DOCUMENT TYPE:	Standard Operating Procedure	
DOCUMENT CLASS:	Sampling Procedure	
TITLE:	Stream Gaging	
PREPARED BY:	Scot Stormo, Earth Systems Southwest	__________________
REVISED BY:	Jeanette de la Rosa, Quality Assurance Officer	__________________
REVIEWED BY:	Anne Cheung, Laboratory Manager	__________________
APPROVED BY:	Marshall K. Cheung, Ph.D., Laboratory Director	__________________

Table of Contents

Document No.:	***SP008 - 01***
***Copy provided to*:**	**Marshall K. Cheung**
***Title*:**	Laboratory Director
	29 Palms Laboratory
	47-250 Dillon Road
	Coachella, CA 92236
***Copy provided by*:**	**Jeanette de la Rosa**
***Title*:**	Quality Assurance Officer
Date:	August 3, 2004

1. **Purpose**
   1.1. In conjunction with water quality testing, stream gaging provides hydrologic information about local surface waters that may prove useful in many ways. Possible uses include:
      - Characterizing current water-quality conditions
      - Determining input rates of various pollutants into lakes, reservoirs, or estuaries
      - Computing the loads of sediment and chemical constituents
      - Understanding biological effects of contamination
      - Setting permit discharge requirements of treated wastewaters
      - Setting minimum flow requirements for meeting aquatic life goals
      - Developing, maintaining, or operating recreational facilities
      - Evaluating surface and ground water interaction
      - Undertaking scientific studies of long-term changes in the hydrologic cycle

   1.2. Stream gaging in the field involves measurement of the stream velocity (based on the revolutions of the stream gage) for each cross-sectional segment of the stream, and compilation of each segment's velocity over the entire width of the stream.

   1.3. As with any scientific or mathematical endeavor, the precision and accuracy of the results is only as reliable as the precision and accuracy of the data. Reliable stream gage data is dependent on the care and consistency field personnel apply to their field stream gaging techniques. This Standard Operating Procedure for stream gaging has been prepared to provide a degree of Quality Assurance and ensure the acquisition of reliable stream flow data by field personnel.

2. **Intended Use and Limitations**
   2.1. This SOP was prepared for use as part of the Whitewater River Monitoring Project (project) being conducted by the Tribal EPA of the Twenty-nine Palms Band of Mission Indians.

   2.2. It was specifically prepared for use at various locations within the lower portion of the Whitewater River, from approximately the location of the Coachella Valley Sanitary District Wastewater Treatment Plant to the mouth of the Whitewater River at the Salton Sea.

   2.3. This SOP is designed for use with the equipment available to the Tribal EPA on this project, notably the Rickly Model 6200 USGS Type AA Current Meter, the Rickly Model 6205 USGS Pygmy Meter, the companion AquaCalc 5000 Basic Stream Flow Computer, and associated accessories.

   2.4. If a different stream gaging system is used, the specific operating procedures described in this SOP for the stream gaging equipment will not apply.

3. **Preparation**
   3.1. Prior to leaving for the field site, preparations should be made which anticipate weather, safety, equipment, and other supply needs.

   3.2. In addition to apparel appropriate to the climate, the following should be packed for transport to the site.

4. **Equipment**
      - Current Meters (2 – Rickly Type AA and Rickly Pygmy)
      - Top Set Wading Rod Assembly

- Sounding weight and hand line assembly, including sounding weight hanger
- Extra bolts, pins, and pivots
- AquaCalc 5000 Basic Stream Flow Computer
- Extra 9 volt battery
- Field copy of SOP for Stream Gaging including Figures and Appendices
- GPS unit
- Digital camera (optional)
- Flat head screwdriver
- Several (4 to 6) 36" to 48" metal stakes
- Hammer (2 pound+)
- Length of rope long enough to accommodate width of the stream, plus 20 feet
- Reel tape measure long enough to accommodate width of the stream
- Second measuring tape with weight tied to one end (for bridge gaging)
- Incrementally marked depth rod that exceeds maximum depth of stream (for boat gaging)
- Two small tarps
- Clipboard
- Calculator
- Duffel bags or backpacks for equipment and supplies
- Chair

5. **Consumable Supplies**
   - Several dozen zip ties and cutter
   - Blank data log forms (Appendices A-1 and A-2)
   - Waterproof pens

