1 Field Notes

Field notes are documents used to annotate and record information that is gathered at the project site. They are a data sheet and should be treated as such. Therefore, they should be written, legible, and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. Field notes should be initialed and dated by the collecting personnel and data entry personnel. For guidance on proper procedure to complete the field notes, refer to your supervisor and or FTE. Field notes can be found at S:\Monitoring\STREAMS\forms\.

7.2 Laboratory Log-in Sheets

Log-in sheets are documents turned into the analytical laboratory for each sample collected. These forms are used to denote the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time of sample collection and be legible and complete. To avoid confusion and loss of data, a new sheet should be used at each new project site. For guidance on proper procedure to complete the log-in sheets, refer to your supervisor and or FTE. Log-in sheets can be found at S:\Monitoring\STREAMS\forms\.

7.3 Chains of Custody

Chains of custody are documents turned into the analytical laboratory for each group of samples collected. These forms are used for several purposes. They act as a legal document to show proper delivery of samples occurred and they make a general list of the parameters that should be analyzed. They are a data sheet and should be treated as such. Therefore, they should include the date and time for each sample collected and be legible and complete. They should also be signed and dated by field and laboratory receiving personnel at the time of delivery. To avoid confusion and loss of data, a new chain of custody should be used for each group of samples. For guidance on proper procedure to complete the chains of custody, refer to your supervisor and or FTE. Chains of custody can be found at S:\Monitoring\STREAMS\forms\.

8.0 Data Storage

All completed paper copies of forms and data sheets should be maintained with the appropriate station notebook. The data from the field notes and laboratory data sheets should be either entered into or uploaded to the Water Quality Biological Database. Each sample should be maintained electronically in the database under a unique sample number.

9.0 References

EPA, (1999) Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers, 2nd Edition, EPA 841-B-99-002, Office of Water, Washington, D.C.

Oklahoma Water Resources Board (1999) Technical Report 99-3: Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria and Development, Oklahoma City, OK.

Oklahoma Conservation Commission, Water Quality Division, (2000) Standard Operating Procedures for the Collection of Fish, Oklahoma City, OK.

Nielsen, L.A. and D.L. Johnson, (1983) Fisheries Techniques, American Fisheries Society.

OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"
STATION FIELD SHEET

Collectors:	**Sampling Trip: 1**	**Project Code: WB-AT**	**SEL #:**
Station Name:			**Site ID:** 720500030010-001AT
Sample Date:	**Time Range at Site (24h):**		**Location Code: 10**

Variables Sampled	**General Chemistry**	☐ nutrients ☐ minerals ☐ solids	**Delivery Date:**
	Metals	☐ all ☐ site specific ☐ MQL	**Delivery Date:**
	Bacteria	☐ fecal col ☐ *E. coli* ☐ enterococci	**Delivery Date:**
	Organics	☐ all ☐ site specific ☐ MQL	**Delivery Date:**

QA INFORMATION

Duplicate Sites	**G Chem Field:**	**G Chem Laboratory:**	
	Metals Field:	**Metals Laboratory:**	
	Organics Field:	**Organics Laboratory:**	
	Bacteria Field:	**Bacteria Laboratory:**	
Blank Sites	**G Chem Field:**	**G Chem Lab:**	**G Chem Anal:**
	Metals Field:	**Metals Lab**	**Metals Anal:**
	Bacteria Field:	**Bacteria Lab:**	**Bacteria Anal:**
	Organics Field:	**Organics Lab:**	**Organics Anal:**
Other QA	**Known:**		
	Spike:		
Type of Collection	☐ depth integrated composite ☐ grab composite ☐ grab		
	If other than D-I composite, please explain: _____		

SAMPLER'S COMMENTS:

_____
_____
_____
_____
_____
_____
_____

	Initials	**Date**
Field Completed	_____	_____
Office Reviewed	_____	_____
Data Entry Recieved	_____	_____
Data Entry Entered	_____	_____
Data Entry Reviewed	_____	_____
Hard Copy Filed	_____	_____

MULTI-PARAMETER INTSTRUMENT

Instrument Type:	Datalogger Serial #:	Multiprobe Serial #:

