Contact Information

Adams County

Michelle Harrison
Conservation Clerk
Adams County Land & Water Conservation
608-339-4268
michelle.harrison@co.adams.wi.us

Trena Larson
Administrative Coordinator/Director of Finance
Phone: (608) 339-4577
trena.larson@co.adams.wi.us

Marquette County

Patrick Kilbey
County Conservationist
Marquette County Land & Water Conservation
Phone: 608-296-2815
patrick.kilbey@WI.nacdnet.net

Portage County

Steve Bradley
County Conservationist
Portage County Land Conservation
Phone: 715-346-1334
Bradleys@co.portage.wi.us

Raymond C. Schmidt
Water Quality Specialist/Soil Scientist
Portage County
Phone: 715-346-1334
schmidtr@co.portage.wi.us

Waupaca County

Brian Haase
County Conservationist
Waupaca County
Phone: 715-258-6482
brian.haase@co.waupaca.wi.us

Waushara County

Ed Hernandez, County Conservationist
Waushara County Land Conservation
Phone: 920-787-0443
ed.courthouse@co.waushara.wi.us

Josh Saykally
Waushara County
Land Conservation Specialist
Phone: 920-787-0443
JoshS.courthouse@co.waushara.wi.us

Wood County

Jerry Storke, County Conservationist
Wood County
Phone: (715) 421-8475
jstorke@co.wood.wi.us

Field Technician

Jessica Haucke
Lab and Field Technician
UW Stevens Point
Phone: 715-630-1748
Jessica.Haucke@uwsp.edu

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Introduction: Importance of Baseflow Monitoring

Stream flow, or discharge, is the volume of water moving down a stream or river per unit of time and is commonly expressed in cubic feet per second (cfs). Stream flow and velocity affect food sources, spawning areas and migration paths of fish and other wildlife (DNR, 2010). In streams with adequate groundwater flow (baseflow), significant flow is maintained during prolonged dry periods allowing fish and tiny aquatic organisms to survive.

Stream flow can be affected by humans. In watersheds with high human impacts, baseflow may be depleted by withdrawals for irrigation, domestic, or industrial purposes. **Figure 1** illustrates the affect groundwater pumping can have on water resources. Groundwater is drawn away from the stream creating a decline in the amount of water that would otherwise flow to the stream. The depletion of baseflow to the stream reduces flows overall, but reduced flows are more noticeable during dry periods and may leave little water for fish and other aquatic life at crucial times.

Streamflows in the Wisconsin Central Sands have been depressed in recent years, more so in areas with large densities of high capacity wells. For example, the Little Plover River, a former high-quality trout stream and a Wisconsin Exceptional Resource Water, was near dry in 2003 and has dried in stretches since (Kraft et al., 2010). Still the question of how big the human impacts are on central Wisconsin rivers and streams remains in question. By meeting the goals of this project, baseflow monitoring can help professionals throughout the state answer this question.

The goals of this project are as follows:

1. Produce high quality stream flow data using advanced methods and equipment.
2. Establish baseline information about a stream's natural flow rate.
3. Provide real stream flow data.
4. Help to clarify the impacts of groundwater pumping on Central Sands rivers and streams.

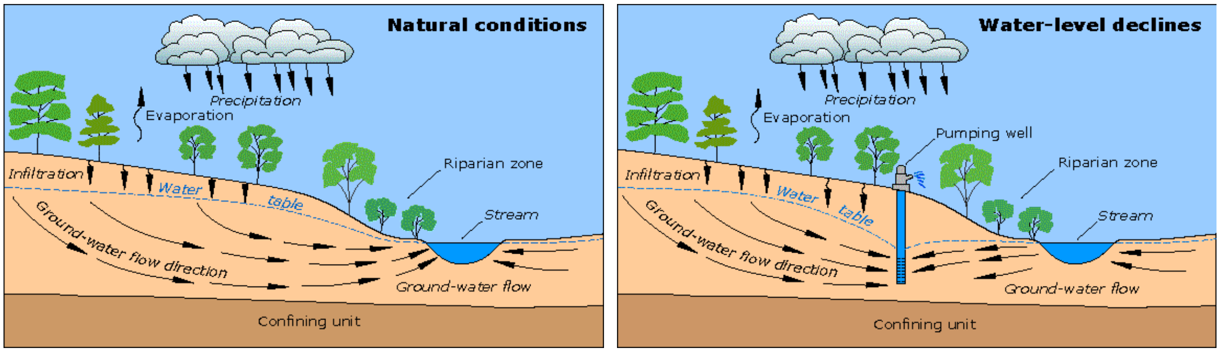


Figure 1. Pumping impacts on groundwater flow (baseflow) to a river.

Background on Baseflow (Where and When to take Measurements)

Where to take baseflow measurements

All rivers have a similar structure. A natural river is neither straight nor uniform yet a river's form remains relatively unchanged no matter its size. There are 3 basic parts to a river; a riffle, run, and a pool. Each is defined as follows:

A riffle has moderate to shallow depth and moderate to fast flow over a rough stream bed. Riffles are the food factories of a stream. Light is able to penetrate the stream bed because of the shallow depth which allows for the growth of aquatic plants. The rough stream bed provides more area for vegetation and aquatic insects to live. This combination results in the riffle being a prime area for fish.

Runs are deeper than riffles and have a smoother stream bed so the water is less turbulent. Flow velocities tend to be lower than in a riffle as a result of greater depth and a smoother stream bed. Runs connect a riffle and pool and are the ideal place to take a baseflow measurement.

Pools are the deep water areas of a river. Because of their depth, pools tend to hold larger fish and the velocity of the water is slow. **Figure 2** shows the different parts of a stream.

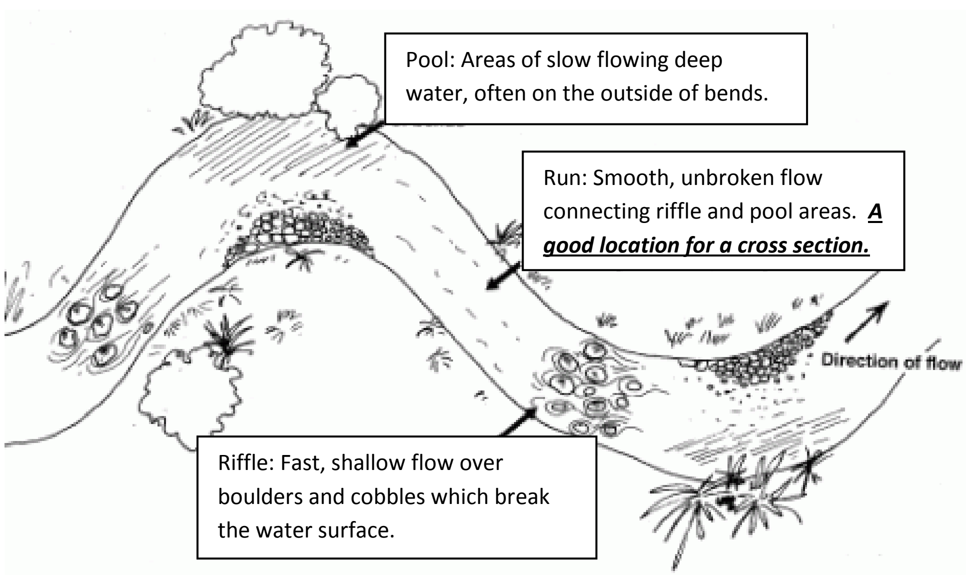


Figure 2. An example of the basic shape of a natural river and the best place to take a baseflow measurement.

The location of your stream site has already been determined, but when you get to your stream you will need to decide what part of the stream to measure. Try to pick an area of stream that most closely resembles a run. Many stream sites will be located at bridges or culverts. Try to choose a straight smooth area above or below the culvert or bridge.

When to take Baseflow Measurements

Water in a stream comes from 3 different sources. A small amount comes from rainfall directly. Larger amounts come from runoff from rain events and from groundwater flowing into the stream called baseflow. Baseflow is defined as the sustained low flow of a stream due to groundwater inflow to the stream channel. Groundwater flows into streams when the water table (top of groundwater saturation) rises above the streambed. Perennial streams flow because groundwater remains above the streambed throughout the year.

An example of when a river or stream is at baseflow conditions: It's late summer and it hasn't rained in a month. The lawn has turned brown and farm fields are dry and cracking. Yet a trip down to the nearby stream channel finds flowing water. What you are witnessing is the interplay between groundwater and surface water. Groundwater seepage into a stream channel is called *baseflow*. When groundwater provides the entire flow of a stream, *baseflow conditions* are said to exist.

For this project, it is important that stream flow data be collected during what are called baseflow conditions. Baseflow does not include runoff from a storm event. Because our main interest in this study is to monitor groundwater levels it is critical that stream flow measurements occur during periods of baseflow. **Figure 3** shows stream discharge during and after a storm event. In **Figure 3** the best time to take a stream flow measurement is day 5 after the storm runoff is not part of the total discharge.

For most streams, baseflow may be measured during a period when there has been no significant thawing or precipitation for at least three to five days. This may vary according to stream size. Smaller streams need less time to return to baseflow conditions. Be extra cautious during period of thaw as more runoff can occur at that time.

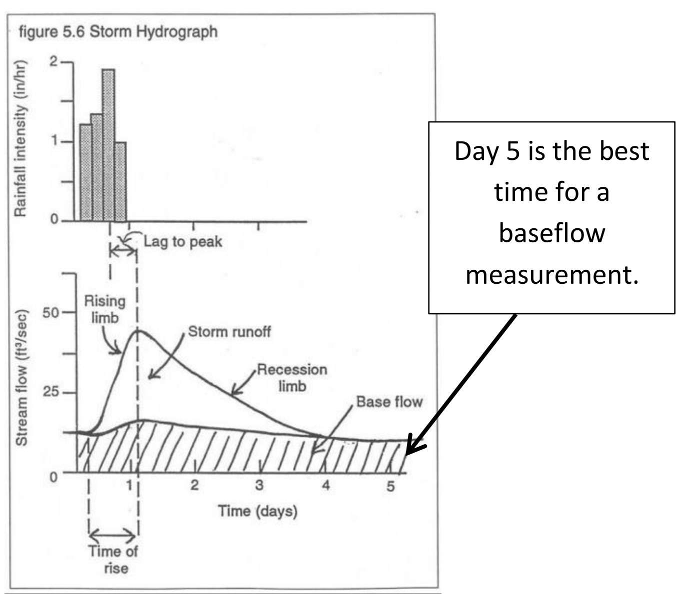
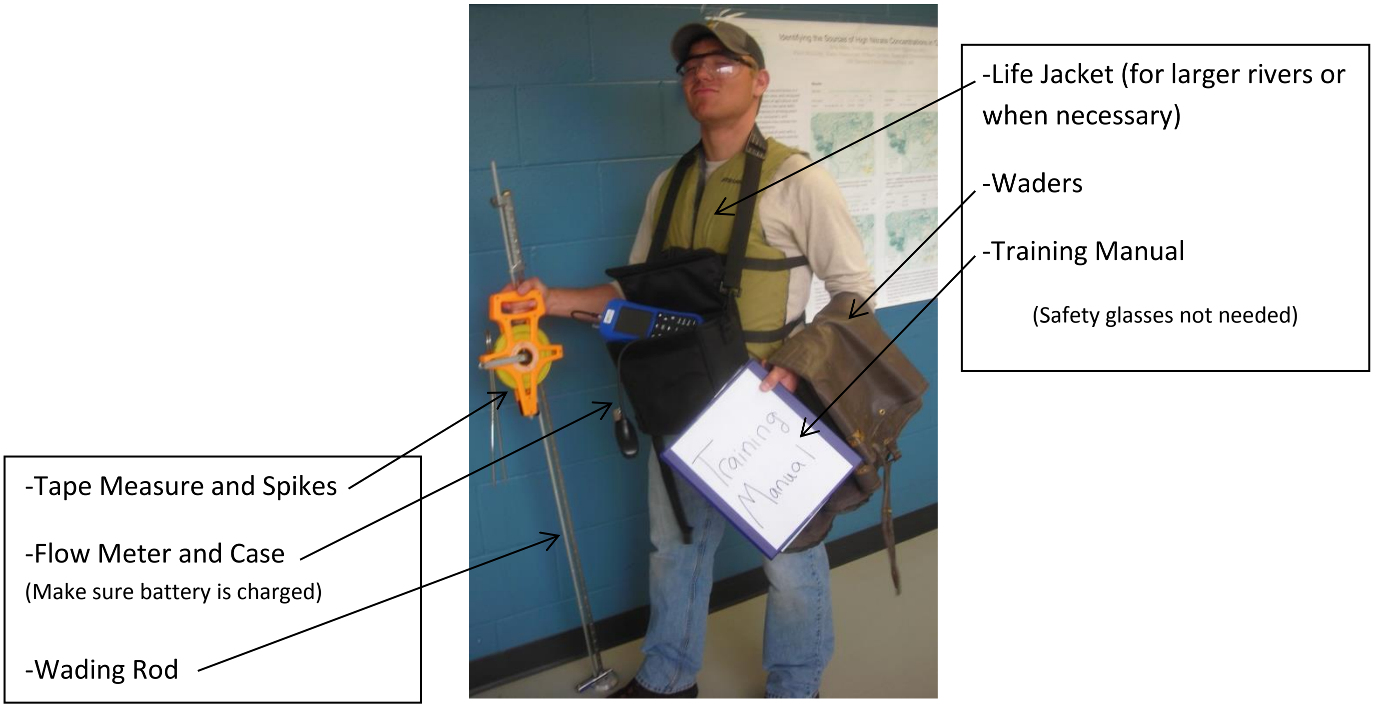


Figure 3. An example of flow in a river before and after a rain event and the best time to take a baseflow measurement.