6. **Safety Gear/Decontamination Supplies**
   - Waterproof gloves
   - Waterproof boots and/or waders (preferably with steel soles)
   - Protective eyewear
   - One length of rope to be used as a safety line
   - 1-gallon multi-sprayer bottle (with spray wand) filled with a 0.001% bleach/water decontamination solution
   - 1-gallon multi-sprayer (with spray wand) filled with tap water for rinsing equipment and gear following decontamination.
   - 1-gallon multi-sprayer bottle (with spray wand) filled with distilled water for rinsing equipment and gear following decontamination
   - Small plastic tarp
   - Lightweight ladder for stream access
   - Personal Floatation Device (if the water is more than knee deep or moving quickly)
   - Drinking water
   - Sunscreen lotion
   - Bug spray
   - Umbrella (optional)

7. Personnel

7.1. A well-organized team need not be extensive, but safety should be the first consideration in determining the number of personnel needed at a site.
7.2. A minimum of a current meter technician (CMT) and a Data Recorder (DR) are recommended.
7.3. In the cases of deeper streams with stronger currents, or when a boat is being utilized, a third person may be required.
7.4. Prior to the start of field activities, a Team Leader should be designated, usually the most senior person at the site.
7.5. A Health and Safety Officer (HSO) should also be designated, usually the Team Leader.
7.6. If hazardous materials may be encountered, a site-specific Health and Safety Plan should also have been prepared (not included as part of this SOP). If hazardous materials are not expected, the main duty of the HSO will be related to physical safety hazards, such as fast moving water, and safe ingress and egress. A Health and Safety Meeting should be held prior to starting the field work to discuss issues such as likely sources of hazards, mitigation procedures, location and directions to closest emergency medical center, and appropriate safety apparel.
7.7. Each staff member must be outfitted with safety apparel appropriate to the task. Some examples of safety apparel include rubber gloves, rubber boots (rubber waders for the CMT), a personal floatation device (life preserver), and protective eyewear.

8. Site Procedures

The general areas for gaging the stream will have been selected as part of the project setup, but the exact location of the measurement will need to be selected based on field conditions. Once the location is selected, gaging the stream is a straightforward process.

Choosing a Transect Location

Stream gaging measurements are performed along a "transect" of the stream, which is essentially a cross-section of the stream at a specific location. Measurements of the length and depth along the transect is important because the area of the stream cross-section is an important part of the calculation of stream discharge rate. The transect location should be chosen based on a variety of general criteria ranging from point-source outfalls of concern, stream morphology, accessibility, safety concerns, and location of pre-established gaging stations. Once chosen, a transect location should be documented to provide a basis for repetition and comparison with previous or future studies.

Stream specific criteria for selecting a transect location include looking for particular characteristics such as (1) a well defined bank; (2) few obstructions in the channel; and (3) no eddies or still water. Conversely, turbulent water should also be avoided, if possible. The stream should be free flowing and unrestricted by obstructions upstream or downstream, which might cause flow diversion or flow backup. A smooth streambed profile, one of relatively consistent depth across its width, is optimal. The depth of the stream must be adequate for the immersion of the current meter. Clear away any movable objects along the profile, which may interfere with the accuracy of the readings by altering the flow of the stream. Removal of channel obstructions, i.e., woody debris, rocks, or other obstructions, is permissible provided enough time is allowed for stream flow re-stabilization before flow measurements are recorded.

If a series of readings are to be taken at a particular transect in the future, it is advisable to install a staff gage in order to provide a relationship between discharge and stream stage over time. A staff gage can be mounted on a pre-existing structure, such as a bridge abutment, or could be a three to four-foot stake with a simple measuring scale stapled to it or painted on it. This stake would be hammered into the ground within the bounds of the flowing stream, preferably in calm or still water to provide accurate readings.

Setup

Once a transect location is selected, the gaging equipment should be laid out as close to the transect as safety allows.

- Lay out two tarps near the area where readings are to be performed, one for equipment, and one for staff seating and miscellaneous supplies.
- Unload equipment and setup the workstation, allowing for easy access to needed materials.
- If contaminants are expected (such as pathogens), establish a decontamination area with the third tarp where staff will be exiting the stream. Place the sprayer bottles with bleach solution and distilled rinse water in this area. If the banks of the stream are steep, place the ladder against the bank for safe ingress and egress.