PARAMETER	VALUE	CALIBRATION RECORD
Time (24 hour)		
Depth (M)		
H_2O Temperature (^{O}C)		
Dissolved Oxygen (mg/L)		
Dissolved Oxygen (% SAT)		
pH (units)		
Specific Conductivity (µM)		
Salinity (mg/L)		
Oxidation Reduction Potential (mV)		
Total Dissolved Solids (mg/L)		

FIELD PHYSICAL AND CHEMICAL DATA

PHYSICAL CHARACTERISTICS

Air Temp (^{O}C) =	Barom Press (mmHg) = ft	Prevailing Wind Dir =	Wind Speed (5 digit range mph) =
Cloud Cover: ☐ clear ☐ 25% ☐ 50% ☐ 75% ☐ 100%		Precipitation ☐ fog ☐ rain ☐ sleet ☐ snow; approx amt. _____	
Stream Type ☐ pool ☐ run ☐ riffle ☐ mix (type) _____		Bank Width (feet) =	Sampled Width (feet) =
Water Color BCS number _____			

FLOW DETERMINATION

Visible Periphyton Line ☐ yes ☐ no	Periphyton Color ☐ green ☐ brown ☐ yellow ☐ other		
Periphyton Texture ☐ slimy ☐ discoloration ☐ gelatinous ☐ filamentous ☐ other			
☐ measured, ☐ rated	Total Discharge (cfs) =	# of Intervals =	Interval Width =
Stage—RP 1=	Stage—RP 2 =	Stage—RP 3 =	Stage—RP 4 =
Visual Flow ☐ minimal ☐ light ☐ moderate ☐ heavy ☐ stormwater ☐ mix (type) _____			

FIELD CHEMISTRY

Nitrogen as Ammonia (ug/L) =	Total Hardness (mg/L CaCO3) =
Total Alkalinity (mg/L CaCO3) =	Phenophthalein Alkalinity (mg/LCaCO3) =
Turbidity (NTU's) =	Type of Turbidity ☐ inorganic ☐ organic ☐ mixed

FIELD OBSERVATIONS (rank 1 to 5 with 1 being best and 5 being worst; make comments in box)

Periphyton ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Odor ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Foaming ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Floating Debris ☐ large ☐ medium ☐ small ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Scum ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Oil and Grease ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.	Nitrogen Series	Phosphorus Series	Other	Other (Optional)	SELS NUMBER
SAMPLERS: (Signature)					NO_2 NO_3 NH_3 TKN	Ortho-P Total P	Chloride Sulfate	Total P NH_3 TKN	
SITE #	DATE	TIME	STATION NAME (QA CODE)						
AT				2	X	X	X		
AT				2	X	X	X		
AT				1				X	
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				2	X	X	X		
AT				1				X	

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME
REMARKS:			REMARKS:		

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY LOG-IN SHEET
OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"

FOR LAB USE ONLY

PROJECT CODE: **WB-AT**

SELS SAMPLE NUMBER: _____

Collector's Initials: **Site ID:** 720500030010-001AT

Station Name: **QA CODE: 10**

Date Collected: **Time:**

Sampler's Comments:_____**TDS=**_____**mg/L**_____
_____
_____
_____
_____
_____

LABORATORY PARAMETERS

Optional Coverage:

☐ Nitrogen as Ammonia	☐ Arsenic (90075)	☐ Calcium (916)
☐ Nitrogen as Nitrite	☐ Barium (01007)	☐ Organics Method 515.3
☐ Nitrogen as Nitrate	☐ Cadmium (01027)	☐ Organics Method 608
☐ Nitrogen, Kjeldahl	☐ Chromium (01034)	☐ Organics Method 614
☐ Phosphorus, Total	☐ Copper (01042)	☐ Organics Method 8260
☐ Phosphorus, Ortho	☐ Lead (01051)	☐ Organics Method 8270
☐ Sulfate	☐ Mercury (71900)	☐ Other
☐ Chloride	☐ Nickel (01067)	☐ Other
☐ Total Solids, Dissolved	☐ Selenium (01147)	☐ Other
☐ Total Solids, Settleable	☐ Silver (01077)	☐ Other
☐ Total Solids, Suspended	☐ Thallium (01059)	☐ Other
☐ Cyanide (00720)	☐ Zinc (01092)	☐ Other
☐ Fluoride (00951)	☐ Sodium (929)	☐ Other