Methods and Procedure

I. Equipment Needed For Measurement (Before you go to the stream)



II. Procedure for Measuring Baseflow with the OTT MF pro Flow Meter

Give yourself at least 2 hours per stream the 1st time you measure baseflow

Safety considerations

You will need to enter the stream channel to make width and depth measurements and to calculate velocity. Be aware of stream velocity, water depth, and bottom conditions at your stream-monitoring site. Do not attempt to measure stream flow if water velocity appears to be fast enough to knock you down when you are working in the stream. If you are unsure of water depth across the width of the stream, be sure to proceed with caution as you move across the stream, or choose an alternate point from which to measure stream flow (DNR, 2010 WAV).

1. *Select a Cross section*

a. The quality of the flow measurement is dependent on the correct selection of a cross section. Figure 4 is an example of what a typical cross section looks like. The following site characteristics are important for cross section selection.

- The site lies within a straight reach of stream. Avoid sites directly below sharp bends.

- The flow directions at each measurement point across the stream are parallel to the bank and perpendicular to the cross section.
- Flow is relatively uniform and free from eddies, slack water and excessive turbulence.
- The streambed is stable and free of large rocks, weeds and protruding obstructions, manmade or natural, that cause turbulence.
- A minimum depth of >0.2 ft. is required to keep water above the flow meter sensor.

b. It is often not possible to completely satisfy all of the recommended conditions. Use the criteria to select the best possible section of stream and then to select a cross section. It may be necessary to "engineer" the stream by moving rocks, logs, branches, algae mats, rooted aquatic vegetation, debris, or other obstructions in order to construct a desirable cross-section free of turbulence. Additionally, one can place rocks or other obstructions in the slack water to create an artificial bank such that no or minimal stream flow goes over or through the obstructions (Rantz et al., 1982). If this is necessary, make all adjustments and wait a few minutes for the system to stabilize prior to beginning the stream flow measurements.

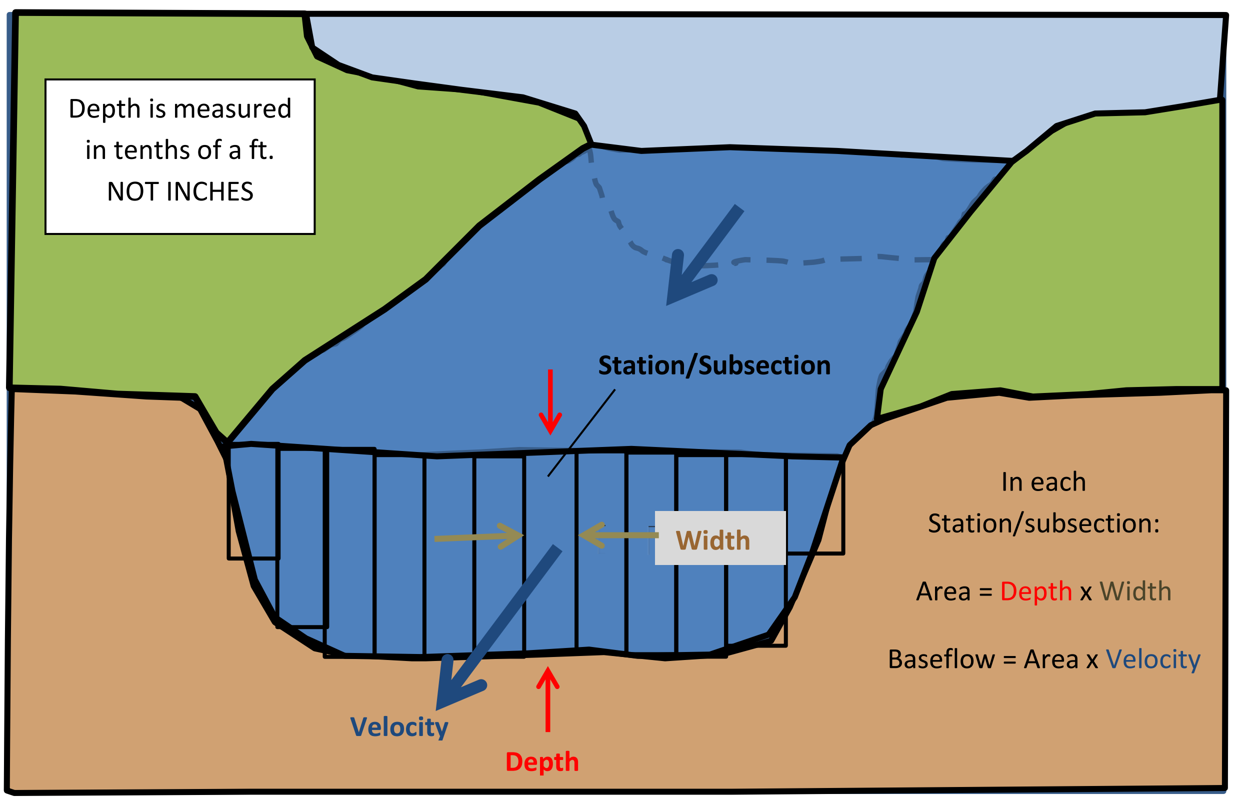


Figure 4. A typical cross section in a stream.

2. Set the Tagline and Determine Station Spacing

a. After you select the best location for a cross section set up the tagline directly above the cross section by stretching the tape measure across the stream (Figure 5). The tagline should be:

- Taut

- Perpendicular to stream flow lines

- Must not touch the water surface

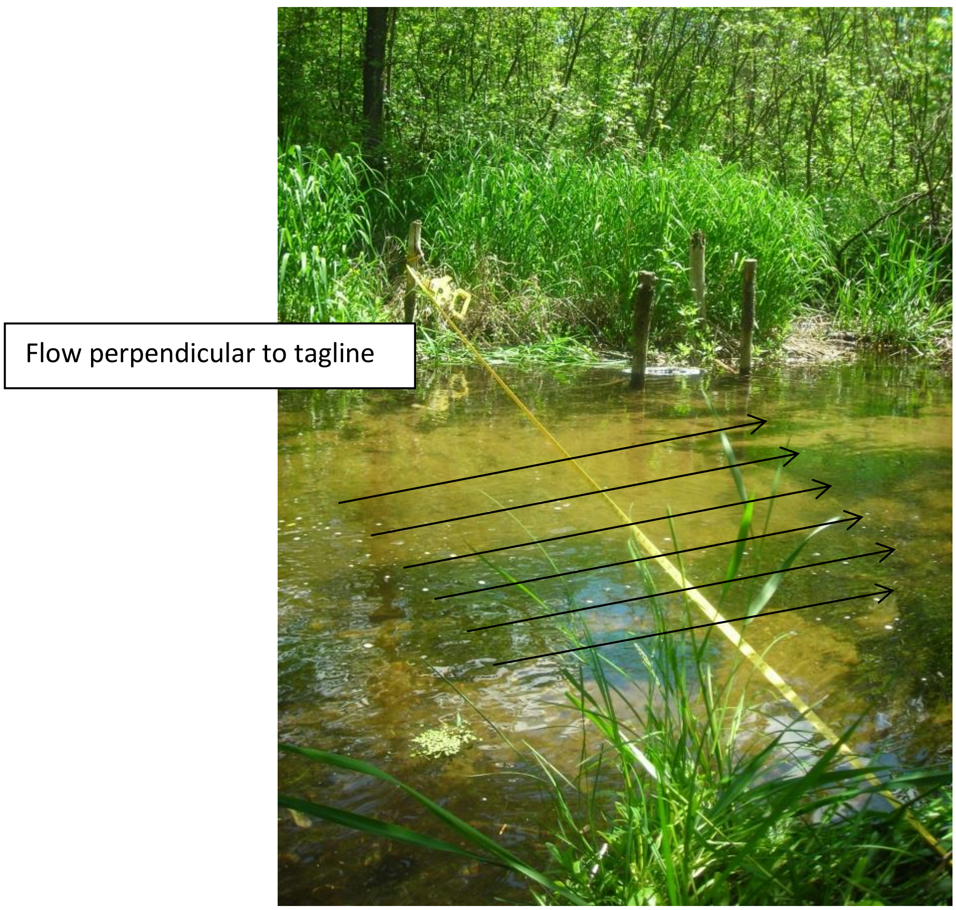


Figure 5. An example of a tagline above a stream cross section.

b. Determine the approximate width of the stream from the edge of the water on one bank to the edge of the water on the other bank. All measurements will be reported in tenths of a foot. Inches won't be used.

c. Divide the stream into stations or subsections based on the width of the stream.

- Divide total width by 10 or 20. You can add stations in between if necessary. This doesn't have to be an exact number.
- Total stream width___________ / 10 = a station every _______ ft. (for small rivers)
- Total stream width___________ / 20 = a station every _______ ft. (for large rivers)
- A guide is to use 10 to 20 stations as a target number for streams <20 ft. wide and 20 to 30 stations for streams >20 ft.
- Stations shouldn't be spaced less than 0.2 ft. apart. Therefore if the width of the stream is less than 1 ft. the total number of stations should be less than 5.

d. Stations can be uniformly spaced across the tagline or unevenly spaced (Figure 6).

-Importantly, the average velocity at one station should not exceed 10% of the total stream discharge (Rantz et al., 1982). This is something you can check at the end of the measurements.

-It may be necessary to space stations more closely together in areas that are deeper or that have a greater velocity than the majority of the stream.

-The spacing of stations may be farther apart in areas that are shallower or have lower velocity compared to the majority of the stream.

-Uniform spacing across the tagline should only be used if the stream is of relative uniform depth and velocity.