Setting up the Transect

The following procedures describe the process for setting up the transect.

- Setup the transect endpoints by driving a stake into the ground on each side of the stream. The resulting transect should be at right angles to the stream flow.
- Stretch the rope across the stream and fasten to each stake, ensuring the rope remains taut and as near the surface of the water as possible.
- Facing upstream, align the zero increment of the tape measure with the left edge of water and secure the measuring tape to the rope across the width of the stream using zip ties. If available, fasten the side of the tape measure marked in tenth of foot increments face-up. It may be convenient to fasten the tape measure to the rope at the specific locations where measurements will be taken.
- Measure the total width of the stream.
- Determine the spacing of the stream velocity readings based on the width of the stream. The reading locations should be equal distances apart, with 20 to 30 readings for streams wider than 20 feet, and at one-foot intervals for streams less than 20 feet wide. To minimize the potential for mistakes, the spacings should be whole number increments. For example, if a stream is 46 feet wide, a spacing of 2 feet (24 readings including both edges) would be preferred to a spacing of 1½ feet (30 readings). The first and last reading locations for each transect should fall at or outside of the left and right edges of the water and will have zero flow and zero depth.

If a boat will be used to take the readings because the stream is deep or moving swiftly, the boat must be stabilized against lateral movement at each transect station. A rope tied to existing secure objects such as trees, guardrails, or other stationary objects (one on either side of the stream) should be attached to the boat through cleats on the boat. The objects should be about as far upstream of the transect as the width of the stream. The ropes must be independently adjustable on the boat to allow for freedom of movement along the transect yet stability from downstream or lateral drift. If stationary objects are not available, vehicles, securely driven stakes, or two secure anchors on each stream bank may be necessary. Motors should not be used because of the potential for them to affect the velocity readings.

Transect Data Log

The recorder will complete the Transect Data Log (Appendix A-1 or A-2). Prior to taking readings, record general information such as:

- Global Positioning System (GPS) reading at the first measuring point;
- Streambed conditions (muddy, rocky, etc), by circling the appropriate description(s) on the Transect Data Log;
- Sketch the transect location and vicinity, citing distance from a fixed object in the vicinity for repeat visits; width of the stream channel, width of stream flow (edge of water to edge of water), and spacing between measuring points. Fill in the "distance" column using the selected spacings, to avoid confusion during the actual measurements;
- Date;
- Job name, job number, or other project identifiers;
- Transect number and location; and,
- Personnel.

Equipment Assembly

Make a determination as to which flow meter is to be used, based on depths and strength of flow. The Type AA Current Meter is not recommended for stream depth less than one foot. The Pygmy Meter should be used for wading measurements in shallow streams, flumes, and canals where depth of water is too shallow for the Type AA Current Meter to perform accurately. The Pygmy can only be used with a wading rod. The Type AA can be used with either a wading rod or a cable (hand line), and therefore is the preferred meter is deep water. The following chart may aid in the selection of an appropriate flow meter.

Stream Depth (feet)	Meter	RELATIVE DEPTHS
2.5 and above	Type AA	0.2 and 0.8
1.5 – 2.5	Either Meter	0.6
0.3 – 1.5	Pygmy	0.6

Relative Depth refers to the depth at which the readings are taken, and are expressed as decimal fractions of the total depth of the stream at each measuring point, measured down from the stream surface. For streams less than 2.5 feet deep, the readings are taken at 0.6 of the depth of the stream, and for streams deeper than 2.5 feet, the readings are taken at 0.2 and 0.8 of the depth of the stream. (For example, if the stream was 2 feet deep, one reading would be taken at 1.2 feet below the surface of the stream. If the stream was 10 feet deep, readings would be taken at both 2 feet and 8 feet below the surface of the stream).

The streambed profile may include isolated instances of extreme depth or shallowness. It is best to not change meters to accommodate these few extremes. The flow in an extremely shallow portion of an otherwise deep stream is not a significant portion of the total flow, so skipping extremely shallow measurements does not introduce significant error in the readings.

If the water is deeper than four feet, or moving too quickly to ensure solid footing, then the readings should be taken from a bridge or a small boat using the Type AA Current Meter (including the tailpiece, hand line, and sounding weight).

Once an appropriate meter has been selected, setup the meter as described below.

