OVERVIEW:

Discharge measurements are a vital part of water quality sampling protocols. Flow measurements are necessary for loading information, dilution factors, and discharge rates. This Standard Operating Procedure (SOP) will focus predominantly on instantaneous flow measurement procedures for open channel water quality sampling protocols used by the Water Quality Control Division of the Colorado Department of Public Health and Environment, stated simply as the ADivision≅ for the remainder of this document. The Division has chosen to use the Marsh-McBirney portable flowmeters utilizing modern electromagnetic sensor technology.
This SOP will discuss methods used in obtaining quality flow information.

TYPES OF FLOW METERS:

There are several types of portable flowmeters available. Pygmy, Price AA, and Marsh-McBirney are the common units used by field personnel. Although they operate differently, they provide comparable results. Care should be taken in following the individual unit's manufacturers operating instructions.

CALIBRATION SCHEDULE

Sampling personnel should calibrate flowmeters at least once per year. The USGS, or a local supplier of flowmeters, have flume setups in which flowmeters may compare readings to the known flow of the flume, traceable to the National Bureau of Standards.

EQUIPMENT AND SUPPLIES

1. Flow meter: Marsh McBirney type or compatible.

2. Wading Rod: Used to measure stream depth and to adjust flow sensor to 60% from the surface.

3. Measuring Tape: 50, 100, or 200 ft measuring tape for setting up across waterbody.

4. Stakes: used to stake measuring tape across stream.

QUALITY ASSURANCE USING DIFFERENT FLOWMETERS:

In detailed and intense studies in which many crews (and equipment) are involved, a quality assurance check should be performed at the beginning of each sampling day to ensure proper and comparable flow readings are taken. This involves eliminating as many factors as possible. Use of the same type of meter is ideal but not always the case. Some of the steps to ensure reliable and comparable readings include:

1. Take flow measurements at the same transect of an open channel.

2. Crews conduct flow measurement QA/QC using the same technique they will use in the field.

3. Field notes and field forms should be the same or similar for use in the same study. (See attached discharge measurement form)

4. Final flow measurements should compare to within 10% of each other. Make any necessary adjustments and duplicate flow measurements until results are within 10%. Ensure correct flow calculations and proper use of flowmeters are used.

FLOW MEASUREMENT PROCEDURES:

1. Selecting a representative cross section for open channel flow measurements is vital. Select a stretch in which the stream is not turbulent, or fluctuating from side to side. A glide type area is the preferred open channel area.

2. Suspend a measuring tape, calibrated in the same units as the velocity readings, one foot above the stream or channel, perpendicular to the flow.

3. Begin by standing downstream of tape and recording distance, depth, and velocity readings. The first measurement noted is the bank. The only measurement here will be the distance, with the depth and velocity being noted as zero. Take no less than 10 measurements per transect. If velocity readings between two adjacent measuring segments are greater than 10%, make the segment smaller. The more measurements taken, the more accurate the resulting flow calculation.

4. The top setting rod, which is used for depth measurements and for placement of the electromagnetic velocity sensor, automatically places the sensor at 60% of the depth from the surface. This is the standard velocity measurement area for depths of 2.5 ft or less. Where the depth is greater than 2.5', a velocity measurement must be taken at 80 and 20% from the surface and averaged for that segment of the transect. This is easily done by adjusting the staff rod to Double the depth reading for the 80% velocity reading and by halving the depth reading for the 20% reading.

DISCHARGE CALCULATIONS:

Stream Profile:

where;

W = Measured width of segment
V = Measured velocity of segment
A = Calculated area of segment
D = Measured depth of segment
Q = Calculated flow of segment

all units should be uniform (ft)

1. Calculate the area of each segment;

$$(D^x + D^{x-1}) / 2 * (W^x + W^{x-1}) / 2 = A^x$$

2. Calculate the average velocity of the segment;

$$V^{avg} = (V^x + V^{x-1}) / 2$$

3. Calculate the flow of each segment;

$$A^x * V^x = Q^x$$

4. Sum the flow of the segments for the total flow.

$$Q^1 + Q^2 + Q^3 + .. + Q^x = Q^{tot}$$