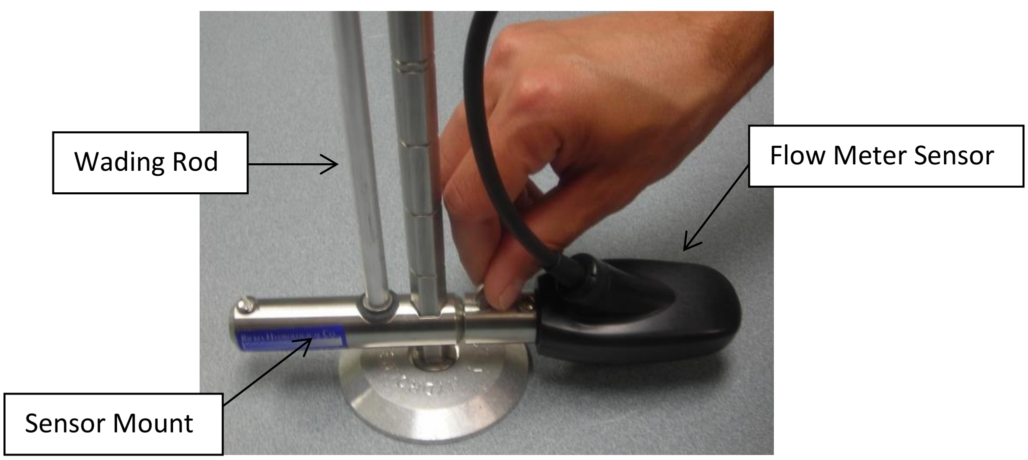
Figure 6. Examples of uniformly (left picture) and unevenly (right picture) spaced stations across a cross section.

e. **If you need additional help keeping track of station locations on your tagline (tape measure), fill out the "Station Worksheet" located in the data sheets section of your training manual. An example of a completed worksheet is also included in the data sheets section of you training manual. Consult the example worksheet for details.**

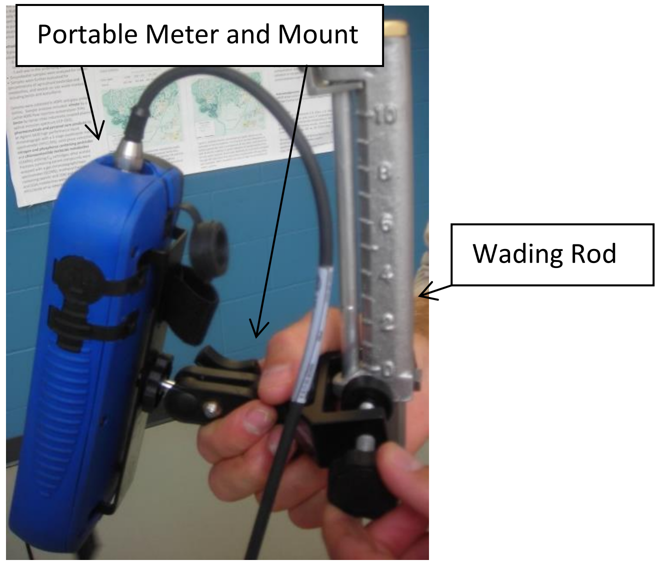
3. Assemble the OTT MF pro Flow Meter

a. Attach the adjustable portable meter mount to the portable meter by screwing the portable meter mount to the back of the portable meter.

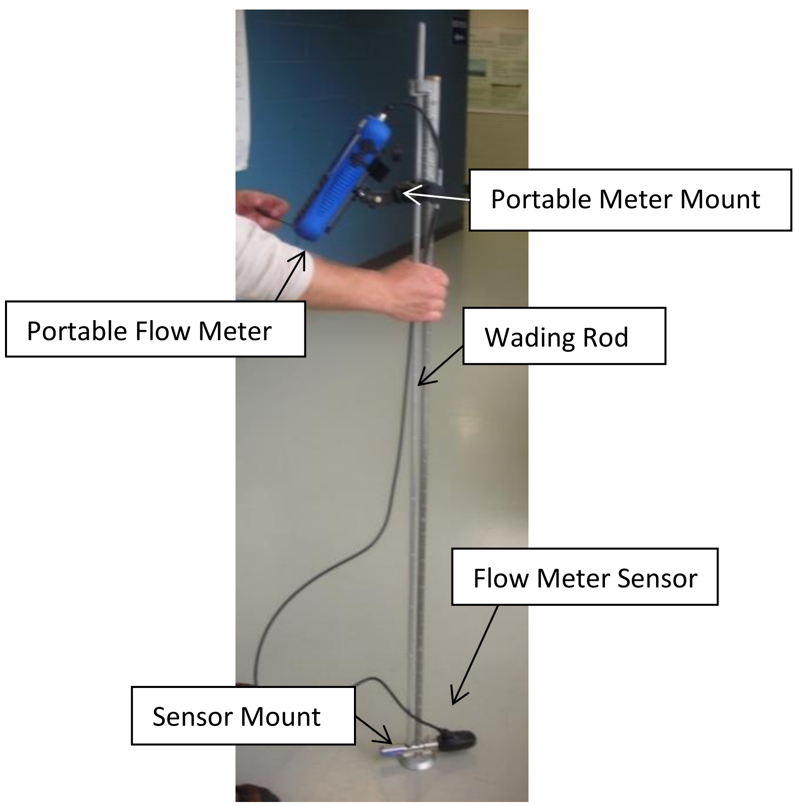
b. Attach the flow meter sensor to the bottom of the wading rod by fitting the flow meter sensor onto the sensor mount and tightening the screw.



c. **Attach the portable meter with mount onto the wading rod by tightening the clamp on the portable meter mount below the 0 near the top of the wading rod.**

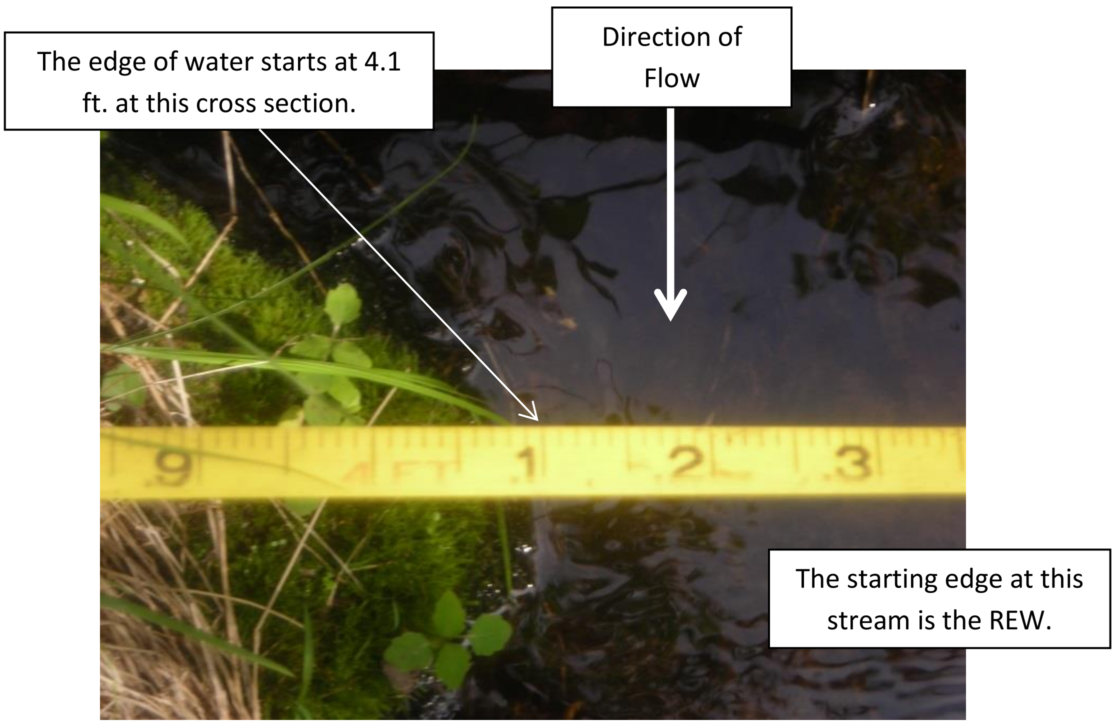


Finished Assembly



4. *Measuring Velocity and Calculating Baseflow (Discharge in cubic feet per second (cfs))*

a. Identify the starting edge as either left edge of water (LEW) or right edge of water (REW) when facing downstream. The edge of the water doesn't need to start at zero on the tagline.



b. **Turn on the portable flow meter and position yourself at Station 1 on your tagline Refer to the "Station Worksheet" if necessary. You should be in the stream at this time facing upstream with the tagline in front of you.**

Power On/Off

Previous Menu: Moves to the previous screen.

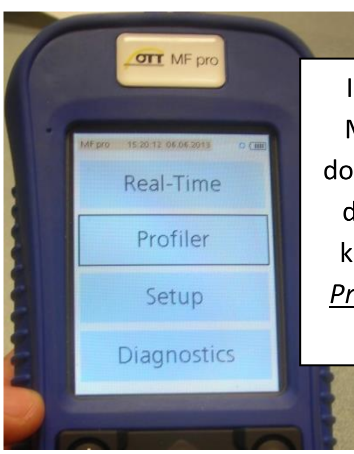
Backspace: Moves the curser back one space.

Quick Jump: Don't worry about this button. Refer to the manual if you want to know more.

Main Menu: Takes you back to the main menu from any screen.

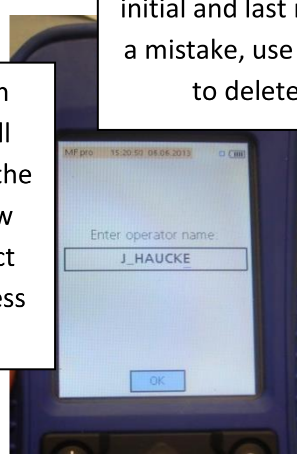
Underscore or Decimal

Turn on the OTT MF Pro by pressing the power button. Press the OK button.

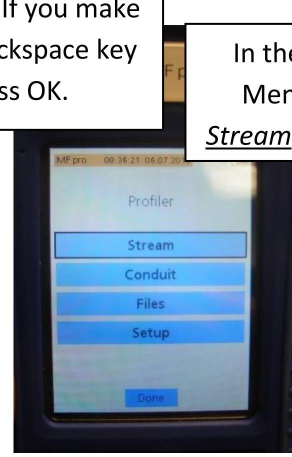


In the Main Menu scroll down using the down arrow key to select *Profiler*. Press OK.

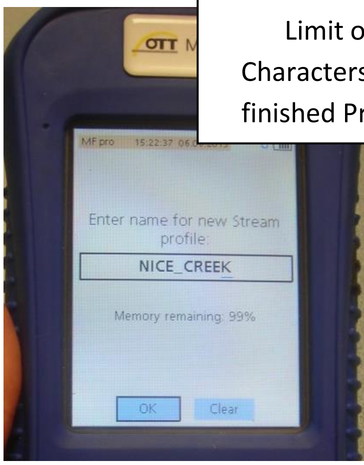
Use the number/letter and underscore key to enter your first initial and last name. If you make a mistake, use the backspace key to delete it. Press OK.



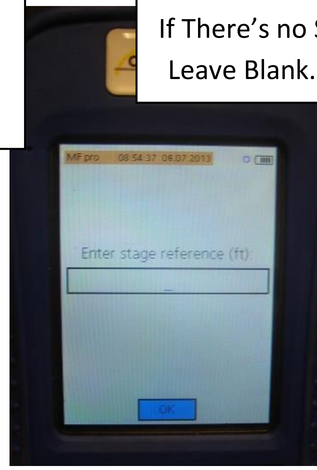
In the Profiler Menu select *Stream*. Press OK.



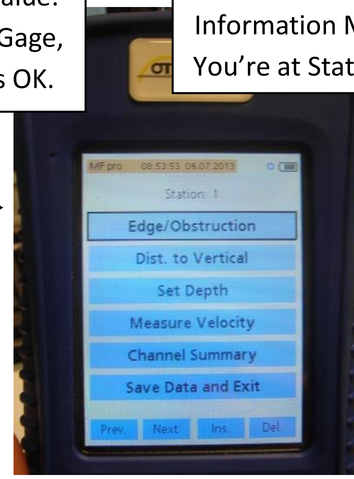
If your screen goes to sleep at any time (by getting dim or going black), push any button to restore your session. After 30 minutes in sleep mode the meter power goes off.



Enter Stream Name: Limit of 11 Characters. When finished Press OK.