Pygmy Current Meter

- In storage and travel mode, the pygmy meter is equipped with a brass pivot (Figure 1, #14) that restricts the movement of the meter to prevent damage. The brass pivot **MUST** be removed and replaced with the stainless steel pivot prior to use. To remove the brass pivot, hold the yolk (#6) in an inverted position so that the brass pivot is facing up and loosen the setscrew (#15). While holding the bucket-wheel assembly in place, gently remove the brass pivot and replace with the stainless steel pivot. Fasten the set screw just enough to hold the pivot and bucket-wheel assembly in place, and conduct a spin test (below).
- A spin test must be conducted to assure free movement of the bucket wheel (#12). Hold the bucket wheel axis in an upright vertical position and give the wheel a quick turn by hand to start it spinning. If operating properly, the Pygmy should spin for about 1½ minutes, with a minimum spin of ½ minute before coming to a gradual stop.
- If the wheel does not spin freely or does not come to a gradual stop, adjust the stainless steel pivot by first loosening the set screw (#16) and then adjust the pivot adjusting nut (#17) in a clockwise direction until a free spin is achieved.
- When free spin is achieved, re-tighten the setscrew and re-conduct the spin test. If proper free spin is not achieved, repeat the steps until the recommended time of free spin and a gradual stop is achieved.

If necessary, see Appendix B for lubrication and maintenance details (Buchanan and Somers, p.8).

Type AA Current Meter

The Type AA Current Meter contains a brass raising-nut instead of the brass pivot, which serves as a lock for travel and storage purposes (Figure 2, #15). A spin test must be performed prior to field use. Turning the brass raising-nut in a clockwise direction will loosen the bucket-wheel assembly for the spin test. Hold the bucket wheel axis in an upright vertical position and give the wheel a quick turn by hand to start it spinning. If operating properly, the Type AA should spin for about 4 minutes with a 1½ minute minimum before coming to a gradual stop. If the wheel is not spinning freely, or the stop is not gradual, hold the meter in an inverted position with pivot (#17) uppermost and follow these steps:

- Release the keeper screw (#19).

- Loosen the pivot-adjusting nut (#18) a few turns.
- Release the setscrew (#7).
- Fully insert the pivot until all vertical play of the hub assembly is eliminated.
- Temporarily tighten set screw (#7)
- Tighten pivot-adjusting nut (#18) until it makes contact with the yoke (#8).
- Slightly loosen the set screw (#7)
- Tighten the pivot adjusting nut (#18) ¼ turn
- Tighten the keeper screw (#19).
- Push pivot inward as far as it will go and tighten setscrew (#7)

Repeat the steps until the recommended time of free spin and a gradual stop is achieved. If necessary, see Appendix B for lubrication and maintenance details.

Fastening Flow Meter to Wading Rod

Both the Pygmy and Type AA Flow Meters attach to the wading rod in the same manner:

- Slip the yoke stem over the shaft mount, which is found on the sliding rod attachment at the lower end of the wading rod.
- Tighten the setscrew.
- Attach the contact wire from the sliding rod to the appropriate contact binding post, #5 for the Pygmy. The Type AA offers two options, the single-contact binding post (#4), or the penta-contact binding post (#5). When using the Aquacalc, attach the contact wire to single-contact binding post (#4). Select the Penta-contact binding post (#5) only if the headset is to be used and the flow rate is expected to exceed 2.5 feet/second.
- For stability purposes, the optional tailfin assembly may be fastened to the bottom of the wading rod on the tailfin shaft, opposite the yoke stem shaft mount. Assemble the two-piece tailfin by sliding the interlocking fins together, making sure the fins are inserted into the proper channels of the opposing tailfin piece. Lock the two pieces together by turning the lock (located on only one of fins) 180 degrees, until the two pieces are securely fastened together. Fasten the assembled tailpiece to the tailfin shaft at the bottom of the wading rod and tighten the setscrew. Use of the tailpiece is optional for Type AA use and is not to be used with the Pygmy flow meter.

Connecting the AquaCalc to the Wading Rod

Connecting the AquaCalc to the wading rod is the same for both Pygmy and Type AA flow meters:

- Turn off the AquaCalc by pressing and holding the "Off" key.
- Plug the current meter cable into both the AquaCalc and the wading rod. The round 8-pin connector on the current meter cable attaches to the AquaCalc's pigtail, and the current meter cable jack connects to the brass receiving post at the top of the wading rod.