FILE COPY
RETURN TO:
OWRB/BILL CAUTHRON
3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

OKLAHOMA WATER RESOURCES BOARD BLANK SAMPLE LOG-IN SHEET

OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"

FOR LAB USE ONLY

PROJECT CODE: **WB-AT**

OWRB SAMPLE NUMBER:_____

Collector's Initials:

Site ID: 720500020450-001AT

Station Name:

QA CODE: 33

Date Collected:

Time:

Trip #: 1

Churn Splitter #:

Sampler's Comments:_____

_____

_____

_____

LABORATORY PARAMETERS

Test	Result	Performed By
Hardness	_____	_____
Total Alkalinity	_____	_____
Turbidity	_____	_____
Nitrogen as Ammonia	_____	_____
Nitrogen as Nitrite	_____	_____
Nitrogen as Nitrate	_____	_____
Nitrogen, Kjeldahl	_____	_____
Phosphorus, Total	_____	_____
Phosphorus, Ortho	_____	_____
Sulfate	_____	_____
Chloride	_____	_____

LabComments:

_____

_____

OKLAHOMA WATER RESOURCES BOARD BLANK SAMPLE LOG-IN SHEET
OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.	FECAL COLIFORM	E. coli	ENTEROCOCCI	SELS NUMBER
SAMPLERS: (Signature)								
PC	**DATE**	**TIME**	**STATION NAME (LOCATION CODE)**					
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	

RELINQUISHED BY: (Signature)	**DATE**	**TIME**	**RECEIVED FOR LABORATORY BY: (Signature)**	**DATE**	**TIME**
REMARKS:			**REMARKS:**		

STATE ENVIRONMENTAL LABORATORY
OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
PO BOX 24104
OKLAHOMA CITY, OK 73124-0104

BACTERIOLOGICAL WATER ANALYSIS

SAMPLE NUMBER:

OWRB

Collector's Initials:

Site ID: 120410010080-001AT

Station Name:

Qaulity Assurance Code: 11

Date Collected:

Time:

County:

Sampler's Comments:_____

FILE COPY

RETURN TO:
OWRB/BILL CAUTHRON
3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

NOTE: PLEASE DO NOT USE TAPE TO SEAL LID, USE A WIDE RUBBER BAND INSTEAD.

FOR LAB USE ONLY

ANALYSIS DATE _____ TIME _____ REJ CODE _____

E COLI	TEST:	MPN	TOTAL/100 ML	
FECAL COLIFORM	TEST:	MF	TOTAL/100 ML	
FECAL STREPTOCOCCI	TEST:	MF	TOTAL/100 ML	
FECAL STREPTOCOCCI CONFIRMATION	TEST:	MF	TOTAL/100 ML	
ENTEROCOCCI	TEST:	MF	TOTAL/100 ML	
ENTEROCOCCI CONFIRMATION	TEST:	MF	TOTAL/100 ML	
SALMONELLA	TEST:	MPN	TOTAL/100 ML	
SALMONELLA	TEST:	PA	TOTAL/100 ML	

ANALYST COMMENTS _____

MF ____ LTB ____ BGB ____ EC ____ PA ____ UV ____ INITIALS ____

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD
HARDNESS DEPENDENT METALS WITH RESTRICTIVE MQL'S (METHOD 200.8)

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.	Cd	Cu	Pb	Ag	SEL'S NUMBER
SAMPLERS: (Signature)					Cadmium	Copper	Lead	Silver	
PC	**DATE**	**TIME**	**STATION NAME (LOCATION CODE)**						
ATHD				1	X	X	X	X	
ATHD				1	X	X	X	X	
ATHD				1	X	X	X	X	
DEQ				1	X	X	X	X	
DEQ				1	X	X	X	X	
ATHD				1	X	X	X	X	

RELINQUISHED BY: (Signature)	**DATE**	**TIME**	**RECEIVED FOR LABORATORY BY: (Signature)**	**DATE**	**TIME**

REMARKS:
HNO_3 TO BE ADDED

REMARKS:

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY LOG-IN SHEET
OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"
HARDNESS DEPENDENT METALS WITH RESTRICTIVE MQL'S (METHOD 200.8)