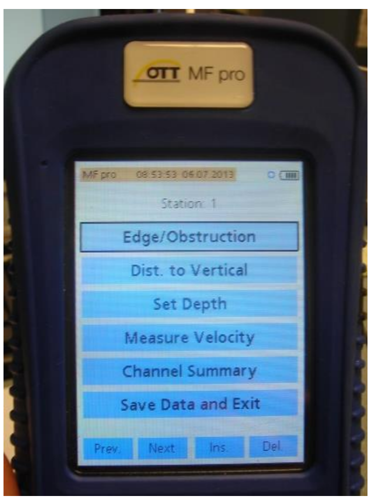


Enter Staff Gage Value: If There's no Staff Gage, Leave Blank. Press OK.

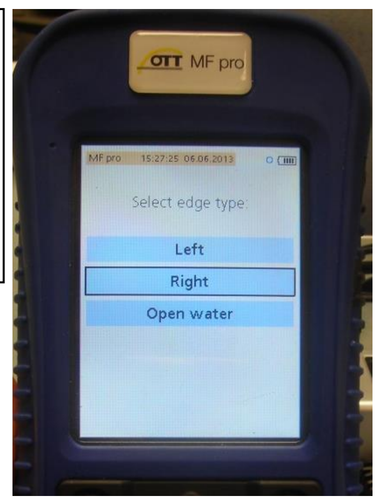


Station Information Menu: You're at Station 1!

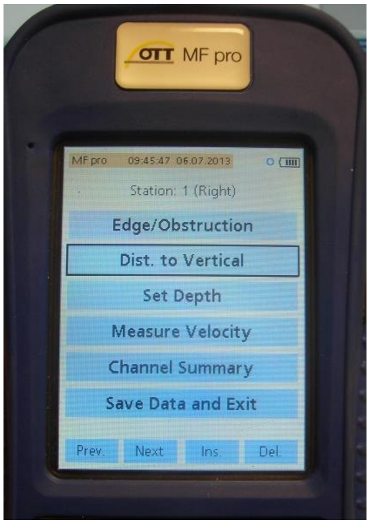
c. Enter Station 1 edge of water Information. The first and last stations will be the edges of water and will have no velocity measurement.



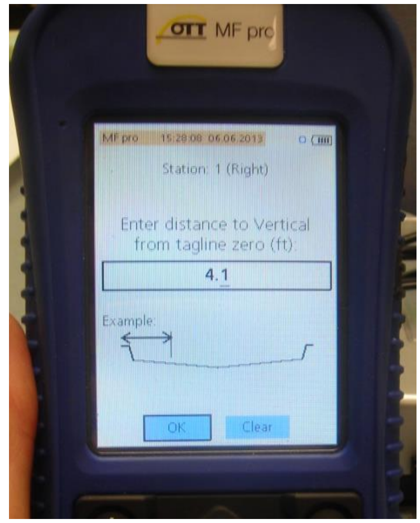
Select *Edge/Obstruction*. Press OK. Then choose the side of the stream you have decided to start your measurements at. Press the OK button.

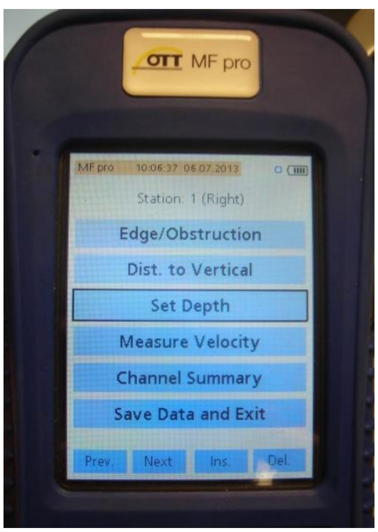


Remember the LEW (Left Edge of Water) and REW (Right Edge of Water) are identified when facing downstream.

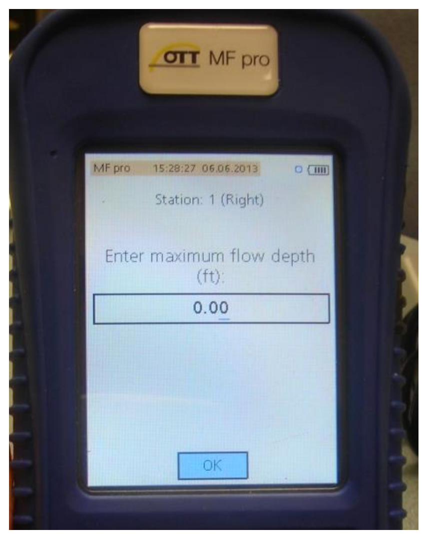


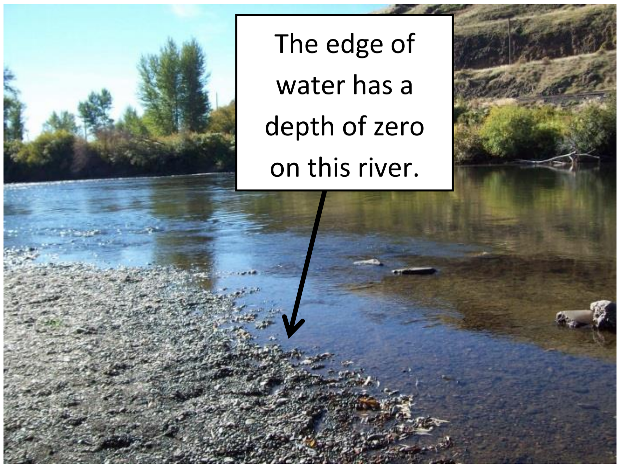
Back at the station information menu scroll down and select _**Dist. To Vertical**_. Press OK. Enter the location on your tape measure where the edge of the water occurs using the number and decimal keys. Press OK.

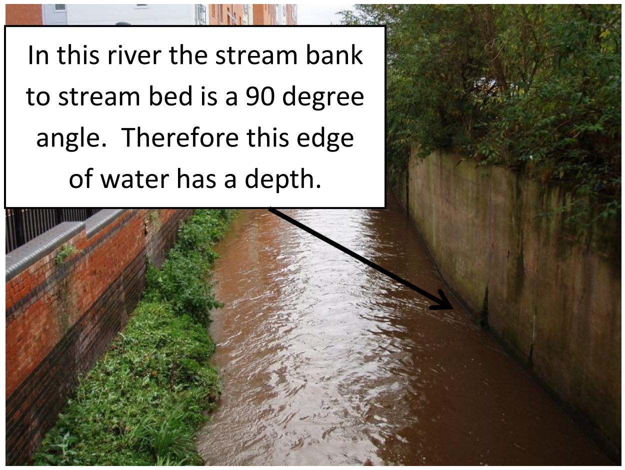




Back at the station information menu scroll down and select _Set Depth_. The default for an edge of water depth is zero. If your edge is a 90 degree angle from the stream bank to the stream bed you should enter a depth. Otherwise leave the depth at zero. Press OK



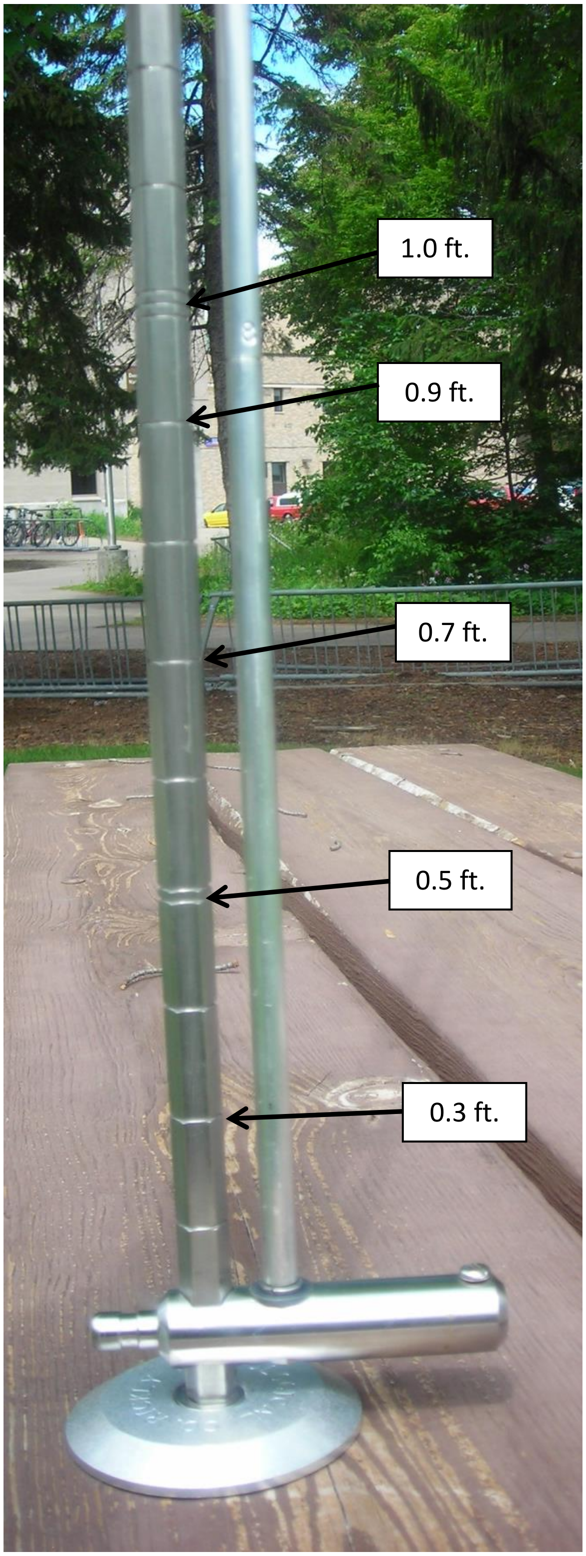


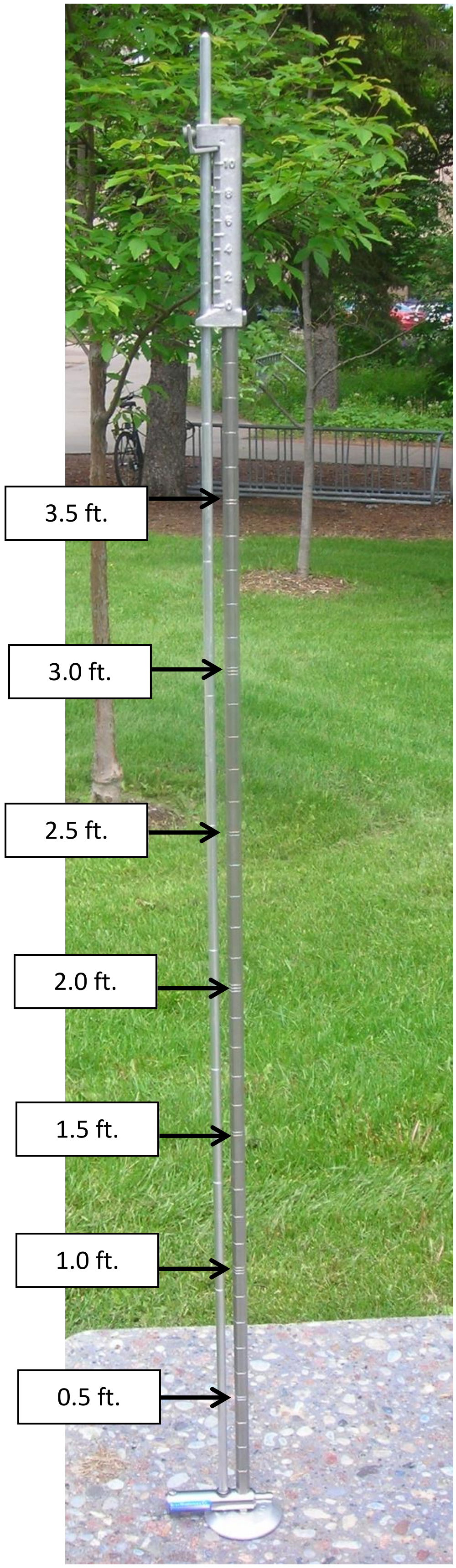


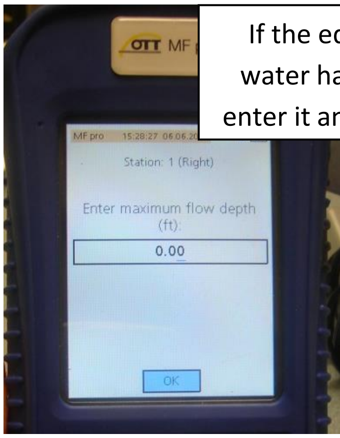
d. If the depth at the edge of the water is NOT zero, measure a depth using the wading rod by placing the wading rod against the side of the bank and reading the mark at the water surface.