- A Velcro strip on the back of the AquCalc attaches to an adjustable platform on the top of the wading rod once the measuring process begins so that the CMT can use both hands to operate the equipment.

Connecting the Type AA Current Meter to the Sounding Weight and Hand line

The Type AA Current Meter with attached tailfin piece (see 5.5.3 above) connects to the sounding weight and hand line via the following steps:

- Lay the sounding weight on the ground with its dorsal fin up.
- Slide the lower end of the sounding weight hanger into the slot in the top of the sounding weight and fasten in place by turning in the threaded securing pin in a clockwise direction until tight.
- Slide the sounding weight hanger into the slot on the Type AA Current Meter, with the tailfin piece facing in the same direction as the sounding weight fins. Screw the meter into place, hole #15 for a 15-pound weight, and hole #30 for a 30-pound weight.
- Slip the top end of the sounding weight hanger into the slot on the connector at the end of the hand line. Secure the hanger in place with the pin and cotter pin.
- Attach the contact wire as described in 5.5.3.
- A cable and cable jack is affixed to the hand line. The cable jack connects to the current meter cable, which then connects to the AquaCalc pigtail as described in 5.5.4. Be sure the AquaCalc is off before connecting it to the meter.

9. Programming the AquaCalc

The AquaCalc 5000 Operating Instructions manual is included as Appendix C (JBS Instruments). It is recommended personnel read the manual and become familiar with some basic procedures and capabilities of the stream flow computer prior to beginning field gaging. The following is a summary of the basic steps needed for simple data acquisition using the AquaCalc 5000. For more detailed instructions and additional information, refer to the Operating Instructions manual in Appendix C.

Prior to data collection, a field test of the current meter and AquaCalc is required to ensure proper operation. This involves an estimated visual count of bucket wheel revolutions as compared to revolutions calculated by the AquaCalc.

- Turn on the AquaCalc by pressing “On” key. At the date/time screen, press and hold “Erase” key to erase old data. Press “Enter” to clear the computer memory and select default settings. The most important default settings, which may need to be changed to accommodate site conditions, are:
    - 0.6 depth reading
    - Measure time 40 seconds
    - Turbulent flow reset
    - Meter type Price (Type) AA 1:1 ST2 (ST2 refers to meters made after 1992).

- Redefine settings as needed by pressing "Menu" key to access main menu. From main menu press "1 (1=TrInfo)," then "Enter" to scroll through available options. Some of these options are not necessary to data acquisition and are not discussed here. See Appendix C for more details.
- Perform a field test to confirm proper connection of meter and AquaCalc.
    1. Turn on AquaCalc by pressing "On" key.
    2. Press "Menu" twice to access main menu.
    3. Select 1 for "TrInfo"
    4. A default measurement time of 40 seconds will display. Press "+" and reset measurement time to 10 seconds. Press "Enter" to accept new setting.
    5. Go to Measurement Display by pressing "Menu" three times. This screen displays settings for a specific transect.
    6. The default transect and Observation are each #1. Press #3 (Next Observe) and the display will show Transect 1 at Observation 2.
    7. Spin the bucket wheel slowly enough that a visual count of the revolutions can be made over a period of 10 seconds. Press "Measurement" key and begin counting revolutions. An assistant may be helpful as the timekeeper. The visual count and the AquaCalc count should agree (within the limits of human accuracy).
    8. If the count totals do not agree, check the electrical connections and retest. If they still do not agree, refer to the Appendix C troubleshooting segment.
    9. Clear the observation by pressing and holding erase until the screen prompts confirmation of erasure and press Enter (Note: this action erases all observations on that transect from that observation upward). Reset the measurement time to 40 seconds by following steps 2 through 4 above.

10. Data Collection

Use of Current Meter

The measuring points on each transect are referred to as Observations. The first observation should be at or to the left of the left edge of the water (when facing upstream). This observation should have a depth reading of zero, and no velocity measurement is taken. The same applies to the last observation on the transect, at or beyond the right edge of water when facing upstream. The CMT should position her/himself downstream of the current meter, if wading or in the boat, beginning the actual first reading at Observation 2. The CMT should stand at a 45-degree angle to the stream and meter location to reduce backwash interference with the current meter.