FOR LAB USE ONLY

PROJECT CODE: **WB-ATHD**

SELS SAMPLE NUMBER: _____

Collector's Initials: **Site ID:** 121300010010-001AT

Station Name: **Location Code: 11**

Date Collected: **Time:**

Sampler's Comments:_____**TDS=**_____**mg/L**
Spec. Conductivity=_____**microSiemens**
Hardness (Actual)= _____**mg/L**
Turbidity= _____ **NTU's**
Hardness (6 Month Average)= ____115_____ mg/L

LABORATORY PARAMETERS

Permanent Coverage:

☐ Cadmium (01027)	☐ Other _____	☐ Other _____
☐ Copper (01042)	☐ Other _____	☐ Other _____
☐ Lead (01051)	☐ Other _____	☐ Other _____
☐ Silver (01077)	☐ Other _____	☐ Other _____

FILE COPY
RETURN TO:
OWRB/BILL CAUTHRON
3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.	As	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Th	Zn	SEL'S NUMBER
SAMPLERS: (Signature)					Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Selenium	Silver	Thallium	Zinc	
PC	DATE	TIME	STATION NAME (QA CODE)													
AT				1	X	X	X	X	X	X	X	X	X	X	X	
AT				1	X	X	X	X	X	X	X	X	X	X	X	
AT				1	X	X	X	X	X	X	X	X	X	X	X	
AT				1	X	X	X	X	X	X	X	X	X	X	X	
AT				1	X	X	X	X	X	X	X	X	X	X	X	
DEQ				1	X		X			X	X	X		X	X	
DEQ				1	X		X			X	X	X		X	X	
DEQ				1	X		X			X	X	X		X	X	
DEQ				1	X		X			X	X	X		X	X	
DEQ				1	X		X			X	X	X		X	X	
AT				1	X		X			X	X	X		X	X	

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:	REMARKS:
ALL SAMPLES NEED NITRIC ACID ADDED	

PROJECT: BENEFICIAL USE MONITORING—STREAMS				# OF CONT.	METHOD 515.3	METHOD 608	METHOD 614	METHOD 8260	METHOD 8270	SEL'S NUMBER
SAMPLERS: (Signature)										
PC	DATE	TIME	STATION NAME (LOCATION CODE)							
104				7	X	X	X	X	X	
104				7	X	X	X	X	X	
104				7	X	X	X	X	X	
104				4				X	X	
104				4				X	X	
ATP				3	X	X	X			
ATP				3	X	X	X			
ATP				3	X	X	X			
DEQ				3	X	X	X			
DEQ				3	X	X	X			
DEQ				3	X	X	X			
DEQ				3	X	X	X			
DEQ				3	X	X	X			

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:	REMARKS:

OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"
BIOLOGICAL COLLECTION FIELD SHEET

Station Name:		
Sample Date:	**Time Range at Site (24h):**	**Site ID:**
QA Code:	**Sampling Trip:**	**Project Code:**
Team Leader:		**Team Members:**

COLLECTION INFORMATION

Fish Collection (shock)	**Reach Length Shocked (meters)**	
	Total Effort (seconds)	
	Total Number of Jars Collected	
Comments:		
Fish Collection (seine)	**Reach Length Seined (meters)**	
	Total Effort (minutes)	
	Total Number of Jars Collected	
Comments:		
Macroinvertebrate Collection (shoreline)	**Reach Length (meters)**	
	Total Effort (minutes)	
	Total Number of Jars Collected	
Comments:		
Macroinvertebrate Collection (woody debris)	**Reach Length (meters)**	
	Total Effort (minutes)	
	Total Number of Jars Collected	
Comments:		
Macroinvertebrate Collection (riffle)	**Total Effort (minutes)**	
	Total Number of Jars Collected	
Comments:		

SAMPLER'S COMMENTS:

_____
_____
_____
_____
_____

	Initials	**Date**
Field Completed	_____	_____
Office Reviewed	_____	_____
Data Entry Recieved	_____	_____
Data Entry Entered	_____	_____
Data Entry Reviewed	_____	_____
Hard Copy Filed	_____	_____

MULTI-PARAMETER INTSTRUMENT

Instrument Type:	Datalogger Serial #:	Multiprobe Serial #:

PARAMETER	VALUE	CALIBRATION RECORD
Time (24 hour)		
Depth (M)		
H_2O Temperature (^{O}C)		
Dissolved Oxygen (mg/L)		
Dissolved Oxygen (% SAT)		
pH (units)		
Specific Conductivity (μM)		
Salinity (mg/L)		
Oxidation Reduction Potential (mV)		
Total Dissolved Solids (mg/L)		

FIELD PHYSICAL AND CHEMICAL DATA

PHYSICAL CHARACTERISTICS

Air Temp (^{O}C) =	Barom Press (mmHg) =	Prevailing Wind Dir =	Wind Speed (5 digit range mph) =
Cloud Cover: ☐ clear ☐ 25% ☐ 50% ☐ 75% ☐ 100%		Precipitation ☐ fog ☐ rain ☐ sleet ☐ snow; approx amt. _____	
Stream Type ☐ pool ☐ run ☐ riffle ☐ mix (type) _____		Bank Width (meters) =	**Sampled Width** (meters) =
Water Color BCS number _____			

FLOW DETERMINATION

Visible Periphyton Line ☐ yes ☐ no	Periphyton Color ☐ green ☐ brown ☐ yellow ☐ other		
Periphyton Texture ☐ slimy ☐ discoloration ☐ gelatinous ☐ filamentous ☐ other			
☐ measured, ☐ rated	Total Discharge (cfs) =	# of Intervals =	Interval Width =
Stage—RP 1=	Stage—RP 2 =	Stage—RP 3 =	Stage—RP 4 =
Visual Flow ☐ minimal ☐ light ☐ moderate ☐ heavy ☐ stormwater ☐ mix (type) _____			

FIELD CHEMISTRY

Nitrogen as Ammonia (ug/L) =	Total Hardness (mg/L CaCO3) =
Total Alkalinity (mg/L CaCO3) =	Phenophthalein Alkalinity (mg/LCaCO3) =
Turbidity (NTU's) =	Type of Turbidity ☐ inorganic ☐ organic ☐ mixed

FIELD OBSERVATIONS (rank 1 to 5 with 1 being best and 5 being worst; make comments in box)

Periphyton ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Odor ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Foaming ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Floating Debris ☐ large ☐ medium ☐ small ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Scum ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5	Oil and Grease ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

SESTONIC CHLOROPHYLL SAMPLE LOG SHEET - STREAMS

OKLAHOMA WATER RESOURCES BOARD

Stream	Date	Collector's Initials	Volume Filtered	Sample #

Stream	Date	Collector's Initials	Volume Filtered	Sample #

Return to:
OWRB
Monty Porter
Water Quality Programs Division
3800 N. Classen Blvd.
Oklahoma City, OK 73118

DISCHARGE MEASUREMENT NOTES
OKLAHOMA WATER RESOURCES BOARD

Completed By _____ Meas# _____ Date: _____ Time: _____

Station No._____ Station Name_____

Meter Information

Type of Meter _____ Meter # _____ Distance from bottom of weight _____

Spin Test (before) (after) Maintenance (before) (after) for M/M calibration to 0 (yes)/(no)

Measurement Location

Suspension Method (wading)/(cable)/(boat) Other (describe)_____

Measurement Location bridge (US)/(DS); gage (above)/(below) by _____(feet)/(mile)

Measurement Information

Methods Used (1 point) (2 point) (3 point) Other (describe)_____

Sections _____ Width _____ Area _____ Ave. Velocity _____ Discharge _____

% difference from rating:_____

Measurement Rated as (excellent 2%)/ (good 5%)/ (fair 8%)/ (poor > 8%) based on the following conditions:

Flow: _____

Cross Section: _____

Control: _____

Weather: _____°C Water Temp. _____°C Air Temp. _____Wind (dir. & vel.)