- The wading rod comes with 2 parts; a thicker and thinner rod. The thicker rod is used to measure the depth of water and is marked in 0.10 foot increments along the rod. It is appropriate to further estimate depth to the 0.02 ft. or 0.05 ft. increment level, despite the wading rod not being marked to this level. Example is shown on the next page.

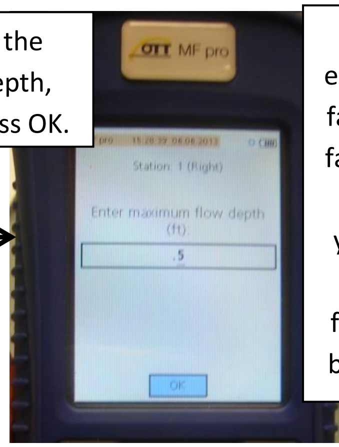
1 line represents 0.10 foot increments,
2 lines represent 0.50 foot increments, and
3 lines represent 1.0 foot increments.



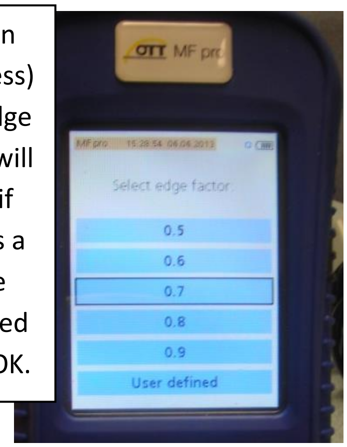




If the edge of the water has a depth, enter it and press OK.

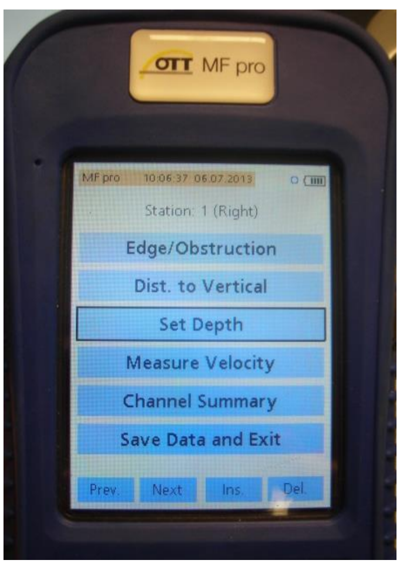


Next select an edge (roughness) factor. The edge factor screen will only pop up if your edge has a depth. Edge factor is defined below. Press OK.



-The edge or roughness factor can vary between 0.50 (very rough) and 1.00 (smooth). Choose one that most closely represents the edge of the stream. The roughness factor is relevant only for the edge of water that is right angled. It is used as a factor in the calculation of the discharge proportion of edge areas. For example:

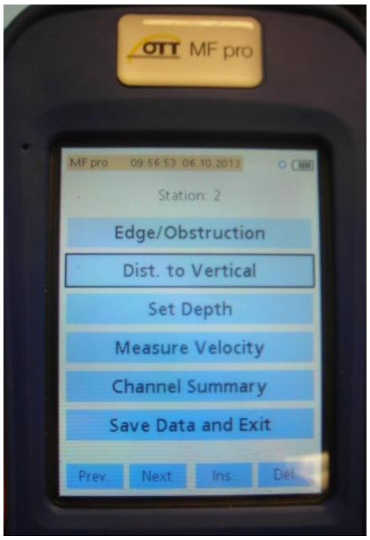
- Smooth edge with no vegetation (e.g., concrete, steel, cement) – 0.8 to 0.9
- Brick sides with vegetation– 0.7
- Rough walls or stream bank with heavy vegetation–0.6 to 0.5



After selecting and edge factor, you will return to the station information menu. The first station is complete. Scroll down and over and select *__Next__*. Press OK.

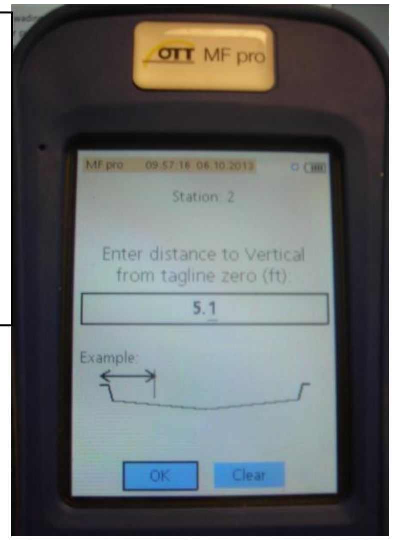
e. **Now move across the cross section and position yourself at station 2. Station 2 will be the first station with a velocity measurement. Station 2 will be located at a point on the tagline you established earlier. Refer to your "Station Worksheet" if necessary.**

f. **Enter station 2 information. Repeat the procedure for entering station 2 information for the rest of the stations across the stream until you get to the other edge of water. Then repeat the procedure described above (c. and d.) for the other edge of the water.**



After selecting *Next*, *Dist. To Vertical* should be highlighted. Select *Dist. To Vertical*. Press OK.

→



Enter the location on your tagline (tape measure) where station 2 occurs. Press OK.

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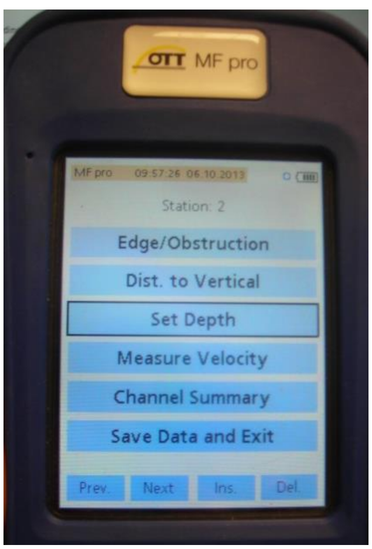
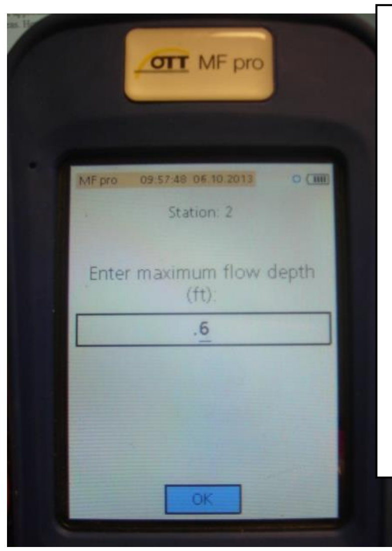


Back at the station information menu, scroll down and select *Set Depth*. Press OK.

→

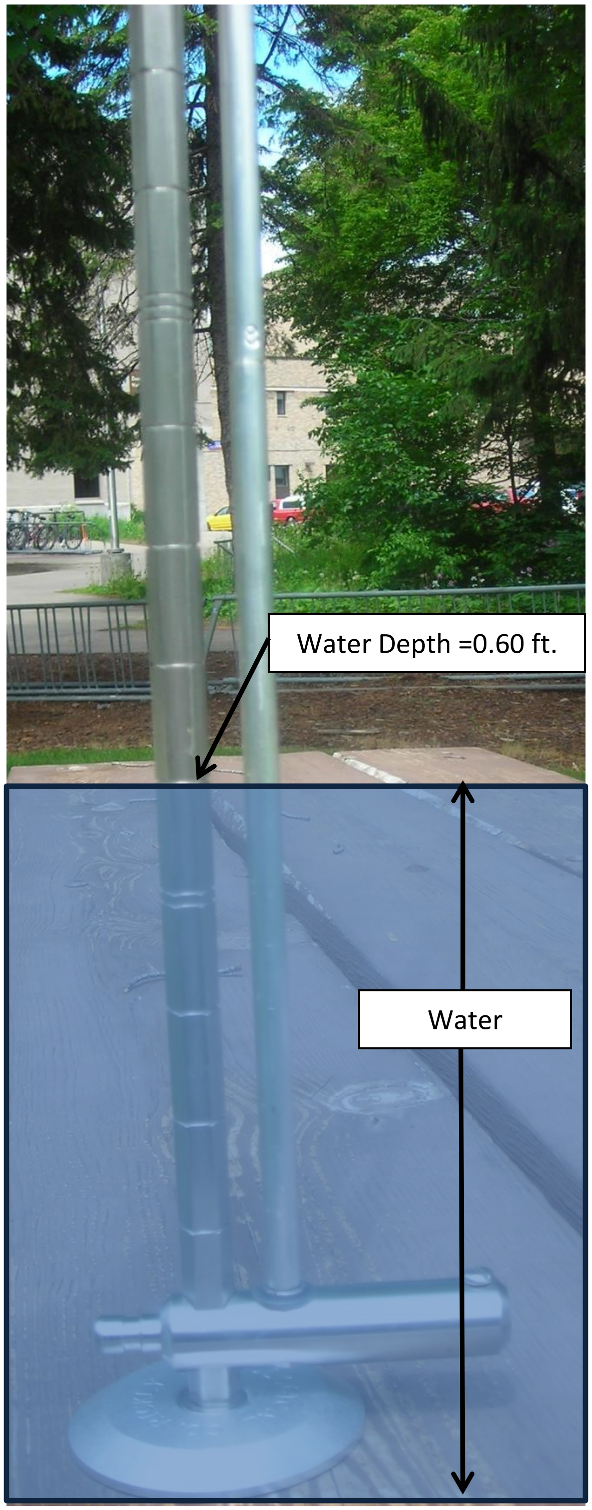


Enter the water depth by reading the wading rod at the water surface. Set the flow meter sensor on the wading rod to the proper depth. That procedure is described below.

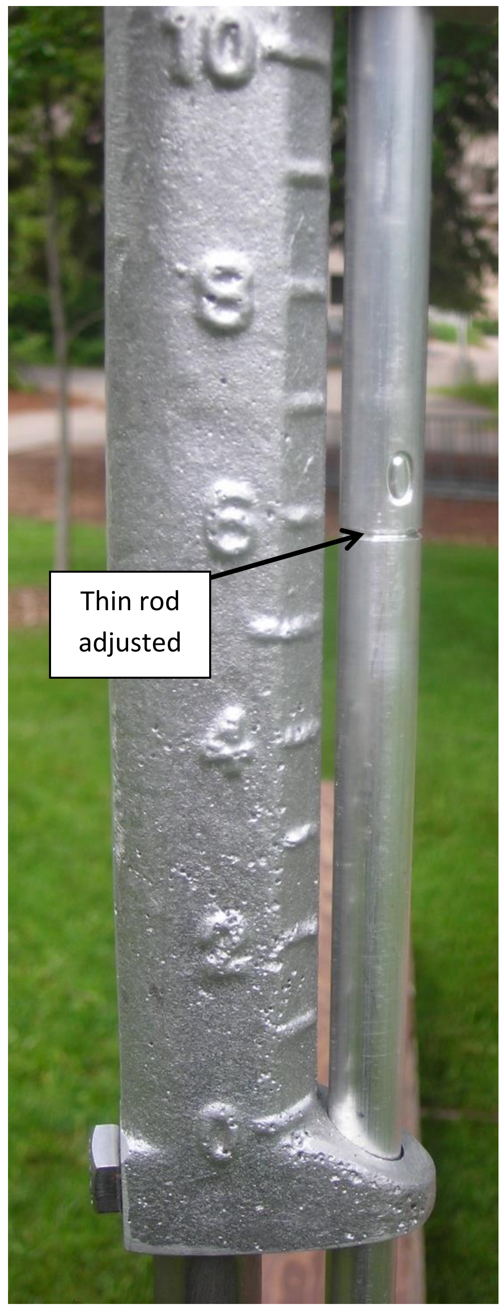
↓

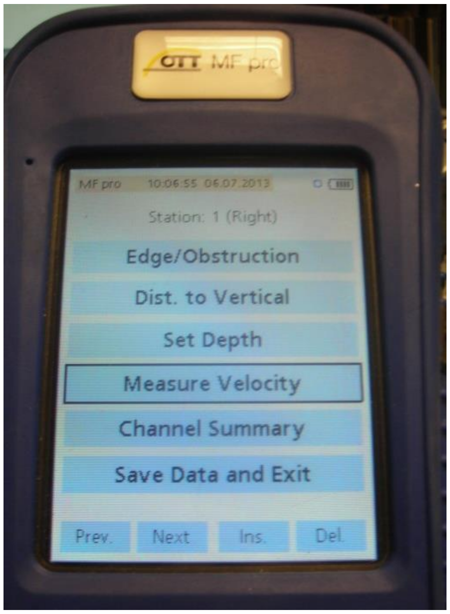
After entering the water depth and adjusting the flow meter sensor on the wading rod, press OK and you will return to the station information menu.