Setting parameters

The CMT programs the AquaCalc with parameters for site specific transects by following these steps:

- Turn on the AquaCalc
- Confirm that date and time is correct. If it is not, refer to Appendix C for more instruction.
- Press "Menu" key once to access Measurement Display
- The default settings are Transect 1, Observation 1, at Observation Depth 0.6.

- To edit Transect number, press "Go to Transect #(1)" and change number to the appropriate number.
- Confirm that the Observation number is #2. To edit Observation number, press "Go to Observe #(2)" and change number to the appropriate number.
- Set distance from edge of stream flow by pressing "Set Distance" key and entering distance in feet to the nearest tenth.
- Measure stream depth
  1. Wading Rod Method:
     Place wading rod in stream so that the base plate rests on the streambed; depth can be read from the marks (slashes) on the hexagonal wading rod (Rod A)
     - Three slashes = 1 foot increments
     - Two slashes = ½ foot increments
     - One slash = 0.1 foot increments
  2. Boat Method:
     - Measure stream depth by direct reading of incrementally marked measuring rod resting on the bottom of the streambed.
  3. Bridge Method:
     - Lower the weighted measuring tape to the bottom of the stream and make note of the depth to a set reference point on the bridge.
     - Raise the weighted measuring tape to the surface of the stream and make note of the depth to the same reference point on the bridge.
     - Subtract the second depth from the first depth to calculate the depth of the stream.
- If the stream depth is less than 2½ feet, proceed to Section 7.1.2 to edit Location Depth. If stream depth is greater than 2½ feet, proceed to Section 7.1.3 to edit Location Depth.

<u>Measurements taken at 0.6 Settings</u>

For streams less than 2½ feet average depth, the wading rod method should be used, with one reading taken at each observation point at 0.6 of the depth of the stream, measured down from the water surface.

1. To edit Observation Depth setting, press the "Observe Depth" key until "6" appears in the display window (to indicate 0.6 of the stream depth).

2. Set depth of water by pressing "Set Depth" key and enter depth in feet to the nearest hundredth, then press Enter to accept.

3. After entering depth of stream into the AquaCalc, the wading rod must be adjusted to position the current meter at the appropriate depth in the stream. The wading rod consists of two parallel rods, one hexagonal rod that rests on the bottom of the stream, and one round rod to which the meter is attached. To set the meter at the appropriate depth, the position of the round rod must be adjusted by pressing the rod release tab (the rubber button with embossed star at top of wading rod handle) to allow movement of the rod. The cast metal scale at the top of the wading rod handle is divided into 10 increments, which represent tenths of feet in stream depth. Rod B is marked incrementally from zero to eight, which represent feet of stream depth. <u>Using the</u>

actual depth of the stream, align the appropriate foot depth increment on Rod B with the appropriate fraction increment on the wading rod handle. For example, if the stream is 3.5 feet deep, aligning the 3 marker on Rob B with the 0.5 marking on the scale on the wading rod will set the meter at the appropriate depth for a stream 3.5 feet deep (2.1 feet from the top, 1.4 feet from the bottom). Note that the spacing of the markings are not real-world distances, but are scaled to allow direct adjustments for stream bed depths.

4. After the meter is set at the appropriate depth, the stream velocity is measured by pressing "Measure". AquaCalc will take 40 seconds (default setting) to count revolutions and calculate a mean velocity for that Observation. This completes the first observation. The data will be displayed on the AquaCalc screen, and stored in memory for later use.

5. At each Observation point along a transect, the data should also be recorded on a Transect Data Log (Appendix A-1) as a backup. This is best accomplished by having the CMT read the data to the DR. The data obtained at each observation point are:
   - Observation number
   - Distance value (if not already recorded)
   - Stream depth
   - Velocity

6. Upon completion of an Observation, check the readout on the AquaCalc to be sure that all of the settings were correct and the information was recorded properly. If not, a repeat Observation must be made.

7. The CMT now moves to the next Observation point for the next reading. Steps 1 through 7 above, are repeated at each observation point until the entire transect has been measured.

To recap Observation procedures:

1. Confirm that AquaCalc Observation number agrees with transect observation number (location on transect).
2. Enter distance along transect into the computer.
3. Enter depth of stream into the computer.
4. Adjust rods to put current meter at appropriate height in stream.
5. Measure velocity.
6. Record values on Transect Data Log as a backup to computerized version.
7. Confirm accuracy of reading.