Encumbrances to Meter: _____

Other: _____

Gage Height of Zero Flow _____

GAGE READINGS						
POINT	BEGINNING GH	TIME	ENDING GH	TIME	GH DIFFEREN	TIME ELAPSED

Sheet _____ of _____

SUSPENSION COEFFICIENT	HOR. ANGLE COEFFICIENT	DIST FROM INITIAL POINT	WIDTH	DEPTH	OBSERVATION DEPTH	REVOLUTIONS	TIME IN SECONDS	VELOCITY AT POINT	MEAN VELOCITY	ADJUSTED VELOCITY	AREA	DISCHARGE

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD

PROJECT:				**TOTAL NUMBER O F FISH**	**PARAMETERS TO BE ANALYZED**			**SEL'S NUMBER**
SAMPLERS: (Signature)					**FISH TOXICS NAALYTES**	**OTHER**	**OTHER**	
PC	**DATE**	**COLL. NUMBER**	**STATION NAME**					

RELINQUISHED BY: (Signature)	**DATE**	**TIME**	**RECEIVED FOR LABORATORY BY: (Signature)**	**DATE**	**TIME**

REMARKS:	**REMARKS:**

OKLAHOMA DEPT ENVIRONMENTAL QUALITY LABORATORY
FISH LOGIN SHEET
OKLAHOMA WATER RESOURCES BOARD

FOR LAB USE ONLY

PROJECT CODE **WB-TIF**

SELS SAMPLE #:_____

Collector's Initials: **Date:** **QA Code:** **Coll. #**

Station Name: **Station ID:**

Legal: ¼_____ ¼_____ ¼_____Sec._____T.S._____ R._____ County:

Collection Data:

Trophic Level Represented:

Collection Method:

Common Name: **Total # of Fish:**

Species Name:

	Weight	**Length**
Fish #1	_____g	_____mm
Fish #2	_____g	_____mm
Fish #3	_____g	_____mm
Fish #4	_____g	_____mm
Fish #5	_____g	_____mm
Fish #6	_____g	_____mm

Prep Method: **whole _____** **fillets _____** **eviscerated _____**

LABORATORY PARAMETERS

Fish Toxic Analytes

Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, PCB, Toxaphene

Metals

Mercury

Other

_____

_____

_____

FILE COPY
RETURN TO:
OWRB/BILL CAUTHRON
3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD
PERIPHYTIN—ETHANOL EXTRACTED

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.	Corrected Chlorophyll-a	Pheophytin-a	SEL'S NUMBER
SAMPLERS: (Signature)							
PC	DATE BEGAN	TIME BEGAN	STATION NAME (LOCATION CODE)				
CLP	05/21/03			1	X	X	
CLP	05/21/03			1	X	X	
CLP	05/21/03			1	X	X	
CLP	05/27/03			1	X	X	
CLP	05/27/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	
CLP	05/28/03			1	X	X	

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:	REMARKS:
Please allow extraction to run for at least 48 hours (time on foil). Please do not expose filter to light!!	

FOR LAB USE ONLY:

PROJECT CODE: WB-CLB

SELS SAMPLE NO.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
STATE ENVIRONMENTAL LABORATORY
707 N. ROBINSON
OKLAHOMA CITY, OK 73102
(405) 702-1113
OKLAHOMA WATER RESOURCES BOARD
PERIPHYTIN LOGIN FORM

Collector's Initials **QA Code** **Site ID:**

Station Name

Date Collected **Time Collected**

Date Filtered **Time Filtered** **Volume Filtered**

Samplers Comments:_____
_____
_____
_____
_____

Benthic (Periphyton) Chlorophyll-a (32241) **Benthic (Periphyton) Pheophytin-a (32242)**

Return To: **OWRB**
Monty Porter
3800 N. Classen Blvd.
Oklahoma City, OK 73118

Copy: File Copy

FOR LAB USE ONLY:

PROJECT CODE: WB-CLP

SELS SAMPLE NO.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
STATE ENVIRONMENTAL LABORATORY
707 N. ROBINSON
OKLAHOMA CITY, OK 73102
(406) 702-1113
OKLAHOMA WATER RESOURCES BOARD
PERIPHYTON LOGIN FORM

Collector's Initial: _____ Source: _____

Date Collected: ____/____/_____ Time Collected: ____:____

Site: _____

Filtered Date: _____/_____/_____

Volume Filtered: _____ml.

Sampler's Comments: _____

Periphyton (32225)

Return To: OWRB
3800 N. Classen Blvd.
Oklahoma City, OK 73118

Copy: File Copy