- To correctly set the flow meter sensor height on the wading rod, determine the water depth on the thicker part of the rod and adjust the thinner rod to the proper height. Example below.

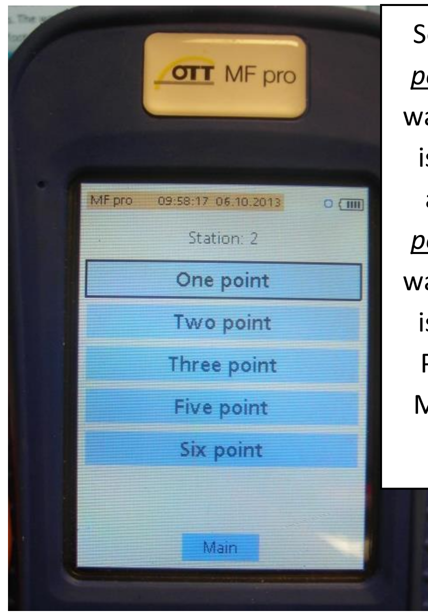


In this example the water depth is 0.60 ft. To adjust the thinner rod, line up the 0 with the 6. This represents 0.60 ft. If the water depth was 1.6 ft., line up the 1 on the thinner rod to the 6 on the thicker rod.





Back at the station information menu, scroll down and select *__Measure Velocity__*. Press OK.

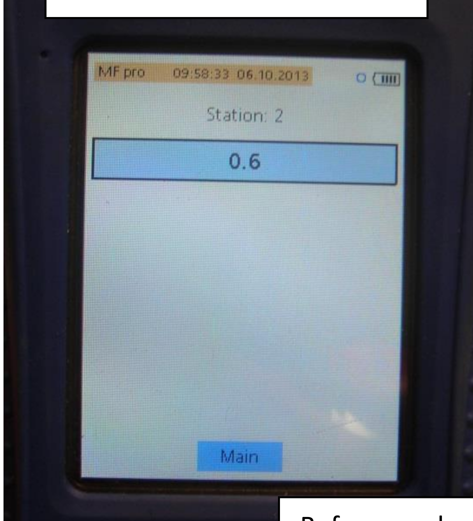


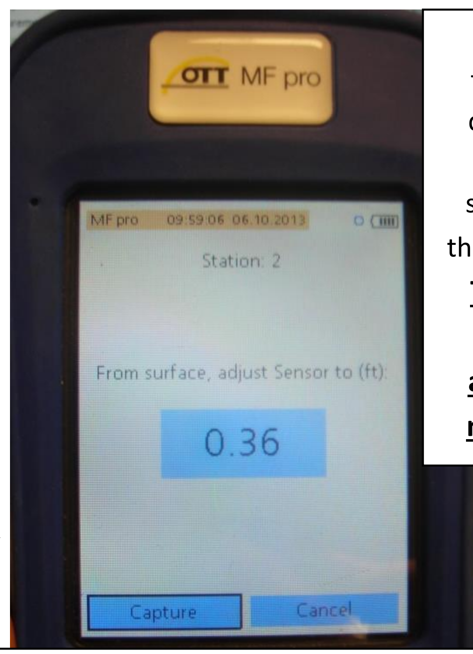
Select *__One point__* if the water depth is ≤ 2.5 ft. and *__Two point__* if the water depth is ≥ 2.5 ft. Press OK. More info. below.

__Depths of ≤ 2.5 feet (*One point*)__

When water depth is ≤ 2.5 feet, velocity is measured at 0.6 of the depth below the water's surface at each station, referred to as the 0.6-depth method (Rantz et al., 1982). A standard wading rod will automatically adjust the flow meter sensor to the proper depth when it is set as shown above.

This screen is telling you that you chose the 0.6-depth method. Press OK.

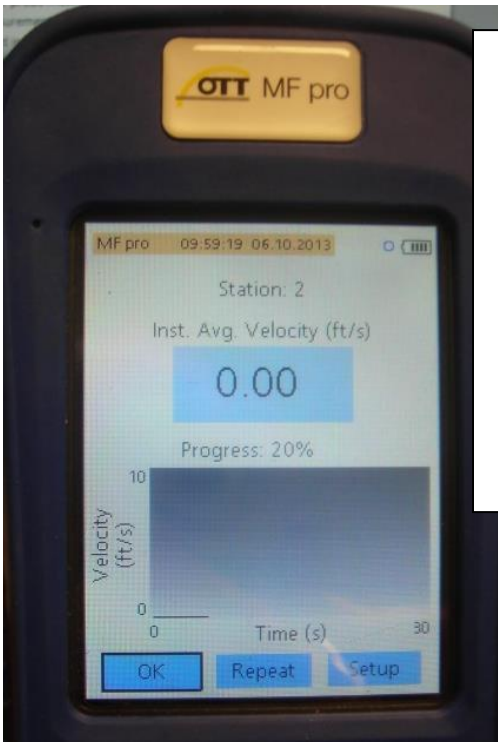




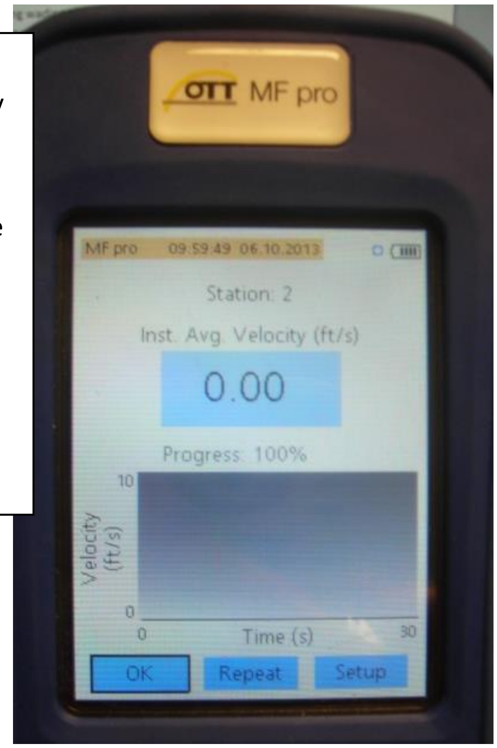
This screen is telling you the depth the flow meter sensor should be from the water surface. **__The sensor is already adjusted. Do nothing here.__**

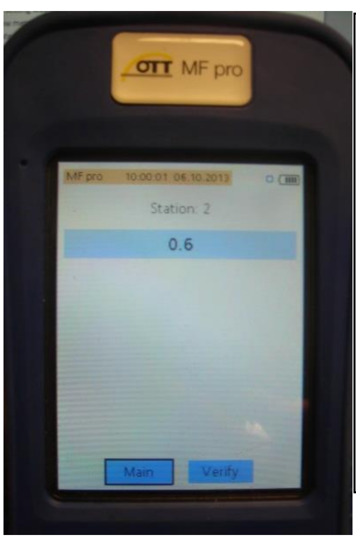
Before you begin the velocity measurement, make sure you're facing upstream, the wading rod is at the proper location on the tagline, the flow meter sensor is parallel to flow, and you're holding the wading rod at arm's length. Press OK to begin the velocity measurement (*__Capture__*).

- While the flow meter sensor is taking the velocity measurement, the wading rod should be held perpendicular to the water's surface and the sensor should be parallel to the stream flow. The individual making the measurements should be at least 1.5 feet away from the sensor and should be as still as possible so no turbulence is created.

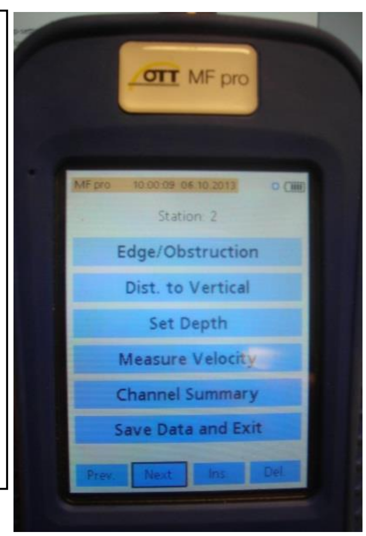


After *Capture* is selected, the velocity measurement will begin. The measurement will be taken over a 30 second time period. When progress is 100% the measurement is complete. Press OK.





After the velocity measurement is complete there will be a check mark next to 0.6 (not shown in photo). You can choose to *Verify* the measurement or return to the station information menu by selecting *Main*. Select *Main*. Press OK. At the station information menu *Next* should be highlighted. If not, select *Next*, press OK, and move to station 3. Repeat the procedure given above.

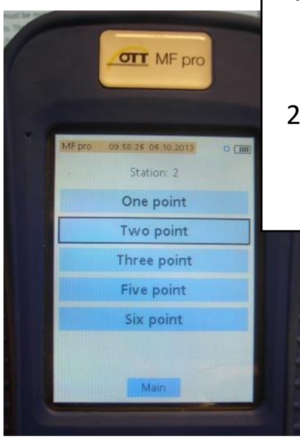


*By selecting *Verify*, you can see the average velocity reading for the station. If you select *Verify*, press OK to get back to the previous screen.*

- <u>Depths of ≥ 2.5 feet (*Two point*)</u>

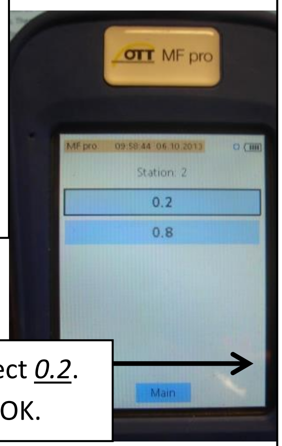
When water depth is ≥ 2.5 feet two velocity measurements are made at the station. Velocity is measured at 0.2 and 0.8 of the total depth below the water's surface at each station, referred to as the two-point method (Rantz et al., 1982).

For example, if the stream depth is 3 feet at a particular station, to set the rod at the 0.2-depth, position the top setting rod at ***half*** the water depth. Line up the 1 on the thin rod to the 5 on the thick rod (this represents 1.5 ft.). To set the rod at the 0.8-depth, position the setting rod at ***twice*** the water depth, so line up the 6 on the thin rod to the 0 on the thick rod (this represents 6.0 ft.).

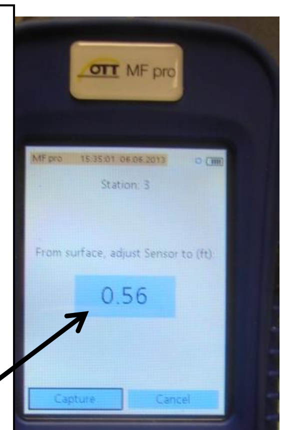


When water depth at a station is ≥ 2.5 ft., Select <u>*Two point*</u>. Press OK.

First select <u>*0.2*</u>. Press OK.