Measurements taken at 0.2 and 0.8

For streams with an average depth exceeding 2½ feet, two readings will be taken at each Observation, one at 0.2 times the depth from the water surface, and the second at 0.8 times the depth from the water surface. Note: this is twice and half the distance, respectively, from the bottom of the stream as compared to the 0.6 reading

1. Edit Observation Depth setting by pressing the "Observe Depth" key until "2" appears in the display window (to indicate 0.2 of the stream depth).

2. Measure the depth of the stream and set depth of water by pressing "Set Depth" key and entering the total depth of the stream in feet, to the nearest hundredth.

3. Adjust the depth of the meter to 0.2 the depth of the stream.

A. Wading Rod Method

The wading rod must be adjusted to position the current meter at the appropriate depths in the stream, similar to the procedure discussed above in 7.1.2.3, except that there are two readings, one at ½ and one at 2 times the depth of the single reading. The wading rod consists of two parallel rods, one hexagonal rod that rests on the bottom of the stream, and one round rod to which the meter is attached. To set the meter at the appropriate depths, the position of the round rod must be adjusted by pressing the rod release tab (the rubber button with embossed star at top of wading rod handle) to allow movement of the rod. The cast metal scale at the top of the wading rod handle is divided into 10 increments, which represent tenths of feet in stream depth. Rod B is marked incrementally from zero to eight, which represent feet of stream depth. Align the appropriate foot depth increment on Rod B with the appropriate fraction increment on the wading rod handle, using ½ the actual depth of the stream for the 0.8 reading, and 2 times the actual depth of the stream for the 0.2 reading. For example, if the stream is 2.6 feet deep, align the 1 marker on Rod B with the 0.3 marking on the scale on the wading rod for the 0.8 reading, and set the 5 mark on Rod B at the 0.2 mark on the scale for 0.2 reading.

B. Boat or Bridge Method

Measure the depth of the stream at the Observation point by measuring the difference in distance from a common measuring point (such as the guard-rail on the bridge) to both the stream surface and the bottom of the stream. Record these values on the version of the Transect Data Log for use on a bridge or boat (Appendix A-2). Manually multiply the depth of the stream by 0.2 and 0.8 to obtain the depth at which to place the meter. Add these distance values to the reading for the distance to the surface of the stream, and lower the meter to the appropriate depth for each reading starting with the 0.2 reading.

4. When all settings have been entered and the meter is at the correct depth, take the first velocity reading by pressing the "Measure" key. AquaCalc will take 40 seconds (default setting) to count revolutions and calculate a mean velocity for that Observation. This completes the 0.2 Observation for that location.

5. CMT should read the data to the recorder, and then the DR confirms that the data was accurately recorded on the Transect Data Log (Appendix A-2) by reading the values back to the CMT. These data are to include:
   - Observation number
   - The Distance value

- Stream depth
- Reading depths
- Velocity

6. Confirm that the AquaCalc has recorded the information accurately. If not, a repeat observation must be made.

7. Edit the Observation Depth setting to 0.8 by pressing the "Observe Depth" key until "8" appears in the display window.
8. Adjust the depth of the meter to 0.8 of the total depth of the stream.

   A. Wading Rod Method
   For the 0.8 readings, divide the stream depth by two, and align the resulting number on Rod B with the mark on the scale on the hexagonal rod, as described above.

   B. Boat or Bridge Method
   Manually hang the meter at 0.8 times the depth of the stream.

9. Take the second velocity reading by pressing the "Measure" key. AquaCalc will take 40 seconds (default setting) to count revolutions and calculate a mean velocity for that observation. This completes the 0.8 observation for that location.

10. Confirm that the AquaCalc has recorded the information accurately. If not, a repeat observation must be made.

11. Record the readings on the Transect Data Log (Appendix A-2) as a backup to the AquaCalc. The CMT should read the data to the recorder, and then the DR confirms that the data was accurately recorded by reading the values back to the CMT. These data are to include:
    - Observation number
    - The Distance value
    - Stream depth
    - Reading depths
    - Velocity

12. The CMT now moves to Observation 3 for the second reading. Repeat steps 1 through 11, above, at each location along the transect until the entire transect has been measured.

In summary, at each location along a transect:
1. Confirm that AquaCalc Observation number agrees with actual location.
2. Confirm that observation depth is set at "2".
3. Enter distance into the AquaCalc.
4. Enter depth into the AquaCalc.
5. Adjust current meter to appropriate height in the stream (0.2 of total depth).
6. Measure velocity.
7. Relate observations to recorder.

8. Confirm accuracy of reading.
9. Edit observation depth to "8".
10. Enter next depth at same location.
11. Adjust meter to appropriate height in the stream (0.8 of total depth).
12. Measure velocity.
13. Relate observations to recorder.
14. Confirm accuracy of reading.
15. Move to the next location along the transect and repeat this procedure.

11. Decontamination and Maintenance

Any equipment, supplies, or apparel, which has been exposed to potentially contaminated stream water must be decontaminated. Using the plastic tarp as a makeshift basin, spray these items with the 0.001% bleach solution. Follow with a rinse of tap water and a second rinse of distilled water to remove the bleach and protect equipment (and skin) from damage. Dispose of the wash water appropriately.

After each transect is completed or sooner if problems occur, perform maintenance on the stream gaging equipment in accordance with manufacturers recommendations. Maintenance procedures are as follows (*Discharge Measurements at Gaging Stations,* Buchanan and Somers, p.8):

> Before and after each discharge measurement, examine the meter cups or vanes, pivot and bearing, and shaft for damage, wear, or faulty alignment. Before using the meter, check its balance if on a hanger, check the alignment of the rotor axis with a hanger or wading rod, and adjust the conductor wire to prevent interference with meter balance and rotor spin.
>
> Clean and oil meters daily when in use. If measurements are made in water carrying noticeable suspended sediment, clean the meter immediately after each measurement. Surfaces to be cleaned and oiled are the pivot bearing, pentagear teeth and shaft, cylindrical shaft bearing, and thrust bearing at the cap.
>
> After oiling, spin the rotor to make certain it operates freely. If the rotor stops abruptly, find the cause and correct the trouble before using the meter. On notes for each measurement, record the duration of spin. Obvious decrease in spin duration indicates need for attention to the bearings.
>
> The pivot needs replacement more often than other meter parts. Examine the pivot after each measurement. Replace a fractured, rough, or worn pivot.
>
> Keep the pivot and pivot bearing separated except during measurements. Use the raising nut if provided, or, for pygmy meters, replace the pivot by the brass plug.
>
> Most minor repairs can be made in the field. Repair attempts, however, should be limited only to minor damages. This is particularly true of the rotor because minor dents in the bucket wheel or cups can have a large influence on the meter rating. Unless minor dents in the cups can be straightened out to "like new" condition, the entire rotor should be replace with a new one.

Badly sprung yokes, bent yoke stems, misaligned bearings and tailpieces, should be reconditioned in shops equipped with the specialized facilities needed.

12. Calculations

Calculate the Total Discharge (Q) at a transect location after completion of all readings by pressing "Calculate Discharge" key on the AquaCalc. For a mathematical explanation of discharge calculation procedures, refer to Appendix C. The AquaCalc requires Datalink software (supplied with purchase) to download the data into a PC in either Windows or DOS formats. Field data may be printed from the Datalink format or imported to Microsoft Excel. The data can be customized in Excel to fit a specific table format or for electronic data storage.

13. Records

A three-ring project binder is to be maintained as an organized compilation of the project, including the field Transect Data Logs, printout of the computerized data, Appendices B and C, and a log of maintenance and servicing of equipment. Entries in the maintenance log should include:

- Date and description of routine maintenance (cleaning, lubrication, battery check)
- Date and description of instrument problems and symptoms
- Date and description of corrective action taken
- Servicing recommendations

14. Review of Standard Operating Procedure

This Standard Operating Procedure for stream gaging is a work in progress and is subject to a minimum annual review for accuracy, and/or changes in equipment and/or procedure. Documentation of review by the project Quality Assurance Officer is maintained within this document preceding the Table of Contents.

15. References

Buchanan, Thomas J., and William P. Somers, *Discharge Measurements at Gaging Stations,* Book 3, Chapter A8, Techniques of Water-Resource Investigations of the United States Geological Survey - Applications of Hydraulics, 1984.

JBS Instruments, *AquaCalc 5000 Basic Stream Flow Computer Operating Instructions Manual,* April 2000.

Rickly Hydrological Company, product information and equipment.

United States Geological Survey, *Overview of the Stream-Gaging Program,* U.S. Geological Survey Circular 1123, 1995.