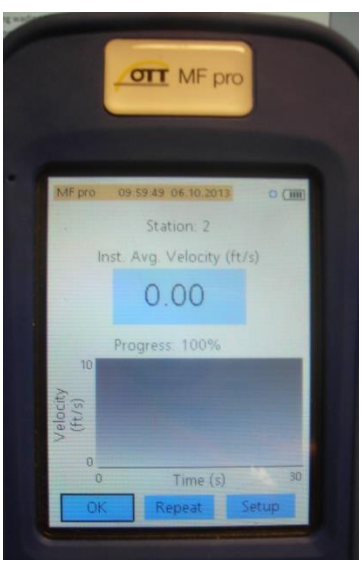


Then adjust the wading rod to ½ the water depth. **<u>Adjust the wading rod according to depth NOT according to the number shown.</u>**

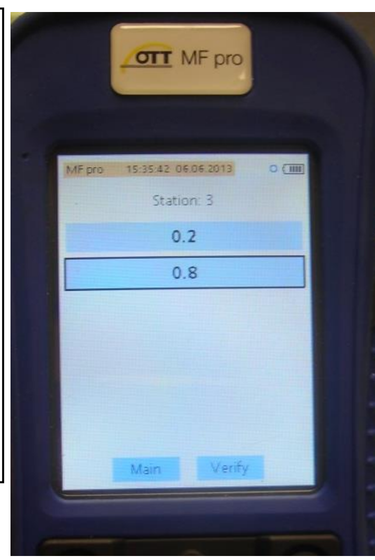


Press OK to start velocity measurement (<u>*capture*</u>).

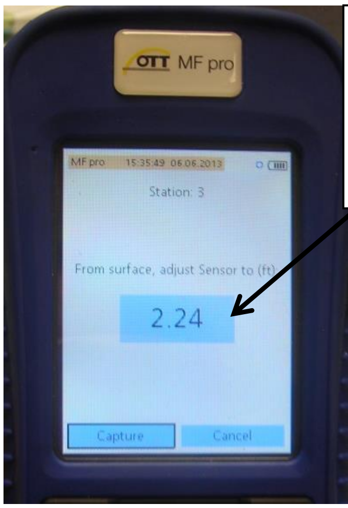
Before you begin the velocity measurement, make sure you're facing upstream, the wading rod is at the proper location on the tagline, the flow meter sensor is parallel to flow, and you're holding the wading rod at arm's length.



When the velocity measurement is 100% press OK. There will be a check mark next to <u>*0.2*</u> (not shown in photo) and <u>*0.8*</u> will be highlighted.

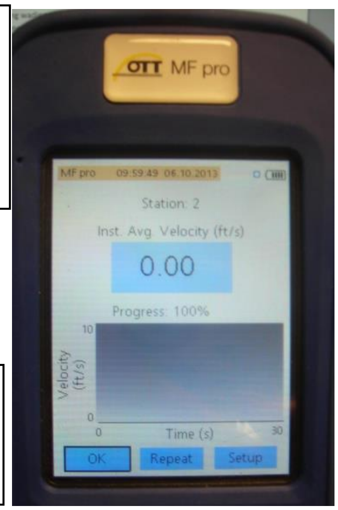


Adjust the wading rod to 2x the water depth and press OK.



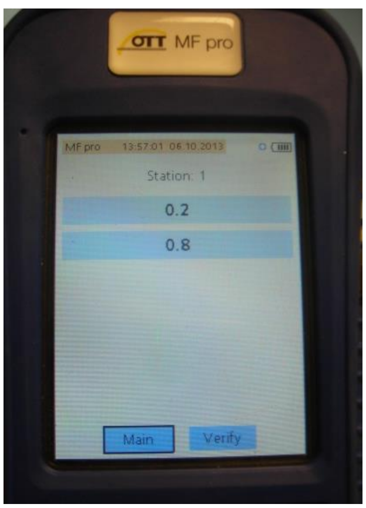
<u>Adjust the wading rod according to depth NOT according to the number shown.</u>

Press OK (*<u>Capture</u>*) to start the velocity measurement.

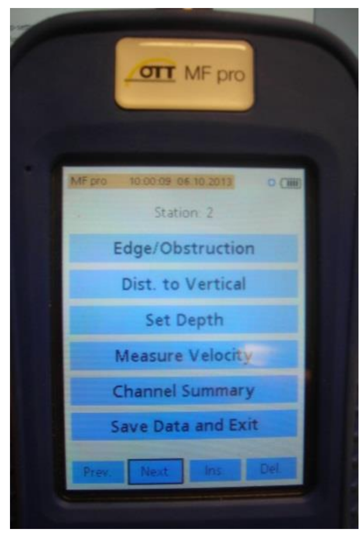


When the velocity measurement is 100%, select OK.

Before you begin the velocity measurement, make sure you're facing upstream, the wading rod is at the proper location on the tagline, the flow meter sensor is parallel to flow, and you're holding the wading rod at arm's length.



There will be a check mark next to *<u>0.2 and 0.8</u>* (not shown in photo). You can choose to *<u>Verify</u>* the measurement or return to the station information menu by selecting *<u>Main</u>*. Select *<u>Main</u>*. Press OK. Select *<u>Next</u>* to move to the next station. Repeat procedures from above.

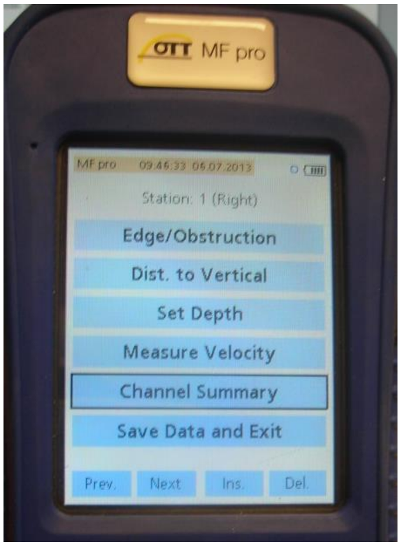


*By selecting *<u>Verify</u>*, you can see the average velocity reading for the station. If you select *<u>Verify</u>*, press OK to get back to the previous screen.*

g. Use procedures e. and f. and your "Station Worksheet" (if necessary) to complete the rest of the stations across the cross section.

h. Use procedures c. and d. to complete the final edge of water station on the other side of the stream.

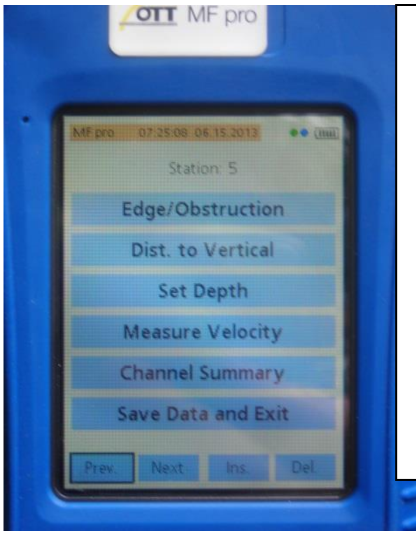
i. **View *Channel Summary* in the station information menu to make sure all stations have less than 10% discharge. If not, determine which station contains more than 10% discharge, and add an extra station by pushing the *Prev.* (Previous) button until the desired station is located and the *Ins* (Insert) button to add another station. Use procedures e. and f. when adding an extra station.**



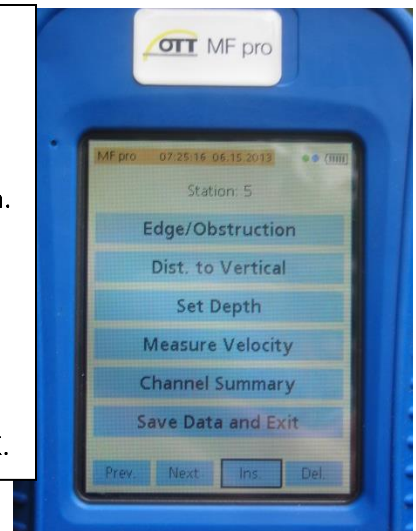
In the station information menu, scroll to and select *Channel Summary*. Press OK. The 1st screen will give you the depth at each of the stations on your cross section. Examine the depths for any problems. Select *Cont.*. Press OK

The next screen will show you the velocities at each station. Examine for error. Select *Cont.* Press OK. The last screen in the *Channel Summary* shows you the % of total discharge at each station. On that screen, the bars marked in red indicate greater than 10 % of the total discharge. There are 5 Stations over 10%.

You can and should go back to the stations with greater than 10% discharge and make the station widths smaller. To figure out what station to begin at, count the number of bars on the chart till you get to the red bar and add 1 (for the edge where no velocity was taken). In this example the 4th bar is red so you would return to station 5. Press OK.

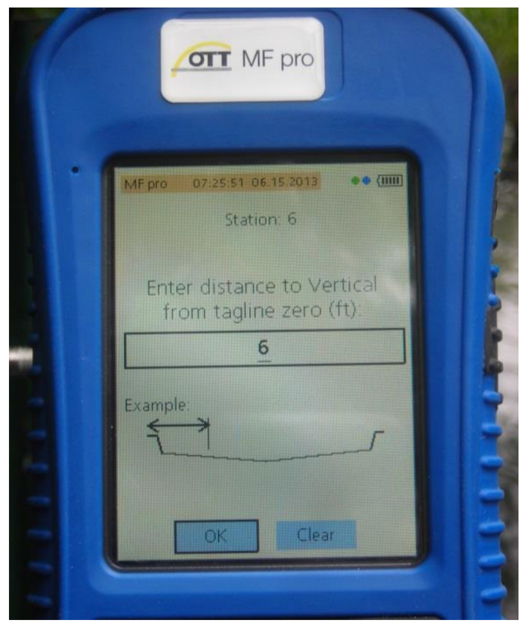


In the station information menu scroll down and select *__Prev.__* Press OK. Continue to Select *__Prev.__* until you arrive at station 5. Station #'s are located at the top of the screen. You can check were Station 5 is located on the tagline by scrolling up and selecting *__Dist. to Vertical__*. Press Ok. Once you know where station 5 is located press OK and scroll down and press *__Ins.__* Press OK.



In my example, Station 5 is located at 5.50 ft. on my tagline. My stations are 1 ft. apart and there were 5 stations with greater than 10% discharge located at 5.50, 6.50, 7.50, 8.50 and 9.50 ft. I will need to put station in between (I'm going to decrease my station width by half). So I will insert stations at 6.00, 7.00, 8.00, and 9.00 ft.

After you select *__Ins__*. and press OK you will be at the station information menu with station 6 at the top of the screen. Make sure you are at 6.00 ft. on the tagline. You enter station data as you have for other stations on your cross section (refer to procedures e. and f. Shown to the right is the distance to vertical for the 1st station I'm going to insert.

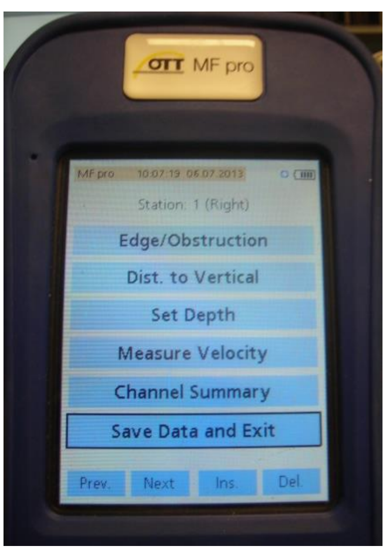


- When you finish the velocity measure for your new station 6, you will scroll down the station information menu and select *__Next__*. The next station in this example will be located at 6.50 ft. (check Dist. to Vertical to make sure). Again you will scroll down and choose Ins. and create the next new station at 7.00 ft. **Always insert a new station in chronological order.** So don't insert a new station that you want at 7.00 ft. when you are at your previously created station of 7.50 ft.

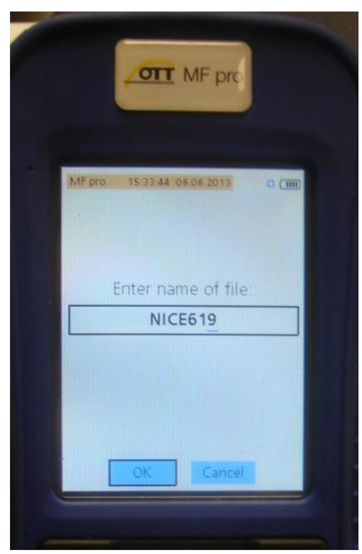
After you have added all the extra stations you need, scroll down to the *Channel Summary* in the station information menu, press OK and examine the depth, velocity, and % Discharge screens again. Shown to the right is the % Discharge screen after I added 4 new stations at 6.00, 7.00, 8.00, and 9.00 ft. Press Ok. Notice no red.

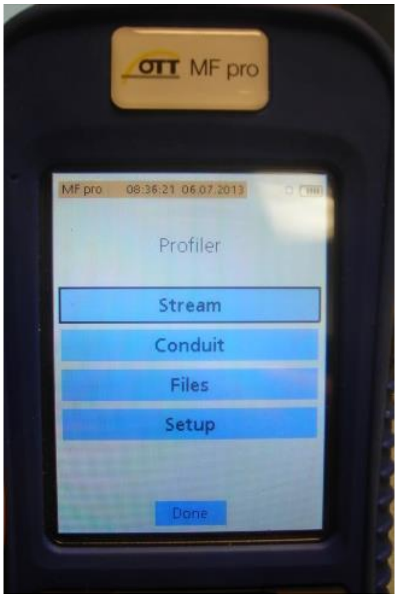
5. Save and Record the Data

a. After the channel summary has been examined and it has been determined that all stations have less than 10% discharge, the cross section and discharge data can be saved.

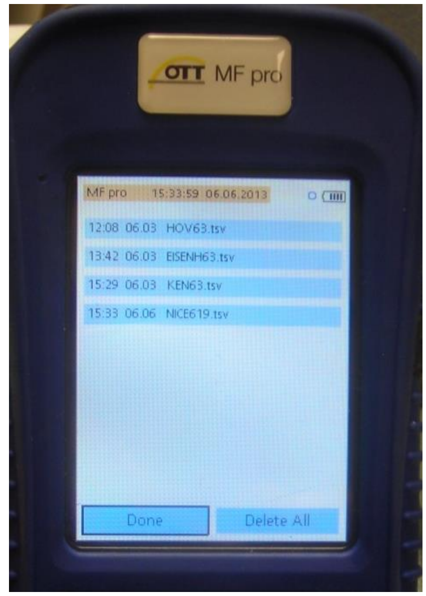


In the station information menu, scroll down and select *Save Data and Exit*. Press Ok. Enter a file name which should include a short version of the stream name and the month and day. Press OK.

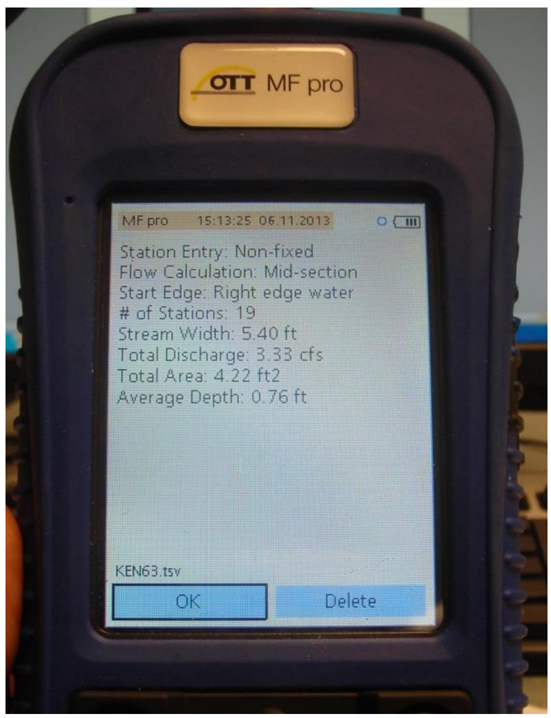




After saving the stream file you will be at the Profiler menu. Scroll down and select ***Files***. Press OK. A list of files will be visible. Scroll up to the file you just saved and press OK.



Examine the data and record it on the data sheets provided (the Citizen Monitoring Worksheet, Baseflow Measurement Notes). When you are done writing down the data. Press Ok.



You will return to the list of saved files. Scroll down and select ***Done***. Press OK. This will return you to the Profiler menu. You can now turn off the flow meter by pressing the power button, scrolling over and selecting ***Yes***. Press OK.

b. If something doesn't look correct, for example if the flow meters says the stream width is 2.20 ft. and you know your stream's width was 5.40 ft., you can press Ok, select *Stream* in the profiler menu and press Ok. When you see your stream name press ok again, and you'll be back at the station information menu where you can select *Prev.* or *Next* and check station information. You can even retake a velocity measurement and resave the file under the same name. It will ask you if you want to replace the file and if you had made some corrections you would select *Yes* and press OK. Once the machine is off you *cannot* make changes to the file.

Methods Quick Guide

1. **Select a Cross section**

    a. The quality of the flow measurement is dependent on the correct selection of a cross section. The site lies within a straight reach of stream. Avoid sites directly below sharp bends. The following site characteristics are important for cross section selection.
        - The flow directions at each measurement point across the stream are parallel to the bank and perpendicular to the cross section.
        - Flow is relatively uniform and free from eddies, slack water and excessive turbulence.
        - The streambed is stable and free of large rocks, weeds and protruding obstructions, manmade or natural, that cause turbulence.
        - A minimum depth of >0.2 ft. is required to keep water above the flow meter sensor.

    b. It is often not possible to completely satisfy all of the recommended conditions. Use the criteria to select the best possible section of stream and then to select a cross section.

    c. After you select the best location for a cross section set up the tagline directly above the cross section by stretching the tape measure across the stream.

    d. Determine the approximate width of the stream from the edge of the water on one bank to the edge of the water on the other bank. All measurements will be reported in tenths of a foot. Inches won't be used.

    e. Divide the stream into stations or subsections based on the width of the stream.

    f. Stations can be uniformly spaced across the tagline or unevenly spaced.

2. **Assemble the OTT MF pro Flow Meter**

    a. Attach the adjustable portable meter mount to the portable meter by screwing the portable meter mount to the back of the portable meter.
    b. Attach the flow meter sensor to the bottom of the wading rod by fitting the flow meter sensor onto the sensor mount and tightening the screw.
    c. Attach the portable meter with mount onto the wading rod by tightening the clamp on the portable meter mount below the 0 near the top of the wading rod.

3. Measuring Velocity and Calculating Baseflow (Discharge in cubic feet per second)

a. Identify the starting edge as either left edge of water (LEW) or right edge of water (REW) when facing downstream. The edge of the water doesn't need to start at zero on the tagline.

b. Turn on the portable flow meter and position yourself at Station 1. You should be in the stream at this time facing upstream with the tagline in front of you.

c. Enter Station 1 edge of water Information (Distance to Vertical and Depth if it's not zero). The first and last stations will be the edges of water and will have no velocity measurement.

d. If the depth at the edge of the water is NOT zero, measure a depth using the wading rod by placing the wading rod against the side of the bank and reading the mark at the water surface.

e. Now move across the cross section and position yourself at station 2. Station 2 will be the first station with a velocity measurement. Station 2 will be located at a point on the tagline you established earlier.

f. Enter station 2 information. Repeat the procedure for entering station 2 information for the rest of the stations across the stream until you get to the other edge of water.

g. Complete the information for the final edge of water station on the other side of the stream.

h. View Channel Summary in the station information menu to make sure all stations have less than 10% discharge. If not, determine which station contains more than 10% discharge, and add an extra station.

4. Save and Record the Data

a. After the channel summary has been examined and it has been determined that all stations have less than 10% discharge, the cross section information and discharge data can be saved.

b. Record the data shown in the stream file on the form provided. Turn the forms into your County Conservation Representative.

c. If something on the recorded data file doesn't look correct go back to the station information menu and make the corrections. Re-save the file under the same name. Once the machine is off you *cannot* make changes to the file.

References

Information, procedures, and references gathered from sources below.

DNR, 2010. University of Wisconsin. DNR PUB WT-755. This publication is part of a seven-series set, "Water Action Volunteers- Volunteer Monitoring Factsheet Series" and is available from the Water Action Volunteers Coordinator at 608/264-8948.

Kentucky Energy and Environment Cabinet. 2010. Standard Operating Procedure. Measuring Discharge. Department for Environmental Protection Division of Water. http://water.ky.gov/permitting/documents/streamdischarge_rev1.pdf

Kraft, G.J. and D.J. Mechenich, 2010. Groundwater Pumping Effects on Groundwater Levels, Lake Levels, and Streamflow in the Wisconsin Central Sands. A Report to the Wisconsin Department of Natural Resources. Center for Watershed Science and Education, University of Wisconsin – Stevens Point/Extension, Project: NMI00000247.

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OTT MF pro, Operating Instructions. 2012. Hach Hydromet , Loveland Colorado. http://www.hachhydromet.com/web/ott_hach.nsf/gfx/A1CD7CCEE69CF45AC1257A7E00645EFA/$file/OTT%20MF%20pro%20Manual.pdf

Rantz, S. E., and others. 1982. Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge. U.S. Geological Survey Water-Supply Paper 2175.

Glossary

Banks: See Stream bank

Baseflow: Sustained low flow of a stream due to groundwater inflow to the stream channel. Often written as a single word.

Bed: See Stream bed

Channel: See Stream channel

Cross-Section: a section of the river when the width and depth are measured to create an image of the river channel. Is used in calculating discharge.

Cubic Feet per Second: A unit of measurement used to express how many cubic feet of water a passing a given point in a second.

Current: The flow of water influenced by gravity as the water moves downhill.

Discharge: Rate of water movement

Downstream: A position of an observer in the water facing the same direction as the water is flowing towards the mouth of the stream or river.

Eddie: The swirling of water in a stream. Often creates a reverse current when the water flows past an obstacle.

Flow: See Stream flow

Flow Meter: An electronic meter that is used to measure the amount of water moving past a given point.

Flow Meter Sensor: The black ball that is attached to the wading rod. The sensor actually measures the flow.

Groundwater: Water occurring in the zone of saturation in an aquifer or soil

LEW: Abbreviation for the Left Edge of the Water in the stream when facing downstream

Perennial Stream: A stream that flows throughout the year

Pool: A quiet slow-moving portion of a stream

REW: Abbreviation for the Right Edge of the Water in the stream when facing downstream
Riffle: The shallow area of a stream where water accelerates and the water surface becomes rippled

Roughness: The roughness of land and stream features. Varies from smooth to rough.

Run: A relatively straight free-flowing stretch of stream.

Runoff: The portion of precipitation, snowmelt, or irrigation that flows over and through the soil, eventually making its way to surface waters.

Station: A given location on the tagline where a flow reading is taken. The number of stations in a stream cross-section is determined by the width of the stream and the amount of flow.

Stream bank: The terrain alongside the bed of a river or stream

Stream bed: The bottom of the stream or river channel. The physical confine of the normal water flow.

Stream channel: The bed and banks of a stream or river that contains a flow of running water.

Stream flow: The rate of water movement in a stream. Often written as two words.

Tagline: The measuring tape stretched across the river that measures stream width and helps to determine where stations are chosen.

Turbulence: Departure in a fluid from a smooth flow. Can often cause eddies.

Upstream: A position of an observer in the water facing into the flow of the water towards the headwaters of the stream or river. The flow will be coming at you.

Velocity: Rate of change of the position of an object, equivalent to a specification of its speed and direction of motion.

Wading Rod: A metal rod with a baseplate that rests on the bottom of the stream channel. The flow meter attaches to the wading rod and the wading rod has demarcations to measure stream depth.

Watershed: Land area that contributes runoff (drains) to a given point in a stream or river. Synonymous with catchment and drainage or river basin.